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Research Article

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Effect of a Four-Week Exercise Training on Knee Indices, Pain Perception, Wellness and Cardiorespiratory Endurance in Patients with Knee Osteoarthritis: A Randomized Control Trial

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| Abstract |

PURPOSE: To determine the effect of four weeks of exercise training on knee circumference and range of motion (ROM), pain perception, wellness, and VO_{2max} in patients at Osun State University Teaching Hospital, Osogbo, Nigeria.

METHODS: Forty subjects who met the inclusion criteria were randomized into control and experimental groups. patients were subjected to four weeks of flexibility and strengthening exercise, which included squatting exercise, ROM exercise, both groups were given some cardiovascular exercise. VO_{2max}), Wellness score and circumference.

RESULTS: Compared to the baseline values (week 1), there was increase in the knee ROM, and decrease in the pain perception in both groups after four weeks. However, the improvements seen in the experimental group, were significantly better relative to the control group after four weeks of intervention. owever, knee ROM and wellness scores of the experimental group, and the VO_{2max} of both significantly increase, but significantly decrease in the knee circumference and pain perception of both groups following 4 weeks of exercise was recorded.

CONCLUSION: he exercise modality in the study promote cardiovascular endurance, knee joint integrity, reduce pain perception in subjects. xercise intervention s beneficia to both groups since both reduction in the pain felt and also in knee swelling.

Key Words: Cardiorespiratory endurance, Exercise, Osteoarthritis, Pain, Wellness

Ⅰ. Introduction

Osteoarthritis of the knee is a degenerative joint disease that causes pain and stiffness in the knee. It is characterized by degradation of joint structures including articular cartilage, subchondral bone, ligaments, the capsule and the synovial membrane, resulting in pain, loss of function [1], swelling and warmth and reduced range of motion the knee joint,

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crepitus [2], pain, stiffness, joint instability, and muscle weakness. These could lead to impaired physical function and a reduced standard of living [3]. It significantly negatively impacts a person's, and ability to perform everyday activities leads to loss of work productivity, increased healthcare costs, and burden on social services as people with severe OA may require assistance in daily activities consequently reduces the quality of life of the sufferers.

The bones of the joints rub more closely against one another results in bone spurs and the aforementioned signs and symptoms [4,5]. Knee OA is the most common form hand and hip OA [6]. X-ray remains the most diagnosing OA [7]. It reveals the level of bone and cartilage damage and the presence of bone spurs. However, magnetic resonance imaging is when X-rays do not joint pain [5]. oth and non-pharmacological means. However, exercise remains one of the most discussed, least controversial, and most non-pharmacological management for OA.

Regular moderate exercise strengthens joints and decreases the risk of OA [8]. A tailored arthritis exercise program can help to relieve pain and fatigue and preserve joint structure and function. Precise and adequately designed exercise programs should be aimed at improving joint mobility and muscle strength, maintaining a healthy weight, and promoting the overall physical conditioning of the patient. [9] Imoto et al., (2012) reported the effects of strengthening and exercises on the muscles around the knee joint. The authors asserted that there was a significant improvement in pain perception, knee joint, and functioning of the joints [10]. Other researchers have shown that muscle and aerobic exercises are effective in reducing pain and improving physical function in patients with OA of the knee [3].

ROM varies among individuals and is influenced by factors such as age, gender, and whether the motion is performed actively or passively [11]. Other factors such as body mass index (BMI), occupational activities, and recreational may affect ROM but have not been as extensively researched as age and gender [12]. Overweight and obesity are risk factors knee OA because when the knee bears more weight than it should, eventually leads to wear and tear inflammation [2]. from local knee parameters, the degree of wellness and cardiorespiratory endurance, indicated by VO2 max is compromised in OA patients [13].

There are insufficient studies in the Nigerian population Therefore, this study to determine the effect of four four-week special exercise training program on knee circumference and, pain perception, wellness, and VO2 max in patients at Osun State University Teaching Hospital, Osogbo, Nigeria.

Ⅱ. Methodology

1. Participants

The population all patients Department of Physiotherapy Osun State University (UNIOSUN)Teaching Hospital, formally Ladoke Akintola University of Technology (LAUTECH) Teaching Hospital, Osogbo between January and December 2018. Forty (40) patients who met the inclusion criteria were purposively sampled for the study.

Inclusion and exclusion criteria

The inclusion criteria for the study included painful right or left knee ; knee OA within two years of onset; no underl pathology; no recent surgical procedure; and absence of any metal implant in the knees. he exclusion criteria were the presence of bone infection; recent serious traumatic injury leading to acute inflammation; fracture or dislocation in the lower limbs; the presence of metal implant in the limbs from open reduction surgery; and knee OA beyond two years.

Ethical concern and informed consent

Patients signed an informed consent form before participating in this research. Ethical approval (for the study was obtained from the Ethical of UNIOSUN Teaching Hospital Osogbo. Ethical approval number was UERC/ ASN/2018/1198).

