



Systematic Review

Knee Osteoarthritis: A Systematic Review on Different Exercise Therapy Interventions on Knee Adduction Movement

Muhammada Mahnoor¹, Muhammad Waseem Akhtar¹, Quratulain Maqsood², Aleena Sumrin², Muhammad Mahmood Alam¹, Danish Hassan³, Muhammad Ramzan¹ and Wajeeha Zia^{3*}

¹Department of Rehabilitation Sciences, Akhtar Saeed Medical and Dental College, Lahore, Pakistan

²Department of Centre for Applied Molecular Biology, University of the Punjab, Lahore, Pakistan

³Riphah College of Rehabilitation and Allied health sciences, Riphah International University, Lahore, Pakistan

ARTICLE INFO

Key Words:

Alignment, Exercise Interventions, Knee Osteoarthritis, Knee Adduction Movement

How to Cite:

Mahnoor, M., Waseem Akhtar, M. ., Maqsood, Q. ., Saeed, A. ., Alam Durrani, M. ., Hassan, D. ., Ramzan, M. ., & Zia, W. (2022). Knee osteoarthritis: A systematic Review on different Exercise therapy Interventions on K.A.M: Different Exercise Therapy Interventions on K.A.M. Pakistan BioMedical Journal, 5(5). https://doi.org/10.54393/pbmj.v5i5.416

*Corresponding Author:

Wajeeha Zia,
Riphah College of Rehabilitation and Allied health sciences, Riphah International University, Lahore, Pakistan

Received Date: 6th May, 2022

Acceptance Date: 26th May, 2022

Published Date: 31st May, 2022

ABSTRACT

Exercise therapy can be part of a conservative treatment plan for knee osteoarthritis. Knee adduction moments (KAMs) are thought to be reduced with exercise therapy. A large study looked at exercise therapy's effect on KAM and other physical factors in persons with knee osteoarthritis. **Methods:** Searches were performed on the following electronic databases: MEDLINE, Google Scholar, Cochrane Central, EMBASE, and OpenGrey. Study participants with knee osteoarthritis undergoing structured exercise therapy were randomized controlled trials. For every study, we conducted independent analyses to extract data and analyze the bias risks. We calculated the mean differences and 95% confidence intervals for each outcome. **Results:** In the three studies that involved 233 participants, there were no significant differences in KAMs between intervention and control groups. Two of the studies observed improvements in physical function after exercise therapy and one of them demonstrated significant reductions in pain. All three trials favor the intervention group in terms of muscle strength and torque. **Conclusions:** A change in knee adduction time was not associated with the therapeutic benefits of exercise therapy. Exercise therapy for knee osteoarthritis may not be effective if there is no momentary adduction. Dynamic joint loading may result from a shift in neuromuscular control after exercise therapy.

INTRODUCTION

The most common clinical presentations include pain, stiffness, and reduced physical ability, resulting in disability and activity limitations. Recent research has looked at the involvement of biomechanical factors in the development and progression of KOA [1]. When a person has KOA, the KAM is used more commonly as a replacement for the medial tibiofemoral contact force, reflecting the relative force distribution across the joint. KAM differs considerably between participants despite its close relationship to medial tibiofemoral contact forces. There is currently no link between structural disease and pain severity [2,3]. Strengthening exercises for the quadriceps

and neuromuscular exercise, as well as hip abductors and adductors, have been utilized to minimize knee joint loading [4]. On the other hand, strengthening hip muscles will correct pelvic imbalances. It is possible for the KAM to increase as a result of the contralateral pelvis dropping and the center of mass shifting from the stance leg. Regardless of the specific ET technique used, the main mission is to restore the correct biomechanics of the lower limbs. Reduced KAM may be one of the reasons for the decrease in pain and impairment. Exercise training has observable clinical benefits, but it is unknown whether it affects the KAM. As a first step, we wanted to determine whether

exercise therapy's clinical benefits related to changes in KAM in people with KOA [5]. As there were so few studies that evaluated the required outcomes, only studies that measured pain scores and physical function were able to confirm ET's effects on KAM in patients with KOA, and qualitative analysis of ET on these dimensions was conducted.

METHODS

Protocol: The Cochrane Collaboration and a preferred reporting technique for systematic reviews and meta-analyses that fulfill PRISMA standards are used to report systematic reviews.

