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"The Effect Of Surya Namaskar (Sun Salutation) On Quality Of Life In Middle Aged Women With Osteoarthritis Knee."

BY

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ABSTRACT

Background: Surya namaskar is considered a part of modern-day yogic practice though it was neither considered an asana nor a part of traditional yoga. Practicing Surya namaskar before beginning routine activities vitalizes the practitioner and give a completely energized day. Starting from Raja of Aundh who first introduced Surya namaskar, there is line of eminent people who popularized this dynamic group of asanas including T Krishnamacharya, Swami Sivananda, Swami Satyananda from Bihar school of yoga, so on and so forth. Their efforts led to the introduction of this wonderful set of asanas to the practitioners. A comprehensive practice including asanas and pranayama is provided by this amazing set of postures, which also incorporate dynamic breathing patterns at each pose. Surya Namaskar practice consists of 12 postures in total, with 24 steps in a single round. Based on available research, we highlight the significance of Surya Namaskar in this review, emphasizing its impact on the physiological, psychological, and physical components of the body.

Objective: To study the effect of Surya namaskar (sun salutation) on middle aged women with osteoarthritis knee and quality of life.

Methods: Sample included 45 women with knee osteoarthritis who voluntarily participated in this comparative semi-experimental study and were divided into 3 groups with 2 control groups (15 each) and a yoga group (15). The yoga group received 35 minutes sessions oy Surya namaskar, 3 times a week and for 4 weeks. Pain, symptoms, daily activities, spare time activities and quality of life were respectively measured by numeric rating scale for pain (nprs) and knee injury and osteoarthritis outcome scale (KOOS) questionnaire. The Analysis of Variance (ANOVA) method for repetitive data was used to analyze the result (P = 2.29).

Results: Finding shows that pain and symptoms were reduced and scores of daily activities, spare time activities and quality of life were significantly improved in yoga group compare to other groups.

Conclusion: It seems that Surya namaskar can be used as a conservative treatment besides usual treatments and medications to improve the condition of people with osteoarthritis.

Keywords: Knee osteoarthritis, pain, quality of life, Surya namaskar

LIST OF ABBREVIATIONS USE

- **OA**: Osteoarthritis
- **NPRS:** Numerical pain rating scale

- **KOOS:** Knee injury and Osteoarthritis Outcome Scale
- **BSY:** Bihar school of yoga
- **FBS:** Fasting blood sugar
- **PPBS:** Post prandial blood sugar
- **T2DM:** Type 2 Diabetes mellitus
- **DM:** Diabetes Mellitus
- **BMI:** Body Mass Index
- **BP:** Blood Pressure

CHAPTER 1

INTRODUCTION

1.1 Surya namaskar:

All living organisms on Earth start their days at sunrise because life as we know it could not survive without the sun. Indeed, the Sun is worshipped as a god in numerous cultures, where it is referred to by a variety of names, including Surya in Indian Vedic literature, Osiris in Egypt, Apollo in Greek, and Mithras in Persian [1]. To show gratitude to the sun, one performs Surya Namaskar, a venerable and sacred yogic ritual. It is a dynamic series of 12 positions, or asanas, that are combined in time with the breath [1, 2]. Although Surya namaskar can be done at any time of day, it is best done at dawn when the sun's rays are at their most potent for rejuvenating the body and mind. Based on requirement of the body, it can be done in 3 speed variation – slow, medium, and fast pace. Slow pace – Helps to increase body flexibility. Medium pace – Helps in muscle toning. Fast/rapid pace – Seep aids with weight loss and provides a great cardiovascular exercise [3].

- **Origin of Surya namaskar**:

Surya Namaskar, another name for the Sun Salutation, is a dynamic sequence of poses that isn't considered an Asana or a part of traditional yoga. The entire physical practice known as Sun salutation is said to have been developed and popularized in the 1920s [4] by Late Shrimant Balasaheb Pant Pratinidhi, the monarch of Aundh, and later by Sri K V Iyer and Sri Krishnamacharya. It was discovered that the Surya namaskar models put out by Sri Krishnamacharya were based on the Danda exercises described in Vyayama Dipika [5]. Dandaal is a traditional, widely used, and significant physical training method used by Indian martial artists and wrestlers. Dandaal may be the source of pushups employed in bodybuilding exercises in western nations. Figure 3 schematically illustrates and explains the commonalities between Dandaal and Surya namaskar. Sun salutation is considered to be the origin of modern physical exercises as it is a classic combination of two separate systems, such as physical culture and yoga [6]. More simplified forms were adopted by other yoga schools, including Samsthana (SVYASA), Bihar School of Yoga (BSY), and Swami Sivananda Yoga Vedanta Centre. These versions were later included into modern yoga practices.

- **The twelve steps of Surya namaskar (BSY tradition):**

Twelve steps (or half a round) make up the Surya Namaskar (Table 1), which consists of two forward and three backward bending poses. All positions are repeated to complete one circle, with the exception of Ashwasanchalanasana, which is executed utilizing the opposing (left or right) side of the body component in the second half [7]. (Figure 1) Every step is executed with a synchronized

breathing pattern in addition to the appropriate body alignment. Step 1 begins with regular breathing. The practitioner inhales while they expand their chest throughout the backward stretching exercises (steps 2, 4, 7, 9, & 11). Exhaling is required during forward bending (steps 3, 5, 8, 10, and 12) while squeezing the chest. Breathing is held out when performing Ashtanga Namaskar (position 6), where the chest region is in contact with the floor. The BSY tradition's dynamic posture sequence is schematically shown in Fig. 3, emphasizing that steps 5, 6, and 7 alone constitute a full physical practice akin to Dandaal as they breathe naturally at their own pace with alternate patterns of inhalation and exhalation. As a result, by consistent Surya Namaskar practice, the dynamic postures assist the practitioner in increasing lung capacity [7].

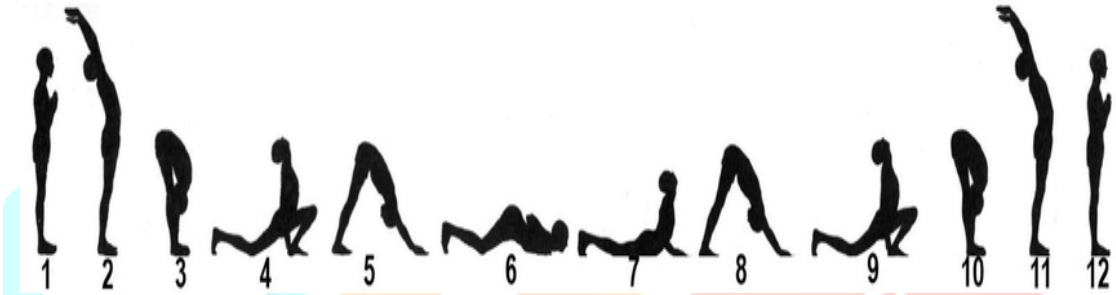
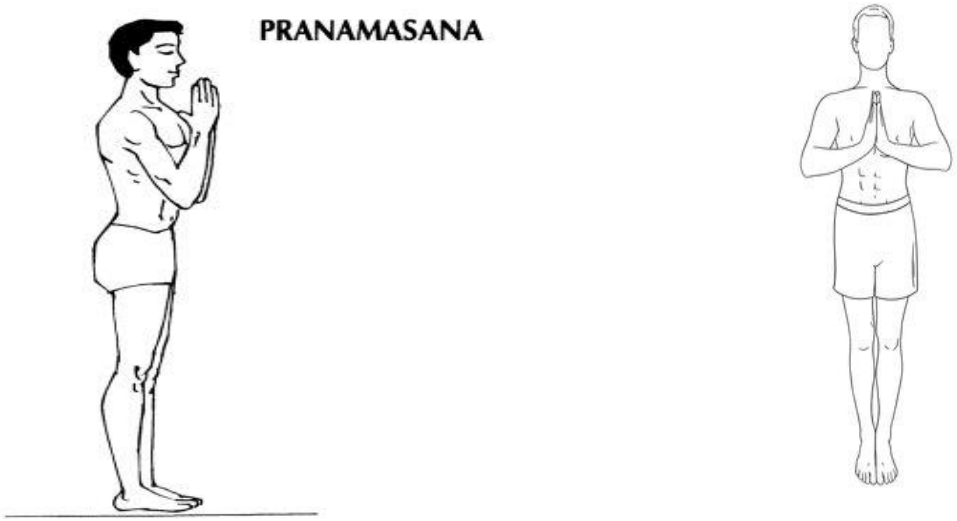
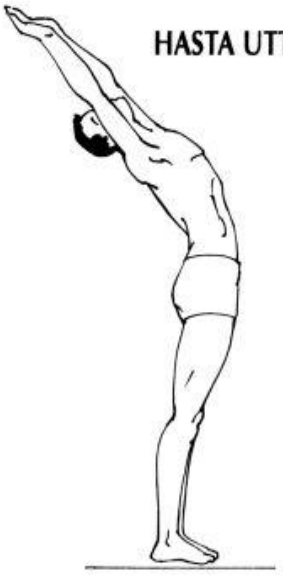


Fig 1
Pictorial representation of Surya namaskar postures (Bihar School of Yoga Tradition): Final position of each step of Surya namaskar of Bihar school of yoga tradition. Numbers (1e12) represents the number of each step as given in Table 1

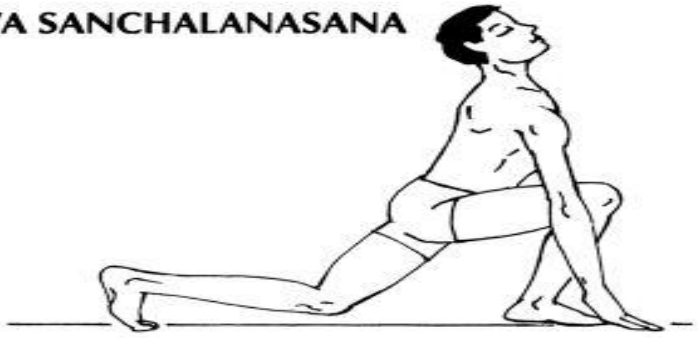


HASTA UTTANASANA

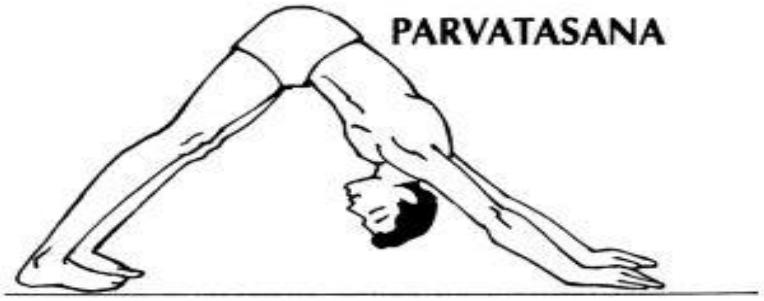


PADAHASTASANA

ASHWA SANCHALANASANA



PARVATASANA



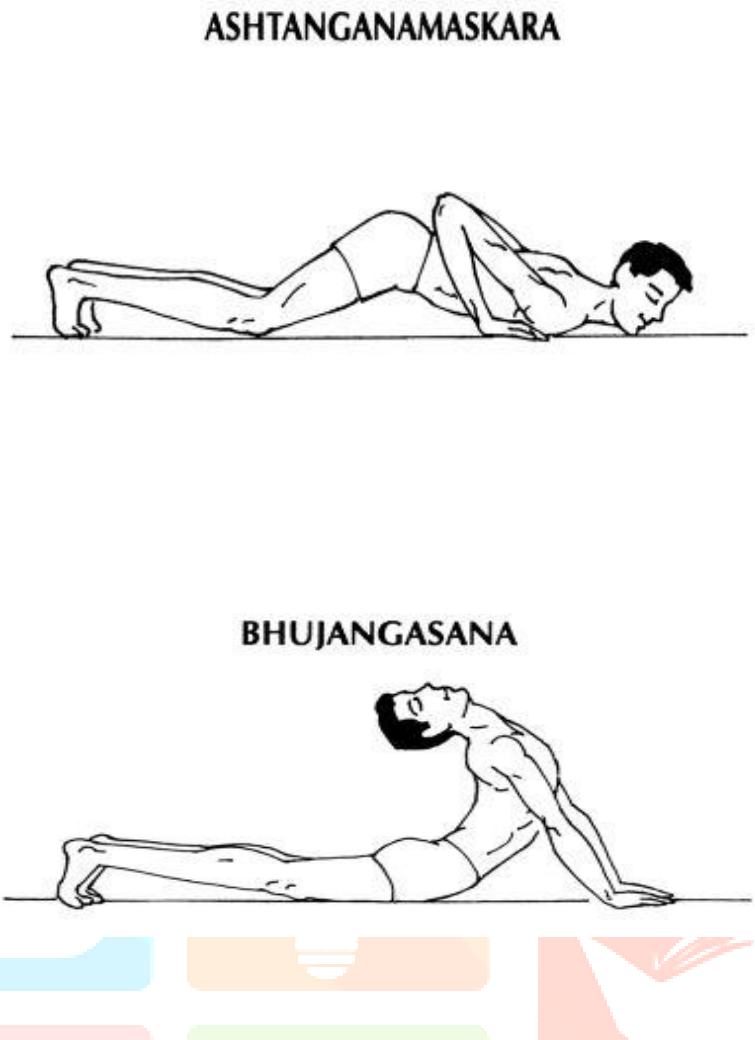


Figure 2
Various poses of Surya namaskar

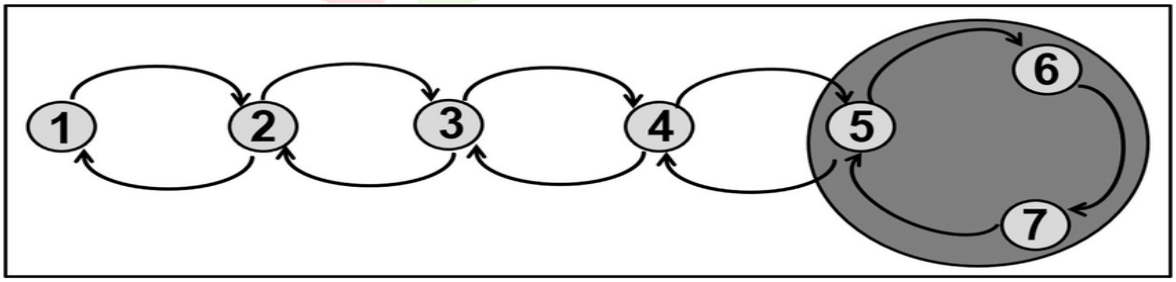


Fig 3
Schematic representation of Surya namaskar postures (Bihar School of Yoga tradition): Schematic of steps of Surya namaskar of Bihar school of yoga tradition numbered as per the sequence. Arrow indicates the flow of steps in the respective direction 1. Pranamasana 2. Hasta utthanasana 3. Pada hastasana 4. Ashwasanchalanasana 5. Parvatasana 6. Ashtanga namaskara 7. Bhujangasana steps 5,6 & 7 highlighted within the circle by themselves fulfill the steps of Dandaal practice.

