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# Postural Control Pre- and Post-Group Supervised Clinic Based Exercise or Home Based Exercise in Patients with Knee Osteoarthritis: A Randomized Clinical Trial

**Évelin Santos Vaz, Juliana Corrêa Soares, Carlos Bolli Mota, Michele Forgiarini Saccol**

*Laboratório de Biomecânica, Universidade Federal de Santa Maria (UFSM), Santa Maria, Brazil*

**CORRESPONDING AUTHOR:**
Évelin Santos Vaz
Laboratório de Biomecânica
Universidade Federal de Santa Maria (UFSM)
Coronel Niederauer 1301
CEP 97.015-121 Santa Maria, Brazil
E-mail: nilevezav@gmail.com

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**SUMMARY**

**Background.** Knee osteoarthritis (OA) is a chronic, multifactorial and progressive disease that decreases range of motion and flexibility and alters proprioception and postural control. Postural control provides stability and conditions to assume and maintain the desired body position. In OA patients, this postural control is diminished along with overall functional capacity, and physical exercise aims to reduce these alterations.

**Objective.** To evaluate and compare the postural control of patients with knee OA before and after a supervised clinic based or home exercises protocol.

**Methods.** 48 OA patients between 40 and 65 years participated in the study. They were assessed using the 40-meter walk test and postural control (force platform). Postural control was evaluated with eyes open, and eyes closed, with and without the use of an unstable surface, in three attempts of 30 seconds each, with a 1-minute rest interval between them. After assessments, participants were randomized into two groups: supervised clinic-based exercise group (CBG) (n = 23) and home based exercise group (HBG) (n = 25). The exercise protocol was the same for both groups, and they were reevaluated after 8 weeks of training.

**Results.** Both groups improved their walking speed after treatment. Regarding postural control, there were no differences in the variables of center of pressure displacement before and after intervention with exercises, regardless of the group.

**Conclusions.** Patients showed no improvement in postural control after the intervention, although there was an increase in walking speed in both groups.

**Study registration.** The study has been registered in Clinical Trials (number NCT0335643).

**KEY WORDS**

*Aged; exercise; osteoarthritis; pain; postural balance.*

## INTRODUCTION

Knee osteoarthritis (OA) is a chronic, degenerative, multifactorial, and progressively advancing disease (1) with 15% of the global population affected (2). This chronic condition is a primary cause of lower limb deficits in elderly with knee OA impacting around 40% of men and 47% of women (2). Numerous alterations occur in patients with knee OA, including reduced quadriceps strength (3, 4), decreased range of motion (4, 5), increased pain levels (3), and decreased proprioception (6). These changes contribute to walking difficulties, stair climbing challenges, general reduction in activities of daily living (5, 7), in addition to less postural control (8-11).

Postural control forms the foundation of the human motor control system, generating stability and enabling movement, encompassing the ability to achieve and maintain the desired body position during any activity, whether static or dynamic (12). Balance relies on the reception and integration of sensory stimuli for planning and subsequent execution of movements, governing the center of gravity over its support base. This essential control is executed through the postural control system, with inputs received from the vestibular system, visual receptors, and somatosensory system (13, 14). In individuals with OA, postural control is diminished (8-11), along with other aspects like overall functional capacity (15), which directly influences quality of life and functional independence (16). Moreover, the prevalence of knee OA increases with age, and as age advances, alterations in the locomotor system, such as reduced step length and velocity, an enlarged base of support, and modification of the center of mass in pursuit of greater balance, become more pronounced (17, 18).

Considering that patients typically live with the disease for around 30 years (19) and that the physiological aging process leads to declines in motor recruitment, balance, and reaction time, therapeutic exercises can help mitigate these changes. Guidelines recommend exercise programs on land, weight control combined with exercises, mind-body exercises, and health education as the primary non-pharmacological treatment for OA patients (20, 21).

Physical exercise aims to slow the disease's progression, in addition to being cost-effective and strongly recommended for maintaining and managing the signs and symptoms of knee OA (22, 23), leading to improved quality of life and functionality (22, 24). When conducted in a group setting, exercise practices reach a larger number of individuals compared to individual sessions and show enhanced pain reduction, quality of life, and patient function (25, 26). Although group strategies incur public health costs, this investment appears to outweigh standard patient care (26). On the other hand, prescribing exercises for home-based practice offers a simple, effective, and secure alternative for these patients (27-29), promoting autonomy and reducing expenses related to in-person visits. Home-based exercises with physiotherapeutic guidance demonstrated superiority over booklet instructions provided by orthopedic specialists (30).