Sources of data and search technique: The researcher searched EMBASE, MEDLINE, and Cochrane CENTRAL from their creation until November 2020. To find potentially qualifying papers, the search was extended to include systematic reviews and citation monitoring methodologies [6]. To find the grey literature, researchers employed Google Scholar and OpenGrey, a specialized library of technical or research reports, conference papers, and government publications.

Patient	Intervention	Type of study
Osteoarthritis of the knee OR	Train in Strength OR Lift Weights OR Strengthen Your Body WITH Weight -Bearing Exercises OR Lift Weights.	(randomized controlled trial [PT] OR controlled clinical trial [PT] OR randomized controlled trial [MH] OR random assignment [MH])
	A lifting -weights strengt h-training program OR plyometric exercises OR cycling to stretch -shorten or stretching drill.	single -blind method [mh] OR clinical trial [pt] OR clinical trials [mh] OR (*clinical trials[tw])
	Exercise Therapy OR Physical Therapy OR Physical Training O R Aerobic Exercise OR Stretch - Shortening Exercise.	The triple (or the tripple) AND the mask (or the blind) OR the latin square (or the placebos [or the placebos[tw] or the randomness))
	Isometric exercise, physical exercise, or a warm -up exercise.	Detailed design [Mh:experiment] OR comparative research [Mh] OR judgment research OR [Mh] review studies
		Study crossovers OR control studies (non-human) OR potential studies (non-human) NOT (animal studies))

Table 1: PubMed database literature search strategy

Eligibility for study: Randomized controlled trials (RCTs) were included if they examined physical function, pain, muscular strength, and KAM in patients with KOA regardless of other outcomes [7]. When diseases or injuries cause pain, physical exercise can be recommended for the relief of symptoms [8]. Exercise training is any type of training regardless of intensity, volume, or type of exercise (for example Exercises that improve motor control and strength, like high-load and low-load strengthening exercises). We excluded a study that did not examine any of the three outcomes above, a study that only tested a single bout of exercise, and a study that used multimodal therapies (e.g., foot orthotics, manual therapy, and exercise therapy)[9].

Selection of studies and data extraction: Based on the

eligibility criteria as shown in Table 1, we used a common screening checklist for each trial. Studies with titles or abstracts that did not meet the requirements were disqualified [10]. The reviewers discussed their differences regarding study eligibility. To obtain clarifications on studies where there was insufficient information to assess eligibility criteria, the authors were contacted via email. Publications reporting results from the same population when more than one publication reported the same result were excluded [11]. At least twice, authors were contacted by email whenever data was required for synthesis or to assess the quality of a study. Missing data estimation was conducted whenever possible. If insufficient data were present, the study was discarded.

Evidence level and bias risk assessment: To assess bias risk the Cochrane Collaboration's method for measuring bias risk was used. In total, three types of bias were evaluated in the included studies: high, low, and unclear bias. In this case, a funnel plot was not appropriate due to the small number of studies examined [12]. Evidence is defined as the consistency of findings across several high-quality trials or studies; Evidence of moderate quality is consistent findings across multiple low-quality trials; Evidence of limited quality is the consistency of findings among low-quality studies; and none (no trial evidence is available)[13]. According to the reviewer team, high-quality studies could only be considered if each of the five factors was present. The trials were deemed low quality when other biases were present. Consequently, the "unclear" classification was deemed harmful, and the evidence was lowered [14].

Measures of outcome: Kinematic and kinetic analysis is used to create KAM, and body weight is used as a normalization factor. The studies included in this review were conducted with subjects walking barefoot at their own pace. To assess pain, this study used the pain subscale of WOMAC, and to assess physical function, it used the physical function subscale. There was a considerable variation in the numeric scales used for the physical function and pain subscales in trials, but there was no pooling, no modifications were necessary, so the data were reported in their raw form [15].