Table 1
Name of the postures in Surya namaskar with its effects on the body [3].

No	Name of the posture / Asana	Effects
1	Pranamasana /prayer pose	Provides relaxation, calmness, increases concentration, reduces anxiety and mental stress
2	Hast Utthanasana / raised arm pose	Strengthen abdominals, respiratory and intercostal muscles, thus improves digestion and relieve anxiety and fatigue in Asthma.
3	Padahastasana / hand to foot pose	Provides back muscle flexibility, stretches hip, hamstring and calves, Strained knees and thighs, reduces excess abdominal fat
4	Ashwa Sanchalanasana / equestrian pose	Balances Central nervous system, strengthen spine, Regulates Abdominal organ e.g.-Liver and Kidney, increases willpower and lung capacity.
5	Parvatasana / mountain pose	Strengthen the nerves and muscles of the upper and lower limbs thus stimulates blood circulation in the upper spine and between the shoulder blade.
6	Ashtanga Namaskara / salute with eight parts or points	Strengthen the musculature of Respiration and upper and lower limbs.
7	Bhujangasana / cobra pose	Strengthens lower back muscles thus improves spine flexibility, also supports the Respiratory, digestive, reproductive and genitourinary systems so beneficial for back pain, sciatica, Asthma and Menstruation.
8	Prvatasana / mountain pose	Strengthen the nerves and muscles of the upper and lower limbs thus stimulates blood circulation in the upper spine and between the shoulder blade.
9	Ashwa Sanchalanasana / equestrian pose	Balances Central nervous system, strengthen spine, Regulates Abdominal organ e.g.-Liver and Kidney, increases willpower and lung capacity.
10	Padahastasana / hand to foot pose	Provides back muscle flexibility, stretches hip, hamstring and calves, Strained knees and thighs, reduces excess abdominal fat
11	Hasta Utthasana / raised arms pose	Strengthen abdominals, respiratory and intercostal muscles, thus improves digestion and relieve anxiety and fatigue in Asthma.

12	Pranamasana / prayer pose	Provides relaxation, calmness, increases concentration, reduces anxiety and mental stress

- **Physiological effects of Surya namaskar on various system:**

The National Centre for Complementary and Alternative Medicine (NCCAM) describes yoga as a --Mind-Body medicine, and suggests using it as a non-pharmacological approach to treat a number of non-communicable illnesses [3,4]. The therapeutic positions, breathing techniques, and meditation of yoga have been shown to be beneficial for many kinds of medical conditions, such as hypertension and type-2 diabetes. (Table 2). Among the aspects or scientific components of physical yoga are (Fig. 4): - The following are some examples of cardiovascular (aerobic) conditioning exercises: breathing, breathing through one nostril, breathing exercises, stretching, isotonic, isometric, and isokinetic strengthening, joint range of motion exercises, breathing exercises, concentration exercises, relaxation exercises, meditation, and health visualization.

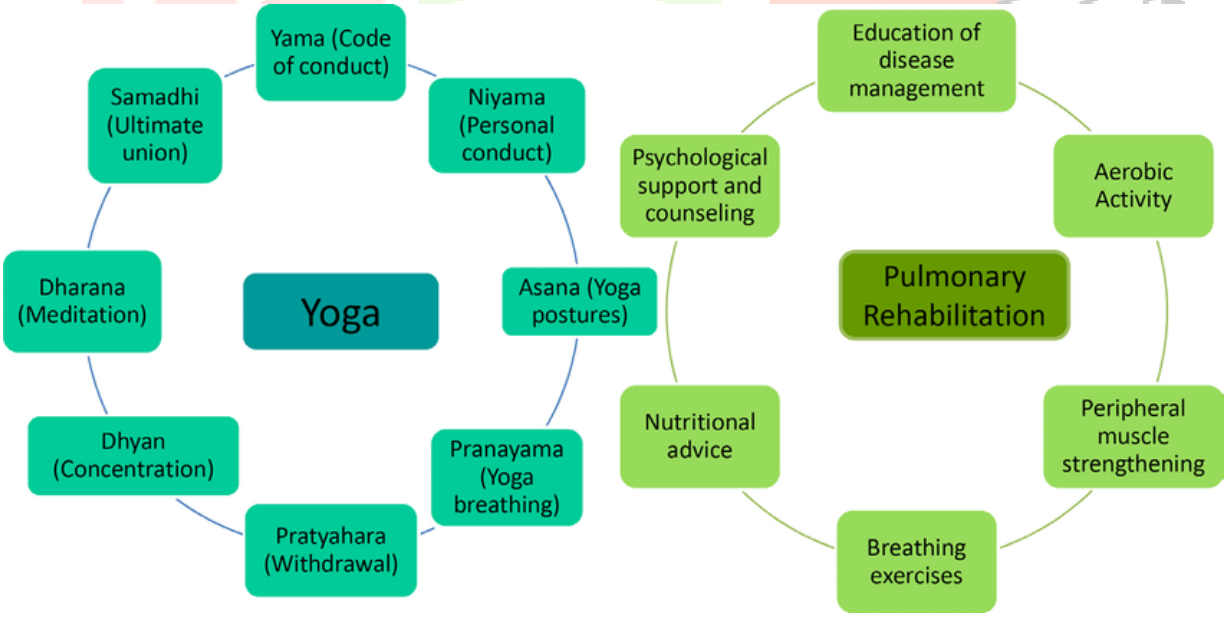


Fig 4
Scientific component of Surya namaskar

Table 2

Physiological effects of Sun salutation on various systems of the body [3].

No	System	Effects
1	Respiratory	Improves Maximum inspiratory and expiratory pressures, forced vital capacity (FVC), Peak expiratory flow Rate (PEFR), Forced expiratory volume in 1st second (FEV1), Vital Capacity (VC)
2	Cardiovascular	Improves Cardiorespiratory efficiency and Fitness, Systolic and Diastolic BP, HR, Leads to vagal Dominance, Sympathetic tone, Cardiovascular Function
3	Lymphatic	Improves Lymphatic circulation, Increase Resistance to Infection and gains better ability to heal
4	Gastro-intestinal	Improves Digestion by increasing digestive fire, Promotes healthy Appetite, Helps in complete and rapid assimilation of food thus combat Constipation and many gastrological problems
5	Urinary	Toning of the spinal muscles, gently massages the kidney
6	Skin	Produces perspiration, speed up the circulation and enhances the elimination of waste through the skin thus maintains healthy skin, Stretches the skin and its elastic tissues, toning it and helping to preserve its function
7	Endocrine	alters the endocranial glands, which include the thyroid, adrenal, pituitary, and pancreas, to provide positive results in cases of metabolic syndrome, obesity, and type 2 diabetes, Hypothyroidism and Menstrual disorders. Prevent pineal degeneration and calcification by influencing the pineal gland and Hypothalamus.
8	Nervous	relaxes the autonomic, peripheral, and central nervous systems by stretching and compressing the entire spine stimulates the whole spinal cord and the nerve plexus.
9	Reproductive	Helps in painless labor by stretching of the supporting muscles of the uterus and vaginal walls, helps to correct menstrual irregularities and pain during menstruation by producing toning effect on the ovaries by improving blood circulation in the pelvic region.

10	Musculoskeletal	Surya Namaskar training on a regular basis burns four times as much energy as required in a daily diet, making it an excellent fat-burning exercise. improves the majority of body muscles' flexibility, especially the back, chest, legs, and buttocks. Hand grip, strength, and endurance can all be considerably improved with regular Surya Namaskar practice.
11	Biochemical parameters	Significantly decreases FBS, PPBS and Glycosylated hemoglobin HbA1c level in diabetic patients. Reduces the Oxidative stress on the body which plays key role in insulin resistance and complication in T2DM patients. Improvement in lipid levels in DM patients causes reduction of weight, BMI and Waist-hip ratio.

1.2 Osteoarthritis:

A degenerative disease that is both persistent and incapacitating is osteoarthritis [1]. About 10% of population suffer from persistent pain and inflammation, making this the second most prevalent complaint among outpatients [2]. The most often affected joint in primary OA is the knee. Knee OA is more frequent in women and overweight patients and primarily affects middle-aged and older adults [3]. The disease progresses slowly, and bilateral and symmetric joint involvement is common [4,5]. Pain, stiffness, and a reduction in range of motion (ROM) are among the symptoms, which lower quality of life and activities [6–8]. For these patients, the major objectives of rehabilitation are to enhance quality of life, lessen pain and stiffness in the joints, and restore function [9].

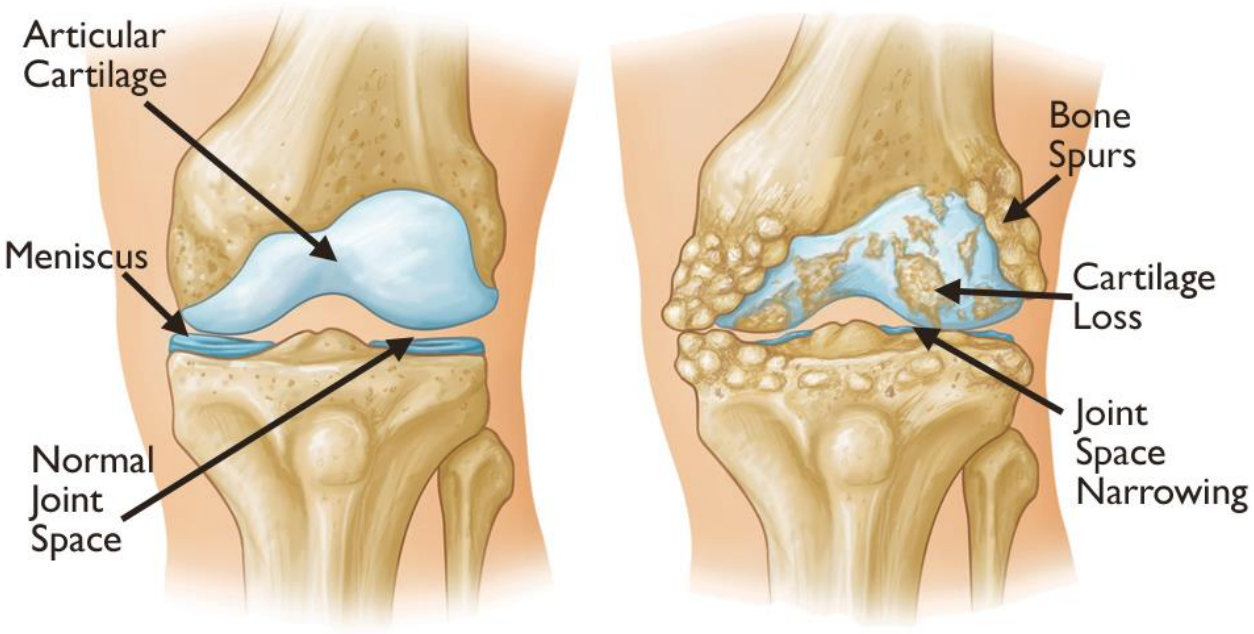


Fig 5
Shows causes of OA knee

CHAPTER 2

REVIEW OF LITERATURE

2.1 Epidemiology of Osteoarthritis:

The loss of articular cartilage, hypertrophy of bone at the margins, subchondral sclerosis, and a variety of biochemical and morphological changes to the synovial membrane and joint capsule are all hallmarks of osteoarthritis (OA), a chronic degenerative disorder with a complex aetiology [5,6]. The articular cartilage softens, ulcerates, and focally disintegrates in the late stage of osteoarthritis (OA). Inflammation of the synovium may also happen [6, 7]. Clinically, discomfort is common, especially after extended activity and weight-bearing; stiffness, Conversely, though is felt after inactivity [6]. It is most likely not a single illness, but rather the culmination of numerous conditions that result in joint deterioration [5,6]. Often affecting the hands, feet, spine, and large weight-bearing joints including the hips and knees, it is often referred to as degenerative arthritis [5-7]. Primary OA refers to the majority of OA cases where the source is unknown [7].

