Original Article

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Quick Response Code:

Website: www.jehp.net

DOI: 10.4103/jehp.jehp_1628_22

Effect of multi-component exercises program on pain-related gait adaptations among individuals with osteoarthritis of the knee joint

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Abstract:

BACKGROUND: Osteoarthritis of the knee causes pain and gait disturbances, as well as a distinct gait pattern. Patients with knee OA have decreased range of motion (ROM) and increased ground reaction force. OA reduces stride length and walking speed.

OBJECTIVES: To determine the effect of a multi-component exercise program on pain-related gait adaptations among individuals with osteoarthritis of the knee joint and to compare the effect of multi-component exercises with traditional exercises on pain-related gait adaptations among individuals with osteoarthritis of the knee joint.

MATERIALS AND METHODS: This was an experimental study done between 120 patients having knee OA, of both genders, and between the age group of 50–65 years. These individuals were residents of the city of Karad and they were randomly divided into group A (conventional/traditional) and group B (experimental). A pretest assessment was done and the treatment was given for 6 weeks. The later posttest assessment was done and further statistical tests like paired and unpaired t tests were used.

RESULTS: Among the 120 subjects with OA knee, the age group of 60–65 years (44%) was found to be commonly affected. Thirty-nine were males (32.5%) and 81 were females (67.5%). Fifty-eight subjects (48%) were found to be commonly overweight. Thirty-two subjects (27%) had Genu Valgum deformity, and 88 subjects (73%) had Genu Varum deformity at the knee joint. The *P*value within both group A and group B was found to be statistically significant for the entire outcome measures used for assessment. The pretest vs post test values of the WOMAC scale for patients with knee OA within both groups were found to be extremely significant ($P < 0.0001$). As for the MMT score in these patients, the Knee Flexors of Group A were not significant for right side ($P = 0.7088$) as well as for left side ($P = 0.083$) and in Group B they were extremely significant ($P < 0.0001$) for both sides. For the ROM scores within both groups, Knee Flexion of Group A for both sides was found to be extremely significant ($P < 0.0001$) for both sides. And for the pretest vs posttest values of within the groups'gait parameters among these patients with OA knees, for cadence both groups B were found to be extremely significant ($P < 0.0001$). The stride length for Group A was found to be very significant ($P = 0.0060$) and for Group B it was ($P < 0.0001$).Also, the *P* values of the various outcome measures between both groups were found to have statistical significance of their own.

CONCLUSION: Effect of Multi-Component Exercise Program on Pain-Related Gait Adaptations Among Individuals with Osteoarthritis of the Knee joint was found to be significant in pain reduction, improving strength, range of motion, and the gait parameters such as an increase in cadence, stride length, step length and decrease in the step width.

Keywords:

Gait, Genu Valgum, Genu Varum, knee osteoarthritis, quality of life, walking speed

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Received: 14-11-2022
Accepted: 12-01-2023
Published: 28-04-2023

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How to cite this article: Bhore P, Shinde S. Effect of multi-component exercises program on pain-related gait adaptations among individuals with osteoarthritis of the knee joint. J Edu Health Promot 2023;12:138.

Introduction

The World Health Organization (WHO) in the year 2022 based on the Best Evidence of Rehabilitation has strongly recommended for people with knee and hip osteoarthritis focus more on the "core area of treatment", which mainly includes patient education, exercise training (muscle strength, joint proprioception, posture correction, Balance, and gait control) and mainly they have highly suggested targeting on weight reduction if the individual is overweight or obese. Nowadays due to digitalization, the world has become more sedentary and activity levels have decreased. In individuals who are in their early fifties, sedentary behavior both due to work and leisure time can contribute to the degenerative factor seen with aging. As their age progresses due to a lack of low limb activity and this kind of sedentary behavior the muscles supporting these weight-bearing joints (mainly—the hip and knee) are weakened, which in turn overloads the joint surfaces causing them to wear more. This increases the pain and inflammation which is experienced by the individual while joint mobility or in weight-bearing activities like walking. These changes can cause variations or "Pain-Related Gait Patterns" to which these individuals eventually adapt and it affects the Biomechanical Chain of the Body (spine, hips, knees, ankle, and foot complex).