2. Study design

The study two groups pre-test and post-test experimental research design. The sampled patients were divided into and control group of twenty patients each, using a random sampling technique (ballot). The experimental group performed the exercise intervention program (flexion and strengthening) during the four weeks of the study. The intervention for the control group procedures such as cryotherapy and thermotherapy treatments without the specific exercise program designed for the experimental group. The cardiovascular exercise therapy for both groups was a simple ergometric exercise on a bicycle ergometer for a period of 20 minutes per session.

This study was carried out over four weeks and data were collected in beginning of week 1 and end of week 4 with the help of three research assistants (physiotherapists) from UNIOSUN Teaching Hospital, Osogbo. The experimental group of the study was made to carry out active ROM exercise on a plinth at a high sitting position. They were made to do free flexion and extension 10 repetitions in week one, 20 repetitions in week 2, 30 repetitions in week 3, and 40 repetitions in week 4, with a rest interval of 30 seconds, 50 seconds, and 60 seconds, consecutively, for all exercises. Strengthening exercises done modified Matric (2015) squatting exercise procedure for strengthening knee joint complex. The squatting was done from a standing position, as the participants held on the back rest of a wooden chair, while the research assistants gave manual support by holding the chair down. The subjects were asked to squat down as much as the knee could permit, and then rise slowly to a standing position. The knee ROM was with a goniometer. The reference points were 10 cm distal to the knee and 10 cm proximal to the knee joint ubjects were made to flex the knee to the last flexion possible, then the knee circumference was taken at the center of the patella [14]. The pain perception was measured standard pain rating scale. [15] While the remaining control were only given the routine pain-relieving interventions such as cryotherapy and thermotherapy over four weeks. Also, both groups were given some cardiovascular endurance exercise such as ergometric exercises for 20mins.

3. Materials (Measurements)

The research instruments used included a standardized goniometer (manufactured by Yiwu, Tongyuan, Yiwu Zhe Jiang, China) calibrated from 0^{o} to 360^{o}, which was used to measure the of the knee joint standardized pain rating scale calibrated from 1 to 10, was used to measure pain perceived by the patients at joint (1 indicate no pain while 10 indicate intolerable pain); a non-elastic measuring tape, graduated in millimeters (1.0 to 150 mm) and inches (1 to 6 inches), was used to measure the knee joint circumference; weighing scale calibrated from 0 kg to 120 kg (manufactured by Marsden imited, Sheffield, Rotherham, UK) to measure the weight of the participants.

Determination of body mass index (BMI)

The BMI was determined by dividing the weight in kg divided by the square of their height (m^2) (BMI = weight/height^2) [14].

Determination of VO_2 max (ml/kg/min)

VO_2 max, an index of cardiorespiratory endurance, was determined as previously indicated by [14]

Determination Wellness scores

Wellness score was determined using questionnaire of wellness and quality of life (adapted WHOQOL. The questionnaire was adapted from the World Health Organization's (WHO, 2004)

4. Statistical Analysis

The data collected from this study were analyzed using GraphPad prism (version 10.0.2). The differences between the mean values of the pre-test and post-test were analyzed using paired t-test at .05 level of significance.

Ⅲ. Results

The result from Table 1 shows that the mean age of the experimental group is 56.70 ± 11.60yrs while that of the control group was 57.60 ± 5.20yrs, this shows that they were age- matched adults, the result also shows that

Table 1. Frequency distribution of participants by body mass index, age, gender, and affected knee

	Experimental Group		Control Group	
Variables	Frequency	Percentage	Frequency	Percentage
BMI (kg/m^2)				
Normal weight	2	10.0	0	0
Overweight	16	80.0	8	40.0
Obese	2	10.0	12	60.0
Age-group (years)				
40-49	4	20	8	40
≥59	16	80	12	60
Gender				
Female	8	40	10	50
Male	12	60	10	50
Affected knee				
Rt knee OA	10	50	8	40
Lt knee OA	10	50	12	60

Table 2. Comparison of the week 1 and week 4 results of the knee circumference, knee range of motion, pain perception between control and experimental group

Variables	Experimental group	Control group	t (p)[a]
Knee circumference (cm)			
Week 1	48.80 ± 5.33	45.10 ± 4.93	
Week 4	43.30 ± 4.67	44.50 ± 4.06	
t (p)[b]	2.971	1.634	.613
p-value	.024	.072	
Knee ROM(%)	Experimental group	Control group	t (p)[a]
Week 1	111.60 ± 14.14	106.20 ± 11.56	
Week 4	123.00 ± 14.51	107.10 ± 11.15	
t (p)[b]	3.67	1.60	2.747
p-value	.001	.210	
Pain perception	Experimental group	Control group	t (p)[a]
Week 1	7.50 ± 1.08	6.70 ± .95	
Week 4	2.30 ± .95	5.90 ± 1.45	
t (p)[b]	5.98	3.87	6.513
p-value	.001	.012	

Table 3: Comparison of the week 1 and week 4 results of the knee circumference, knee range of motion, pain perception, wellness rating, and VO_{2max} betweenthecontrol and experimental group

Variables	Experimental group	Control group	t (p)[a]
Wellness score			
Week 1	3.00 ± 2.40	2.0 ± 2.34	
Week 4	4.00 ± 0.21	4.00 ± 1.45	
t (p)[b]	4.08	1.79	2.53
p-value	.030	.032	
VO_{2max} (ml/kg/min)	Experimental group	Control group	t (p)[a]
Week 1	24.3 ± 3.21	26.8 ± 1.41	
Week 4	40.43 ± 4.10	32.56 ± 4.03	
t (p)[b]	6.000	1.34	2.47
p-value	.021	.070	

one only (5.0%) patient possessed normal body BMI, while 19 (95%) possessed unhealthy (overweight and obese) BMI. Out of 20 participants, 9(45%) were females, while 11(55%) were males.

