Comparative effects of pilates and isometric exercises on pain, functional disability and range of motion in patients with knee osteoarthritis

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Abstract

Objectives: Knee osteoarthritis is the most common disease of the knee joint and a growing public health problem with physical disability, preventing performance of daily activities. The purpose of this study was to compare the effect of isometric and Pilates exercise on pain, functional disability and range of motion in patients with knee osteoarthritis.

Methods: A total of 33 subjects with osteoarthritis of the knee joint completed the study. They were recruited from two tertiary hospitals in Lagos state, Nigeria and were assigned to three different groups (A, B, C). Group A included subjects that received Pilates exercises and Transcutaneous Electrical Nerve Stimulation (TENS). Group B included subjects that were treated using isometric exercise and Transcutaneous Electrical Nerve Stimulation (TENS). Group C comprised of subjects that underwent lifestyle modification and received Transcutaneous Electrical Nerve Stimulation (TENS). Subject underwent this protocol twice weekly for 8 consecutive weeks. They were assessed for pain, functional disability and range of motion using VAS scores, WOMAC scores and Goniometer as outcome measures. Data was analyzed using SPSS version 21. Level of significance was set at $p<0.05$.

Results: The results showed that in both Pilates and isometric groups there was reduction in pain intensity (P=0.001) and functional disability (P=0.001) as well as improvement in the range of motion (P=0.001) of the subjects.

Conclusion: Pilates and isometric exercises can reduce pain, improve functional ability and also range of motion of patient with knee osteoarthritis.

Keywords: Isometric exercises, Pilate's exercises, knee osteoarthritis

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Effets comparatifs des pilates et des exercices isométriques sur la douleur, l'incapacité fonctionnelle et la gamme de mouvement chez les patients atteints d'arthrose du genou

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Resume

Objectifs: L'arthrose du genou est la maladie la plus fréquente de l'articulation du genou et un problème de santé publique croissant avec un handicap physique, empêchant la performance des activités quotidiennes. Le but de cette étude était de comparer l'effet de l'exercice isométrique et du Pilates sur la douleur, l'incapacité fonctionnelle et la gamme de mouvement chez les patients atteints d'arthrose du genou.

Méthodes: Au total, 33 sujets atteints d'arthrose de l'articulation du genou ont terminé l'étude. Ils ont été recrutés dans deux hôpitaux tertiaires dans l'État de Lagos, au Nigéria et ont été affectés à trois groupes différents (A, B, C). Le groupe A a inclus des sujets qui ont reçu des exercices de Pilates et la stimulation nerveuse électrique transcutanée (TENS). Le groupe B comprenait des sujets traités par exercice isométrique et stimulation nerveuse électrique transcutanée (TENS). Le groupe C comprenait des sujets qui ont subi une modification du mode de vie et ont reçu une stimulation nerveuse électrique transcutanée (TENS). Le sujet a subi ce protocole deux fois par semaine pendant 8 semaines consécutives. Ils ont été évalués en fonction de la douleur, de l'incapacité fonctionnelle et de l'amplitude des mouvements en utilisant les scores VAS, scores WOMAC et Goniometer comme mesure de résultat. Les données ont été analysées à l'aide de SPSS version 21. Le niveau de signification a été fixé à $p < 0,05$.

Résultats: Les résultats ont montré que dans les groupes Pilates et isométriques, il y avait une réduction de l'intensité de la douleur ($P = 0,001$) et de l'incapacité fonctionnelle ($P = 0,001$) ainsi que de l'amélioration de la gamme de mouvement ($P = 0,001$) des sujets.

Conclusion: les exercices pilates et isométriques peuvent réduire la douleur, améliorer la capacité fonctionnelle et aussi la gamme de mouvement du patient souffrant d'arthrose du genou.

Mots-clés: exercices isométriques, exercices de Pilate, arthrose du genou

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INTRODUCTION

The knee is one of the most mechanically vulnerable areas in the body due to force and leverage acting on the joint both in terms of acute traumatic impacts and also in terms of weight bearing (1). Pain and disability are also major problems in patients with knee osteoarthritis; these lead to decreased physical functioning, and greater difficulty performing their activities of daily living, resulting in a decline in health-related quality of life (2).

