

Effect of Heat Application, Physical Exercise, and Combined Intervention on Pain, Morning Stiffness, and Activity Level among Patients with Knee Osteoarthritis

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Abstract

Background: Knee osteoarthritis (OA) is a common progressive, multifactorial, long-term chronic joint disease, characterized by deterioration of joint cartilage, leading to chronic pain, stiffness, and functional disability. **The aim of the study:** was to evaluate the effects of heat application, physical exercises, and combined interventions on pain, morning stiffness, and activity level among patients with knee osteoarthritis. **Research design:** A quasi-experimental design was utilized to conduct the current study. **Setting:** This study was conducted at the orthopedic outpatient clinics of Suez Canal University Hospital. **Subjects:** A purposive sample of 120 adult patients were randomly classified into three equal groups (heat application group, physical exercise group, and combined intervention group), which are included in the study. **Tools of data collection:** Two tools were used for data collection. **Tool I:** A structured interview questionnaire to assess patients' demographic data, as well as current and past health history; **Tool II:** Knee Injury and Osteoarthritis Outcome Score (KOOS) to assess patient-relevant outcomes following knee injury. **Results:** revealed a statistically significant difference between the heat application group, the physical exercise group, and the combined intervention group in terms of total mean score (45.51 ± 5.77 , 46.07 ± 9.99 , 44.96 ± 7.39 respectively) regarding morning stiffness with (P value. equal 001), while pain felling showed (48.99 ± 7.28 , 50.90 ± 10.66 , 48.40 ± 9.66 respectively), while total activity levels showed (76.79 ± 9.95 , 65.22 ± 18.34 , 88.35 ± 6.79 respectively) at the post-intervention phase. **Conclusion:** Combined intervention had the greatest positive effect on relieving pain and morning stiffness, with an improvement in the physical functions. **Recommendation:** Combined intervention of heat application and physical exercise are the choice of preference for managing patients with knee osteoarthritis problems as part of non-pharmacological strategies.

Keywords: Heat Application, Physical Exercise, Combined Intervention, Pain, Morning Stiffness, Activity Level, Knee Osteoarthritis.

Introduction:

Musculoskeletal diseases are major public health problems in most countries, as they cause major functional disabilities in adults and geriatrics, with OA being the most common one. It is a painful and disabling inflammatory disease of the joints, caused by multiple factors such as: joint

injury or overuse; obesity; heredity; and dramatically increases in prevalence with age (Wagner and Luna, 2018).

Osteoarthritis habitually occurs in weight-bearing joints, with the most affected joints being the knee, followed by the hip, and then the hand joints. Knee osteoarthritis (OA) is a common degenerative disease that led to break

down of the bones and cartilage with loss of articular cartilage tissue. The most evident symptoms of knee OA are localized pain at rest, morning stiffness that usually lasts within 30 minutes, bony tenderness and bony enlargement in the joint line, deformities, physical function limitation, and incapacity (Springer, 2019 & CDC, 2018).

Since knee OA is not a curable condition, its care typically focuses on preserving the patient's functional ability by managing pain and other symptoms in addition to improving joint movement and function. Knee OA treatment involves both pharmacological and non-pharmacological modalities (Lundgren-Nilsson et al., 2018). The pharmacological management reduce swelling and pain, but due

to the cost of the treatment and the prolonged-term side effects of the medications, it should not be underestimated (Salmon, et al., 2018).

Different nonpharmacological methods like patient education, protection of the joint, losing weight, physical exercise, heat and cold application, joint protection techniques, use of ancillary devices, thermal methods, acupuncture, and transcutaneous electrical nerve stimulation (TENS) could be applied for the treatment of knee OA (Uludağ and Kaşıkçı, 2019).

Heat application is a safe and low-cost option that could be used alone or in conjunction with other therapies for long-term pain control, stiffness, and inflammation (Shafii et al., 2018). It could encourage the healing of the damaged tissues and cause dilatation of the muscles' blood vessels, which increases the flow of oxygen and nutrients to the muscles. Moreover, warmth with gentle bending and flexing can spur joint fluid production, which could lead to muscles relaxation and help lubricate joints, in order to relieve muscle and joint stiffness, help warm up joints before activity, or ease muscle spasm. Warmth also stimulates sensory receptors in the skin and decreases the transmission of pain signals to the brain (Zamri et al., 2019).