Previous studies assessing postural control in OA patients have identified that these individuals tend to exhibit deficits in maintaining postural control and increased instability – conditions linked to functional limitations, advanced age, reduced quality of life, and decreased social interaction (4, 5, 16, 31, 32). The aim of this study was to compare postural control of patients with knee OA before and after group supervised clinic based or home-based exercises.

## MATERIALS AND METHODS

### Study design

This study was a randomized controlled trial, following the guidelines of the Consolidated Standards of Reporting Trials (CONSORT) and approved by the Ethics Committee on Research Involving Human Beings of a University Institution under number 2.009.624 – Date of approval: April 10, 2017. All participants were informed about the objectives and procedures of the research and signed the informed consent form in duplicate, one copy for themselves and the other for the researcher. The authors declare that the procedures were followed according to the regulations established by the Ethics Committee and to the Helsinki Declaration of the World Medical Association.

### Patients

Individuals aged between 40 and 65 years, clinically diagnosed with knee OA classified as grades I, II, and III through the criteria of Kellgren Lawrence using anterior posterior knee radiographs (33-35) participated in the study. Individuals with prior lower limb surgeries, recent physiotherapy within the last six months, cardiac, respiratory, rheumatic, neurological, or vestibular disorders hinder participation in the proposed assessments and interventions, as well as those unable to attend treatment sessions were excluded from the study. Patients were recruited from the Physical Therapy Clinic at the University Hospital and through pamphlets distributed within the University.

### Measurements

Participants completed a comprehensive assessment form, collecting identification data, sociodemographic characteristics, and current medical history to identify comorbidities and past medical history. Anthropometric measurements of body mass and height were performed, and body mass index (BMI) was calculated based on this measurement.

#### *Gait velocity assessment*

The participants' gait velocity was assessed through the 40-meter walk test. This test involves marking a 10-meter distance on the floor, with cones positioned 1 meter before the start and end marks, requiring the participant to make a turn and eliminate acceleration and deceleration components. The participant performs four laps in the designated space, walking as fast and safely as possible, with the total time recorded using a chronometer. The velocity (m/s) is then estimated by dividing the distance by the time taken (36, 37).

#### *Postural control assessment*

Participants were instructed to stand barefoot with one foot on each force platform (AMTI, model OR6-6-2000), arms alongside the body, looking on a point positioned 3 meters away (**figure 1**). Participants with visual impairments were required to wear glasses during assessments. Foot positioning was marked on a sheet of paper to ensure consistent placement for all attempts.

Participants were tested under four different conditions: 1) standing with eyes open; 2) standing with eyes closed; 3) standing with eyes open on a foam surface; and 4) standing with eyes closed on a foam surface. A non-deformable foam surface (Airex balance pad, Airex®) with dimensions of 49 cm length, 420 cm width, 6.35 cm height, and weighing 680 grams was used. This foam surface demonstrated high test-retest reliability in previous studies assessing postural control (38). Three attempts of 30-seconds were conducted under each test condition, with a 1-minute rest interval between them. Platform acquisition frequency was set at 100 Hz, and the raw force and moment data obtained from the platform were filtered using a fourth order low pass Butterworth filter with a cutoff frequency of 10 Hz. After filtering through a Matlab software routine, this data was used to calculate the center of pressure (COP) coordinates, from which the variables of interest were taken: amplitude of anteroposterior COP displacement (COPap) and mediolateral COP displacement (COPml). Larger values of these variables indicate greater postural oscillation.

## Randomization

Participants were randomized through individual sealed opaque envelopes, each containing a treatment card, and one researcher was responsible for randomization and blinding.

The supervised clinic-based exercise group (CBG) and the home-based exercise group (HBG) followed the same exercise protocol for 6 weeks. Each group was led by two blinded researchers in relation to the patient's assessment data, with each researcher responsible for one of the treatment groups (CBG or HBG).

The CBG performed two supervised group exercise sessions per week, in groups of four patients. The HBG group had one weekly oriented exercise session and another session at home. The weekly oriented session lasted about 30 minutes, during which the patient received exercise instructions and adjustments in their activity diary. The second weekly session, the patient has to do the exercise at home.