The main cause of primary osteoarthritis is aging [5,6]. It may manifest as erosive OA 7,8, or as localized or widespread. Another illness or ailment is the cause of secondary osteoarthritis [8]. With a prevalence of 22% to 39% in India, osteoarthritis is the most common joint condition and the second

most common rheumatologic issue [5-7]. Women are more likely than men to have OA, although as people age, the frequency increases significantly [5,6,9]. Approximately 45% of women over 65 experience symptoms, while 70% of those over 65 show radiological evidence [5,7,9]. A common cause of reduced mobility, especially in women, is osteoarthritis (OA) of the knee [6, 8]. As of [6,7], OA was ranked as the tenth most frequent cause of nonfatal burden.

Because of the possibility of unreported cases in the population, self-report surveys may not provide an accurate estimate of OA [10]. Few OA investigations have made use of a radiological disease categorization. Although radiography-based prevalence estimates are presumably a valid population estimate, X-ray findings don't always match the symptoms [11]. Based on existing literature, OA of the knee is more common. Therefore, it was crucial to conduct this study on the prevalence of knee OA in the Indian population in order to ascertain the present burden of OA and its relationship with lifestyle-related factors [11].

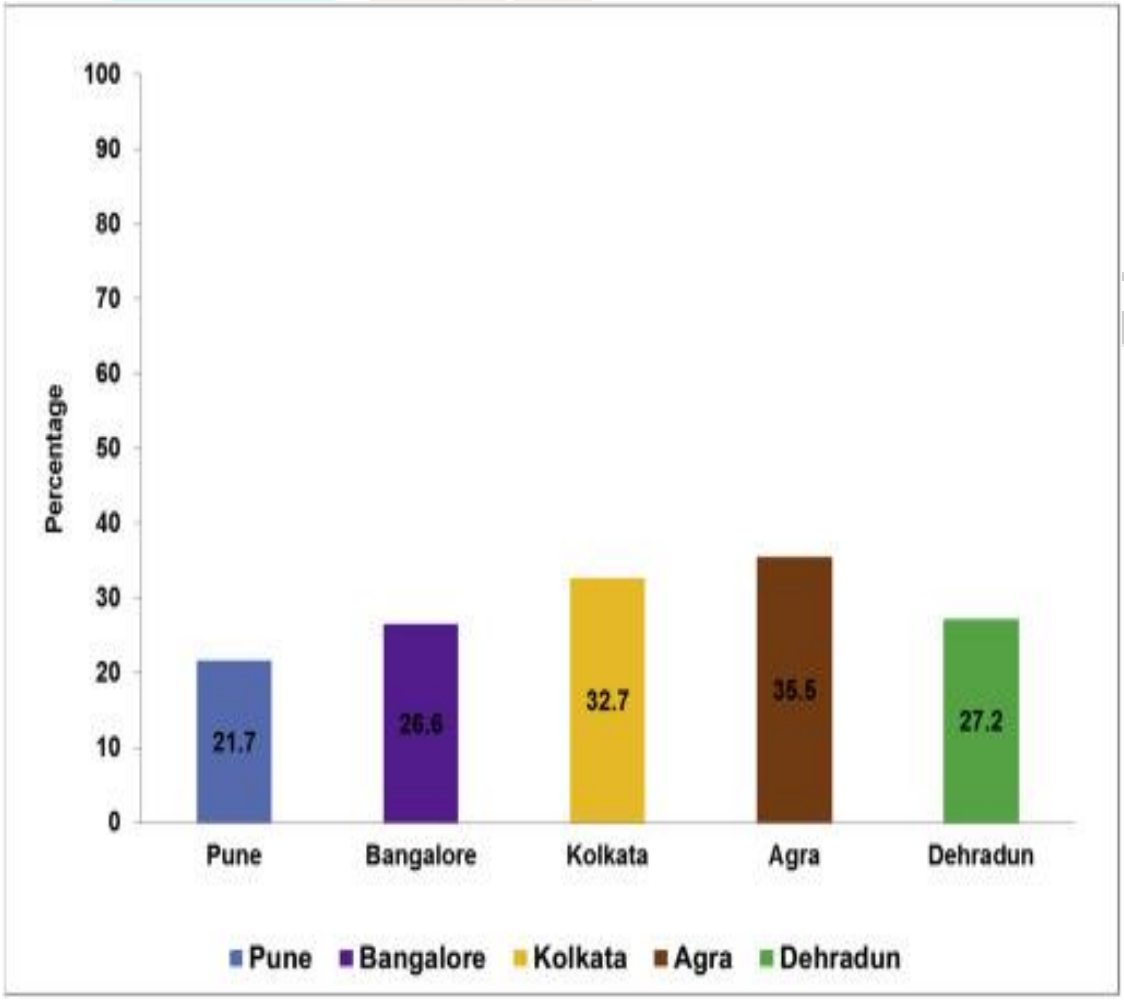


Fig 6
Percentage of OA knee in various city of India

2.2 Factors affecting OA knee:

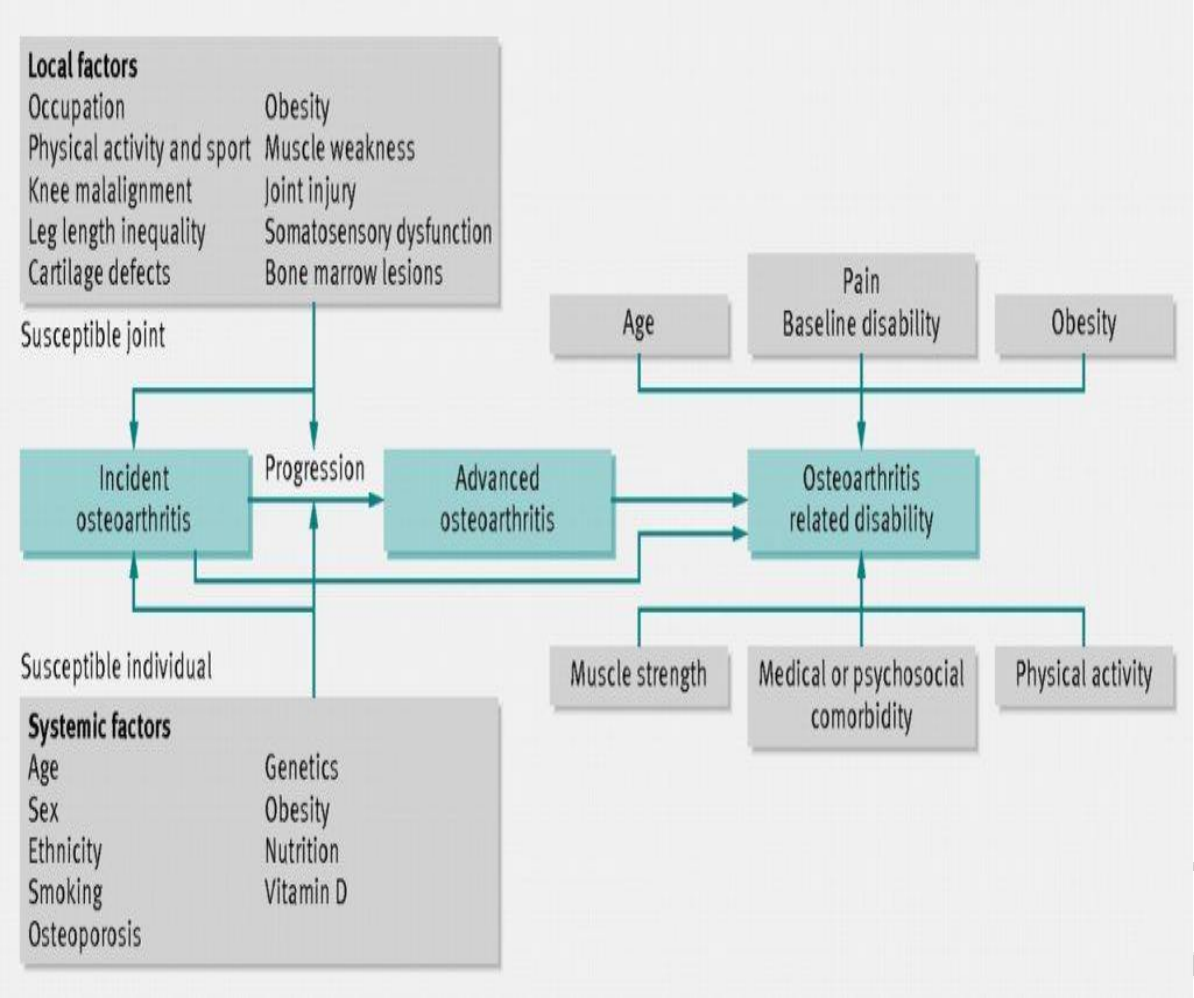


Fig 7
Factors affecting OA knee

2.3 Grades of OA knee:

- Grade 0 – "Normal" knee health
- Grade 1 – Very small bone spur growth with no pain or discomfort
- Grade 2 – Mild stage of OA, people will encounter symptom for 1st time, Pain after a long day of walking and sense a greater stiffness in the joint, Greater bone spur growth in X-ray, Cartilage likely remain at a healthy size
- Grade 3 – Moderate stage of OA, frequent pain during movement, more joint stiffness after prolonged sitting and in the morning, The cartilage between the bones shows obvious damage and space between bones is getting smaller
- Grade 4: The most serious stage of OA, Joint space between the bones reduces dramatically, the cartilage will almost be completely worn, reduced synovial fluid, this stage is normally connected

with elevated levels of pain and discomfort during walking or moving the joint.

2.2 Treatment of OA:

Treatment options for OA knee include medication, surgery, and non-surgical/medical approaches. For OA, non-steroid anti-inflammatory medications are typically recommended. Although intra-articular corticosteroid injections are occasionally used, they possess several detrimental side effects on the kidneys, digestive tract, and cardiovascular system [14,20]. Surgical techniques include joint arthrodesis, arthroplasty, debridement, and osteotomies; however, these operations are costly and time-consuming, particularly for senior patients whose tolerance for extensive surgical procedures is compromised [14].

Because they have no negative side effects, non-surgical treatments such physical therapy, acupuncture, utilizing crutches, knee braces, and heel wedges, exercising, and decreasing weight are highly well-liked by both doctors and patients [1,13,14, 21]. To treat pain and other problems, physical therapists employ a variety of therapeutic techniques, including exercise therapy (mobilization), electrotherapy, and ergonomic counselling. Warmth, cold, ultrasound, diathermy, and transcutaneous nerve stimulation (TENS) are all employed in electrotherapy [14, 16]. Research indicates that physical activity can lower pain, stiffness in the morning, and other symptoms associated with osteoarthritis. Maintaining control over each of these can enhance function, which raises quality of life [1,13,14,15, 20].

Ebenezer et al. (2012) investigated how yoga poses affected the pain, stiffness in the morning, and anxiety levels of 250 patients who had osteoarthritis in their knees. While the control group just received physical therapy, the experimental group also received yoga. Researchers discovered that the advantages of yoga plus physical treatment exceed those of physical therapy by alone. The patients in the experimental group had a higher reduction in pain, stiffness in the morning, and anxiety, according to the data [24]. The benefits of a home regimen for strengthening the hip abductors on osteoarthritis in the knee were investigated by Sled et al. (2010). The findings demonstrated that hip abductors strengthening at-home workouts improved function and reduced pain in OA knee patients [25]. The positive effects of a 12-week of tai chi workouts on individuals with osteoarthritis in the knee were investigated by Wang et al. The findings indicated decreased pain in the VAS and improvements in the parameters assessed by the Western Ontario and the McMaster Universities Osteoarthritis Index (WOMAC) questionnaire [26].

Among the least harmful sports, yoga has been shown to have beneficial physiological and psychological effects when treating chronic illnesses [27–30]. One of the most prevalent inflammatory diseases affecting the knee joint is osteoarthritis [31]. If treatment is not received, the majority of individuals will experience persistent pain and knee difficulties, even though the condition is not lethal [32]. We decided to do this study since yoga is quite popular and there haven't been many studies on how it affects individuals with osteoarthritis in their knees.

CHAPTER 3

NEED OF THE STUDY

Owing to a poor lifestyle and household activities, OA knee is the most usual degenerative disease among women in our area. Surya Namaskar is the most esteemed traditional form of yoga that has been demonstrated to be beneficial for this disease. For middle-aged Indian women, the risk of age-related musculoskeletal problems, particularly OA knee, is elevated. Therefore, research is required. Earlier research has shown that practicing Surya Namaskar regularly helps to improve overall body flexibility, strength, and endurance, which is helpful in musculoskeletal pain and weakness. However, Gujarat has not yet conducted a study of this kind, so by doing so, women in these areas can receive more support and understanding related to the same.

CHAPTER 4

AIM AND OBJECTIVES

1. To investigate the impact of Surya Namaskar on knee function and overall well-being.
2. To investigate the influence of Surya Namaskar on quality of life and knee osteoarthritis in middle-aged women.
3. To contrast the various groups using various training regimens.
4. We chose to conduct this study because, despite yoga's widespread use, little is known about how it benefits individuals with osteoarthritis of the knee.

CHAPTER 5

HYPOTHESIS

5.1 Null Hypothesis

Surya namaskar and quality of life and musculoskeletal discomfort may be significantly correlated.

5.2 Alternative Hypothesis

There may not be significant correlation between Surya namaskar and musculoskeletal pain and quality of life.

CHAPTER 6

METHODOLOGY

6.1 Source of collection of data:

Information was gathered from a number of yoga centres and hospitals in Jamnagar, Gujarat, India.

6.2 Study Design and sample size:

Methodology of this study is pre and post comparative semi-experimental in execution and applicable in results. Forty-five (45) women with OA knee diagnosed by a physician were voluntarily participating in this study. They were put in two control groups (15 each) and a yoga group (15).

