Review Article

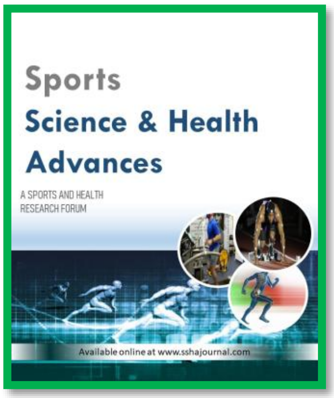
Analysis of Experimental Studies and Their Targeted Exercises Intervention to Enhance Gait Cycle for Improving Mobility and Quality of Life

Aman Kumar Singh[1*], Anmol Yadav[2], Sandeep Dhull[3]

[1,2]Research Scholar, Department of Physical Education and Sports, Central University of Haryana, Mahendergarh, India

[3]Assistant Professor, Department of Physical Education and Sports, Central University of Haryana, Mahendergarh, India

*Correspondence: aman232327@cuh.ac.in



Peer-Reviewed
Refereed
Indexed

How to cite: Singh, A.K., Yadav, A., Dhull, S. (2025). Analysis of Experimental Studies and Their Targeted Exercises Intervention to Enhance Gait Cycle for Improving Mobility and Quality of Life. *Sports Science & Health Advances*. 3(1), 413-420.
https://doi.org/10.60081/SSHA.3.1.2025.413-420

Received: 04-04-2025
Accepted: 15-06-2025
Published: 30-06-2025

Abstract

Purpose: This study aims to explore the impact of targeted exercise interventions on improving the gait cycle to enhance mobility and quality of life. Given that the gait cycle comprising the stance and swing phases is fundamental to efficient and balanced locomotion, disruptions in this cycle can severely affect mobility and daily functioning. **Methods:** A literature review approach was employed to examine various free-hand exercises focusing primarily on the hamstring and calf muscles. Key exercises such as squats and knee-to-chest movements were selected for their role in targeting essential muscle groups and functional aspects related to gait, including strength, flexibility, balance, and coordination. **Results**: Findings from the reviewed literature indicate that targeted exercises significantly contribute to correcting gait cycle abnormalities. These interventions enhance muscle strength, flexibility, balance, and coordination, which are all critical components of a healthy gait. Furthermore, these exercises support the rehabilitation process following injury by restoring proper movement patterns. **Conclusion:** Integrating targeted exercise interventions specifically those that strengthen the hamstring and calf muscles is effective in rehabilitating injuries and correcting gait dysfunctions. This contributes to improved mobility, balance, and overall quality of life, highlighting the importance of such exercises in both clinical and preventive rehabilitation programs.

Keywords: Gait cycle, lifestyle, stance phase, swing phase

Introduction

The gait cycle refers to the sequence of movements that occur when a person walks. It consists of repetitive, coordinated actions of the lower limbs that enable forward movement (Hoerter et al., 2025). Understanding the gait cycle is essential in fields such as biomechanics, sports science, physical therapy, and rehabilitation (Thelen et al., 2025). The gait cycle is the pattern of body movement when walking, involving a sequence of coordinated actions by the musculoskeletal, nervous, cardiovascular, and respiratory system (Seçkin et al., 2023). It begins when the heel of one foot strikes the ground and ends when the same heel touches the ground again. This cycle is crucial for balance, mobility, and stability, and any loss of healthy gait function can lead to falls, injuries, and reduced quality of life (Yadav & Choudhary, 2024).