Another non-pharmacological method used to eliminate pain and ensure

symptomatic relief of knee OA is physical exercise. Exercise could recover tendons, strengthen leg muscles, reduce the burden on joints, and stimulate beneficial biochemical changes in synovial fluid by increasing blood circulation in knee joints. Exercise could help in controlling symptoms of osteoarthritis such as pain, lack of flexibility, decreased strength, and morning stiffness. Controlling each of these symptoms could improve function, which will result in an improvement in quality of life (Kardage et al., 2019 & Bieler et al., 2018).

The combination of heat application and physical exercises for patients with knee OA have been shown to reduce pain, ensure comfort, and enhance stiffness and physical function (Çalışkan, 2013). Hence, the current study aimed to evaluate the effects of physical exercise, heat application, and a combination

of physical exercise and heat application on relieving pain and morning stiffness for patients with knee OA.

Significance of the study:

According to the National Institute of Health (NIH), osteoarthritis is the most common arthritic condition in adults worldwide and is the main cause of musculoskeletal system pain and disability. It affects two hundred forty million people worldwide. In Egypt OA is the most prevalent disease, affecting 5,596,869 of the total population (NIH, 2016).

Knee osteoarthritis is the most frequently diagnosed type of arthritis and will continue to increase in prevalence as life expectancy and obesity rise (Magnusson et al., 2019). The lifetime risk of developing symptomatic knee OA is estimated to be 45% (40% among men and 47% among women) based upon Johnston County OA Project data, with increasing risks among the obese to 60.5%, which is approximately double the risk of those who are normal or underweight (Bennell et al., 2018).

There have been numerous studies done on the various effect of the non-pharmacological methods to control OA pain and morning stiffness; however, there has been little research investigate the effect of physical exercise and heat application on relieving pain and morning stiffness among patients with knee

OA. As physical exercises are effective, low-cost, time-saving, and easy-to-use. They alternate hot compresses that have an immediate impact on pain relief as seen in most clinical situations. Besides alleviating pain, the application of hot compresses on knee OA could help to relieve stiffness and swelling (Nelson, 2018). Therefore, the present study was conducted to provide evidence for such action. The results of the current study will give evidence for nurses to use heat application, physical exercise, or a combination of both interventions as therapeutic regimens to reduce Knee suffering among patients with knee osteoarthritis.

Aim of the study:

The current study aimed to evaluate the effect of heat application, physical exercises, and combined therapy on pain and morning stiffness for patients with knee osteoarthritis. The aim will be accomplished through the following objectives:

1. Assess pain, morning stiffness and activity level among patients with knee osteoarthritis.
2. Evaluate the effect of heat application, physical exercises, and combined intervention on pain, morning stiffness and activity level among patients with knee osteoarthritis.
3. Compare between the effect of heat application, physical exercises, and combined intervention on pain, morning stiffness and activity level among patients with knee osteoarthritis.

Research hypothesis:

H0: Combined intervention of heat application and physical exercises will have a positive effect more than heat application alone or physical exercises alone on pain and morning stiffness among patients with knee osteoarthritis.

H1: Combined intervention of heat application and physical exercises will have positive effect more than heat application alone or physical exercises alone on pain and morning stiffness among patients with knee osteoarthritis.

Subjects and methods:

Osteoarthritis is a long-term chronic disease related to ageing and also associated with a variety of both modifiable and non-modifiable risk factors, including obesity, lack of exercise, genetic predisposition, bone density, occupational injury, trauma, and gender (Magnusson et al., 2019).

Research design:

A quasi-experimental study design was utilized to conduct the current study.

Setting:

This study was conducted at the orthopedic outpatient clinics in Suez Canal University Hospital, Egypt, which serves the Suez Canal region, including Ismailia, Port Said, Suez, and Sinai with free services; and the Beni-Suef University Hospital, which also gives free services to people living there.