However, reviewing the articles which have concentrated on utilizing exercise to alleviate pain and improving the function in patients with Osteoarthritis arthritis (OA) indicates the noteworthy role of using exercises in the treatment of knee OA (3).

In a study, by Lange *et al*. (4) it was concluded that resistance training can decrease pain and improve function in 50-70% of patients with osteoarthritis. Also in a study by Brosseau *et al.* (5), it was reported that strengthening exercises can only alleviate the pain in patients, although the proper intervention involves the functional training and aerobic exercises. This type of treatment is applied in order to decrease the pain, reach the normal tissue and joint biomechanics, and also improve function (6). Literature is sparse about the comparative efficacy of Isometric and Pilates exercise in the management of knee OA, as there is a dearth of clinical trials and research in this area.

Therefore this study was designed to determine and compare the therapeutic effects of isometric and Pilate exercises, on pain intensity, functional disability, and knee range of motion in patients with knee OA.

MATERIALS AND METHODS

A total of 50 subjects with osteoarthritis (OA) of the knee joint were screened for this study. They were recruited from the Physiotherapy Outpatient Clinics of Lagos University Teaching Hospital, Idi-Araba (LUTH), Lagos and the National Orthopaedic Hospital, Igbobi, Lagos. Included into the study are patients who had been diagnosed of either unilateral or bilateral knee osteoarthritis by the orthopaedic surgeon and also confirmed by the physiotherapist, while patients with neurological deficits on the lower limbs or those with previous knee injury, severe OA of grade 4 using the Kellgren and Lawrence System of Classification or those who had taken intra-articular steroid injections (in the past 6 months) were excluded from the study.

Subjects were selected into the study using a non-probability consecutive sampling technique. They were further assigned into groups (A, B&C) using simple random sampling method. (Fish bowl technique).

Of the 50 patients that initially consented to the study, 12 were found ineligible for the study and were excluded. Thirty-eight eligible subjects were randomly assigned into 3 groups (Group A, Band C) through the simple random sampling method. 33 subjects completed the study (Figure 1).

Group A: Subject in this group received Pilate's exercises and Transcutaneous Electrical Nerve Stimulation (TENS).

Group B: Subjects in this group were treated using isometric exercise and Transcutaneous Electrical Nerve Stimulation (TENS).

Group C: comprised subjects that were requested to maintain their own usual daily life-style and abstain from participating in any exercises and sporting activities in this period. They had lifestyle modification such as; diet education, losing weight, knee care education and joint protection measures such as braces (7) and the use of Transcutaneous Electrical Nerve Stimulation (TENS) and served as the control.

Subjects were treated twice daily for 8 consecutive weeks. Outcome measures were assessed at baseline, 4weeks and 8weeks.

Ethical approval was obtained from the Health Research and Ethics Committee of Lagos University Teaching Hospital (LUTH) Idi-Araba, Lagos with Approval number: ADM/DCST/HREC/APP/691. Informed written consent was also obtained from each subject. All the patients were assured of confidentiality of all information obtained. The research design was a randomized controlled study.

Subjects were assessed by obtaining a detailed history and by carrying out physical examinations and radiographic assessment of the knee joint. Information relating to age, sex, weight, height, Body mass index (BMI) and duration of knee pain was taken. Subjects were also questioned about past and present medications. After satisfying the inclusion criteria, the subjects were fully incorporated into the study after giving a written informed consent

duly signed by the subjects. Subjects were assessed for pain, functional disability and range of motion using VAS scores, WOMAC scores and Goniometer.

Procedure For Data Collection

The aims and objectives of this study were clearly explained to the subjects and their informed consent was sought. Subjects were randomly assigned into three groups (A, B and C), using a simple random sampling method (Fish bowl technique):

After satisfying the inclusion criteria, the subjects were fully incorporated into the study after giving a written informed consent duly signed by the subjects.

The subjects were evaluated at the Out-patient Clinic of the Physiotherapy Department of Lagos University Teaching Hospital Idi-araba (LUTH), and the National Orthopaedic Hospital, Igbobi, Lagos.

All subjects were assessed for inclusion and exclusion criteria. The weight and height of all the subjects were taken prior to the commencement of the study.

Baseline assessment of pain intensity, functional disability, knee range of motion and quality of life were carried out before involving the subjects in the study using; Visual Analogue Scale, WOMAC Questionnaire and Goniometer respectively.