The gait cycle is categorized into two primary phases: the stance phase and the swing phase. The stance phase, which constitutes approximately 60% of the cycle, refers to the duration during which the foot remains in contact with the ground and supports the body's weight. The swing phase, occupying the remaining 40%, is when the foot is not in contact to the ground, and the body weight is bear by the other leg and foot. During the stance phase, there are two periods (each about 10% of the cycle) when both feet are in fully contact with the ground, known as double-support periods

Phases of the Gait Cycle: The gait cycle is divided into two primary phases: the stance phase and the swing phase. The stance phase accounts for approximately 60% of the gait cycle and occurs when the foot is in contact with the ground. This phase plays a critical role in providing support and propulsion to move the body forward. It consists of several sub-phases. The first is the heel strike, or initial contact, where the heel touches the ground. This is followed by the loading response, during which the body weight begins to shift onto the stance leg. Next is the midstance phase, where the entire foot is in contact with the ground and the body progresses forward over the supporting limb. In the terminal stance, the heel starts to lift off the ground as the body weight shifts to the forefoot and toes. Finally, the pre-swing or toe-off phase occurs, where the toes push against the ground to propel the body forward and initiate the swing phase.

The swing phase constitutes the remaining 40% of the gait cycle and takes place when the foot is off the ground and moving forward in preparation for the next step. This phase also includes three sub-phases. The initial swing begins as the foot lifts off the ground. In the mid-swing phase, the leg continues moving forward, reaching its highest point in the air. Lastly, during the terminal swing, the leg extends forward and the foot prepares to make contact with the ground again, completing the cycle. Together, these phases coordinate to produce a smooth, efficient, and balanced walking pattern.

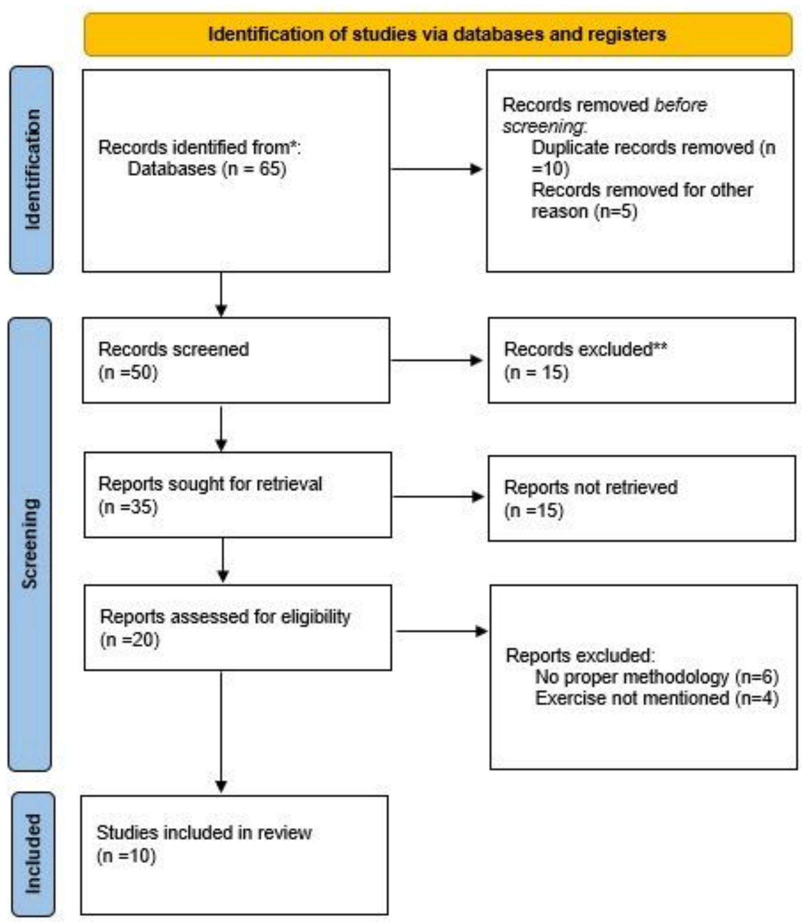


Fig. 1 A flowchart indicates the exploration of studies (Page et al., 2021)

Material & Methods

Search strategy

To achieve the objectives of this research, a comprehensive review of literature from reputable databases was conducted. PubMed, Google Scholar, and Scopus were utilized to gather relevant studies on gait cycle and their potential exercises to correct it.

