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# EFFECT OF SWISS BALL EXERCISES OVER CONVENTIONAL EXERCISES ON PAIN, STRENGTH AND FUNCTIONAL ACTIVITIES AMONG THE SUBJECTS WITH KNEE OSTEOARTHRITIS: A RANDOMISED CONTROL TRAIL

**Physiotherapy**

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## ABSTRACT

This randomized control trial aimed to compare the effectiveness of Swiss ball exercises and conventional exercises, both combined with ultrasound therapy, on pain, strength, and functional activities in subjects with knee osteoarthritis (KOA). Conducted over six weeks at COP-SVIMS, 30 participants aged 45-60 with grade-1 and grade-2 KOA were randomly assigned to either the experimental group (Swiss ball exercises plus ultrasound therapy) or the control group (conventional exercises plus ultrasound therapy). Outcome measures included the Numerical Pain Rating Scale (NPRS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire, and 1-Repetition Maximum (1RM) leg press test. Both groups exhibited significant improvements in NPRS, WOMAC, and 1RM leg press test scores, with no significant differences between the two, suggesting that Swiss ball exercises and conventional exercises are equally effective when combined with ultrasound therapy in managing KOA symptoms.

## KEYWORDS

Knee osteoarthritis, NPRS, WOMAC, 1RM.

## INTRODUCTION

Osteoarthritis (OA), the leading cause of joint disability, significantly lowers quality of life by affecting mobility and social participation due to cartilage erosion, subchondral bone changes, synovial inflammation, and meniscus degeneration (1).

Knee osteoarthritis (KOA) particularly affects 12% to 35% of the population, emerging as a leading cause of musculoskeletal disability among the elderly worldwide (2).The prevalence of knee osteoarthritis (OA) is anticipated to increase with an aging population, affecting women than men, attributed to hormonal changes during menopause. Worldwide, OA affects 10%-15% of those over 50, predominantly impacting knees and hips, causing pain, muscle weakness, limited mobility, and joint instability (3, 4).

Knee osteoarthritis (KOA) manifests as post-activity pain, stiffness, crepitation, swelling, and reduced mobility, with pain being a key factor for seeking medical advice, influenced by psychological and sociocultural elements (4,6). OA diagnosis is based on clinical examination and radiographic evidence, utilizing the Kellgren and Lawrence scale to grade severity through indicators like osteophytes and joint space narrowing (7).

Therapeutically, ultrasound is used for its benefits in tissue healing, inflammation reduction, and pain relief. Pain severity is often measured using the NPRS, and the WOMAC index is used to assess pain, stiffness, and functional ability in knee and hip OA. Muscle strength assessment through the 1-RM method offers insights into the functional impact of OA on physical performance (6,7,8,9).

## NEED OF THE STUDY

There are lack of studies done on the effect of ultrasound and swiss ball exercises among knee osteoarthritis subjects.

So, the purpose of the study is to compare the conventional exercises and swiss ball exercises in knee osteoarthritis subjects.

## AIM OF THE STUDY

To determine the effect of Swiss ball exercises over conventional exercises on pain, functional activity and strength among knee osteoarthritis subjects.

## OBJECTIVES OF THE STUDY

To evaluate the pre and post values of NPRS, WOMAC questionnaire and 1RM leg press test after conventional exercises in control group and Swiss ball exercises in experimental group and to compare pre- and post-intervention values between the experimental and conventional groups.

## MATERIALS AND METHODOLOGY:

### MATERIALS:

- Ultrasound
- Swiss ball
- Leg press bench
- Pen and paper

### METHODOLOGY:

Study design: experimental study

Study duration: 6 weeks

Study setting: COP - SVIMS

Sample collection: COP, BIRRD HOSPITAL -SVIMS

Sampling method: simple random sampling

Sample size: 30 subjects (allocated randomly 15 in each group)

### Ethical Approval:

Ethical approval was obtained from the Institution ethics committee (IEC) of SVIMS University (IEC No: 1538 dt: 02-01-2023).