Data Management

The data was entered using Microsoft Excel 2007 and then analyzed using the statistical Package for Social Science (SPSS Inc., Chicago, Illinois, USA) 21.0 versions for Windows package program. Descriptive statistics of frequencies and percentages were then calculated. The results were represented using tables.

Data Analysis

Demographic and quantitative data were expressed as mean ± standard deviation. Analysis of variance (ANOVA) was used to compare demographic variables across the groups and to compare the baseline; 4 weeks and the end of 8 weeks mean value of all outcome variables across the groups. Paired sample t-test was used to compare the baseline and 8th week values of the outcome measures. The level of significance was set at $p \leq 0.05$.

RESULTS

A total of 33 subjects (28 females and 5 males) took part in this study. Of the 33 subjects, nine 9 (27.3%) were within the normal Body Msss Index (BMI) range (<25kg/m^2), eight 8 (24.24%) were overweight (25-29kg/m^2), while sixteen 16 (48.5%) were obese ($\geq$30 kg/m^2).

Table 1 shows the physical characteristics of subjects in the 3 groups. The mean age of participants was 55.54 ±9.7 years, 52.27 ±14.85 years, 63.22 ±4.02 years respectively and the mean body mass index (BMI) was 30.66±6.02, 28.71±4.54, 29.78±5.83 in groups A,B and C respectively.

Analysis of variance (ANOVA) showed that there was no significant difference in the physical characteristics of subjects in the three groups.

Table 2 shows a comparison of the changes in the pain, range of motion and functional disability variables at baseline, at the end of 4th week and 8th week (post intervention). Analysis of variance showed significant difference at the baseline for pain and functional disability.

Table 3 shows the comparison of the changes in pain intensity, range of motion and functional disability between the baseline (pre-intervention) and end of 8th week (post-intervention) within each group. The paired t-test showed that there was significant difference between the pre and post intervention for pain intensity, range of motion and functional disability within each group.

DISCUSSION

In this study there was a marked improvement in clinical outcomes (pain intensity, functional disability and Lumbar ROM) obtained in all the study groups that are; Pilate exercise group, Isometric exercise group and the TENS only group. All outcome measures assessed in the study improved significantly post-intervention.

The socio-demographic detail of the participating subjects revealed that more females (28) were affected than males (5), this supports the findings of Felson, (8), and Akinpelu *et al,* (9), who reported that knee OA increases in prevalence throughout the elderly years especially in women than in men (8). An epidemiologic study of OA suggests the relevant difference between pathological pathways occurring during the onset of this disease in males and females (10). Women usually show a higher prevalence of OA in the knee than men (10).

The result of this study showed that

twenty-four (24) subjects of a total of thirty-three (33) were either overweight or obese (BMI greater than 25.0kg/m^2). This observation was similar to the findings of Eymard *et al*, (11) who found that increased BMI and weight bring about increased pain intensity in patients with knee Osteoarthritis. OA is increasingly considered as a systemic disease, especially in terms of a possible relationship to metabolic disorders linked to obesity. Obesity is one of the risk factors for knee OA, since mechanical overload on weight-bearing joints activates chondrocytes and accelerates cartilage degeneration (11). The knee is a weight bearing joint and obesity increases the loading of the knee joints which then speeds up the rate of degeneration of the articular components of the knee increasing the risk of knee osteoarthritis. BMI in excess of the normal healthy range has also been associated with accelerated disease progression (12). This further substantiates the report which states that Obesity is therefore classified as a risk factor that is mechanical in nature, which is consistent with its association in weight bearing joints (12).

The findings of this study showed that there were significant differences in the clinical outcome measures for Group A that received TENS and Pilates exercises, the effect of Pilates exercises on pain showed that there was reduction in pain intensity, functional disability and increase in range of motion of the knee joint. This is similar to a study by Najafabaadi *et al*, (13), who compared the effect of isometric exercise and Pilates on knee pain in individuals with knee osteoarthritis. There are limited evidence-based studies focusing on the influence of Pilates training on knee OA. Erfani *et al*, (14) studied the effects of a Pilates-based program on knee OA in healthy athletes; they concluded that a Pilates training protocol can be utilized as a safe and effective therapeutic method to improve function in individuals with knee OA. The findings of this study revealed that the effect of Pilates exercise on pain showed that there was reduction in pain intensity. There was an improvement in the range of motion for Group A that received TENS and Pilates exercises, this finding agrees with the result of a study by Phrompaet *et al*, (15) where it was stated that the prime purpose of Pilates training is to improve flexibility and general body status and also activate special groups of muscles during exercise. It was reported in a study by Keays *et al*. (16) that Pilates was used with the aim of increasing range of motion of joints of the upper limb in women with breast cancer. They concluded that Pilates training can be introduced as an effectual and safe therapeutic method for regaining joint motion and function of stiff upper limb.