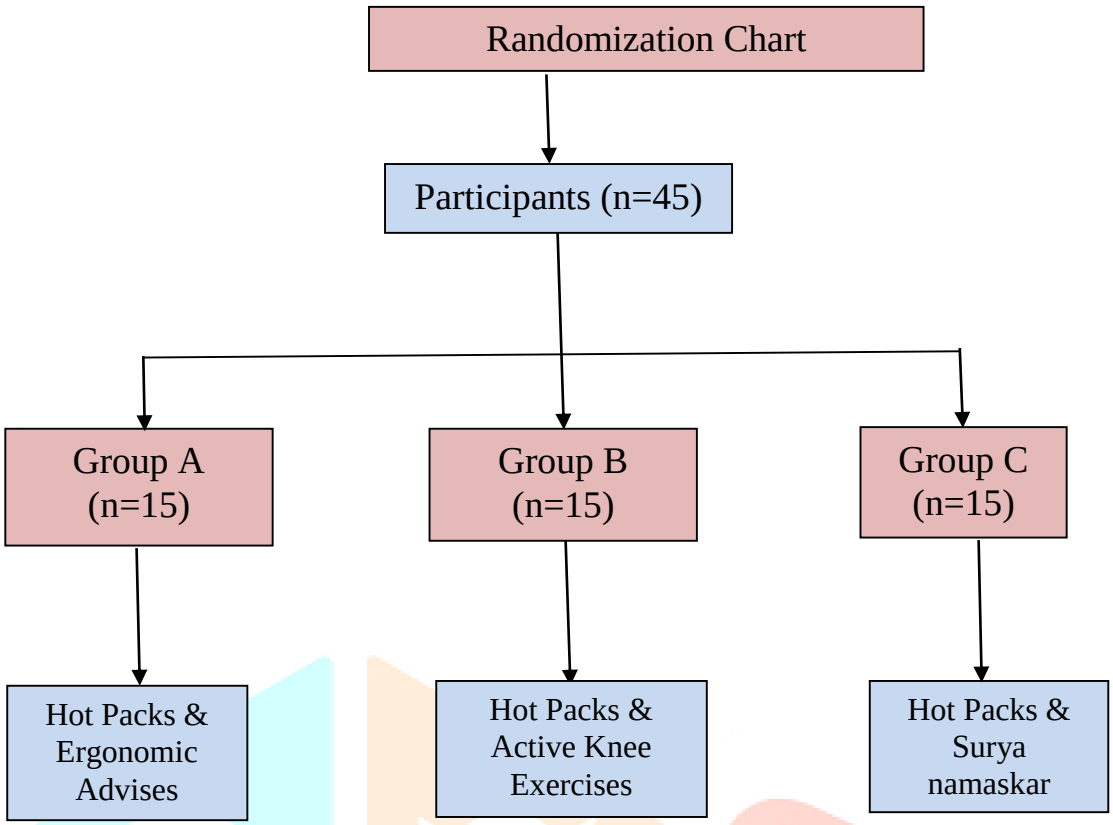


Fig 8
Study Design

6.3 Sampling Criteria:

- **Inclusion** - Working and non-working middle-aged females with osteoarthritic knee more than 3 months,
  - Willing to participate
  - Age group: 45 – 55 years
  - OA grades 2 & 3
- **Exclusion** - History of knee, back and heart surgeries
  - OA grades 1 & 4
  - History of Acute knee damage in recent 6 months
  - Any recent fracture or injury
  - Patients of Hernia and Intestinal Tuberculosis
  - Patients with high BP and acute infections
  - People suffering from acute back conditions and shoulder pain
  - Coronary artery disease or those who had a stroke, as it may over stimulate or damage a weak heart or blood vessel system
  - Pregnant women,
  - Any congenital deformity and neurological disorders

6.4 Outcome measures:

- **Numeric Pain Rating Scale –** The numeric Pain rating scale (NPRS) and the VAS have a comparable bounded set: "no pain" at the left end and "worst pain imaginable" (or a similar phrase) at the right. The distinction is that numbers 0 through 10 are uniformly distributed throughout the page rather than in a line devoid of markings. During the evaluation, it is requested of the patients to circle the number that represents the degree of pain they are experiencing. A variation of this measure called the verbal numeric scale (VNS) asks patients to audibly describe the amount of pain they are experiencing right now, on a numerical rating system from 0 to 10. The NPRS and VNS have the advantages of being rapid, simple, and validated. When speed of evaluation is critical, like in the acute environment, the VNS is very easy to use clinically [37].

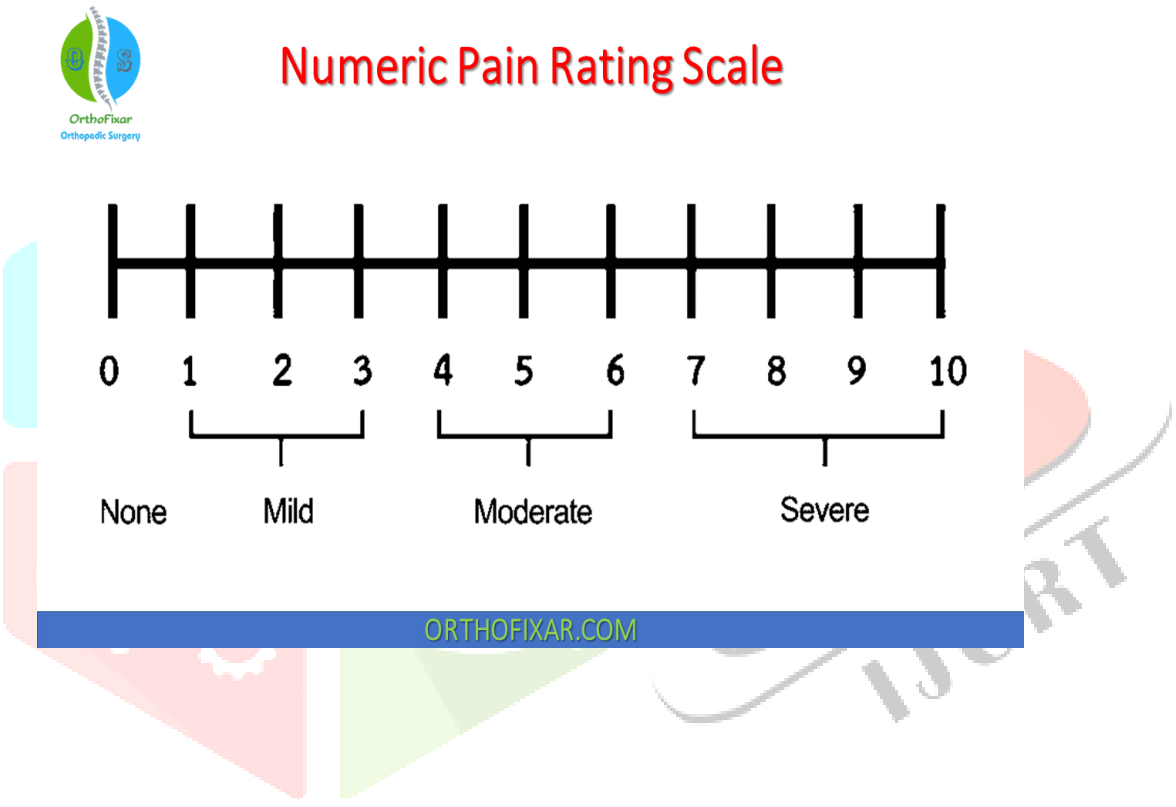


Fig 9
Numeric Pain Rating Scale

- **KOOS Questionnaire -** A questionnaire called the Knee Injury and Osteoarthritis Outcome Score (KOOS) is used to evaluate patient-relevant outcomes both in the near and long terms after a knee injury. The self-administered KOOS evaluates five results: standard of living, discomfort, indications, function in sports and leisure, and activities of everyday living with regard to the knee. The KOOS meets the basic criteria for outcome measures since it may be used to assess the course of an injured knee and the effectiveness of treatment. Completing KOOS is easy and takes about ten minutes. It is administered by the patient [1, 36, 48].

Knee Injury and Osteoarthritis Outcome Score (KOOS) Questionnaire

Pain

P1 How often is your knee painful?	Never	monthly	Weekly	Daily	always

What degree of pain have you experienced the last week when…?

P2 Twisting/pivoting on your knee	Never	monthly	Weekly	Daily	always
P3 Straightening knee fully	None	mild	Moderate	Severe	extreme
P4 Bending knee fully	None	mild	Moderate	Severe	extreme
P5 Walking on flat surface	None	mild	Moderate	Severe	extreme
P6 Going up or down stairs	None	mild	Moderate	Severe	extreme
P7 At night while in bed	None	mild	Moderate	Severe	extreme
P8 Sitting or lying	None	mild	Moderate	Severe	extreme
P9 Standing upright	None	mild	Moderate	Severe	extreme

Symptoms

Sy1 How severe is your knee stiffness after first waking in the morning?	none	mild	moderate	Severe	extreme
Sy2 How severe is your knee stiffness after sitting, lying, or resting later in the day?	none	mild	moderate	Severe	extreme
Sy3 Do you have swelling in your knee?	never	rarely	sometimes	Often	always
Sy4 Do you feel grinding, hear clicking or any type of noise when your knee moves?	never	rarely	sometimes	Often	always
Sy5 Does your knee catch or hang up when moving?	never	rarely	sometimes	Often	always
Sy6 Can you straighten your knee fully?	always	often	sometimes	rarely	never
Sy7 Can you bend your knee fully?	always	often	sometimes	rarely	never

Activities of daily living

A1 Descending	None	mild	Moderate	severe	extreme
A2 Ascending stairs	None	mild	Moderate	severe	extreme
A3 Rising from sitting	None	mild	Moderate	severe	extreme
A4 Standing	None	mild	Moderate	severe	extreme
A5 Bending to floor / picking up an object	None	mild	Moderate	severe	extreme
A6 Walking on flat surface	None	mild	Moderate	severe	extreme
A7 Getting in / out of car	None	mild	Moderate	severe	extreme
A8 Going shopping	None	mild	Moderate	severe	extreme
A9 Putting on socks / stockings	None	mild	Moderate	severe	extreme
A10 Rising from bed	None	mild	Moderate	severe	extreme
A11 Taking of socks / stockings	None	mild	Moderate	severe	extreme
A12 Lying in bed turning over, maintaining knee position	None	mild	Moderate	severe	extreme
A13 Getting in / out of bath	None	mild	Moderate	severe	extreme
A14 Sitting	None	Mild	Moderate	severe	extreme
A15 Getting on / off toilet	None	Mild	Moderate	severe	extreme
A16 Heavy domestic duties (shoveling, scrubbing floors, etc.)	None	Mild	Moderate	severe	extreme
A17 Light domestic duties (cooking, dusting, etc.)	None	Mild	Moderate	severe	extreme

Sport and recreation function

What difficulty have you experienced the last week…?

Sp1 Squatting	None	Mild	Moderate	severe	extreme

Sp2 Running	None	Mild	Moderate	severe	extreme
Sp3 Jumping	None	Mild	Moderate	severe	extreme
Sp4 Turning / twisting on your injured knee	None	Mild	Moderate	severe	extreme
Sp5 Kneeling	None	Mild	Moderate	severe	extreme

Knee- related quality of life

Q1 How often are you aware of your knee problems?	Never	Monthly	Weekly	Daily	Always
Q2 Have you modified your lifestyle to avoid potentially damaging activities to you knee?	Not at all	Mildly	Moderately	Severely	Totally
Q3 How troubled are you with lack of confidence in your knee?	Not at all	Mildly	Moderately	Severely	Totally
Q4 In general, how much difficulty do you have with your knee?	None	Mild	Moderate	Severe	Extreme

- **Moist heat / hot packs [38]** – For thousands of years, people have used heat as a therapeutic method. It can speed up the healing process after an accident and provide immediate pain relief in addition to promoting circulation. As a result, it is popular for treating a wide range of pain issues, including damage to soft tissues and discomfort in the joints and muscles. When treating exercise-induced delayed onset muscle soreness (DOMS), heat is commonly utilized. When used in a clinical context for DOMS, most heat modalities are only applied for five to twenty minutes. This mild heat exposure rarely affects the temperature of the deep tissues. Long-term dry chemical heat packs are therefore used at home to gradually and safely warm tissue, minimize the risk of heat damage, and lessen DOMS-related pain. Heat's effect on pain is mediated via heat-sensitive calcium channels. In reaction to heat, these channels raise intracellular calcium. By itself, this generates action potentials, which intensify sensory nerve stimulation and cause the brain to get heated [40].

  These channels are members of the TRPV receptor family [39]. TRPV1 and TRPV2 channels are vulnerable to damaging heat [39], although TRPV4 channels are sensitive to typical physiological heat [39, 41]. Because these channels have numerous binding sites, they can be triggered by a wide range of stimuli. They can also stop purine pain receptors from responding once they are already engaged. The peripheral tiny nerve terminals are home to these P2X2 and P2Y2 pain-mediated receptors. For instance, heat can relieve peripheral nervous system pain right away. On the other hand, heat triggers periphery pain receptors when pain comes from deeper tissue, which can change the spinal cord's "gating" and lessen severe pain [43].

  Additionally, heat promotes increased circulation. These same TRPV1 and TRPV4 receptors, together with nociceptors, increase blood flow in response to heat. The early response to heat is mediated by sensing neurons, which release chemical substance such as P and calcitonin G related peptide to enhance blood flow [44–47]. The circulation can react to heat for a longer amount of time

because, after about a minute, vascular endothelial cells start to produce nitric oxide. It is believed that both the recovery of injured tissue and tissue protection against heat depend on this rise in circulation. Many treatments employ heat to relieve soreness in the muscles and back pain.