Moment of knee adduction	Clinical results	Conclusions
KAM1 has an MD of 0.13 (95 percent CI -0.12 to 0.38)	The pain walking (0-10) scale has an MD of 1.37. (95 percent confidence interval: -2.16 to -0.59)	Increasing strength[16]
	MD -2.40 for inflammatory pain (0-20). (95 percent CI- 3.25 to -1.54)	KAM was not affected by these symptoms.
	The function (0-68) is 6.17 (95% CI-9.41 to -2.93)	
The md1 value forKAM1 is -0.12 (95% CI-0.36 to 0.82)	MD -0.67 for inflammatory pain (0-20). (95 percent CI- 2.03 to 0.69)	The high intensity resistance training did not work[17]
	When function (0-68) is considered, MD -2.99 (95 percent CI-7.77 to 1.79)	KAM should be improved relative to controls.
KAM1malalignment MD 0.18 (95 percent CI - 0.06 to 0.42)	-1.6 MD (95 percent CI-7.06 to 3.86) for maligned pain (0-20)	Strengthening quadriceps had no significant effect
The alignment of KAM1 was -0.02. (95 percent credible interval -0.38 to 0.34)	MD -13.9 (95 percent CI - 19.24 to -8.55) aligned pain (0-20)	Participants with either more or less KAM[18]
	Usefulness (0-68) MD 2.20, 3 slandered (95 percent CI 4.39 to 11.07)	Aligned in a neutral or maligned direction
		MD -6.40 is aligned by a function (0-68). (95 percent CI-8.50 to 0.41).

Table 2: Results and conclusions. The original scale is used for all values

Analysis of Data: The biomechanical differences among the workouts included in the study precluded the pooling of data due to clinical heterogeneity. The results were therefore analyzed qualitatively [19].

RESULTS

There were 1917 records produced by manual and automated searches from Oct. to Nov. 2021. A search of gray literature on Google Scholar found 1850 citations, but none on OpenGrey. These two databases contained no relevant articles, other than duplicates already on the list [20]. The title and abstract of the 1803 records were reviewed, with 1770 being discarded. The remaining 33 were subjected to a full-text review, as indicated in figure 1. The qualitative analysis included 233 patients. In all other studies, except for the one that recruited only females, the age ranged from 60.8 to 67.2. The average Body Mass Index ranged from 28.5 to 34.2. Two studies used Kellgren-Lawrence classifications, while the third used Modified Outerbridge classifications.

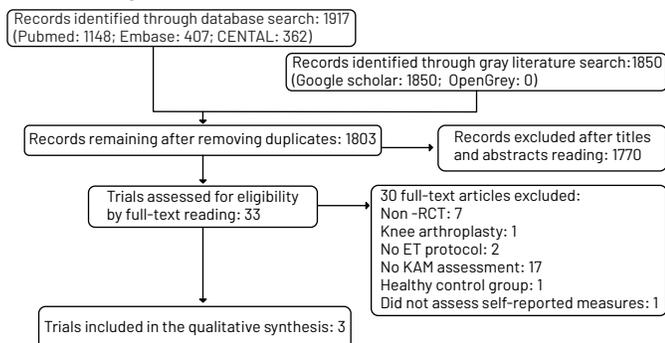


Figure 1: The PRISMA inclusion procedure flow chart

Throughout the included trials, training protocols varied. In a 12-week treatment, patients used ankle cuff weights and elastic bands five times/week to develop hip adductor and abductor muscles [21]. To achieve the goals of the study, patients carried out home workouts as well as visited a physiotherapy clinic seven times to get instructions and measure their load progression. In the exercise program, exercise physiologists focused on knee extension, hip adduction, hip abduction, leg press, and ankle flexion strengthening. As a control group, study participants did not undergo any ET procedures and were advised not to undergo additional treatments [22].

Intervention effects

Exercise's effect on KAM: The KAM did not differ between the strengthening and control groups during the 12-week study and the 95% confidence interval (CI) is between 0.039 and 0.335 Nm/BW * HT% = 0.146. As compared to the control group, KAM in the strengthening group increased by 4.6 percent. In KAM, there were no statistically significant differences between the strengthening and sham-exercise groups [23].

Effect of exercise on physical function and pain: After six months, trial participants had better pain and physical function, with no significant differences between groups. Strengthening participants showed significant pain reduction when compared with controls in the neutrally aligned group [24].

Exercise's effects on muscle strength: Patients in the hip strengthening group had considerably larger hip joint torques and knee extension torques than those in the control group, according to the study. When patients in the strengthening group were compared to those in the sham-exercise group, in terms of knee extension strength, knee flexion, plantar flexion, hip adduction, and hip abduction, identical results were achieved. [25]. In the study, both aligned and maligned individuals who participated in a strengthening program significantly increased their quadriceps strength compared to the control group.

Evaluation of bias and evidence: In general, the interventions in these studies did not perform blinding of therapists and patients [26]. ET positively affects pain, physical function, and muscle strength; however, ET does not have a meaningful effect on KAM (Figure 2).