There were significant differences in the clinical outcome measures for Group B that received TENS and Isometric exercises, the effect of Isometric exercises showed that there was reduction in pain intensity, functional disability and range motion of the knee joint. This finding was similarly reported in the result of the study by Cibor *et al*, (17) who investigated the "effect of Isometric Quadriceps Strengthening in Individuals with Knee Osteoarthritis" and stated that the subjects experienced improvements in pain levels, stiffness, functional performance, and overall disability level after completion of the six weeks resisted isometric training program. The findings also agrees with the result of the study of Shahnawaz and Ahmad (18) which concluded that a 5-weeks isometric quadriceps exercise program showed beneficial effects on quadriceps muscle strength, pain, and functional disability in patients with osteoarthritis of the knee. The result also agrees with the result of the study by Najafabaadi *et al*. (13) who in their study compared the effect of isometric and Pilates exercise on knee pain and quality of life in women with knee osteoarthritis.

The first step in rehabilitation is to increase the activation of the muscle around the knee the joint and to eliminate the inhibition. By training the quadriceps isometrically, motor unit activation is increased and the muscle is strengthened without triggering the pain that often comes from moving the joint against resistance. Quadriceps muscles get stronger and could absorb more of the shock in the joint from ground reaction forces during weight bearing activities. A reduction in protective muscle guarding and spasm in the peri-articular muscles was a likely explanation for any reduction in stiffness the subjects experienced. Cibor *et al*, (17) (1999) attributed these improvements to subject's gains in strength.

The study that investigated the comparative efficacy of Electrical Stimulation and isometric Exercise in the Treatment of Knee Osteoarthritis by Kocaman et al. (19) (2007) also corroborates the result of this study which revealed, that both electrical stimulation and isometric exercise reduced pain intensity and improved functional ability of patients with knee OA. This finding also support the cochrane report of meta analysis of land based exercise for knee

osteoarthritis, which included 32 randomized controlled trial of exercise for persons with symptomatic knee osteoarthritis, and it was concluded that exercise yielded small but significant benefit for self-reported pain and function (20).

In the control group; Group C that received TENS and advice on life style modification, there were also significant differences in the clinical outcome measures, the effect of lifestyle modification showed that there was reduction in pain intensity and functional disability. This was in agreement with previous studies (Messier *et al,* (21), Kidd, (22); Messier *et al,* (12) which asserted that interventions aimed at lifestyle modification, with diet-induced weight loss have been found to be effective for management of knee OA. The diet should remain well-balanced, and consistent with established dietary guidelines that promotes a desirable body weight. Also they were advised on the kind of foot wear to put on in order to reduce leg and foot pain, disability and improve their quality of life, (23).

There was no significant difference for pain, functional disability, and range of motion at 4^{th} week and at the 8^{th} week (post-intervention) across the three groups, therefore this indicates that all interventions were efficacious to the same degree, this might be due to the fact that all groups used TENS which has been shown in previous studies to be effective even when used alone. This assertion was corroborated by the study of Altay *et al*,(24) who found out the effect of TENS on Pain, Disability, Quality of Life and Depression in Patients with Knee Osteoarthritis and concluded that the addition of TENS to heating modalities and exercise program is more effective in decreasing knee pain and related disability in patients with knee OA. The study by Bal *et al*, (25) evaluated the long term efficiency of TENS on pain and disability and they found the superiority of TENS over placebo.

Some Pilates exercises like hundred and single-leg circles contains some components of isometric exercises, this might account for the similarities in the significance of the different interventions since isometric exercises has been found effective in the management of knee OA. Each of the interventions was efficacious and produced the desired change. However there was significant difference in the pain and functional disability of Group A at the baseline, this might be due to the over exacerbation of pain by the patient in the Pilates group. Moreover, overall scores for the treatment group improved significantly more than scores for the control group, with the improvements most likely due to the intervention.