Arthritis is a general term for joint inflammation.[1] Osteoarthritis (OA) is the most common type of degenerative disorder.[2] It is a type of joint disease caused by the breakdown of joint cartilage and underlying bone.[3] It is estimated that more than 10% of the world's population over the age of 60 suffers from joint pain caused by osteoarthritis.[4] Osteoarthritis is the second most common rheumatologic problem and the most common joint disease in India, with a prevalence ranging from 22 to 39%.[4,5]

Pain is the most common reason OA patients seek treatment, and it is the endpoint for all approved treatments. The pathogenic significance of OA knee pain is unknown. Despite the fact that exercise is the most commonly recommended treatment,[2] pharmacological pain treatment is still commonly prescribed for pain management. Although clinically beneficial, pain reduction or elimination may disrupt the protective motor system response to nociception and may hurt OA, particularly in mechanically mediated knee and hip OA. Initial evidence suggests a link between mechanical loading at the knee joint and structural and symptomatic severity, as well as a possible role for mechanics in structural and symptomatic progression.[6]

Pain plays an important physiologic role in that it interferes with or stimulates the motor system even though protects tissue from a perceived or actual threat of damage. The joint capsule, synovial lining, ligaments, menisci, periosteum, and subchondral bone all contain nociceptive nerve fibers.[7]

Osteoarthritis is the most common joint disorder and is strongly linked to aging.[8] Knee OA causes pain and gait disturbances, as well as a distinct gait pattern.[7,9] Patients with knee OA have decreased range of motion (ROM) and increased ground reaction force.[7,9] OA reduces stride length and walking speed.[10] Patients try to alleviate pain by reducing the impact on their knees.[11] Patients with knee OA have a higher knee adduction moment (KAM), which is a marker of medial joint loading and a known risk factor for arthritis progression.[12–14] Such gait changes in knee OA can have an impact on adjacent weight-bearing joints, such as the hip and ankle joints.[15–17]

Conservative treatments, such as education, regular and moderate exercise, and physical conditioning, as well as aid devices and joint protection strategies, have been advocated for elderly people with knee OA.[18] Exercise protocol and the walking program can improve the quality of life of elderly people with knee OA.[19] In older individuals with poor lower limb performance, it is reasonable to believe that obesity and the alterations in the lumbar spine can affect the gait pattern more than in younger individuals. Increased body mass may increase the risk of damage with increased forces across weight-bearing joints, injury to the joint surfaces and articular cartilage overloading is believed to contribute to the development of medial compartment knee OA. The medial compartment is affected 10 times more often than the lateral compartment, which is likely due to greater medial compartment loading during gait as the forces on the joint surfaces are maximized. Despite various significant interests and efforts to improve pain management and to develop novel targets, there has been very limited success regarding the pain management. None have mentioned any adaptive gait patterns associated with OA knee to accommodate the pain. Masking the pain may also lead to changes in the magnitude or pattern of loading at the painful site. Although clinically beneficial, reduction or removal of pain may interrupt the protective motor system response to nociception and may have a negative consequence in OA, in particular for knee joints, which are mechanically mediated, which in turn will lead to overloading of the joint and gradually both structural and symptomatic progression will accelerate eventually. The link between knee OA pain and gait changes is still unclear, and a better understanding of this link could advance disease treatment and prevention. Hence, this study was done to determine the Effect of a Multi-Component Exercise Program on

Pain-Related Gait Adaptations among individuals with Osteoarthritis of the knee joint.

Materials and Methods

Study design: Experimental Study of Pre- and Post-Design.

Study participants and sampling: A total of 120 patients diagnosed with osteoarthritis (OA) of the knee, both male and female, within the age group of 50 to 65 years, with grade 1 and 3 OA knees were selected for this study. The majority of patients were residents of Karad, Maharashtra. The purpose of the study and the role of patients were clearly explained to the patients before starting the actual study. The objectives were to determine the effect of a multi-component exercise program on pain-related gait adaptations among individuals with osteoarthritis of the knee joint and to compare the effect of multi-component exercises with traditional exercises on pain-related gait adaptations among individuals with osteoarthritis of the knee joint.