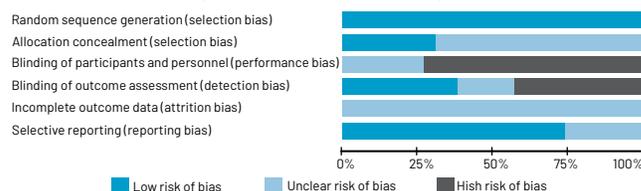


Figure 2: Percentage of each risk of bias item judged by review

authors for all included studies

DISCUSSION

According to the current systematic study, ET significantly reduces pain, increases athletic ability, and increases muscle strength, but it has minimal impact on KAM. Thus, the clinical effectiveness of different Exercise Therapy procedures did not result in a change in KAM in patients with KOA [27]. ET has been shown to have good clinical effects in several rigorous systematic studies and clinical guidelines; however, this is the first systematic evaluation to show that, even when ET had therapeutic improvements, its dynamic KAM remained unchanged. Only a few studies are included in this review, so conclusions should be interpreted with caution. On the other hand, the results of the study are supported by research that did not meet the inclusion criteria. After eight weeks of strengthening hip abductors, pain and strength improved, but no significant changes were detected in KAM. Data consistently demonstrate that the biomechanical principles underlying exercise efficacy owing to KAM reduction have no validity in the literature. In contrast, the KAM's balance is justified by the ability to induce abduction moments through quadriceps contraction. Increasing quadriceps power decreases knee flexion, thus decreasing compression loads on the tibia and femur. Before they can be considered clinically as unloading factors in KOA patients, these pathways need to be studied further. The hip abductors have also been proposed as an unloading mechanism. Offloading is done by strengthening the hip abductors on the stance limb and shifting the center of mass towards the swing limb. KAM is only affected by such processes when the hip abductors are weak and there is a contralateral hip drop. Only one study addressing this issue concluded that pelvic drops increased with age. A protective intervention in terms of joint loading was not examined in this review. According to any of the included studies, the KAM did not change significantly after ET, but other parameters should be assessed as well, including muscle strength and neuromuscular control, although each of these may contribute to illness progression. KOA is associated with high BMI levels, which were often observed in the studies included in the analysis. KOA is highly associated with a high BMI, according to previous research. When KOA was moderate, increased BMI was linked to alterations in knee biomechanical characteristics during locomotion in cross-sectional research. Weight loss provides a number of therapeutic benefits. It can lead to joint degeneration, as well as reduced pain and disability, increased walking speed, and improved knee function. Despite an increase in joint stress, over the course of a year, a 16-week weight loss program had excellent clinical improvements but no improvement in structural markers of disease progression. Future research should investigate other mechanisms that explain ET's therapeutic success. In addition, the few studies we included could affect the generalizability of our findings. Because of clinical variability within ET regimens, data pooling was not possible. Due to the absence of control groups in randomized controlled trials, the available evidence may have been diminished. To test the effect of ET on dynamic knee stress, some specific types of biomechanical changes were required - for example, a greater trunk lean or reduced contralateral pelvic drop

- rather than considering the entire KOA population. Researchers will be better able to control possible biases in future studies. Evidence quality was lowered by the absence of selective reporting bias and outcome assessor blinding in some of the included studies. ET did not reduce KAM, but it did improve physical function and pain. Aside from reducing dynamic joint load, there may be other mechanisms by which ET affects KOA.

CONCLUSION

A change in knee adduction time was not associated with the therapeutic benefits of exercise therapy. Exercise therapy for knee osteoarthritis may not be effective if there is no momentary adduction. Dynamic joint loading may result from a shift in neuromuscular control after exercise therapy.