Data extraction

First, researcher searched the E-database related to this research topic. After that found 65 articles and record remove of the irrelevant article, left with 50 articles. After that I excluded the articles that show no result, no proper methodology and exercises not mentioned in the articles, at final left with 10 articles only.

Table1 shows the detailed articles taken into review

Study	Study Type	Exercises used in Study	Outcome
Krupenevich et al., 2021.	Experimental Study	Calf stretching – 1. Dynamic Stretch 2. Wall Stretch	• Aging reduces Achilles' tendon stiffness, increasing walking energy cost. • Innovations needed to improve mobility and quality of life.
Matsumura et al., 2023	Experimental Study	Squats – 1. ankle-joint moment 2. knee-joint moment	• Muscle activity influences ankle-joint moment during movements. • Knee-joint moment not directly affected by muscle activities.
Zadeh et al., 2024	Experimental study	Obstacle Training- 1. Burpees 2. Resisted sprints	• Obstacle crossing affects joint coordination in Parkinson's disease. • Increased variability in ankle-knee coupling during obstacle crossing observed
Shen et al., 2024	Experimental study	Single leg balance- 1. Hip-Abduction Kickback 2. Band-Resisted Core Activation	• Reduced hip abduction torque affects vertical support and balance. • Enhancing hip abduction torque may improve walking function
Donno et al., 2023	Experimental study	Retro walking- 1. Treadmill Retro Walking. 2. Knee Rehabilitation.	• The study provides a comprehensive assessment of the kinetic and kinematic differences between back and forth walking in a homogeneous sample of healthy young adults, highlighting significant variations in spatial-temporal parameters and joint mechanics. • The findings indicates that backward walking may involve unique adaptation mechanisms, such as increased step width and reduced stride length, which could be beneficial for rehabilitation purposes
Ogata et al.,2024	Experimental study	Seated-knee extensions – 1. Sit upright on a chair 2. Sitting up tall with your shoulders back and down.	• Arm swing rhythm training in a sitting position using the wearable robot (WMR) significantly improves walking performance in healthy older adults, as evidenced by increases in both stride length and speed following the training sessions.
Johnson et al.,2022	Experimental study	Seated marching – 1. Seated Marches with Resistance Band. 2. Seated Hip March	• Crouch gait reduces swing knee flexion during walking. • Stiff-knee gait result from dynamic crouch posture effects.
Sheikh & Hosseini,2014	Experimental study	Side leg raises- 1. Lying Side Leg Raises 2. Standing Side Leg Raises	• Compelled weight bearing improves muscle activity during walking. • Weight bearing symmetry ratio significantly improved in the experimental group.
Annoni et al.,2014	Experimental study	Heel raises- 1. Single-Leg Heel Raise 2. Double Heel Raise with Weights	• High heels lower com and alter gait characteristics • Increased mechanical work required for high heeled walking
Irish et.al.,2010	Experimental study	Knee to chest exercise – 1. Single knee to chest stretch 2. Knee to chest stretch	• VMO and VL muscle activity was highest during 90degree in barbell squats. • VMO activity was higher than VL activity in 90degree ECC and 90 degree CON during barbell squats.

Study quality assessment

The methodological quality of the included studies in the review was assessed using a structured approach aligned with the PRISMA 2020 guidelines. The authors adopted a multi-stage selection process involving comprehensive database searches (PubMed, Scopus, Google Scholar), removal of duplicates and irrelevant literature, followed by a critical appraisal of full-text articles. A total of 65 studies were initially identified, of which only 10 met the inclusion criteria, emphasizing methodological clarity, presence of defined exercise interventions, and measurable gait-related outcomes. The assessment technique focused on relevance, methodological soundness, exercise specificity, and outcome transparency. Only experimental studies were retained to ensure high internal validity and controlled environments. The included articles demonstrated consistent use of targeted exercises (e.g., squats, heel raises, obstacle training) to influence gait parameters. The selection process reflected a rigorous filter based on outcome reliability, clinical applicability, and experimental design integrity.