Outcome measures

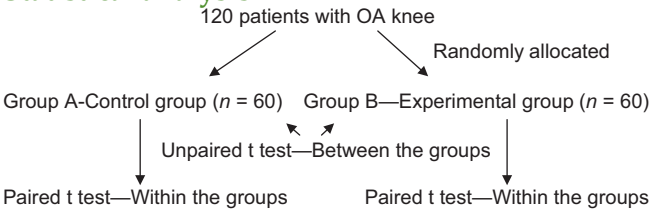
1) Western Ontario and McMaster's Universities Osteoarthritis Index (WOMAC): The WOMAC is a self-assessed disease-specific measure for patients with OA of the knee and hip, comprising 24 items in three dimensions: pain, function, and stiffness. Can be used in the evaluation of patients with OA treated conservatively. Its inter-rater and intra-rater reliability was found to be 0.91 and 0.81, respectively, with satisfactory ICC.
2) Manual muscle testing: MMT is the most commonly used method for documenting impairments in muscle strength. The examiner in the application of force to the subject's resistance evaluates the muscle groups being studied as subjectively "weak" or "strong" on a five-point scale.
3) Range of motion: Knee ROM is commonly used as an outcome measure in clinical trials of people with knee OA. Goniometry is a reliable and valid method of measuring knee ROM, as well as a convenient and accessible outcome measure in clinical trials and physiotherapy practice.
4) Gait analysis: The gait parameters such as cadence, stride length, step length, and step width of the individuals were recorded. Cadence is the number of steps in a minute, stride length is the distance between the heel of a foot while the heel strike to the next heel strike of the same foot, step length is the distance between the heels of both feet, and step width is both feet when both feet are on the ground.

Procedure: After the approval from the Institutional Ethics Committee of KIMSDU, Individuals were approached and selected based on the inclusion and exclusion criteria. The procedure was explained and written informed consent was taken from those willing to participate. Demographic information of the subjects was taken. The individuals haveexplained the purpose of the study. Also, they were informed about the procedure. The 120 individuals were randomly allotted toboth groups, i.e., 60 in each group. A pretest assessment was done using the WOMAC scale, MMT, ROM, and gait analysis. Then, the protocol was implemented as per the groups. The experimental group program consisted of 30 sessions for both groups, with each session of 45 to 60 min, which was performed. The intervention program consisted of 30 sessions, with the sessions performed five times per week for 6 weeks. The later post test assessment was done by using the same outcome measures as mentioned above. Data were recorded for both groups and the values were compared to test the hypothesis and level of significance among both groups.

For Group A—Conventional Group (CG), the treatment protocol included electrotherapy modalities like the hot moist pack for a period of 10 to 15 min, interferential therapy (4 VP) for 15 min, and ultrasonic therapy (0.8–1.2 W/cm^2) for 7 min. These patients were also given active ROM exercises and progressive resistance exercises simultaneously.

For Group B—Multi-Component Exercise Program or the Experimental Group (EG), the treatment protocol began with a warm-up session of 10 min. The conditioning session was for45 to 60 min, of moderate intensity, and three sets of 10 repetitions. It included core strengthening exercises such as abdominal draw-in maneuver exercise, pelvic bridging exercise, and isometric back exercise. Isometric to isotonic lower limb strengthening exercise for quadriceps, hamstrings, and adductors muscles. For proprioception, balance half squats and lunges, leg press, modified Romberg exercise, and balance board exercises were included. At the initial stage of gait training, the patients were taught about the phases of gait and asked to perform walking on heels and toes, forward walking, backward walking, side walking, and stair climbing. At the end, cool down session was taken for 10 mins.

Statistical analysis



Statistical analysis was done manually and by using the statistics software's SPSS version 16.0. Paired *t* test was used for statistical analysis of pre- and post-intervention

within the group. Unpaired *t* test was used for statistical analysis of pre- and post-intervention between the groups.The ethical code number was 028/2021–2022 which was given by the Institutional Ethics Committee.