REFERENCES

- [1] Bokaeian HR, Esfandiarpour F, Zahednejad S, Mohammadi HK, Farahmand F. Effects of an Exercise Therapy Targeting Knee Kinetics on Pain, Function, and Gait Kinetics in Patients With Knee Osteoarthritis: A Randomized Clinical Trial. *Adapt Phys Activ Q*. 2021 Mar 30;38(3):377-395. doi: 10.1123/apaq.2020-0144.
- [2] Cheung RTH, Ho KKW, Au IPH, An WW, Zhang JHW, Chan ZYS et al. Immediate and short-term effects of gait retraining on the knee joint moments and symptoms in patients with early tibiofemoral joint osteoarthritis: a randomized controlled trial. *Osteoarthritis Cartilage*. 2018 Nov;26(11):1479-1486. doi: 10.1016/j.joca.2018.07.011.
- [3] Edd SN, Bennour S, Ulrich B, Jolles BM, Favre J. Modifying Stride Length in Isolation and in Combination With Foot Progression Angle and Step Width Can Improve Knee Kinetics Related to Osteoarthritis; A Preliminary Study in Healthy Subjects. *J Biomech Eng*. 2020 Jul 1;142(7):074505. doi: 10.1115/1.4046713.
- [4] Erhart-Hledik JC, Mahtani GB, Asay JL, Migliore E, Nguyen MM, Andriacchi TP et al. Changes in knee adduction moment wearing a variable-stiffness shoe correlate with changes in pain and mechanically stimulated cartilage oligomeric matrix levels. *J Orthop Res*. 2021 Mar;39(3):619-627. doi: 10.1002/jor.24770.
- [5] Hall M, Bennell KL, Wrigley TV, Metcalf BR, Campbell PK, Kasza J et al. The knee adduction moment and knee osteoarthritis symptoms: relationships according to radiographic disease severity. *Osteoarthritis Cartilage*. 2017 Jan;25(1):34-41. doi: 10.1016/j.joca.2016.08.014.
- [6] Huang C, Chan PK, Chiu KY, Yan CH, Yeung SS, Fu SN. Exploring the relationship between pain intensity and

- knee moments in participants with medial knee osteoarthritis: a cross-sectional study. *BMC Musculoskelet Disord*. 2021 Aug 12;22(1):685. doi: 10.1186/s12891-021-04587-w.
- [7] Hunt MA, Charlton JM, Krowchuk NM, Tse CTF, Hatfield GL. Clinical and biomechanical changes following a 4-month toe-out gait modification program for people with medial knee osteoarthritis: a randomized controlled trial. *Osteoarthritis Cartilage*. 2018 Jul;26(7):903-911. doi: 10.1016/j.joca.2018.04.010.
- [8] Hunt MA, Charlton JM, Felson DT, Liu A, Chapman GJ, Graffos A et al. Frontal plane knee alignment mediates the effect of frontal plane rearfoot motion on knee joint load distribution during walking in people with medial knee osteoarthritis. *Osteoarthritis Cartilage*. 2021 May;29(5):678-686. doi: 10.1016/j.joca.2021.02.003.
- [9] Jackson B, Gordon KE, Chang AH. Immediate and short-term effects of real-time knee adduction moment feedback on the peak and cumulative knee load during walking. *J Orthop Res*. 2018 Jan;36(1):397-404. doi: 10.1002/jor.23659.
- [10] Khan SJ, Khan SS, Usman J, Mokhtar AH, Abu Osman NA. Combined effects of knee brace, laterally wedged insoles, and toe-out gait on knee adduction moment and fall risk in moderate medial knee osteoarthritis patients. *Prosthet Orthot Int*. 2019 Apr;43(2):148-157. doi: 10.1177/0309364618796849.
- [11] Khan SJ, Khan SS, Usman J, Mokhtar AH, Abu Osman NA. Combined effects of knee brace, laterally wedged insoles and toe-in gait on knee adduction moment and balance in moderate medial knee osteoarthritis patients. *Gait Posture*. 2018 Mar;61:243-249. doi: 10.1016/j.gaitpost.2018.01.024.
- [12] Kudo K, Nagura T, Harato K, Kobayashi S, Niki Y, Matsumoto M et al. Correlation between static limb alignment and peak knee adduction angle during gait is affected by subject pain in medial knee osteoarthritis. *Knee*. 2020 Mar;27(2):348-355. doi: 10.1016/j.knee.2019.11.008.
- [13] Li S, Ng WH, Abujaber S, Shaharudin S. Effects of resistance training on gait velocity and knee adduction moment in knee osteoarthritis patients: a systematic review and meta-analysis. *Sci Rep*. 2021 Aug 9;11(1):16104. doi: 10.1038/s41598-021-95426-4.
- [14] Mochizuki T, Omori G, Nishino K, Tanaka M, Tanifuji O, Koga H et al. The medial inclination of the proximal tibia is associated with the external knee adduction moment in advanced varus knee osteoarthritis. *Knee Surg Sports Traumatol Arthrosc*. 2022 Feb;30(2):574-583. doi: 10.1007/s00167-020-06323-8.
- [15] Mohd Sharif NA, Usman J, Wan Safwani WKZ, Siew Li G, Abdul Karim S, Mohamed NA et al. Effects of simple knee sleeves on pain and knee adduction moment in early unilateral knee osteoarthritis. *Proc Inst Mech Eng H*. 2019 Nov;233(11):1132-1140. doi: 10.1177/0954411919874614.
- [16] Fantini Pagani C, Funken J, Heinrich K, Ellermann A, Schmidt-Wiethoff R, Potthast W. Predicting the knee adduction moment after high tibial osteotomy in patients with medial knee osteoarthritis using dynamic simulations. *Knee*. 2020 Jan;27(1):61-70. doi: 10.1016/j.knee.2019.08.003.
- [17] Paterson KL, Bennell KL, Wrigley TV, Metcalf BR, Kasza J, Hinman RS. Effects of footwear on the knee adduction moment in medial knee osteoarthritis: classification criteria for flat flexible vs stable supportive shoes. *Osteoarthritis Cartilage*. 2017 Feb;25(2):234-241. doi: 10.1016/j.joca.2016.10.001.
- [18] Pereira LC, Runhaar J, Favre J, Jolles BM, Bierma-Zeinstra S. Association between changes in the knee adduction moment and changes in knee pain and function in response to non-surgical biomechanical interventions for medial knee osteoarthritis: a systematic review. *Eur J Phys Rehabil Med*. 2021 Dec;57(6):948-958. doi: 10.23736/S1973-9087.21.06828-3.
- [19] Paterson KL, Kasza J, Bennell KL, Wrigley TV, Metcalf BR, Campbell PK et al. Moderators and mediators of effects of unloading shoes on knee pain in people with knee osteoarthritis: an exploratory analysis of the SHARK randomised controlled trial. *Osteoarthritis Cartilage*. 2018 Feb;26(2):227-235. doi: 10.1016/j.joca.2017.11.002.
- [20] Richards R, van den Noort JC, Dekker J, Harlaar J. Gait Retraining With Real-Time Biofeedback to Reduce Knee Adduction Moment: Systematic Review of Effects and Methods Used. *Arch Phys Med Rehabil*. 2017 Jan;98(1):137-150. doi: 10.1016/j.apmr.2016.07.006.
- [21] Robert-Lachaine X, Dessery Y, Belzile ÉL, Turmel S, Corbeil P. Three-month efficacy of three knee braces in the treatment of medial knee osteoarthritis in a randomized crossover trial. *J Orthop Res*. 2020 Oct;38(10):2262-2271. doi: 10.1002/jor.24634.
- [22] Schuster E, Routson RL, Hinchcliff M, Benoff K, Suri P, Richburg C et al. A novel walking cane with haptic biofeedback reduces knee adduction moment in the osteoarthritic knee. *J Biomech*. 2021 Jan 4;114:110150. doi: 10.1016/j.jbiomech.2020.110150.