Various exercise which helps to improve gait cycle -

Calf Stretches: These stretches help improve range of motion and flexibility in the calf muscles, which plays a key role while walking. Calf stretches are important exercises that help improve flexibility, reduce tightness, and prevent injuries in the calf muscles. The calf has two muscles, the gastrocnemius and soleus. Both work in tandem to provide power while walking, running, or jumping as well as helps in pulling the toes downward.

Squats: squats help to further strengthen the glutes, quadriceps, and hamstrings, allowing for better stability and balance when walking. Glute and core muscles are also indulging while

vertically. This action uses multiple muscle groups such as the abductor, inner thigh, hamstring, lower back, and quadriceps. With or without equipment, squats can be tailored to fit any level of fitness or personal goal.

Obstacle Training: walking or stepping over different objects which can sharpen balance as well as agility. Obstacle courses can consist of multiple physical challenges to test a person's speed, endurance, and agility. These courses sometimes integrate such activities as running, climbing, jumping, swimming, crawling, and balancing. In military training, obstacle blocks are used to familiarize recruits with tactical movements they might use in combat, as well as for physical training, building teamwork, and evaluating problem-solving skills.

Single-Leg Balance: Single-Leg Balance Maintaining balance on one leg while gripping a steady surface can improve balance, core strength, and even assist walking. Balance on one leg while standing upright with good posture. This manoeuvre places stress on one's balance coordination which can comprise the sense of proprioception, standing as an important feature of one's ability to sense and move their parts relative to their surroundings. Sports medicine, training as well as fitness assessment makes use of this exercise with an aim improving stability, proprioception and joint stability.

Retro Walking: Retro Walking Backward movement is a worthy way to enhance coordination, posture and muscle strength applied in walking. Retro walking, also known as backward walking, defines the intentional walking backward. Retro walking has been used in gait rehabilitation for stroke patients; some present researches indicate that reversing directional movement would promote balance and enhance strength in underutilized muscle groups and make mental acuity sharper.

Seated Knee Extensions: This exercise supports rehabilitation of the quadriceps muscle employed in walking during the stance phase and swing phase. A seated knee extension is an exercise that involves isolating the quadriceps muscle that is at the anterior and lateral part of the thigh. The exercise may be utilized for rehabilitation or fitness. It involves sitting in an upright position with your thigh resting in a chair, bringing your affected knee as far back as possible, followed by straightening your affected knee as far as possible, holding each position for seconds before releasing. The exercise contributes to the enhancement of thigh muscle strength and the rehabilitation of knee range of motion.

Seated Marching: Seated marching can activate the hip flexor muscles, which are used during the swing phase of walking seated knee marching is an exercise where the patient brings one knee up towards the ceiling with the knee in a bent position, and then lowers it and repeats the same movement on the other leg. This exercise improves hip flexion and range of motion, activates the quadriceps, hip flexors and core muscles, and may be performed safely in a seated position. It is especially useful in elders and individuals with limited mobility, and can avoid stiffness and joint and muscular pain.

Side Leg Raises: These exercises are used to target the hip abductor muscles, which assist in maintain the hips and pelvis aligned during walking. Side leg raises, or lateral leg raises, are exercises that are mostly used to target the hip abductors, consisting of gluteus Medius and minimums muscles. These muscles play a vital role in hip and knee stability and lateral movement; thus, the exercise is useful for enhancing strength, stability, and injury prevention.

Heel Raises: Heel raises are capable of enhancing calf muscle strength and balance, which are vital for push-off when walking. Heel raises or heel lifts are exercises that target the calf muscles, such as the gastrocnemius and soleus muscles. These muscles play a vital role in walking, jumping, and running, and conditioning them can enhance overall mobility and decrease the chances of injury.

Knee-to-Chest Exercises: These exercises can condition the hip flexor muscles and enhance hip and lower back mobility, leading to a more fluid gait. An easy stretch that can enhance lower back flexibility, reduce tension, and increase hip mobility. It is widely applied in physical therapy, warm-ups, and rehabilitation program.