Results

Among the 120 subjects with OA knee, the age group of 60–65 years (44%) was found to be commonly affected. Thirty-nine were males (32.5%) and 81 were females (67.5%).Fifty-eight subjects (48%) were found to be commonly overweight. Out of these120 subjects, 32 subjects (27%) had Genu Valgum deformity and 88 subjects (73%) had Genu Varum deformity at the knee joint [Table 1].

The comparison of the mean values of the WOMAC scale for patients with knee OA, within and between both the groups was found to be statistically significant ($P < 0.0001$). [Table 2]

The comparison of the mean values of MMT scores within the groups for patients with knee OA, for Knee Flexors of Group A, was not significant for the right side ($P = 0.7088$) and for the left side ($P = 0.083$) and Group B was extremely significant ($P < 0.0001$) for both the right and left sides. For Knee Extensors, Group A was significant ($P = 0.013$) for the right side and ($P = 0.019$) for the left side and Group B is extremely significant ($P < 0.0001$) for both sides. The mean values between the group of MMT for right and left Knee Flexors were found to be extremely significant. For the right knee extensor, it was very significant ($P = 0.0019$) and for the left knee extensor, it was found to be significant ($P = 0.0267$) [Table 3].

The comparison of mean values of ROM score within the groups for patients with OA knees, Knee Flexion of Group A for both sides was found to be extremely significant ($P < 0.0001$) and for Group B also both sides were found to be extremely significant ($P < 0.0001$). For Knee Extensors ofGroup A wasextremely significant ($P = 0.0007$) for the right side and ($P = 0.0008$) for the left side and Group B is extremely significant ($P < 0.0001$) for both sides. The posttest mean values between the groups of ROM for Right and left Knee Flexion which was found to be very significant ($P = 0.0069$) and ($P = 0.0022$), respectively. For right and left knee extension, it was significant ($P = 0.0161$) and ($P = 0.0497$), respectively [Table 4].

The pretest vs posttest mean values of gait parameters for patients with OA knees, for cadence of both Groups A and B were found to be extremely significant ($P < 0.0001$). The stride length for Group A was found to be very significant ($P = 0.0060$), and for Group B, it is extremely significant ($P < 0.0001$). Step lengths for Group A and Group B were both very significant ($P = 0.0042$) and (0.0052), respectively. Step width for both Group A and Group B were found to be extremely significant ($P < 0.0001$). The post test mean values between both groups ofgait parameters, cadence was found to be significant ($P = 0.0208$), stride length was found to be extremely significant ($P < 0.0001$), step length was very significant ($P = 0.0012$), and step width was found to be very significant ($P = 0.0037$) [Table 5].

Table 1: Demographic Details

Demographic details	No. of individuals	Percentage
Age		
50-55 yrs	46	38
55-60 yrs	22	18
60-65 yrs	52	44
Gender		
Male	39	32.5
Female	81	67.5
Normal	41	34
BMI		
Overweight	58	48
Obese 1	17	14
Obese 2	04	4
Deformity		
Genu Valgum	32	27
Genu Varum	88	73

Table 2: Comparison of mean scores of WOMAC within and between both the groups

WOMAC	Pretest	Posttest	*P*	Inference
Group A	63.01+7.9	58.3+9.4	<0.0001	Extremely significant
Group B	65.6+8.4	42.9+14.09	<0.0001	Extremely significant
Inference	Not significant	Extremely significant		

Discussion

This study "Effect of Multi-Component Exercise Program On Pain-Related Gait Adaptations Among Individuals With Osteoarthritis Of The Knee Joint" was conducted to see the effect of multi-component exercises on pain, strength, range of motion, and the various gait parameters on pain-related gait adaptations among individuals with osteoarthritis of knee joint. It was conducted among subjects with bilateral osteoarthritis (OA) between the age group of 50 to 65 years of age and with grade 1 to 3 of OA knee according to the Kellgren and Lawrence classification. Osteoarthritis commonly affects middle age to the elderly population.