The selected exercises were based on previous studies that addressed pain and function management in individuals with OA (39-45) and included isometric quadriceps contraction, isotonic knee extension and flexion, sit-to-stand exercise, step-up and step-down exercise and quadriceps and hamstring stretching (**figures 2,3**).

According to patient evolution per patient progression and reports, exercise resistance was gradually increased according to the patient's report.

Considering the minimum relevant difference of 13.3% in the Western Ontario and McMaster Universities Osteoar-

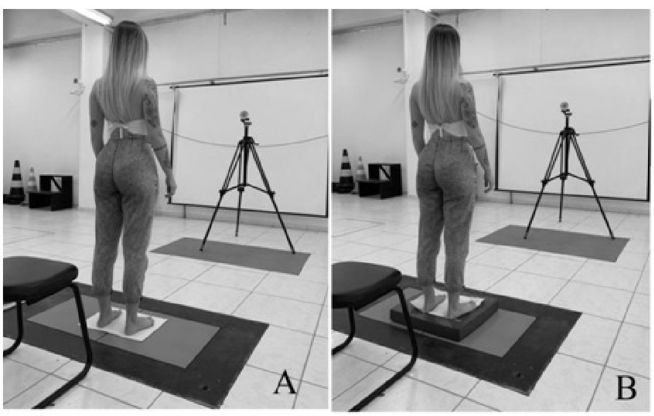


**Figure 1.** Postural control assessment positioning standing without foam surface **(A)** and with foam surface **(B)** under eyes open and eyes closed conditions.

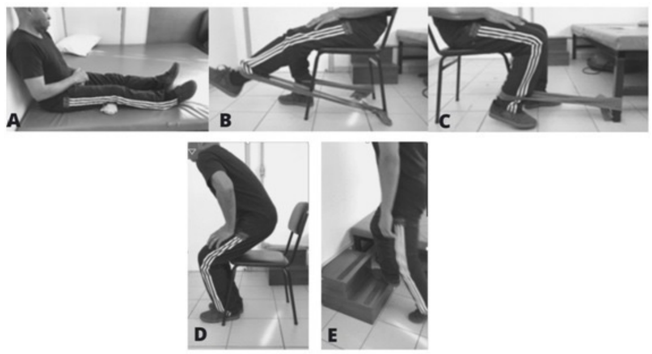


**Figure 2.** Knee osteoarthritis strengthening exercise protocol: isometric quadriceps contraction **(A)**, isotonic knee extension **(B)**, isotonic knee flexion **(C)**, sit-to-stand exercise **(D)**, and step-up and step-down exercise **(E)**.

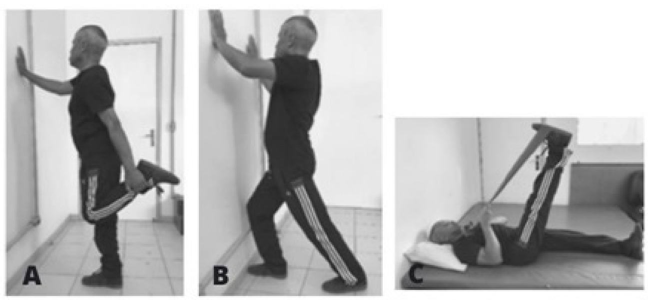


**Figure 3.** Knee osteoarthritis stretching exercise protocol: quadriceps stretch **(A)**, standing hamstring stretch **(B)**, and lying hamstring stretch **(C)**.

thritis Index (WOMAC) questionnaire, the WOMAC mean in an intervention for OA was used for the sample calculation. The effect size was 0.84, and a sample size ratio of 1:1 for all groups, so a minimum "n" of 23 individuals was adopted in each intervention group.

Pre-intervention group comparisons were performed using the independent samples t-test. A Two-Way ANOVA was used for group and time comparisons (pre and post) and Bonferroni's post hoc test was employed to identify potential differences. Intention-to-treat analysis was used and the significance level for all tests was set at 5%. The analyses were performed using the Statistical Package for the Social Sciences (SPSS) software.

## RESULTS

Fifty-eight patients were enrolled to the study (**figure 4**), with 48 (35 females and 13 males) randomized into one of the exercise groups. The sample was homogeneous regarding anthropometric characteristics (**table I**), with no significant differences between the groups.