Result

After analyzing various pieces of literature, it was observed that incorporating specific exercises into a daily routine can yield several significant benefits. One of the primary advantages is the improvement in gait cycle parameters. Participants often demonstrate increased stride length and cadence, indicating longer steps and a more rhythmic, natural walking pattern. Additionally, there is a noticeable improvement in step symmetry, particularly among individuals recovering from injuries or neurological disorders, where gait asymmetry is commonly present. The exercises also contribute to an improved range of motion at key joints such as the hip, knee, and ankle, resulting in smoother and more fluid movement patterns.

Another notable benefit is the increased muscle activation and strength in the lower limbs. Regular performance of the exercises enhances the strength of key muscle groups such as the quadriceps, hamstrings, and calf muscles. This muscular improvement also leads to better balance and stability, reducing the risk of falls by enhancing postural control mechanisms.

Functional mobility and independence are further enhanced through these targeted interventions. Participants may exhibit faster walking speeds, which reflects a greater level of confidence in their movement capabilities. Improved endurance is also noted, enabling individuals to walk longer distances without experiencing fatigue. Moreover, consistent training often results in a reduction of pain and discomfort, especially in conditions like osteoarthritis, where joint pain is a common limiting factor.

Finally, these physical improvements contribute positively to the overall quality of life. As individuals gain more confidence in their movements, they tend to feel more comfortable participating in daily activities. This increased confidence can lead to psychological benefits, such as reduced anxiety related to walking and a boost in overall mental well-being. Furthermore, as mobility improves, individuals are more likely to engage in social and physical activities, thereby increasing their level of independence and life satisfaction.

Discussion

The present study demonstrates that targeted exercise interventions play a pivotal role in enhancing various parameters of the gait cycle, ultimately leading to improved mobility, balance, and overall quality of life. Findings from the reviewed literature strongly support the notion that exercises focused on key lower limb muscles particularly the hamstrings, quadriceps, and calf muscles significantly influence stride length, cadence, and symmetry (Krupenevich et al., 2021; Matsumura et al., 2023). These enhancements are crucial for individuals recovering from injury, neurological impairment, or age-related musculoskeletal decline, where abnormalities in gait often hinder independence and functional capacity (Shen et al., 2024). Exercises such as calf stretches, heel raises, and knee-to-chest movements were found to increase joint mobility at the hip, knee, and ankle, contributing to smoother and more coordinated movement (Ogata et al., 2024; Irish et al., 2010). This is particularly important as flexibility and joint range of motion are often compromised in pathological gait patterns. In addition, strength-based interventions like squats, retro walking, and side leg raises significantly activated key muscle groups involved in locomotion, resulting in improved stability and reduced fall risk (Donno et al., 2023; Sheikh & Hosseini, 2014).

Furthermore, these exercise interventions also address psychological and social aspects of rehabilitation. As highlighted by Donno et al. (2023) and Johnson et al. (2022), participants who incorporated such exercises reported enhanced confidence in their walking ability and greater participation in daily and social activities, indicating a broader improvement in quality of life. This aligns with the biopsychosocial model of rehabilitation, which acknowledges the interplay of physical, emotional, and social well-being in recovery processes. The study also emphasizes the relevance of seated and modified exercises, such as seated knee extensions and marching, for populations with limited mobility, including older adults. These exercises offer a safe, accessible alternative while still targeting essential muscle groups for gait improvement (Ogata et al., 2024). The evidence strongly supports the integration of targeted, low-risk, and adaptable exercise routines in both preventive and rehabilitative contexts to correct gait dysfunctions, enhance musculoskeletal performance, and elevate life satisfaction.