The sample size consisted of 120 subjects (males $n = 39$, females = 81). Between 50 to 65 years old, with a mean age of 57.69 ± 7.7 and a mean BMI of 29.2 ± 6.4.

Table 3: Comparison of mean scores of MMT within and between both the groups

	Right Knee Flexors			
MMT	**Pretest**	**Posttest**	***P***	**Inference**
Right Knee Flexors				
Group A	3.18+0.39	3.17+0.38	0.7088	Not significant
Group B	3.20+0.40	4.033+0.88	<0.0001	Extremely significant
Inference	Not significant	Extremely significant		
Left Knee Flexors				
Group A	3.03+0.18	3.08+0.28	0.083	Not significant
Group B	3.05+0.22	3.6+0.74	<0.0001	Extremely significant
Inference	Not significant	Extremely significant		
Right Knee Extensors				
Group A	3+0.00	3.1+0.30	0.013	Significant
Group B	3.03+0.18	3.5+0.59	<0.0001	Extremely significant
Inference	Not significant	Very significant		
Right Knee Extensors				
Group A	3.07+0.25	3.22+0.49	0.019	Significant
Group B	3.12+0.32	3.62+0.85	<0.0001	Extremely significant
Inference	Not significant	Significant		

Table 4: Comparison of mean scores of ROM within and between both the groups

ROM	**Pretest**	**Posttest**	***P***	**Inference**
Right Knee Flexion				
Group A	112.07+13.5	112.95+12.98	<0.0001	Extremely significant
Group B	110.72+14.43	118.87+12.07	<0.0001	Extremely significant
Inference	Not significant	Very significant		
Left Knee Flexion				
Group A	106.78+11.06	108.27+11.06	<0.0001	Extremely significant
Group B	106.6+11.21	114.58+9.9	<0.0001	Extremely significant
Inference	Not significant	Very significant		
Right Knee Extension				
Group A	107.28+11.68	114.15+11.30	0.0007	Extremely significant
Group B	106.85+11.93	109.02+11.6	0.0008	Extremely significant
Inference	Not significant	Significant		
Left Knee Extension				
Group A	102.18+10.57	103.80+10.49	<0.0001	Extremely significant
Group B	102.10+10.69	107.32+10.69	<0.0001	Extremely significant
Inference	Not significant	Significant		

Table 5: Comparison of mean scores of gait parameters within and between both the groups

Gait	**Pretest**	**Posttest**	***P***	**Inference**
Cadence				
Group A	65.77±17.13	67.22±17	<0.0001 (ES)	Extremely significant
Group B	60.07±12.47	72.85±13.74	<0.0001 (ES)	Extremely significant
Inference	Not significant	Significant		
Stride Length				
Group A	64.03±2.56	63.15±3.24	0.0060 (VS)	Verysignificant
Group B	64.03±2.56	70.83±2.56	<0.0001 (ES)	Extremely significant
Inference	Not significant	Extremely significant		
Step Length				
Group A	17.58±1.58	16.73±2.59	0.0042 (VS)	Verysignificant
Group B	17.73±2.11	18.35±2.56	0.0052 (VS)	Verysignificant
Inference	Not significant	Very significant		
Step Width				
Group A	7.88±2.88	6.98±2.34	<0.0001 (ES)	Extremely significant
Group B	8.15±2.05	5.72±2.001	<0.0001 (ES)	Extremely significant
Inference	Not significant	Very significant		

According to Venkatachalam *et al*., the radiologic features of knee osteoarthritis (OA) were very common in adults: 13% of women aged 45 to 65 years old (an incidence of three percent per year).[20] Wallace *et al*. mentioned in their study that the right knee is more commonly affected in men aged 60 to 64 than the left knee, whereas the right and left knees are nearly equally affected in women.[21]

Physiotherapists are professionals who provide prescribed physical therapy. Their role is to assess, rehab, and educate patients using various techniques (massage, drainage, physiotherapy, ROM, muscle strengthening, exercise retraining, and proprioceptive rehabilitation).[22]Katherine Boyer has mentioned in her review that, treating the pain in OA knee can give relief for some duration but a long-term basis can cause joint overloading, leading to progression of the degenerative changes and increase in its severity.[6]