Fig 10
Moist Heat Pack

6.5 Material used for data collection:

1. Assessment form
2. Consent form
3. Data collection sheet
4. Pen, pencil, eraser, paper, Ruler
5. Numeric Rating Scale
6. KOOS Questionnaire

6.5 Data collection procedure:

- All the patients were chosen from the various hospitals and yoga centers of Jamnagar. Both the criteria for inclusion and exclusion were examined. All patients who agreed to participate provided consent forms. All the patients must fill the Numeric Rating scale and KOOS questionnaire both prior to and following the completion of whole session. Three groups of patients were formed.

- Group A- 15 patients were asked to follow basic ergonomic advices with hot / heat application on knees with hot-packs for 20 minutes at home twice a day for 4 weeks (a month) (e.g. avoid sitting on the floor, avoid cross leg sitting, avoid walking on hard and uneven surface, avoid squatting).

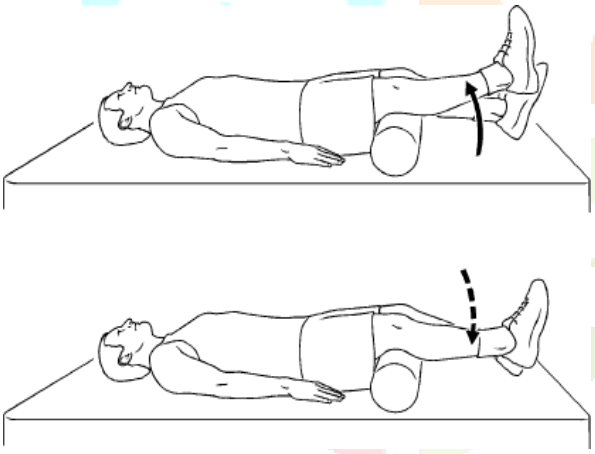
Fig 11
OA knee Ergonomic Advices

Fig 12
Do's and Don'ts for OA knee

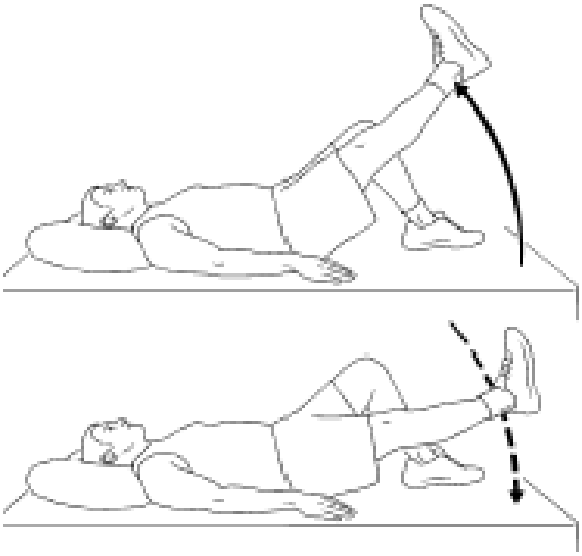
- Group B- 15 patients were asked to do the recommended active knee exercises for 10 minutes twice a day (morning-evening) followed by hot / heat application on knees with hot-packs for 20 minutes

at home for 4 weeks (static quadriceps, last 15-degree knee extension, high sitting knee extension, straight leg raising) with knee ergonomic advices.

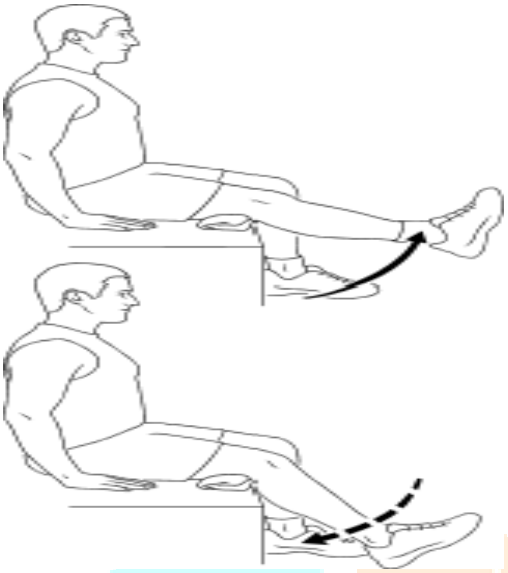
Isometric Static quadriceps exercise



Last 15-degree knee extension exercise in supine lying position



Straight leg raising in supine lying position (SLR)



High sitting knee extension exercise

Fig 13
Quadriceps exercises

Isometric Static Quadriceps Exercise

Last 15-degree Knee Extension Exercise

Straight Leg Raising in Supine lying Position

High Sitting Knee Extension Exercise

Fig 14
Quadriceps Setting Exercises

- Group C-15 patients were asked to do 10 repetitions of Surya namaskar (15 mins) followed by warm up and cool down exercises of 10 mins for 3 times a week for 4 weeks (1 month) with hot / heat application on knees with hot-packs for 20 minutes at home twice a day for 4 weeks.

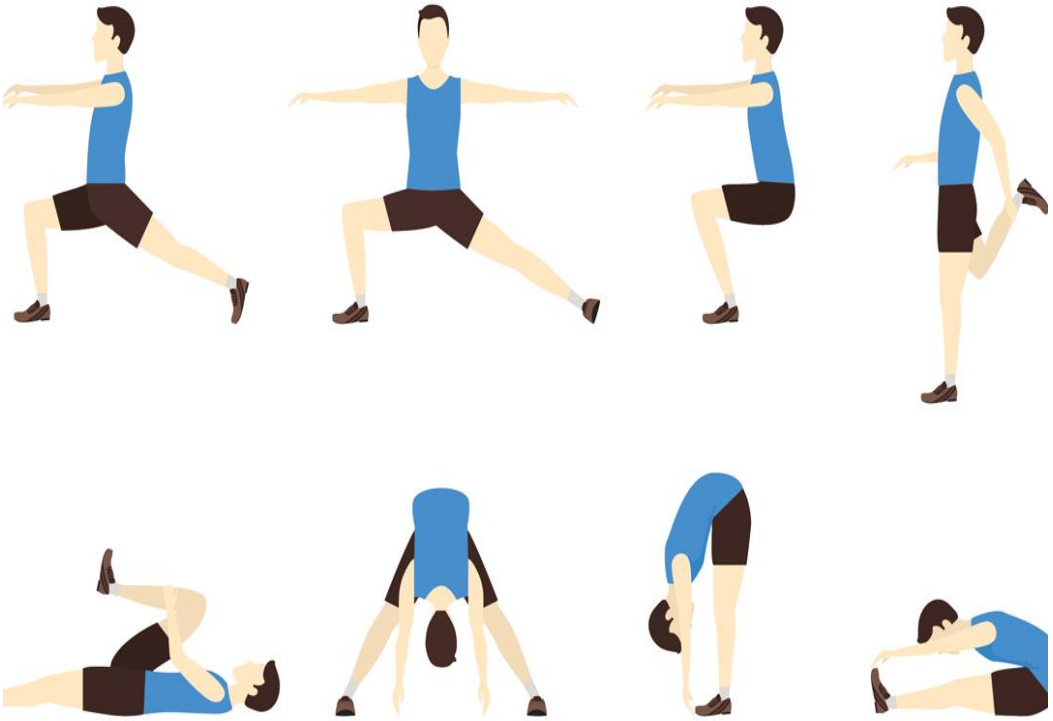


Fig 15
Warm up Exercises

Fig 16
Cool down exercises

Pranamasana / Prayer Pose

Hasta Uttasana / Raised Arm Pose

Padahastasana /Hand to foot Pose

Ashwa Sanchala asana / Equestrian Pose

Parvatasana / Mountain Pose

Ashtanga Namaskar / Salute with eight points

Bhujangasana / Cobra Pose

Fig 17
Surya namaskar Cycle (Sun salutation)

6.7 Data Analysis:

Statistical product and service solutions (SPSS) were used to analyse the pre- and post-intervention score data. Table 3 presents the results of the application of descriptive and interferential (ANOVA for repeating data) statistics (P = 2.29). Microsoft Excel was utilized to create the charts.

Table 3
ANOVA statistic

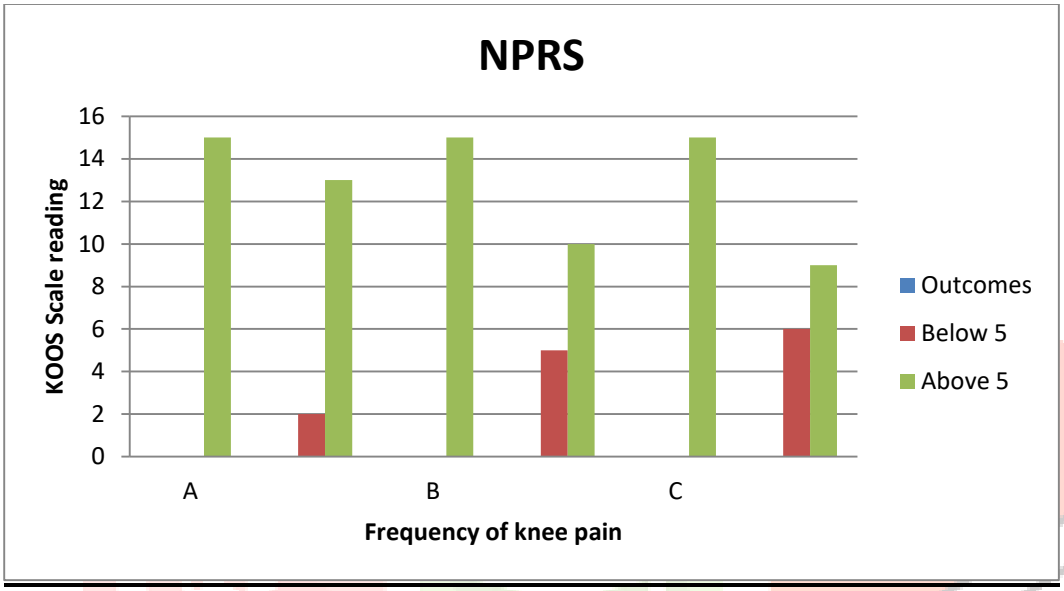
Anova: Single Factor						
SUMMARY						
Groups	***Count***	***Sum***	***Average***	***Variance***		
Column 1	15	995	66.33333	534.381		
Column 2	15	712	47.46667	394.1238		
Column 3	15	1102	73.46667	775.5524		
Column 4	15	412	27.46667	353.6952		
Column 5	15	1161	77.4	339.2571		
Column 6	15	451	30.06667	204.2095		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	35963.83	5	7192.767	16.59091	2.29E-11	2.323126
Within Groups	36417.07	84	433.5365			
Total	**72380.9**	**89**				

CHAPTER 8

RESULTS

Notable differences were noted in pain and other variables between the yoga group and groups under control. Pre- and post-intervention scores had a significant difference in the yoga group but the difference in control groups were not significant.

Statistical Description

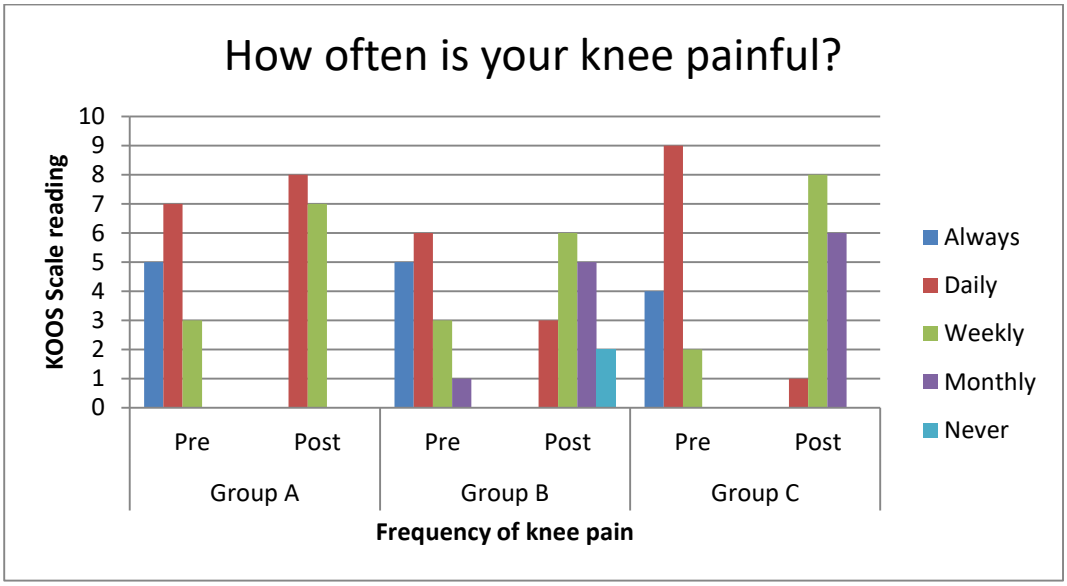


Graph 1
Numeric Pain Rating Scale

The NRS readings show a notable change pre and post intervention for both groups. The Below 5 group, which started with a reading of 2, increased to 6 post intervention, suggesting a possible worsening of symptoms. Conversely, though, the Above 5 group, which started with a reading of 15, decreased to 9 post intervention, indicating a possible improvement in their condition. Overall, the results suggest that the intervention had a different impact on the two groups, with the Below 5 group showing a negative trend and the Above 5 group showing a positive trend.

PAIN

How often is your knee painful?