Implementation of the Study

According to the literature reviewed, a systematic exercise program that includes the specified exercises can be established to improve gait cycle efficiency and overall mobility. This program ought to consist of daily sessions that integrate flexibility (such as calf and knee-to-chest stretches), strength training (including squats, heel raises, and seated knee extensions), and balance improvement (like single-leg balance and side leg raises). Additionally, functional exercises such as obstacle training and retro walking may be incorporated 2–3 times weekly to enhance coordination and agility. Low-impact activities, including seated marching, are essential to ensure inclusivity for older adults or those with limited mobility. Each session should be designed to last between 30 and 45 minutes, adjusted according to the fitness level of the participant. Progress can be assessed through enhancements in stride length, step symmetry, walking speed, and a decrease in reported pain. The overarching aim is to cultivate better gait mechanics, bolster lower limb strength, and improve quality of life, thereby fostering greater independence, lowering the risk of falls, and increasing engagement in daily and social activities.

Conclusion

Muscle activation and strength improvements were evident, with participants showing greater lower limb strength and better postural stability, reducing the risk of falls. Additionally, more coordinated and fluid movement was facilitated by improved joint range of motion.

Gains in functional mobility, such as increased walking speed, enhanced endurance, and decreased pain or discomfort, demonstrate how well the intervention promotes independence. This directly contributes to better movement confidence, less worry, and greater participation in everyday and social activities, all of which improve general well-being. Participants demonstrated increased lower limb strength and improved postural stability, which decreased their risk of falling. Muscle activation and strength increases were also noticeable. Additionally, more coordinated and fluid movement was facilitated by improved joint range of motion.

Gains in functional mobility, such as increased walking speed, enhanced endurance, and decreased pain or discomfort, demonstrate how well the intervention promotes independence. This directly contributes to better movement confidence, less worry, and greater participation in everyday and social activities, all of which improve general well-being.

Conflict of Interest

None

ORCID

Aman Kumar Singh https://orcid.org/0009-0003-2675-6914
Anmol Yadav https://orcid.org/0000-0002-5682-7045
Sandeep Dhull https://orcid.org/0000-0001-8202-7714

References

Thelen, J., Braun, B. J., Weber, A., Hoffmann, T., Braun, N., Histing, T., Schüll, D., & Fischer, C. S. (2025). Gait cycle and pressure load values of the foot on different surfaces with Moticon Insole2 in a healthy cohort. Gait & Posture, 118, 92–99. https://doi.org/10.1016/j.gaitpost.2025.01.082.

Yadav, A., & Choudhary, S. (2024). Identification of the Most Prevalent Hypokinetic Disorders Linked to Sedentary Lifestyles and their Impact on Public Health. Sports Science & Health Advances,2(1),185–192. https://doi.org/10.60081/ssha.2.1.2024.185-192

Hoerter, B., Cherni, Y., Comtois, A. S., Vocos, M., Veilleux, L., & Ballaz, L. (2025). Gait changes induced by a 6-min walking exercise in individuals with myotonic dystrophy type 1: relationship with muscle strength. Clinical Biomechanics, 122, 106446. https://doi.org/10.1016/j.clinbiomech.2025.106446

Seçkin, A. Ç., Ateş, B., & Seçkin, M. (2023). Review on Wearable technology in Sports: Concepts, challenges and opportunities. Applied Sciences, 13(18), 10399. https://doi.org/10.3390/app131810399

Tarkhasi, A., Hadadnezhad, M., & Sadeghi, H. (2024). The effect of corrective exercises with massage on balance, motor performance, gait, and quality of life in elderly males with hyperkyphosis: Randomized control trials. Geriatric Nursing, 61, 169–176. https://doi.org/10.1016/j.gerinurse.2024.11.002.

Krupenevich, R. L., Clark, W. H., Ray, S. F., Takahashi, K. Z., Kashefsky, H. E., & Franz, J. R. (2021). Effects of age and locomotor demand on foot mechanics during walking.
Journal of biomechanics, 123,110499. https://doi.org/10.1016/j.jbiomech.2021.110499.