This study showed that there were considerable changes in Group B with reduced pain, improved strength, range of motion, and gait parameters such as cadence, stride length, step length, and a decrease in the step width as compared to Group A at the end of week 6. Improving these pain-related adaptations can help the individual to ambulate independently and also improve their quality of life. In a study, there was a significant improvement in physical function, reduction in pain, and decreasing OA symptom severity. There were significant improvements in physical function.[23] Thus, they stated that exercise protocol and walking program have a positive effect on the quality of life of elderly individuals with knee OA.[23]

While some studies found that obesity causes slower velocity,[24-26] decreased cadence,[27-29] decreased stride length and single support time,[25-27,30] decreased swing time,[30,31] increased stance time,[27-29] and increased double support time,[27,29] others failed to find differences in velocity,[25,27–29] cadence,[29-31] step length,[29,30] stride length,[31] stance time,[31]and single. However, most papers[25,32] report increased step width.

This study used conventional method of treatment which included the application of electrotherapeutic modalities (Shortwave Diathermy or Hot Moist Pack, Ultrasound, Interferential Therapy), active range of motion exercises, and progressive resistance exercises, which were found to be statistically significant but not more than compared to the other Group B.

In this study, we used the multi-component exercises for OA knee for Group B, as it not only focuses on treating just the knee joint but also on correcting other factors other affect the knees. These factors can be due to muscular weakness or muscular imbalances, faulty biomechanics, and joint overloading while walking at the spine, hips, and ankle joints that may eventually affect the knees. This exercise program helped in correcting the biomechanical chain and posture of the lower extremities.

The multi-component exercise program was found to have a positive effect in reducing pain, as we used isometric exercises for the muscles of the knee joint (quadriceps, hamstrings, and adductors group of muscles) and muscles of the core (abdominals, lower back group of muscles), it showed to reduce pain as these exercises activatethe muscles and found to have an effect on the Golgi tendon reflex in which while contracting the muscle, the sensory nerve carries the impulses to the excitatory synapse, then the inhibitory synapse is activated due to the inhibitory interneuron, and then, this impulse is carried to the muscle back via the motor nerve while the muscle relaxes.

It was found to have a positive effect in increasing the strength asthe progressive resistance exercises were implemented in accordance to 25%, 50%, 75%, and 100% effort of 1 repetition maximum (1 RM) in supine, side lying, and later in bedside sitting positions as the pain was reduced simultaneously. For core strengthening, abdominal drawing in maneuver and pelvic bridging exercises were used.

The range of motion (ROM) was found to be increased as the pain reduced and strength increased which were the main contributing factors in affecting the available range of ROM. In the initial stages of the treatment, the subjects were asked to perform all the active ROM exercises in the non-painful ranges to avoid exaggeration of respective muscle working due each active ROM exercise for the hip, knee, and ankle joints.

The multi-component exercise program also had a positive impact on balance and coordination which is necessary while walking. It was corrected by the joint proprioceptive training of the knee joint mainly including exercises like half squats, half lunges, one-leg standing, etc., Initially, all of these exercises were taught with one hand holding the edge of the chair as support or with the assistance of the therapist later we progressed without support.

The gait parameters were also found to have improved in these individuals with OA knees. The gait training was taught by breaking down various components of the gait cycle. They mainly included, toe standing, heel standing, toe standing, marching, and normal walking with the implementation of heel strike, toe off, mid-stance, heel off, and toe-off phase correction. Later, we progressed to side walking and stair-climbing activities.

Hence, this study showed that multi-component exercise program had a clinically beneficial impact on pain, range of motion, strength, and various gait parameters in individuals with osteoarthritis of the knee joint. And results were found statistically significant for pain, range of motion, strength, and gait parameters in Group B, i.e., the experimental group. Thus, this study accepts the alternate hypothesis, i.e., there is a significant effect of multi-component exercise program on pain-related gait adaptations among individuals with osteoarthritis of knee joint.