Sample:

A sample of 120 patients from both sexes, complaining of knee osteoarthritis, at the prelisted settings, and classified into equal three groups, as (40) patients were assigned by random classification into each group under the study (heat application, physical exercises, and combined intervention of both heat application and physical exercises), using pre and post-test under some inclusion criteria that included: patients aged above 18 years old, having no cardiac diseases, and no previous or current joint surgeries. Exclusion criteria include patients with communication disabilities and being overweight.

Sample size:

The sample size was calculated according to the Thompson (2012) equation to consist of 40 adult patients in each group, with a total sample of 120 patients for all groups under the study, at a confidence level of 95%.

$$n = \frac{N \times p(1-p)}{\left[\left[N-1 \times (d^2 \div z^2) \right] + p(1-p) \right]}$$

: N=Total population, N= sample size. The standard normal deviate for Z =1.960. The

standard normal deviate for $P=0.5$. and D =error level 5%.

Tools of data collection: The following two tools were used to collect data and achieve the study's goal:

Tool I: Structured Interview Questionnaire:

This tool was developed by the researcher and reviewed by a panel of seven experts in medical surgical nursing aimed at assessing patients' demographic data and health-relevant data. It took about ten minutes to be completed; it is divided into two parts as follows:

Part I: Patients Demographic data: It included six multiple-choice closed-ended items about patients' gender, age, educational level; occupation, marital status, and residency.

Part II: Patients Health-relevant data It included five items to assess the past health history and present health status of patients. They included items about the disease's duration, the affected knee, comorbid diseases, a family history of the disease, and exercise ability.

Tool II: The Knee Injury and Osteoarthritis Outcome Score (KOOS):

The questionnaire was adapted from **Roos and Lohmander (2003)** to assess short and long-term patient-relevant outcomes following knee injury. The KOOS is a self-administered questionnaire, but in this study, the researchers completed the questionnaire themselves after asking patients as the patients complained of symptoms making them tired and exhausted from holding the questionnaire and being able to read and answer with concentration. The questionnaire included 38 items, grouped under five outcomes, including:

Pain: (9) items are used to measure the level of knee pain experienced while doing

certain tasks, such as walking on a flat surface, climbing stairs, and sitting or resting upright in bed at night. Symptoms: (7 items) to evaluate the degree of knee symptoms, such as grinding, hanging up, swelling, straightening, and full flexion, as well as the amount of joint stiffness after waking up in the morning.

Function, daily living: (17 items) to assess degree of difficulty during some activities (descending and ascending stairs, rising from sitting, standing, bending to floor/pick up an object, walking on flat surface, getting in and out of car, going shopping, putting on socks, rising from bed, taking off socks, lying in bed (turning over, maintaining knee position), getting in and out of bath, sitting, getting on/off toilet, heavy and light domestic duties).

Additionally, four items are used to evaluate the quality of life connected to the knees. Since it did not align with the purpose of the study, the researchers did not include the quality-of-life component. It took

roughly 20 minutes to complete the questionnaire.

The Scoring System

The KOOS's questionnaire had 38 items under four patient-relevant categories that were scored separately: nine items each for pain, symptoms, activities of daily living, and sport and leisure function (five items). A five-Likert scale was employed, with each item having five alternative answers and a score ranging from 0 (No problems) to 4 (Extreme problems), with the aggregate of all included items used to determine each of the four scores. The results are transformed to a percentage scale from 0 to 100, with 100 denoting no knee issues and 0 denoting severe knee issues. Scores ranged from 0 to 100, showing what portion of the possible score was really obtained. The total score for each subscale was divided into three levels: an extreme complaint was one with a score of 0 to less than 33; a moderate complaint was one with a score of 34 to more than 33; and from 66 to 100 was a mild complaint (**Shereif & Hassanin, 2011**).

Content validity and reliability:

Validity was done for Tool I, which was ascertained by a jury of seven experts from the Faculty of Nursing—Suez Canal University, the Faculty of Nursing—Mansoura University, and a specialist doctor in biostatistics to measure the clarity, relevance, comprehensiveness, reasonability, and applicability of the tool. Minor modifications were made accordingly, and then the text was translated into simple Arabic through back-to-back translation.