CONCLUSION

The results of this study provide further evidence that patients with knee OA can achieve significant benefits from using, Pilate exercise, Isometric Exercises and TENS therapy. They have been found to be efficacious in the reduction of pain intensity and functional disability and have also been found to be efficacious in improving knee range of motion in patients with knee osteoarthritis.

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Conflict of interest: The authors declare no conflict of interest.

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Table 1: physical characteristics of subjects

	Group A X±SD	Group B X±SD	Group C X±SD	F	P-value
Age (years)	55.54 ±9.7	52.27 ±14.85	63.22 ±4.02	2.656	0.087
Height (m)	1.605±0.659	1.631±0.075	1.55±0.080	2.908	0.070
Weight (kg)	79.308±17.79	76.5±13.24	72.5±14.7	0.499	0.612
BMI (kg/m)	30.66±6.02	28.71±4.54	29.7±5.83	0.370	0.694

*: Significant at $p<0.05$ within the treatment groups

Key:
X±SD: Mean ± standard deviation
BMI: Body Mass Index
Group A: Pilates exercise group
Group B: Isometric exercise group
Group C: Control group
F: Analysis of Variance
n: number of subjects

Table 2: Comparison of subject's pain intensity, range of motion and functional disability at baseline, 4th week and 8th week across the three groups

	OUTCOME MEASURES	GROUP A X±SD	GROUP B X±SD	GROUP C X±SD	F VALUE	P VALUE
Baseline	Pain	8.54±1.19	7.36±0.80	6.89±0.78	8.531	0.001*
	Rom LT	108±11.05	117±7.91	110±13.8	2.051	0.146
	Rom RT	99.62±9.74	109.7±7.53	108±16.3	2.770	0.094
	Functional disability	44.31±6.9	40.00±7.18	33.00±6.00	7.361	0.003*
4 weeks	Pain	5.31±0.85	4.73±0.65	4.78±0.97	1.802	0.182
	Rom LT	114±9.86	119.5±8.19	114.67±13.15	0.928	0.407
	Rom RT	106±8.75	113.9±6.26	111.7±15.3	1.850	0.174
	Functional disability	37.5±5.54	34.82±6.63	29.3±6.93	4.471	0.206
8 weeks	Pain	2.36±8.09	2.73±0.91	2.57±0.53	0.578	0.568
	Rom LT	119.30±9.86	121.63±7.62	122±10.61	0.269	0.767
	Rom RT	112.50±8.96	116.64±5.72	117.84±15.2	0.769	0.474
	Functional disability	29.91±4.63	29.36±7.53	27.71±5.36	0.294	0.748

*: Significant at $p<0.05$ within the treatment groups

Key:
Rom-LT: knee range of motion in the left lower limb
Rom-RT: knee range of motion in the right lower limb
Rx: Treatment
Group A: Pilates exercise group
Group B: Isometric exercise group
Group C: Control group
F: Analysis of variance
X±SD: Mean and standard deviation

Table 3: Comparison of changes in Outcome measure parameters at baseline and 8th week within groups

	Outcome varaibles	Baseline X±SD	8th week X±SD	t-value	P value
Group A	Pain	8.73±1.00	2.36±0.80	14.725	0.001*
	Rom LT	108.16±11.05	114.02±9.87	5.879	0.001*
	Rom RT	99.63±9.70	112.52±8.96	-5.251	0.001*
	FD	44.31±6.94	29.91±4.64	-10.057	0.001*
Group B	Pain	7.36±0.81	2.73±0.91	14.974	0.001*
	Rom LT	117.11±7.91	121.62±7.62	5.862	0.001*
	Rom RT	109.01±7.5	116.63±5.75	-7.127	0.001*
	FD	40.34±7.18	29.36±14.0	-6.881	0.001*
Group C	Pain	7.13±1.13	2.75±0.70	9.045	0.001*
	Rom LT	115.43±13.24	122.80±10.06	7.175	0.007*
	Rom RT	112.32±15.59	118.10±14.06	-3.991	0.002*
	FD	34.15±6.70	28.91±5.86	-5.499	0.001*