Suggestions

1) More profound outcomes such as postural analysis for the spine can be used.
2) Study could be done with large sample size.
3) Intervention can be planned in graded format for further progression with more follow-ups.

Conclusion

As clinical guidelines recommend exercise, education, self-management, and healthy weight maintenance in individuals with OA knee in India as well as many other nations. Hence, the effect of a multi-component exercise program on pain-related gait adaptations among individuals with osteoarthritis of the knee joint was found to be significant in pain reduction, improving strength, range of motion, and the gait parameters such as increase in cadence, stride length, step length and decrease in the step width.

WHO—World Health Organization, OA—Osteoarthritis, NSAIDS—Non-steroidal anti-inflammatory drugs, CG—Control group, EG—Experimental group, WOMAC—Western Ontario and McMaster Universities Arthritis Index, MMT—Manual Muscle Testing, ROM—Range of Motion, BMI—Body Mass Index.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Srilekha C, Kumar CP. The study on prevalence and management of osteoarthritis in South India. Int J Orthop Sci 2019;5:112–7.
2. Di Nicola V. Degenerative osteoarthritis a reversible chronic disease. Regen Ther 2020;15:149–60.
3. Simon TM, Jackson DW. Articular cartilage: Injury pathways and treatment options. Sports Med Arthrosc Rev 2018;26:31–9.
4. Mistry SK, Ali AM, Yadav UN, Das Gupta R, Anwar A, Basu S, *et al*. A tale of osteoarthritis among older adults during the COVID-19 pandemic in Bangladesh: A repeated cross-sectional study. PloSOne 2022;17:e0274838.
5. Bala K, Bavoria S, Sahni B, Bhagat P, Langeh S, Sobti S. Prevalence, risk factors, and health seeking behavior for knee osteoarthritis among adult population in rural Jammu–A Community based Cross Sectional Study. J Family Med Prim Care 2020;9:5282–7.
6. Boyer KA. Biomechanical response to osteoarthritis pain treatment may impair long-term efficacy. Exerc Sport Sci Rev 2018;46:121–8.
7. Ross JA, Greenwood AC, Sasser P3rd, Jiranek WA. Periarticular injections in knee and hip arthroplasty: Where and what to inject. J Arthroplasty 2017;32:S77–80.
8. Fernandes GS, Parekh SM, Moses J, Fuller C, Scammell B, Batt ME, *et al*. Prevalence of knee pain, radiographic osteoarthritis and arthroplasty in retired professional footballers compared with men in the general population: A cross-sectional study. Br J Sports Med 2018;52:678–83.
9. Pirker W, Katzenschlager R. Gait disorders in adults and the elderly. Wien Klin Wochenschr 2017;129:81–95.
10. Vaghela N, Mishra D, Patel J, Dani V. Promoting health and quality of life of patients with osteoarthritis of knee joint through non-pharmacological treatment strategies: A randomized controlled trial. J Educ Health Promot 2020;9:156.
11. Ro DH, Lee J, Lee J, Park JY, Han HS, Lee MC. Effects of knee osteoarthritis on hip and ankle gait mechanics. Adv Orthop 2019;2019:9757369.
12. Chang AH, Moisio KC, Chmiel JS, Eckstein F, Guermazi A, Prasad PV, *et al*. External knee adduction and flexion moments during gait and medial tibiofemoral disease progression in knee osteoarthritis. Osteoarthritis Cartilage 2015;23:1099–106.
13. Birmingham TB, Moyer R, Leitch K, Chesworth B, Bryant D, Willits K, *et al*. Changes in biomechanical risk factors for knee osteoarthritis and their association with 5-year clinically important improvement after limb realignment surgery. Osteoarthritis Cartilage 2017;25:1999–2006.
14. Pal CP, Singh P, Chaturvedi S, Pruthi KK, Vij A. Epidemiology of knee osteoarthritis in India and related factors. Indian J Orthopaedics 2016;50:518–22.
15. Kumar H, Pal CP, Sharma YK, Kumar S, Uppal A. Epidemiology of knee osteoarthritis using Kellgren and Lawrence scale in Indian population. J Clin Orthop Trauma 2020;11:S125–9.
16. Brockett CL, Chapman GJ. Biomechanics of the ankle. Orthopaedics Trauma 2016;30:232–8.
17. Steele A, Gonzalez R, Garbalosa JC, Steigbigel K, Grgurich T, Parisi EJ, *et al*. Osteoarthritis, osteophytes, and enthesophytes affect biomechanical function in adults with X-linked hypophosphatemia. J Clin Endocrinol Metab 2020;105:e1798–814.
18. Ranjan P, Vikram NK, Chournar A, Pradeep Y, Ahuja M, Meeta, *et al*. Executive summary of evidence and consensus-based clinical practice guidelines for management of obesity and overweight in midlife women: An AIIMS-DST initiative. Diabetes Metab Syndr 2022;16:102426.
19. Norozi E, Nazari F, Moodi M. The effect of educational intervention based on the health belief model on osteoarthritis-preventive behaviors in middle-aged women. J Educ Health Promot 2020;9:327.
20. Venkatachalam J, Natesan M, Eswaran M, Johnson AK, Bharath V, Singh Z. Prevalence of osteoarthritis of knee joint among adult population in a rural area of Kanchipuram District, Tamil Nadu. Indian J Public Health 2018;62:117–22.
21. Wallace IJ, Worthington S, Felson DT, Jurmain RD, Wren KT, Maijanen H, *et al*. Knee osteoarthritis has doubled in prevalence since the mid-20th century. Proc Natl Acad Sci U S A 2017;114:9332–6.
22. Teo PL, Bennell KL, Lawford BJ, Egerton T, Dziedzic KS, Hinman RS. Physiotherapists may improve management of knee osteoarthritis through greater psychosocial focus, being proactive with advice, and offering longer-term reviews: A qualitative study. J Physiother 2020;66:256–65.
23. Gomes-Neto M, Araujo AD, Junqueira ID, Oliveira D, Brasileiro A, Arcanjo FL. Comparative study of functional capacity and quality of life among obese and non-obese elderly people with knee