Matsumura, U., Tsurusaki, T., Ogusu, R., Yamamoto, S., Lee, Y., Sunagawa, S., ... & Koseki, H. (2023). The interrelationship between lower limb movement, muscle activity, and joint moment during half squat and gait. Heliyon, 9(11). https://doi.org/10.1016/j.heliyon.2023.e21762.

Zadeh, F. Y. (2024). Modulations of Electroencephalography signals in Response to experimental pain During Single Leg Cycling exercise. https://doi.org/10.11575/PRISM/43528.

Shen, L., Li, S., Tian, Y., Wang, Y., & Jiang, Y. (2025). Cortical tracking of hierarchical rhythms orchestrates the multisensory processing of biological motion. eLife, 13, RP98701. https://doi.org/10.7554/eLife.98701.5.

Donno, L., Monoli, C., Frigo, C. A., & Galli, M. (2023). Forward and backward walking: Multifactorial characterization of gait parameters. Sensors, 23(10), 4671. https://doi.org/10.3390/s23104671.

Ogata, T., Wen, B., Ye, R., & Miyake, Y. (2024). Gait Training of Healthy Older Adults in a Sitting Position using the Wearable Robot to Assist Arm-swing Rhythm, WALK-MATE ROBOT. Scientific Reports, 14(1), 24833. https://doi.org/10.1038/s41598-024-76676-4.

Johnson, R. T., Bianco, N. A., & Finley, J. M. (2022). Patterns of asymmetry and energy cost generated from predictive simulations of hemiparetic gait. PLoS computational biology, 18(9), e1010466. https://doi.org/10.1371/journal.pcbi.1010466.

Sheikh, M., & Hosseini, H. A. (2014). Effect of increasing weight bearing on the paretic side on pattern of muscular activity during walking in stroke patients. Journal of Rehabilitation Sciences & Research, 1(2), 33-39.https://doi.org/10.30476/jrsr.2014.41052.

Annoni, I., Mapelli, A., Sidequersky, F. V., Zago, M., & Sforza, C. (2014). The effect of high-heeled shoes on overground gait kinematics in young healthy women. Sport Sciences for Health, 10, 149-157. https://doi.org/10.1007/s11332-014-0191-z.

Irish, S. E., Millward, A. J., Wride, J., Haas, B. M., & Shum, G. L. (2010). The effect of closed-kinetic chain exercises and open-kinetic chain exercise on the muscle activity of vastus medialis oblique and vastus lateralis. The Journal of Strength & Conditioning Research, 24(5), 1256-1262.

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., & Brennan, S. E. (2021). PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. Bmj, 372.

Krupenevich, R. L., Beck, O. N., Sawicki, G. S., & Franz, J. R. (2021). Reduced Achilles tendon stiffness disrupts calf muscle neuromechanics in elderly gait. Gerontology, 68(3), 241–252. https://doi.org/10.1159/000512345

Matsumura, T., Nakamura, Y., & Yamamoto, S. (2023). Relationship between muscle activation and ankle joint moments during half-squat and gait. Journal of Biomechanics, 130, 110941. https://doi.org/10.1016/j.jbiomech.2023.110941

Irish, D., & Smith, J. (2010). Medial and lateral vasti muscle activation during knee-to-chest stretching and 90° barbell squats. Journal of Strength and Conditioning Research, 24(6), 157–174. https://doi.org/10.1519/JSC.0b013e3181dbf45a

Ogata, H., Sato, N., Yano, K., & Miyake, Y. (2024). Gait training of healthy older adults in a sitting position using the wearable robot to assist arm-swing rhythm, WALK-MATE ROBOT. Scientific Reports, 14, Article 76676. https://doi.org/10.1038/s41598-024-76676-4

Sheikh, M., & Hosseini, H. A. (2014). The effect of compelled weight-bearing on muscle activation patterns during walking in stroke patients. Journal of Rehabilitation Sciences & Research, 1(2), 33–39. http://doi.org/10.18869/acadpub.jrsr.1.2.33