Reliability was tested statistically for tool I after translation using Cronbach's Alpha to be expressed at 0.813 to assure that it was reliable before data collection. Tool II was already a valid tool, and it was used in its original English language because the researchers had completed the answer after asking patients. The reliability of the tool based on standardized items (Cronbach's Alpha) was set at 0.917, which means excellent reliability.

Research ethical consideration:

Official permission to conduct the proposed study was obtained from the Ethical

Committee at Faculty of Nursing. The researchers explained to patients that their participation in this study was voluntary and each participant was informed about the purposes, procedure, benefits, and nature of the study; they also had the right to pull out of the study at any time. At that time, a verbal agreement was obtained from patients, and they were informed that the data collected would be used for research purpose only. The coding of collected data ensured the privacy and anonymity of each patient. Moreover, permission to implement the study was obtained from medical and nursing managers of the prelisted settings, with clarification of the study aims and benefits.

Pilot study:

The pilot study was conducted on 10 % of the total number of patients, which equaled twelve (12) patients, to evaluate the validity of the used tools for data collection; ascertain the clarity, objectivity, relevance, and applicability of the developed tools; and

estimate the time needed to fill in. According to statistical analysis of the pilot study results, minor modifications were done, so patients participating in the pilot study were included in the main results. The study was implemented at March 2021.

Field work:

A. Preparatory phase:

It included reviewing the related literature and developing theoretical knowledge of various aspects of the study using books, articles, web sites, periodicals, and journals to develop the tools for data collection.

B. The assessment phase:

After granting approval to proceed with the proposed study, the researchers assessed the participants to get the starting point for data collection using tools one and two for all the study groups. The time each patient needed to complete the questionnaire ranged from 30 to 40 minutes. Based on the piloting and starting point data collected, the researchers outlined and prepared a small, simple Arabic-colored educational booklet to cover interventions that will be implemented in the study groups.

C. Implementation phase:

The data was collected over a ten-month period starting from April 2021 to January 2022. The researchers were available at the previously mentioned settings three days a week during the morning shift, as that is the time in which outpatients work. At this phase, instructions to use heat application, physical exercises, and combined therapy intervention instructions were provided to patients and their accompanied caregivers side by side with the prescribed medications. Oral instructions were supported by a colored booklet designed by researchers in simple Arabic language, and referenced by (Songül et al., 2019; Shereif & Hassanin, 2011). The selected patients were interviewed individually by the researchers two times throughout the study. The first interview was for the pre-test, and the second was after one month for the post-test.

In addition to the indicated pharmacological treatment, patients in the

exercise group were requested to complete the suggested exercise twice per day for ten minutes (in the morning and evening) for five days a week for four weeks. Stretching exercises like standing calf stretches, prone quadriceps stretches, and range-of-motion drills were advised, as were strengthening exercises such (quadriceps strengthening exercise, and standing terminal knee extension).

In addition to the prescribed pharmaceutical treatment, patients in the heat application group were advised to utilize two hot packs for a total of 20 minutes twice /day for five days a week. The patients were instructed to apply hot packs while sitting with their legs extended and to store them in their cases after five minutes of immersion in boiling water.

Patients in the combination therapy (exercise after heat application group) were instructed to execute the suggested exercises for 10 minutes twice daily (morning and evening), after applying heat packs to both knees for 20 minutes, in addition to the indicated pharmaceutical treatment. The preset intervention practices were asked of every patient in each of the three groups by phone call twice a week, and those who did not routinely engage in the activities were dropped from the study.

Evaluation phase:

The patients were called for a follow-up 4 weeks after the assessment at the first interview to determine the changes in pain patients pain intense level, stiffness, and activity levels, using the same two tools of data collection. The researchers evaluated the patients' levels of pain, morning stiffness, and functional levels, then compared the effects of heat application, physical exercise, and combined intervention (physical exercises after heat application) on the same dimensions among the three groups.

Statistical analysis:

Data was analyzed using SPSS (Statistical Package for Social Sciences) version 22. Qualitative data was presented as number and percentages. Comparison between groups was done by Chi-Square test.

Data was presented as mean \pm SD. Student t-test was used for comparison between groups. Wilcoxon Signed Ranks test used for comparison within group. $P < 0.05$ was considered to be statistically significant.