### Inclusion Criteria

- Age group >45 and <60
- Patient having clinical symptoms at least 6 months with degeneration OA of grade-1,2 based on radiographs
- BMI ranges : 25 to <30
  >30 and <40
- Knee pain NPRS >4
- No treatment in previous 3 months

### Exclusion Criteria

- Fractures
- Tendon or ligament tears
- Meniscal injury
- Rheumatoid arthritis

- Previous knee surgery
- Cardiac problems

**Outcome Measures**
- NPRS scale is used to measure the pain
- WOMAC questionnaire is used to measure the functional disability
- 1RM leg press test is used to measure the strength

**Study Protocol:**
The following protocols, swiss ball exercises and conventional exercises along with ultrasound therapy outlines a six-week progressive training program. These protocols were described in detail below:

**Swiss Ball**
The Swiss ball (or gym ball) is widely reported in the training environment to be a training device for core stability exercises and extremities. There is scientific evidence to support its use. Utilizing an exercise ball for workouts, as opposed to a stable, flat surface, introduces instability that the body must counteract to maintain balance. This adaptation requires the activation of additional muscles, providing a more comprehensive muscle engagement compared to exercises performed on stable ground. Those muscles become stronger over time to keep balance (10).

**Swiss Ball Exercises**
- Swiss ball hamstring curl
- Swiss ball squats
- Swiss ball leg press
- Swiss ball bridging exercise
- Seated leg raise
- Swiss ball Roll in
- Squat arch
- Swiss ball leg lift

**CONVENTIONAL EXERCISES**
Standardized exercise protocol for KOA which consists of SLR, quadriceps sets, pillow squeeze, heel raise, one leg balance, step ups, and quadriceps strengthening exercises.

**ULTRASOUND THERAPY**
Ultra sound has been used as a valuable tool to stimulate the repair of soft tissue injuries and to relieve pain. Ultrasound is based on the application of high frequency sound waves to the tissues of the body in order to obtain mechanical or thermal effects.

For both groups, the ultrasound equipment is given at a frequency of 1 MHz and a power of 2 W/cm2 and pulsed mode of 1:4 and 7 min per session.

Treatment was given once a day, for 5 days a week for 3 weeks, i.e. a total of 15 sessions.

**DATA ANALYSIS & RESULTS**
The variables considered under the study are NPRS, WOMAC score and 1RM leg press test. These three variables of two groups were measured at base line and after 6 weeks of conventional exercises and swiss ball exercises along with ultrasound therapy respectively. The data was tabulated into Microsoft excel spreadsheet and statistical analysis was done by using the statistical software Statistical Package for Social Sciences (SPSS) 25.0 version.

Paired t- test is used as the statistical technique to compare the pre and post values of the dependent variable of each group for parametric data and one way ANNOVA is used to compare the pre and post values between the two groups.

The statistical analysis results for the three outcome measures - NPRS, WOMAC and 1RM leg press test pre and post the intervention were organized and presented in table 1&2.

The data shows significant improvements in both Group-1 and Group-2. In Group-1, the mean NPRS score decreased from 7.80 to 2.07, WOMAC score from 66.00 to 17.87, and 1RM increased from 0.94 to 1.30. Group-2 saw similar improvements, with NPRS scores falling from 8.27 to 1.93, WOMAC scores from 65.33 to 15.67, and 1RM from 0.83 to 1.32. The substantial reductions in pain and improvements in function and strength for both groups were statistically significant, as evidenced by the t-values far exceeding the critical two-tail value of 4.140, and the p-values being 0.000** (indicating $p<0.05$). These results suggest that both treatments were highly effective in managing symptoms of knee osteoarthritis.