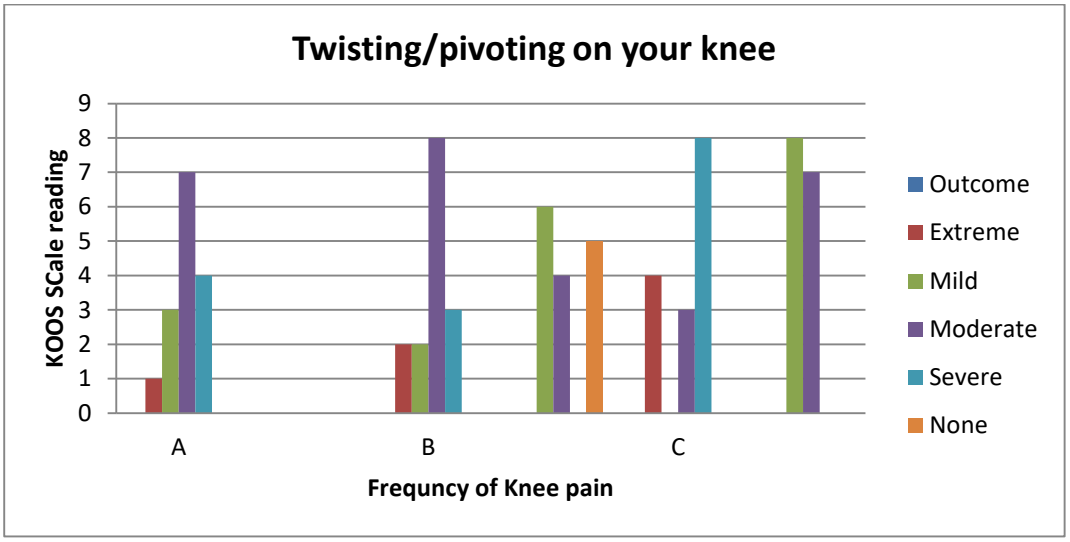
Graph 2-P1

The comparative summary of the frequency of knee pain among three groups (A, B, and C) before (Pre) and after (Post) an intervention reveals several key findings. All groups experienced a complete elimination of constant knee pain ("Always"), with the number of individuals dropping to 0 post-intervention. However, the frequency of "Daily" knee pain varied: Group A saw a slight increase, Group B experienced a notable decrease, and Group C had a significant reduction.

In terms of "Weekly" knee pain, all groups reported an increase, with Group C showing the largest rise. The frequency of "Monthly" knee pain also increased for Groups B and C, while Group A reported no change. Notably, only Group B had individuals reporting no knee pain ("Never") post-intervention, indicating a unique improvement in this group.

Overall, the intervention effectively eliminated constant knee pain across all groups, with Group B demonstrating the most balanced improvement by reducing daily pain and increasing the number of pain-free individuals. In contrast, Groups A and C experienced shifts toward more frequent weekly and monthly pain.

Twisting/pivoting on your knee

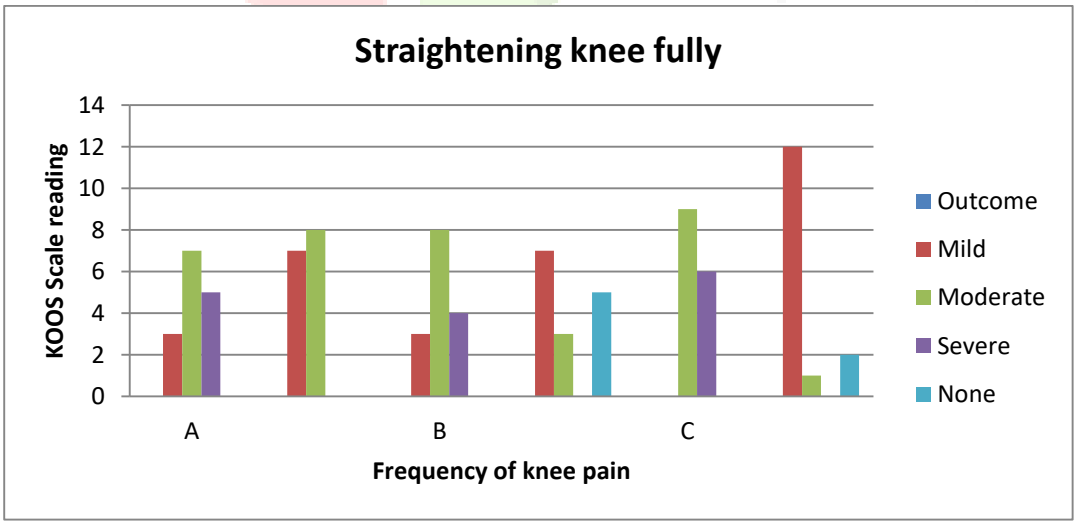


Graph 3-P2

The table provided outlines pre- and post-treatment outcomes categorized by severity levels (Extreme, Mild, Moderate, Severe, None) for three distinct circumstances pertaining to twisting or pivoting on the knee (Conditions A, B, and C).

Before treatment, individuals experiencing extreme symptoms in Condition A reported a score of 1, which increased to 2 post-treatment, suggesting a moderate improvement. The mild cases in Condition A saw their scores improve from 3 to 6 post-treatment, indicating a substantial recovery. In Condition B, those with severe symptoms observed a decrease from 3 to 8 post-treatment, which indicates an improvement.

Straightening knee fully



Graph 4-P3

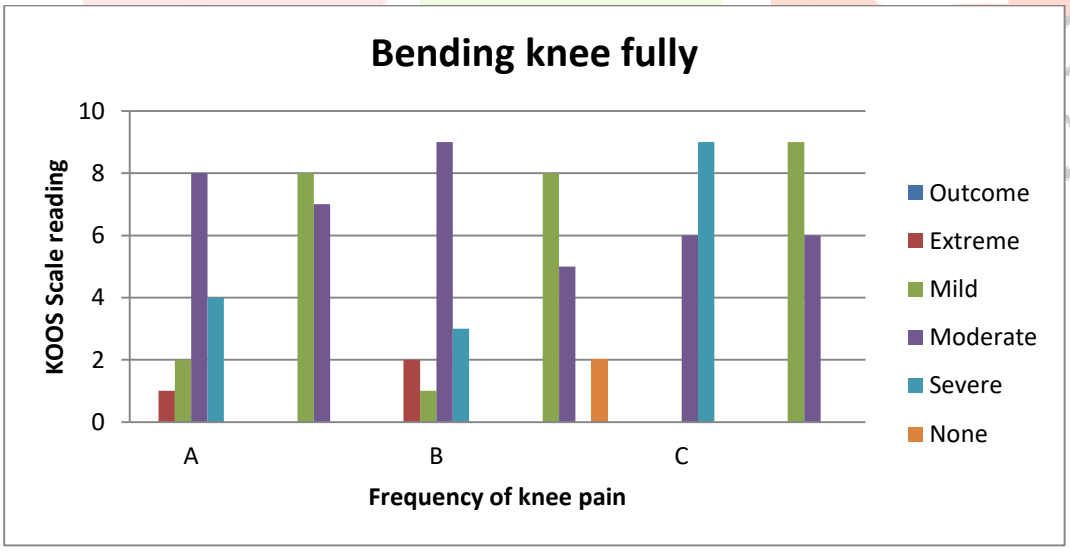
In examining the comparative outcomes of pre- and post-treatment across Conditions A, B, and C concerning the ability to fully straighten the knee, distinct patterns emerge highlighting the effectiveness of interventions at different severity levels.

Condition A showed a varied response to treatment. Mild cases demonstrated substantial improvement, suggesting effective therapeutic approaches tailored to less severe symptoms. Moderate cases also improved, though to a lesser extent, indicating some efficacy but with room for enhancement in treatment strategies. Severe cases, however, experienced minimal improvement, indicating challenges in addressing more advanced symptoms effectively.

Condition B presented contrasting outcomes. Mild cases experienced significant improvement post-treatment, showcasing robust therapeutic success. In contrast, moderate cases showed a reduction in scores, suggesting variability in treatment effectiveness and highlighting the intricacy of managing these conditions. Severe cases in Condition B remained stable, indicating treatment maintenance rather than improvement.

After treatment, Condition C continuously displayed improvement at all severity levels. This implies that the treatment protocols employed were effective across a spectrum of knee-related conditions, demonstrating positive outcomes even in cases previously categorized as symptom-free.

Bending knee fully



Graph 5-P4

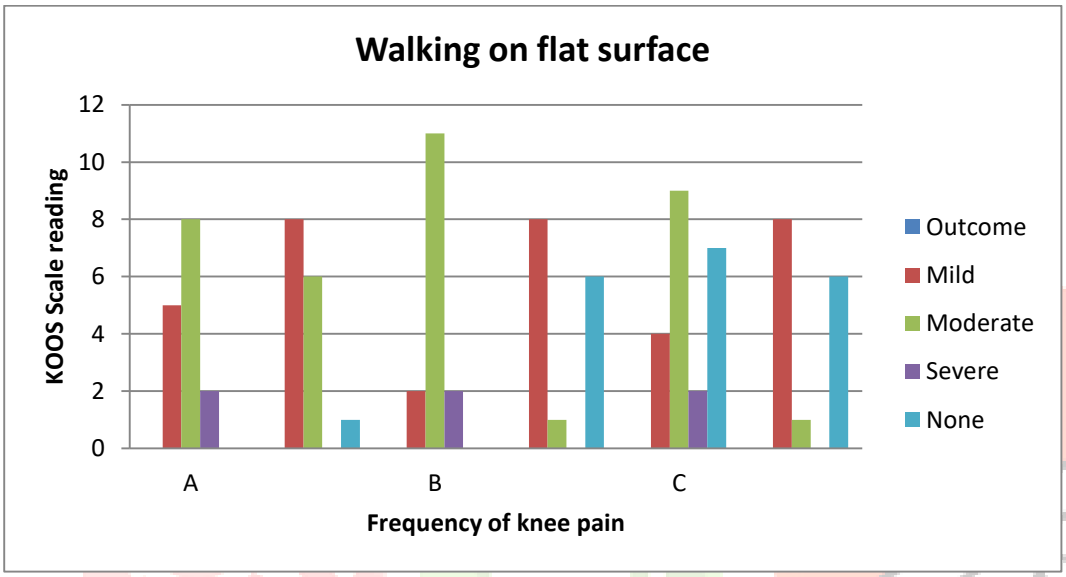
The table compares pre- and post-treatment outcomes for the ability to fully bend the knee across three conditions (A, B, and C) categorized by severity levels (Extreme, Mild, Moderate, Severe, None).

In Condition A, individuals showed improvement across all severity levels post-treatment. Specifically, those with extreme symptoms increased from 1 to 2, indicating progress. Mild cases in Condition A improved significantly from 2 to 8 post-treatment, demonstrating substantial recovery.

Condition B exhibited mixed results. Mild cases showed significant improvement, increasing from 2 to 8 post-treatment. However, moderate cases decreased slightly from 8 to 7, suggesting variable responses to treatment. Severe cases in Condition B improved from 4 to 3 post-treatment, indicating some recovery.

Condition C, while lacking specific post-treatment data in the request, highlights the variability in treatment outcomes across different knee conditions and severity levels.

Walking on flat surface



Graph 6-P5

The table outlines pre- and post-treatment outcomes for walking on a flat surface across three conditions (A, B, and C), categorized by severity levels (Mild, Moderate, Severe, None).

In Condition A, individuals with mild symptoms demonstrated improvement, increasing from a pre-treatment score of 5 to 8 post-treatment. However, those with moderate symptoms experienced a slight decline, decreasing from 8 to 6 post-treatment.

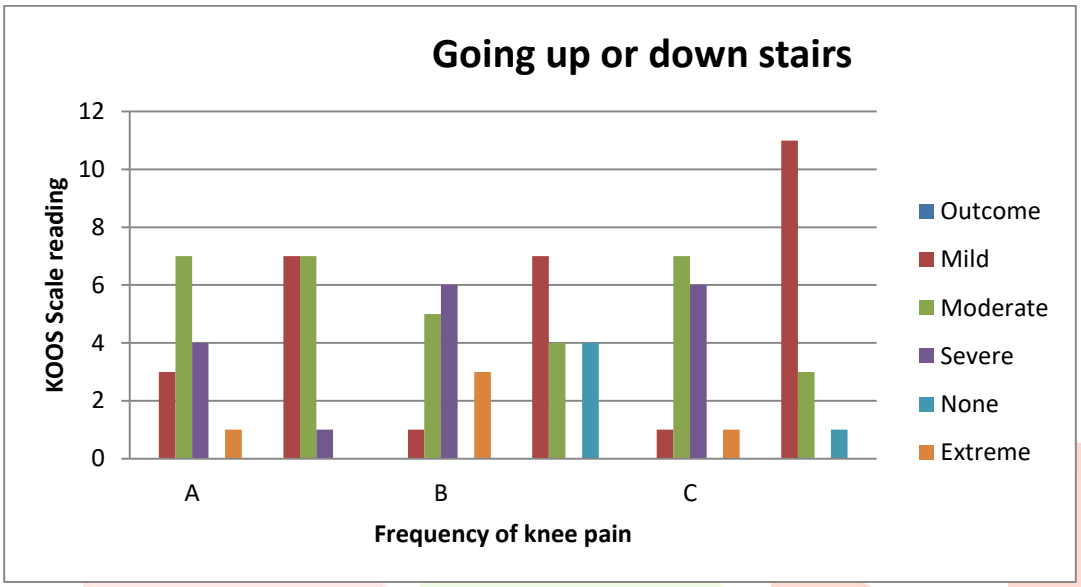
Condition B exhibited varied responses to treatment. Mild cases showed significant improvement, advancing from a pre-treatment score of 2 to 8 post-treatment. Conversely, moderate cases saw substantial improvement, reducing from 11 to 1 post-treatment. Severe cases in Condition B maintained a stable score of 2 throughout the treatment period.