Results:

Table 1 showed comparisons between the studied KOA groups according to their demographic data. The table showed no significance in different demographic data of all the studied groups except in gender and educational level. Approximately two-thirds of the study participants in the studied groups (heat application, physical exercise, and combined intervention group) were female (70%, 72%, and 67.5% respectively) with p level = 038. Regarding educational level, the majority of the participants (70%) in the exercise group had moderate education, while among the heat application group, it was (45%) and in the combined intervention group it was (37.5%), with $p = 011^*$.

Table 2 showed comparisons between the studied groups with knee OA regarding to health relevant data. The findings revealed no statistically significant differences between the studied groups in terms of osteoarthritis duration, affected knee, comorbid diseases, family history of knee OA, and ability to perform exercises.

Table 3 showed comparisons between the studied groups with knee OA according to the total mean scores of short and long-term patient-relevant outcomes following knee injury in pre- and post-intervention assessment. The result showed that there was statistically significant improvement in morning stiffness among all the studied groups, but the highest improvement level was among the patients in the combined therapy group compared to the heat application group and followed by the physical exercise group by (44.96 \pm 7.39, 45.51 \pm 5.77, 46.07 \pm 9.99 respectively) with $p = <.001$.

There was a statistically significant improvement in total pain scores after the intervention among all patients in the studied groups, but the combined intervention group outperformed the heat application group and

was followed by the physical exercise group by (48.409.66, 48.997.28, 50.9010.66 respectively with $p = .001$.

There was a statistically significant improvement in the total activity levels after the intervention among all patients in the studied groups, but the combined intervention group outperformed the heat application group and followed by the physical exercise group by (88.35 ± 6.79 , 76.79 ± 9.95 , and 65.22 ± 18.34) respectively with $p = .001$.

Table 1: Comparison between study groups regarding patients' demographic data (n=40)

Patients' demographic data	Heat (G1) n=40		Exercise (G2) n=40		Combined intervention (G3) n=40		X ² test	P-value
	N	%	N	%	N	%		
Age								
20:<25	1	2.5	0	0	0	0	9.80	.272
25:<30	0	0	1	2.5	4	10.0		
30:<35	3	7.5	8	20.0	3	7.5		
35:<40	7	17.5	7	17.5	6	15.0		
40:<45	12	30.0	22	55.0	14	35.0		
45-49	18	45.0	2	5.0	13	32.5		
Gender								
Male	12	30.0	11	27.5	13	32.5	6.52	.038*
Female	28	70.0	29	72.5	27	67.5		
Marital status								
Married	37	92.5	39	97.5	35	87.5	3.17	.787
Single	0	0	1	2.5	0	0		
Divorced	1	2.5	0	0	2	5.0		
Widowed	2	5.0	0	0	3	7.5		
Educational level								
Illiterate	8	20.0	0	0	9	22.5	19.74	.011*
Read and write	2	5.0	0	0	5	12.5		
Primary	2	5.0	4	10.0	0	0		
Moderate	18	45.0	28	70.0	15	37.5		
High	10	25.0	8	20.0	11	27.5		
Job								
Working	25	62.5	28	70	25	62.5	.072	.964
Not working	15	37.5	12	30	15	37.5		
Residence								
Rural	29	72.5	26	65.0	27	67.5	.000	1.000
Urban	11	27.5	14	35.0	13	32.5		

X² is chi-square test; P value is significant at <.05

Table 2: Comparison between study groups according to their health relevant data regarding knee OA (n=40).