**Table 1: Representing The Pre And Post Values Of Group-1 & Group-2.**

| Variables | Group-1(n=15) | | | | | | Group-2 (n=15) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPRS SCALE | | WOMAC Score | | 1RM | | NPRS SCALE | | WOMAC SCORE | | 1RM | |
| Treatment | PRE | POST | PRE | POST | PRE | POST | PRE | POST | PRE | POST | PRE | POST |
| Mean | 7.80 | 2.07 | 66.00 | 17.87 | 0.94 | 1.30 | 8.27 | 1.93 | 65.33 | 15.67 | 0.83 | 1.32 |
| SD | 1.61 | 1.44 | 7.23 | 4.84 | 0.13 | 0.19 | 1.53 | 1.16 | 9.39 | 6.41 | 0.12 | 0.10 |
| t-value | 31.553 | | 33.885 | | 13.056 | | 19 | | 27.062 | | 20.843 | |
| P-value | 0.000** | | 0.000** | | 0.000** | | 0.000** | | 0.000** | | 0.000** | |
| t Critical two-tail | 4.140 | | | | | | | | | | | |
| Df | 14 | | | | | | | | | | | |

**Table-2: Representing Pre And Post Values Of NPRS, WOMAC &1RM Leg Press Test Between And Within The Groups.**

| Variables | NPRS (PRE) | | NPRS (POST) | | WOMAC (PRE) | | WOMAC (POST) | | 1RM (PRE) | | 1RM (POST) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Group1 | Group2 | Group1 | Group2 | Group1 | Group2 | Group1 | Group2 | Group1 | Group2 | Group1 | Group2 |
| Mean | 7.80 | 8.27 | 2.07 | 1.93 | 66.0 | 65.33 | 17.87 | 15.67 | 0.94 | 0.83 | 1.30 | 1.32 |
| SD | 1.61 | 1.53 | 1.44 | 1.16 | 7.23 | 9.39 | 4.84 | 6.41 | 0.13 | 0.12 | 0.19 | 0.10 |
| Sov | B | W | B | W | B | W | B | W | B | W | B | W |
| SS | 1.63 | 69.33 | 0.133 | 47.867 | 3.33 | 1967.3 | 36.3 | 903.06 | 0.10 | 0.451 | 0.001 | 0.633 |
| DF | 1 | 28 | 1 | 28 | 1 | 28 | 1 | 28 | 1 | 28 | 1 | 28 |
| MS | 1.63 | 2.47 | 0.133 | 1.70 | 3.33 | 70.26 | 36.3 | 32.25 | 0.102 | 0.016 | 0.001 | 0.022 |
| F Value | 0.659 | | 0.077 | | 0.047 | | 1.125 | | 6.344 | | 0.087 | |
| P value | 0.423 | | 0.782 | | 0.829 | | 0.297 | | 0.017 | | 0.770 | |
| F critical | 4.195 | | 4.195 | | 4.195 | | 4.195 | | 4.195 | | 4.195 | |

The mean scores indicate significant improvements in both groups for all metrics post-treatment. However, when assessing the statistical significance of these changes between groups and within groups through ANOVA, most comparisons (NPRS, WOMAC post-treatment, and 1RM post-treatment) yielded high p-values (greater than 0.05), indicating no significant difference between the treatment effects of the two groups, except for the WOMAC pre-treatment score, which showed a significant difference ($p=0.017$) indicating a significant reduction in joint pain and stiffness, and improvement in physical function in one of the groups. The F-values compared to the F critical value of 4.195 for most metrics did not reach statistical significance, further suggesting that the differences between the treatments' effects on the KOA symptoms are minimal. This suggests that both conventional exercises and Swiss ball exercises, when combined with ultrasound therapy, may offer similar benefits in

managing KOA symptoms.