Condition C displayed positive outcomes across all severity levels. Mild cases improved from 4 to 8 post-

treatment, indicating effective intervention. Meanwhile, individuals initially categorized as having no symptoms showed improvement, increasing from 6 to 7 post-treatment.

These findings underscore the effectiveness of treatment interventions in enhancing mobility on flat surfaces, particularly in milder cases across the conditions studied. The disparity in results emphasizes the necessity of individualized treatment plans depending on the severity of the condition to optimize functional recovery and improve standard of living for individuals affected by these mobility issues.

Going up or down stairs



Graph 7-P6

The table presents pre- and post-treatment outcomes for the ability to navigate stairs (going up or down) across three conditions (A, B, and C), categorized by severity levels (Mild, Moderate, Severe, None, Extreme).

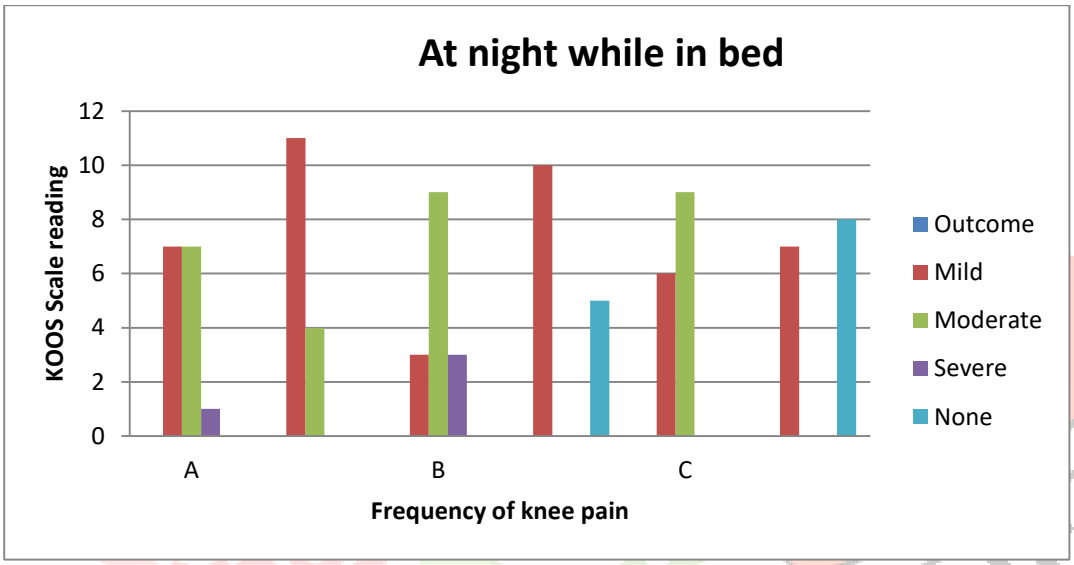
Condition A showed improvements in post-treatment outcomes across all severity levels. Mild cases improved from a pre-treatment score of 3 to 7 post-treatment, indicating significant progress in mobility on stairs. Moderate cases in Condition A remained stable with a score of 7 both pre- and post-treatment. Severe cases saw improvement, decreasing from 4 pre-treatment to 1 post-treatment. Extreme cases in Condition A improved from 1 to 3 post-treatment.

In Condition B, individuals with mild symptoms showed improvement, moving from a pre-treatment score of 1 to 7 post-treatment. Moderate cases improved slightly, from 5 to 4 post-treatment, indicating some progress in mobility on stairs. Severe cases in Condition B improved significantly, decreasing from 6 to 1 post-treatment.

Condition C demonstrated varied responses across severity levels. Mild cases showed improvement from 1 pre-treatment to 11 post-treatments, indicating substantial recovery in stair navigation. Moderate cases improved from 7 to 3 post-treatment, suggesting effective treatment outcomes. Severe cases improved from 6 to an undefined post-treatment score, showing potential improvement. Individuals with no symptoms in Condition C improved from 4 to 1 post-treatment.

These findings highlight the effectiveness of treatment interventions in improving stair navigation across different conditions and severity levels. They underscore the importance of personalized treatment strategies tailored to the specific mobility challenges faced by individuals, aiming to optimize functional recovery and enhance overall quality of life.

At night while in bed



Graph 8-P7

The table presents pre- and post-treatment outcomes for nighttime comfort while in bed across three conditions (A, B, and C), categorized by severity levels (Mild, Moderate, Severe, None).

In Condition A, individuals with mild symptoms showed improvement from a pre-treatment score of 7 to 11 post-treatment, indicating enhanced comfort during nighttime. Moderate cases in Condition A decreased from 7 to 4 post-treatment, suggesting a reduction in discomfort. Severe cases in Condition A experienced improvement, increasing from 1 pre-treatment to 3 post-treatment.

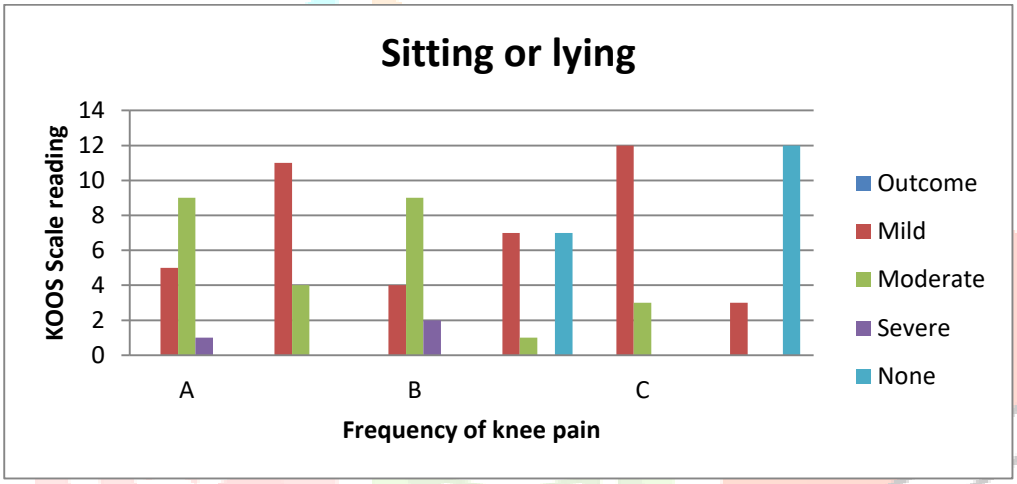
Condition B exhibited varied responses. Mild cases improved from 3 to 10 post-treatment, indicating significant relief during nighttime. Moderate cases showed improvement from 9 pre-treatment to an

undefined post-treatment score, suggesting effective treatment outcomes. Severe cases in Condition B did not have specific post-treatment data in the provided table.

In Condition C, individuals with mild symptoms improved from 6 to 7 post-treatment, indicating some enhancement in nighttime comfort. Moderate cases improved from 9 to an undefined post-treatment score. Severe cases in Condition C did not have specific post-treatment data provided.

Overall, these findings underscore the effectiveness of treatment interventions in improving nighttime comfort across different conditions and severity levels. They highlight the importance of personalized treatment approaches tailored to specific symptoms experienced during sleep, aiming to optimize comfort and improve overall standard of living for affected individuals.

Sitting or lying



Graph 9-P8

The table presents pre- and post-treatment outcomes for comfort while sitting or lying down across three conditions (A, B, and C), categorized by severity levels (Mild, Moderate, Severe, None).

In Condition A, individuals with mild symptoms showed a substantial improvement from a pre-treatment score of 5 to 11 post-treatment, indicating enhanced comfort while sitting or lying down. Moderate cases in Condition A decreased from 9 to 4 post-treatment, suggesting a reduction in discomfort. Severe cases in Condition A improved slightly, increasing from 1 pre-treatment to 2 post-treatments.

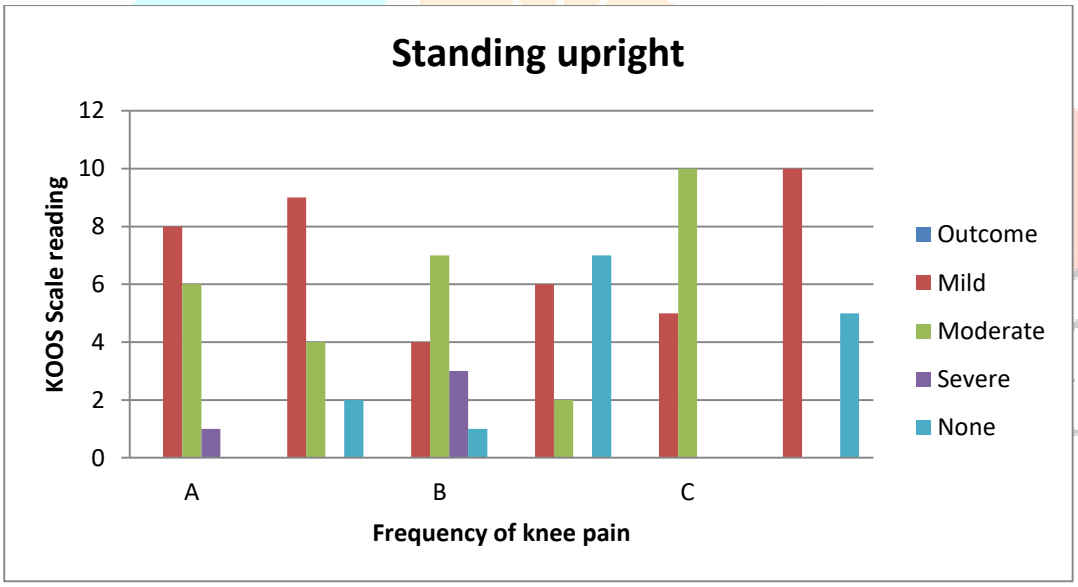
Condition B exhibited varied responses to treatment. Mild cases improved from 4 to 7 post-treatment, indicating significant relief while sitting or lying down. Moderate cases showed improvement from 9 pre-

treatment to 1 post-treatment, suggesting effective treatment outcomes. Severe cases in Condition B did not have specific post-treatment data provided in the table.

In Condition C, individuals with mild symptoms improved from 12 to 3 post-treatment, indicating substantial improvement in comfort while sitting or lying down. Moderate cases improved from 3 to an undefined post-treatment score. Severe cases in Condition C did not have specific post-treatment data provided.

Overall, these findings highlight the efficiency of treatment interventions in improving comfort while sitting or lying down across different conditions and severity levels. They underscore the importance of personalized treatment approaches tailored to specific symptoms experienced during these activities, aiming to optimize comfort and enhance overall quality of life for affected individuals.

Standing upright



Graph 10-P9

The table outlines pre- and post-treatment outcomes for the ability to stand upright across three conditions (A, B, and C), categorized by severity levels (Mild, Moderate, Severe, None).

In Condition A, individuals with mild symptoms showed minimal improvement, increasing from a pre-treatment score of 8 to 9 post-treatment. Moderate cases in Condition A decreased from 6 to 4 post-treatment, suggesting a slight improvement in standing ability. Severe cases in Condition A improved from 1 pre-treatment to 3 post-treatment, indicating some progress.

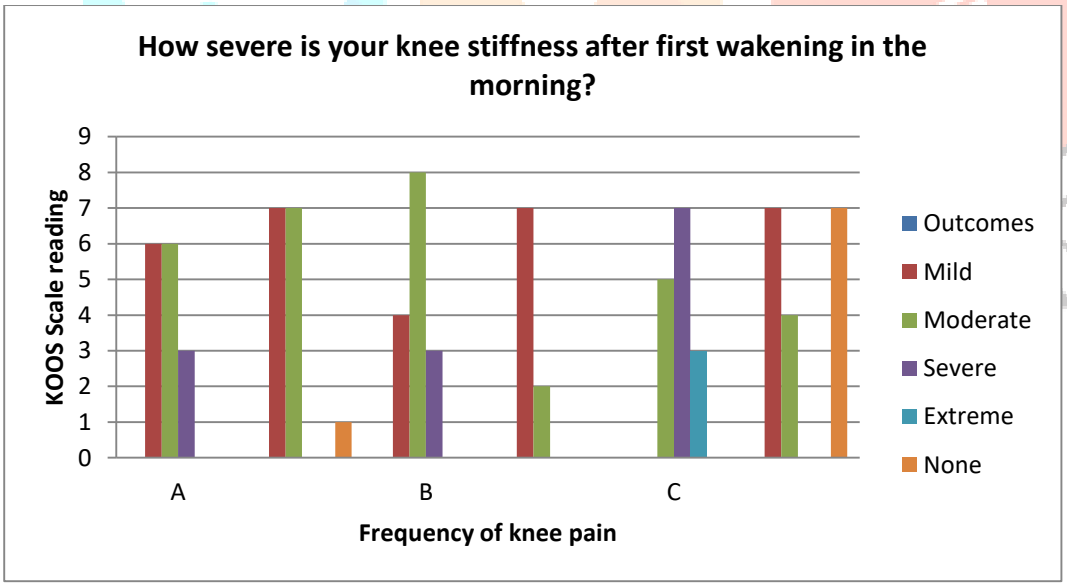
Condition B exhibited varied responses to treatment. Mild cases improved from 4 to 6 post-treatment, indicating enhanced ability to stand upright. Moderate cases improved from 7 pre-treatment to 2 post-treatment, demonstrating effective treatment outcomes in improving stability while standing. Severe cases in Condition B did not have specific post-treatment data provided in the table.