*: Significant at $p<0.05$ within the treatment groups

Key:
Rom-LT: knee range of motion in the left lower limb
Rom-RT: knee range of motion in the right lower limb
FD: Functional disability
Rx: Treatment
Group A: Pilates exercise group
Group B: Isometric exercise group
Group C: Control group
t-value: Paired t test
X±SD: Mean and standard deviation

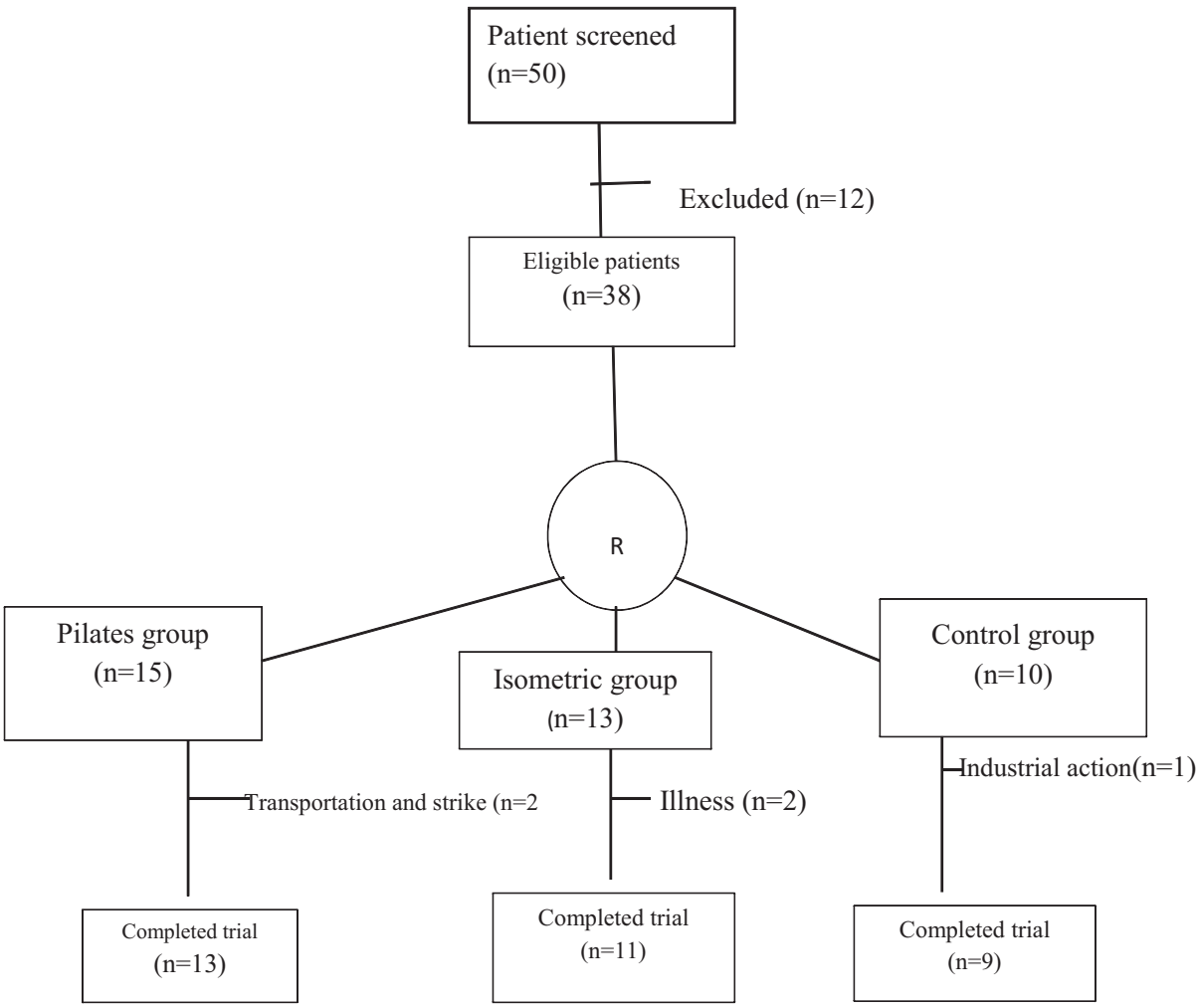

Figure 1: Flow of patients through the study. R: Randomization.