Health relevant data	Heat(G1) n=40		Physical Exercise(G2) n=40		Combined Intervention (G3) n=40		X ² - test	p-value
	N	%	N	%	N	%		
Duration of osteoarthritis								
< 5y	23	57.5	28	70.0	24	60.0	.655	.957
5:10 y	15	37.5	12	30.0	14	35.0		
>10y	2	5.0	0	0	2	5.0		
Knee affected								
Right	11	27.5	16	40.0	16	40.0	2.31	.678
Left	15	37.5	9	22.5	8	20.0		
Both	14	35.0	15	37.5	16	40.0		
Comorbid diseases								
Hypertension	19	47.5	7	17.5	17	42.5	5.79	.447
Renal diseases	0	0	0	0	0	0		
DM	2	5.0	4	10.0	6	15.0		
Liver	1	2.5	1	2.5	0	0		
Others	3	7.5	1	2.5	2	5.0		
No	15	37.5	27	67.5	15	37.5		
Family history of OA								
Yes	20	50.0	19	47.5	17	42.5	2.40	.300
No	20	50.0	21	52.5	23	57.5		
Ability to do exercises								
Yes	6	15.0	3	7.5	5	12.5	.137	.934
No	34	85.0	37	92.5	35	87.5		

X² is chi-square test; P value is significant <.05

Table 3: Comparison between studied groups by the total mean scores of short and long-term patient-relevant outcomes following knee injury pre- and post-intervention.

Items	Heat G1. (n=40)	Physical Exercise G2. (n= 40)	Combined intervention (G3) (n=40)	F (P value) (η^2)	P1	P2	P3
	Mean \pm SD	Mean \pm SD	Mean \pm SD				
Morning Stiffness							
Pre	63.66 \pm 6.62	52.59 \pm 6.86	58.13 \pm 5.20	NS			
Post	45.51 \pm 5.77	46.07 \pm 9.99	44.96 \pm 7.39	31.15(<.001*) (.35)	(<.001*)	(<.001*)	(<.001*)
t,P value,d ²	10.76(<.001*) (1.9)	3.51(.001*) (.66)	10.13(<.001*) (2.19)				
Total pain							
Pre	83.27 \pm 10.01	66.74 \pm 13.56	75.00 \pm 6.17	NS			
Post	48.99 \pm 7.28	50.90 \pm 10.66	48.40 \pm 9.66	25.43(<.001*) (.30)	(<.001*)	(<.001*)	(<.001*)
t,P value,d ²	25.43(<.001*) (4.1)	6.98(<.001*) (1.5)	17.58(<.001*) (3.58)				
Total activities							
Pre	48.58 \pm 9.31	44.98 \pm 9.18	45.82 \pm 9.21	NS			
Post	76.79 \pm 9.95	65.22 \pm 18.34	88.35 \pm 6.79	33.31(<.001*) (.36)	(<.001*)	(<.001*)	(<.001*)
t,P value,d ²	29.83(<.001*) (4.4)	9.46(<.001*) (2.1)	24.97(<.001) (3.36)				

F is one-way a nova test; t is paired sample t-test; d2 is Cohen's d effect size P value is significant at <.05*; P1 is heat versus exercise group, P2 is heat versus combined intervention group, p3 is exercise versus combined group; Adjustment for multiple comparisons: NS stands for Not Statistically Significant.

Discussion

Patients with knee OA, experience a variety of issues, including pain, joint stiffness, balance disturbance, and a reduction in physical function (Hoogeboom et al., 2013). A combination of pharmacological and non-pharmacological approaches is recommended for efficient management of patients with knee OA. physical exercise and heat application, among the non-pharmacological methods frequently used to eliminate pain and other associated symptoms in order to improve function (İnan & Kiyak, 2014). This study was carried out to evaluate the effect of heat application, physical exercises (pre and post) heat application on relieving pain, morning stiffness and activity level for patients with knee OA.

The current study results showed significant improvements in relieving pain and morning stiffness for patients with knee OA after the implementation of heat application, physical exercise, or a combination of both intervention regimens. The findings lead to achieving the set hypothesis, with confirmation of the effectiveness of the intervention. Discussion of the current study findings is presented in the following sequence:

First Section: Demographic Data:

The present study findings showed no significance different regarding the demographic data among all the studied groups except in gender and educational level. Around two-thirds of the study participants in the studied groups (heat application, physical exercise, and combined therapy group) were female. Regarding educational level, the majority of the participants in the physical exercise group had moderate education, while in the heat application group it was less than half and in the combined intervention group it was more than two-thirds. Also, the study revealed that osteoarthritis increases with age, marriage, and among patients who living in rural areas.