- [23] Ulrich B, Hoffmann L, Jolles BM, Favre J. Changes in ambulatory knee adduction moment with lateral wedge insoles differ with respect to the natural foot progression angle. *J Biomech.* 2020 Apr 16;103:109655. doi: 10.1016/j.jbiomech.2020.109655.
- [24] Verlaan L, Boekesteijn RJ, Oomen PW, Liu WY, Peters MJM, Emans PJ et al. Knee adduction moments are not increased in obese knee osteoarthritis patients during stair negotiation. *Gait Posture.* 2019 Sep;73:154-160. doi: 10.1016/j.gaitpost.2019.07.192.
- [25] Wang S, Chan PPK, Lam BMF, Chan ZYS, Zhang JHW, Wang C et al. Sensor-Based Gait Retraining Lowers Knee Adduction Moment and Improves Symptoms in Patients with Knee Osteoarthritis: A Randomized Controlled Trial. *Sensors (Basel).* 2021 Aug 19;21(16):5596. doi: 10.3390/s21165596.
- [26] Whelton C, Thomas A, Elson DW, Metcalfe A, Forrest S, Wilson C et al. Combined effect of toe out gait and high tibial osteotomy on knee adduction moment in patients with varus knee deformity. *Clin Biomech (Bristol, Avon).* 2017 Mar;43:109-114. doi: 10.1016/j.clinbiomech.2017.02.009.
- [27] Yamagata M, Taniguchi M, Tateuchi H, Kobayashi M, Ichihashi N. The effects of knee pain on knee contact force and external knee adduction moment in patients with knee osteoarthritis. *J Biomech.* 2021 Jun 23;123:110538. doi: 10.1016/j.jbiomech.2021.110538