osteoarthritis. Rev Bras Reumatol Engl Ed 2016;56:126–30.
24. Arazpour M, Bahramian F, Abutorabi A, Nourbakhsh ST, Alidousti A, Aslani H. The effect of patellofemoral pain syndrome on gait parameters: A literature review. Arch Bone Jt Surg 2016;4:298–306.
25. Gill SV. The impact of weight classification on safety: Timing steps to adapt to external constraints. J musculoskeletal Neuronal Interact 2015;15:103–8.
26. Pau M, Capodaglio P, Leban B, Porta M, Galli M, Cimolin V. Kinematics adaptation and inter-limb symmetry during gait in obese adults. Sensors (Basel) 2021;21:5980.
27. Bonab M, Colak TK, Toktas ZO, Konya D. Assessment of spatiotemporal gait parameters in patients with lumbar disc herniation and patients with chronic mechanical low back pain. Turk Neurosurg 2020;30:277–84.
28. Capodaglio P, Gobbi M, Donno L, Fumagalli A, Buratto C, Galli M, *et al*. Effect of obesity on knee and ankle biomechanics during walking. Sensors 2021;21:7114.
29. Abualait TS, Ahsan M. Comparison of Gender, Age, and Body Mass Index Levels for Spatiotemporal Parameters of Bilateral Gait Pattern.
30. Cruz-Jimenez M. Normal changes in gait and mobility problems in the elderly. Phys Med Rehabil Clin 2017;28:713–25.
31. Ellington MC. Effect of BMI and race on clinical outcomes and spatio-temporal gait characteristics in adults with knee osteoarthritis: Analysis of the baseline data from the we-can randomized clinical trial. Doctoral dissertation, Wake Forest University.
32. Peixoto JG, de Souza Moreira B, Diz JBM, Timoteo EF, Kirkwood RN, Teixeira-Salmela LF. Analysis of symmetry between lower limbs during gait of older women with bilateral knee osteoarthritis. Aging Clin Exp Res 2019;31:67–73.