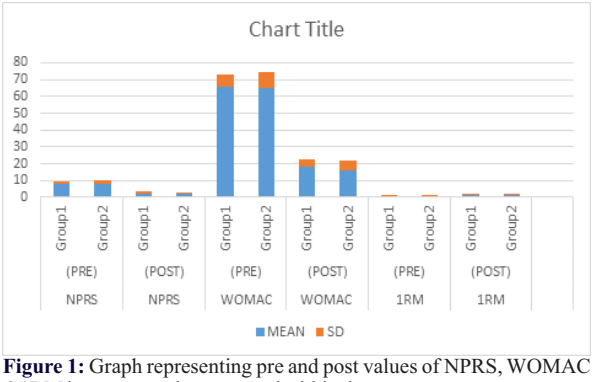


**Figure 1:** Graph representing pre and post values of NPRS, WOMAC &1RM leg press test between and within the groups.

## DISCUSSION

This randomized control trial assesses Swiss ball versus conventional exercises' effects on knee osteoarthritis pain, strength, and function in 40-60-year-olds. Group-1 underwent ultrasound therapy with Swiss ball exercises. Each exercise done with 30 seconds resting time between each exercise and repeated it for 3 sets with 3 minutes resting time between each set for 4 sessions in a week. Progression of 15 seconds time for each exercise for every 2 weeks is taken. Subjects of Group-2 (control group) received ultrasound therapy with conventional exercises was done in three sets of ten repetitions with a 3-min rest between them.

Ultrasound therapy for knee osteoarthritis enhances blood flow, reducing inflammation and facilitating tissue repair by delivering nutrients and oxygen. Its deep heating effects improve tissue flexibility and reduce stiffness, while also modulating pain through improved nerve conduction. Additionally, the therapy promotes better joint lubrication by improving synovial fluid quality, thereby reducing friction and improving knee function.

In their systematic review and meta-analysis, Zhang et al. demonstrated the efficacy of therapeutic ultrasound in the management of knee osteoarthritis. They reported significant improvements in pain relief and physical function, evidenced by a reduction in the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) physical function scores. Their findings advocate for the inclusion of therapeutic ultrasound as a beneficial and safe treatment modality for individuals with knee osteoarthritis. (11)

Conventional exercises for knee osteoarthritis focus on muscle strengthening, range of motion, and weight management to reduce joint stress and improve stability. Activities such as walking and cycling stimulate cartilage health and synovial fluid production, while exercise-induced endorphins provide natural pain relief. Improved circulation, balance, and proprioception exercises contribute to joint stability and reduced fall risk, collectively enhancing quality of life for individuals with knee osteoarthritis.

Chhabr and Sathya explored the impact of incorporating balance training with conventional exercises on individuals with knee osteoarthritis. Their research revealed that the combination significantly enhanced patients' functional abilities compared to conventional exercises alone. The study highlights the importance of exercises that focus on neuromuscular and proprioceptive training, neutral knee alignment, and muscle strengthening for improving knee joint stability (12).

Swiss ball exercises for knee osteoarthritis focus on building muscle strength, endurance, and enhancing joint flexibility, which aids in lowering the risk of injuries. These exercises improve balance and stability through proprioception challenges, while dynamic movements distribute weight to alleviate knee joint stress. Stimulating blood flow aids tissue repair and health, with pain modulation through endorphin release and improved joint lubrication from enhanced synovial fluid circulation. It's advised to consult healthcare professionals for proper execution and supervision.

Yoo and Yim investigated the combined impact of elastic band and Swiss ball exercises on lower extremity strength, balance, and pain in middle-aged women with knee osteoarthritis. Their findings indicated significant improvements in muscle strength, dynamic and static balance, and pain reduction in the experimental group, while the control group saw improvements in muscle strength and dynamic balance only. The study concluded that integrating Swiss ball with elastic band exercises offers more substantial benefits in balance and pain management for this demographic (13).

## CONCLUSION

The present study concluded that both conventional exercises and swiss ball exercises combined with ultrasound therapy have the similar effect of treatment on three outcomes (NPRS, WOMAC and 1RM leg press test) between the two groups.

## LIMITATIONS AND RECOMMENDATIONS

- Small sample size
- Short duration of the study
- In this study we considered only NPRS, WOMAC, and 1RM leg press test.
- We thus recommended future with multicentric studies with large sample size and long duration to further strengthen our study findings.
- We thus recommended the effect of swiss ball exercises on ROM, balance, and lower extrimities to strengthen their findings.

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