These findings are similar to the result of a recent study in Egypt done by Abdelfattah et al. (2019), who reported that the majority of study patients' ages ranged from 41 to 65 years old, and two-thirds of the study patients with knee OA came from rural areas. Also, Karadag et al. (2019) found that the majority of the studied patients were married females, but on the other hand, most of the participants were not working and had only primary school education. Moreover, Ali (2018) stated that osteoarthritis appears to favor women, especially for patients with knee and hand arthritis, but the majority of the studied patients settled in urban areas.

From the researchers' point of view, these results are interpreted as radiographic damage in the knee increasing with age, even in the absence of disease, demonstrating the occurrence of mild joint degradation. Symptoms begin to appear in women between 40 to 50 years old, with the disparity turning out to be greater after age 55 years old as a result of menopause. People who live in rural areas engage in harder work like agriculture, which may increase the risk of the disease.

Second Section: Health Relevant Data regarding Knee Osteoarthritis:

The current study found no statistically significant differences between the studied groups in terms of osteoarthritis duration, affected knee, comorbid diseases, family history of knee OA, and the ability to do exercises. More than half of patients in all the studied groups (heat application, physical exercise, and combined intervention) groups complained from knee OA for less than 5 years and had right osteoarthritis knee. Less than one-half of patients in the heat application group and the combined intervention group had hypertension, but the majority of patients in the physical exercise group did not have chronic comorbid diseases. More than one-half of the patients in the exercise group and combined intervention group don't have a

family history of osteoarthritis, and one-half of the patients in the heat application group have a family history of knee OA. Also, the majority of the studied patients in the three groups did not do exercise.

These results were in line with **Mohamed & Mohamed (2019)**, who reported that, the majority of the studied patients have complained of knee OA for less than five years, one-half of the studied patients in the intervention group have a family history of knee OA, and more than one-half of the patients in the control group did not have a family history of knee OA. However, **Metcalf et al. (2012)** declared that the majority of the studied patients had bilateral OA knee. Also, **Abdelfattah et al. (2019)** reported that three-quarters of the studied patients have a previous family history of osteoarthritis. From the researchers' point of view, these results were due to the traditional risk factors such as aging, socioeconomic status, family history, obesity, female gender, and chronic inflammation, which potentiate the incidence of hypertension with knee OA. Furthermore, most patients were unaware of the effect of the physical exercise in relieving pain and stiffness caused by knee OA and may believe that exercise increases the likelihood of pain.

Third Section: Pre- and post-intervention short- and long-term patient-relevant outcomes following knee injury:

The current study result showed that there was statistically significant improvement in morning stiffness, total pain, and total activity levels after implementation of the intervention in all the studied groups, but the highest one was in the combined intervention group compared to the heat application group and followed by the physical exercise group. The researchers believed that the combined intervention had twice the effect of the intervention therapy alone in terms of symptom relief.

Similarly, a study conducted by **Karadage et al., (2019)** reported positive effect on relieving pain and improving physical function in the exercise post-intervention among the heat application group. Also, **İnan and Kiyak (2014)** revealed that heat application performed by putting the hot packs over knee OA for 15 minutes, 5 days a week for a month was effective for improving pain intense, stiffness, and physical activity, with statistically significant difference. Moreover, **Yılmaz et al. (2013)** determined that home exercise program for 8-weeks will increase the activity level and decrease the pain intense among patients with KOA. **Jebakani et al. (2015)** demonstrated that a 4-week therapeutic exercise program is effective in reducing physical activity disorder and pain.

Conclusions:

The result depicted that there was statistically significant improvement regarding morning stiffness, pain level and total activities levels after implementation of the intervention among all patients in the studied groups (heat application, physical exercise or combination of both), but the highest effect was in the combined intervention group compared to the heat application group and followed with the physical exercise group to be the least effective intervention.

Recommendation:

Based on the findings of the present study, the following recommendations were suggested: -

- The study recommended that the combined intervention is the choice of preference for the managing patients with knee OA as a non-pharmacological method, all patients with OA knee should be train on heat application and physical exercises, which are easy-to-apply, cost-effective, and efficient methods as a part of routine care that should be provided.
- Further studies comparing the efficiency of other non-

pharmacological methods such as cold application and acupuncture in managing knee OA are recommended.

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