Majority of the patients were between 59 years and above, meaning that they are old people as only 6(30%) were between 40-49 years. 11(55%) patients suffered left knee OA while 9(45%) suffered left knee OA Compared to the baseline values (week 1), there s a significant increase in the knee ROM, a significant decrease in the pain perception in both experimental group and control group after four weeks of exercise intervention. There was a significant difference observed in the knee circumference among the experimental group (Table 2).

Relative to the baseline (week 1), there as a significant increase in the wellness rating the experimental group, and in the VO_{2max} of both groups, after 4 weeks of intervention. here significant decreases in the knee circumference and the pain perception of both groups following 4 weeks of exercise intervention (Table 3). there was a significant increase in the wellness rating in the experimental group, and in the VO_{2max} of both groups, after 4 weeks of intervention.

Ⅳ. Discussion

In the present study, 80% of the experimental subjects re overweight, while 10% re obese. excessive body weight is predisposing factors knee OA in these subjects. It results in elevated stress on the knee joints and misalignment during daily activities ver time, this cause the degradation of the protective cartilage in the knee leading to [15]. Moreover, excess adiposity causes an increase in the systemic cytokine chronic inflammation, which have been implicated in the pathogenesis of damage to joint structures [16]eHe. A from the BMI, age is another predisposing factor for knee OA. 80% were 59 years old. With advancement of age, cartilage naturally undergoes wear and tear the stress it had been exposed to over time. Moreover, there is decline in the amount of lubricating synovial fluid within the joint and poor reparative process at the systemic level. These events promote the knee OA [17].

Compared to women, men tend to be more involved in physical activities that pose significant repetitive stress on the knee, precipitating OA. Moreover, men tend to have body weight relative to women. This exerts more stress on the knee joints, and promotes cartilage degenerate. Women have been noted to be more proactive and

concerned about their health and therefore more likely to seek medical care and counsel, which could reduce their exposure to modifiable risk factors that could cause knee OA. It should be noted that after the prevalence of OA tends to increase in female because of the decline in the protective action of estrogen [18]. However, the increase in the percentage of men with knee OA compared to the women in this study is associated with the sample size.

Knee pain in OA patients is often caused by degeneration of joint structures which results in inflammation, and the sensitization of the nerve the joint structure, which transmit signal to the central nervous system [20,21]. In the study, compared to the baseline values (week 1), there was a significant decrease in pain perception in both groups after four weeks of exercise intervention. Exercise strengthens the muscles around the knee joint and this helps to stabilize the joint structure. It promotes the flexibility and of the joint, helps in weight reduction, and stimulates the release of endorphins – a natural pain killer from the endogenous opioid system [22]. These explain the reduction pain perception following exercise intervention in this study. Moreover, relative to the baseline results, there was significant decrease in pain perception of both the control and experimental groups following 4 weeks of intervention. Knee pain is an early indicator for the development of knee OA [23]. It is considered as an early predictor of knee OA [23]. Individuals with knee OA shows increased pain perception in the affected knee joint but in this study there was a reduction in pain perception after the interventions [24].

The exercise intervention adopted in this study increased the knee joint in OA subjects, possibly in part by the same mechanism by which it reduces pain perception. In addition, could also be due to the reductions in the swelling around the knee joint that were recorded in this study. We observed that compared to the baseline, there was a significant reduction in the knee circumference of both experimental and control groups following 4 weeks of exercise intervention. There is reduction in the ROM of the knee joint in OA [26], and this was observed in the baseline values of the participants in our study. Further, our study showed that compared to the baseline values, there was an increase in the knee ROM in both the experimental and control groups, with a significant increase seen in the experimental group relative to the control group after four weeks of exercise intervention. Moreover, relative to the baseline, there is a significant increase in the wellness rating of the experimental group after 4 weeks of intervention. [27] Quaney et al. (2009) and [14] Ojo et al (2021) reported an improvement in wellness and cardiovascular endurance, marked by $VO_{2\ max}$ after exercise activities. This with the present study in which we observed that relative to baseline, there was a significant increase in the VO_2 max of both the control and experimental groups, after 4 weeks of intervention.

Ⅴ. Conclusion

The exercise modality in the study promotes cardiovascular endurance, wellness ratings, knee joint integrity, reduce pain perception in subjects. Finally, it observed that the parameters showed significant improvement in the control group, despite the experimental group showing better improvement compared to control group. This fact shows that the intervention each group beneficial, with greater improvement in the experimental group. There was also a significant reduction in pain and swelling of the affected knee(s), specifically in the exercise group

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