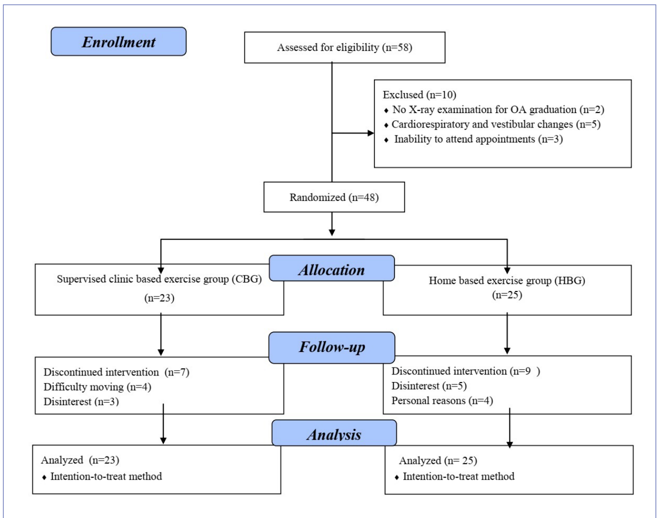


**Figure 4.** Study flowchart for distribution of volunteers.

There were no statistically significant differences in COPap and COPml variables before and after exercise intervention, regardless of the group. An interaction (time and group) was observed for gait speed, demonstrating an increase in walking speed in patients of the CBG (**table II**).

## DISCUSSION

This study investigated the postural control of patients with knee OA before and after an exercise protocol applied in a supervised clinic or home-based exercise group. Both groups did not show improvement in postural control variables, regardless of the mode of intervention. However, walking speed was superior in supervised clinic-based exercises.

Ghandali *et al.* (45) used a force platform to determine balance measurements in elderly knee OA patients after Tai Chi exercises. The balance assessments were similar to this study, and the groups were instructed to perform Tai Chi exercises for 8 weeks. They found a decrease in the area and speed of COP oscillation after Tai Chi exercises, both on rigid and unstable foam surfaces. The results of our study conflict with those of Ghandali *et al.* (45), as no significant differences were found in the COP area. Considering that Tai Chi exercises include relaxation, deep breathing, slow movements, and destabilization of the center of mass, promoting greater body awareness and flexibility (46), we believe that the type of exercise employed in the study explains this difference in results.

Costa *et al.* investigated the effect of using the undenatured collagen combined with a physiotherapy program on symptomatology, joint mobility, muscle strength, and knee joint function in patients with knee OA. Based on these findings, muscle strengthening exercises improved pain, mobility, strength, and function in knee OA patients. Pain reduction after strengthening exercises can be attributed to reversal of quadriceps weakness, which is one of the main conditions present in patients with knee OA (47).

**Table I.** Characterization of the sample of knee osteoarthritis patients randomized into treatment groups.

| | CBG (n = 23) | HBG (n = 25) | P-value |
|---|---|---|---|
| Female | 17 (74 %) | 18 (72%) | - |
| Age (years) | 56.22 ± 7.51 | 57.76 ± 5.46 | 0.42 |
| Body Mass (kg) | 85.60 ± 17.86 | 85.30 ± 15.43 | 0.95 |
| Heigth (m) | 1.59 ± 0.09 | 1.61 ± 0.08 | 0.59 |
| BMI (kg/m²) | 33.61 ± 5.94 | 33.30 ± 7.28 | 0.87 |

Data presented in % (percentage), mean ± standard deviation. CBG: supervised clinic-based exercise group; HBG: home based exercise group.

**Table II.** Comparison of postural control center of pressure (COP) in conditions of eyes open and eyes closed, with or without foam, in antero-posterior (AP) and medio-lateral (ML) directions (COPap and COPml) in patients with knee osteoarthritis who underwent clinic based exercise group (CBG) or home based exercise group (HBG).

| | | CBG (n = 23) | HBG (n = 25) | Anova (P-value) | | |
|---|---|---|---|---|---|---|
| | | | | Time | Group | Interaction |
| COPap | | | | | | |
| Open Eyes | Pre | 2.23 ± 0.53 | 2.33 ± 0.75 | 0.59 | 0.68 | 0.70 |
| | Post | 2.23 ± 0.52 | 2.28 ± 0.80 | | | |
| Close Eyes | Pre | 2.48 ± 0.76 | 2.53 ± 0.72 | 0.23 | 0.67 | 0.64 |
| | Post | 2.35 ± 0.60 | 2.47 ± 0.85 | | | |
| Open Eyes + Foam | Pre | 4.54 ± 0.77 | 4.31 ± 0.71 | 0.99 | 0.13 | 0.34 |
| | Post | 4.65 ± 1.09 | 4.20 ± 0.87 | | | |
| Close Eyes + Foam | Pre | 6.47 ± 1.45 | 6.05 ± 1.23 | 0.99 | 0.44 | 0.36 |
| | Post | 6.35 ± 1.40 | 6.17 ± 1.60 | | | |
| COPml | | | | | | |
| Open Eyes | Pre | 1.76 ± 0.63 | 1.95 ± 1.41 | 0.84 | 0.46 | 0.55 |
| | Post | 1.73 ± 0.66 | 2.00 ± 1.40 | | | |
| Close Eyes | Pre | 1.71 ± 0.64 | 2.07 ± 1.68 | 0.25 | 0.44 | 0.30 |
| | Post | 1.85 ± 0.86 | 2.08 ± 1.65 | | | |
| Open Eyes + Foam | Pre | 4.95 ± 1.03 | 4.47 ± 1.15 | 0.11 | 0.12 | 0.89 |
| | Pos | 4.72 ± 1.09 | 4.20 ± 1.53 | | | |
| Close Eyes + Foam | Pre | 7.24 ± 2.19 | 6.78 ± 2.22 | 0.40 | 0.47 | 0.91 |
| | Post | 7.09 ± 1.98 | 6.66 ± 2.24 | | | |
| Gait Velocity (m/s) | Pre | 0.60 ± 0.12 | 0.66 ± 0.19 | < 0.001* | 0.47 | 0.03* |
| | Post | 0.68 ± 0.13 | 0.69 ± 0.18 | | | |

Data presented as mean ± standard deviation.

Although there are studies evaluating postural control in elderly individuals with knee OA (44-46), most of them use clinical tests to measure balance and compare healthy individuals with individuals with OA, being necessary to compare between the two groups of knee OA patients with different protocols (48). A recent meta-analysis investigating the influence of Tai Chi practice on walking speed and postural control in elderly individuals with knee OA (44) used indirect measures such as the 6-minute walk test and the WOMAC questionnaire to assess postural control ability. Authors claim that postures such as climbing and descending stairs, sitting and standing up, and maintaining both seated and standing positions and walking require balance. Thus, changes in these two indices may intuitively reflect the capacity for improving postural control. Even though clinical evaluations are important to assess balance, the gold standard measurement is force platform (12), leading to significant methodological differences between studies.

Regarding walking speed, patients showed better results after treatment, indicating post-exercise improvement in both groups. In other words, regardless of the intervention group, post-exercise results were better than pre-treatment. Although home-based exercise interventions for OA patients have reported good effectiveness in the literature (12, 27, 39-41) and offer benefits that do not significantly differ from individually supervised programs or clinic-based exercises (22), in countries like Brazil, this approach is not yet widely used (49). Cultural issues and concerns about treatment adherence could be reasons for the low implementation of this approach in our population. However, this study demonstrated that both approaches can be successfully implemented, reinforcing the possibility of using home-based exercises and weekly guidance, with the use of few materials and fewer visits to public rehabilitation clinics, thereby reducing expenses for patients and the healthcare system.

Some study limitations must be addressed. There was a lack of standardization in the elastic band resistance, with only patient-reported effort used to increase the load. Also, our sample was predominantly composed of females, which prevented the comparison of results between sexes. As strengths of the study, overall, both exercise programs were well tolerated, and the protocols were low-cost and easy to reproduce, making them more viable for the general public. Considering the impact that knee OA has on the general capacity of patients, both home-based and group exercises improve walking speed in this population, with no benefit in postural control. The possibility of easy practical application and the use of few materials to provide patient autonomy in their exercises are factors to be considered in implementing these exercises in the population. It is suggested that exercises to improve postural control be implemented in the protocols for these patients, as maintaining postural control in the aging population should be a health concern, in addition to addressing the clinical changes of OA.

## CONCLUSIONS

Patients with knee OA undergoing either a group supervised clinic or home-based exercise intervention did not show improves in postural control after the treatment. Both groups demonstrated better gait speed after the stretching and lower limb strengthening exercise protocol.

## FUNDINGS

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## DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

## CONTRIBUTIONS

ESV: methodology, investigation, formal analysis, writing - original draft. JCS: methodology, investigation, formal analysis, writing - original draft. CBM: writing - original draft. MFS: conceptualization, methodology, supervision, writing-reviewing & editing. All authors: final approval.

## CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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