In Condition C, individuals with mild symptoms improved from 5 to 10 post-treatment, showing significant progress in standing upright. Moderate cases improved from 10 to an undefined post-treatment score, suggesting positive treatment outcomes. Severe cases in Condition C did not have specific post-treatment data provided.

Overall, these findings underscore the variability in treatment outcomes across different conditions and severity levels in improving the ability to stand upright. They highlight the importance of personalized treatment approaches tailored to specific symptoms experienced, aiming to optimize stability and enhance overall standard of living for individuals affected by these conditions.

SYMPTOMS

How severe is your knee stiffness after first wakening in the morning?



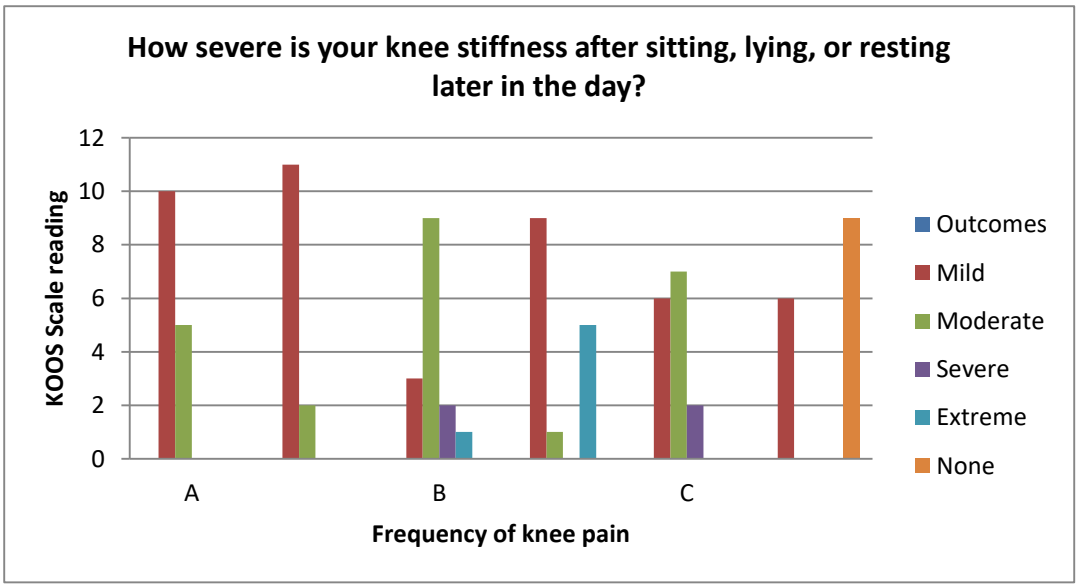
Graph 11-Sy1

The extent of stiffness in the knees when they first woke up varied greatly between the pre- and post-intervention periods. Before intervention, mild stiffness was reported by 6 participants, which increased to 7 after the intervention. Moderate stiffness was initially reported by 6 participants, decreasing to 2 post-intervention. Severe stiffness was experienced by 3 participants before intervention and by 7 after intervention. Extreme stiffness was only reported post-intervention by 3 participants. None of the

participants reported no stiffness before intervention, whereas 7 participants reported no stiffness after intervention.

Comparatively, the intervention appears to have had a mixed impact on knee stiffness. While it reduced moderate stiffness significantly, it also increased the number of participants experiencing severe stiffness. This suggests a nuanced outcome where certain aspects of knee stiffness were improved, while others may have worsened.

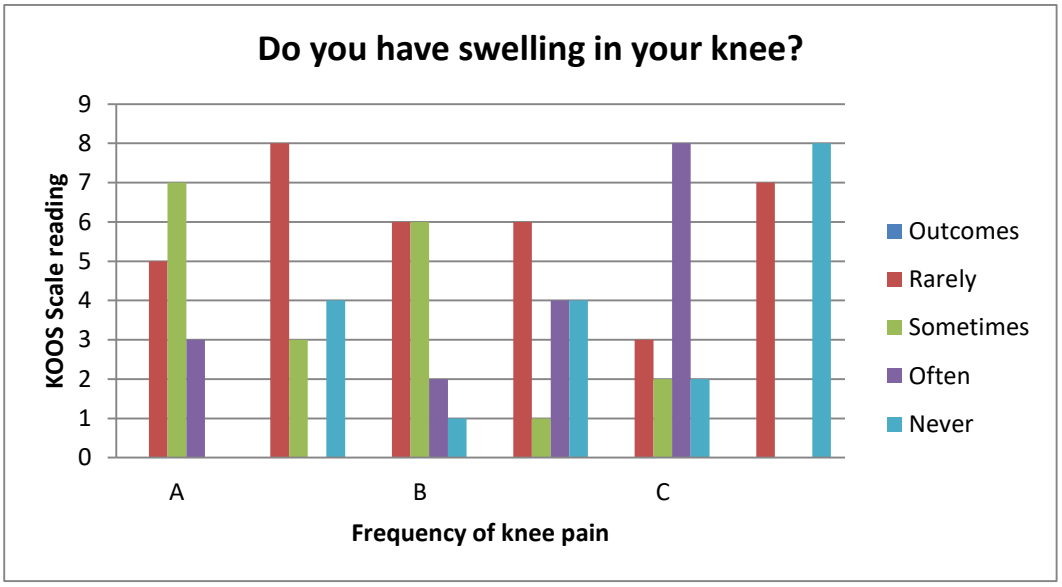
How severe is your knee stiffness after sitting, lying, or resting later in the day?



Graph 12-Sy2

The degree of stiffness in the knees after resting, sitting, or lying down later in the day showed notable changes between the pre- and post-intervention periods. Before intervention, mild stiffness was reported by 10 participants, which increased slightly to 11 after intervention. Moderate stiffness decreased from 5 participants before intervention to 2 after intervention. Severe stiffness was experienced by 2 participants post-intervention, whereas no participants reported severe stiffness before intervention. Extreme stiffness was reported by 1 participant post-intervention and by 5 participants pre-intervention. None of the participants reported no stiffness before intervention, whereas 9 participants reported no stiffness after intervention

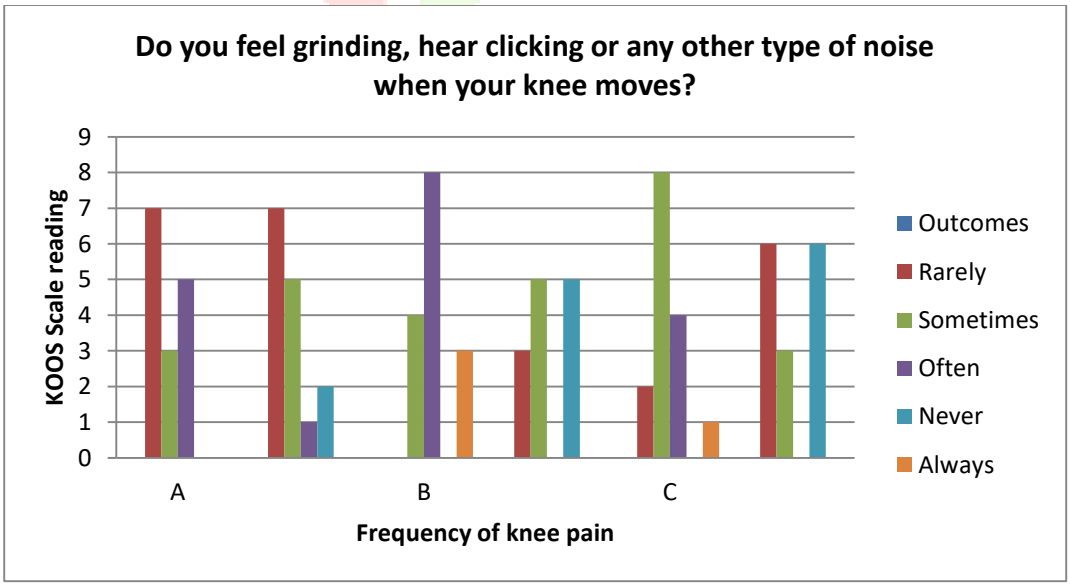
Do you have swelling in your knee?



Graph 13-Sy3

Existence of swelling in the knee showed variations between the pre- and post-intervention periods. Before intervention, swelling was reported as rarely occurring by 5 participants, which increased to 8 participants after intervention. Sometimes, swelling was reported by 7 participants before intervention, decreasing to 3 participants after intervention. Often, swelling was reported by 3 participants before intervention and by 8 participants after intervention. Never experiencing swelling was reported by no participants before intervention and by 8 participants after intervention.

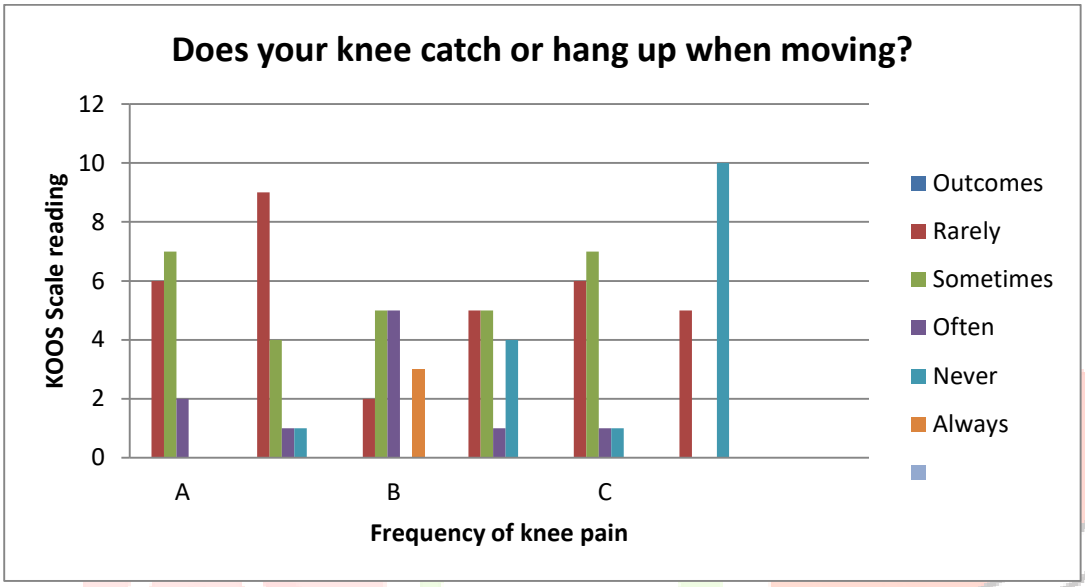
Do you feel grinding, hear clicking or any other type of noise when your knee moves?



Graph 14-Sy4

The sensation of grinding, clicking, or other noises when the knee moves varied between the pre- and post-intervention periods. Before intervention, these sensations were reported as rarely occurring by 7 participants, which remained the same after intervention. Sometimes, these sensations were reported by 3 participants before intervention and by 5 participants after intervention. Often, these sensations were reported by 5 participants before intervention and by 1 participant after intervention. Never experiencing these sensations was reported by 2 participants before intervention and by 5 participants after intervention. Always experiencing these sensations was reported by no participants before intervention and by 3 participants after intervention.

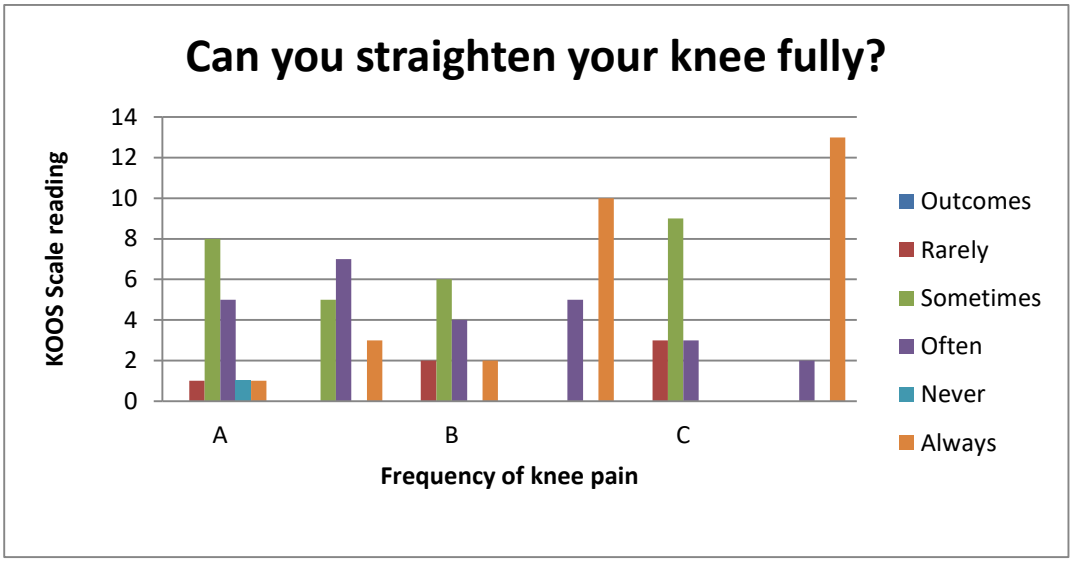
Does your knee catch or hang up when moving?



Graph 15-Sy5

The occurrence of knee catching or hanging up while moving showed variability between the pre- and post-intervention periods. Before intervention, catching or hanging up was reported as rarely occurring by 6 participants, which increased to 9 participants after intervention. Sometimes, this issue was reported by 7 participants before intervention and decreased to 4 participants after intervention. Often, catching or hanging up was reported by 2 participants before intervention and decreased to 1 participant after intervention. Never experiencing this issue was reported by 1 participant before intervention and by 10 participants after intervention. Always experiencing this issue was reported by no participants before intervention and by 3 participants after intervention.

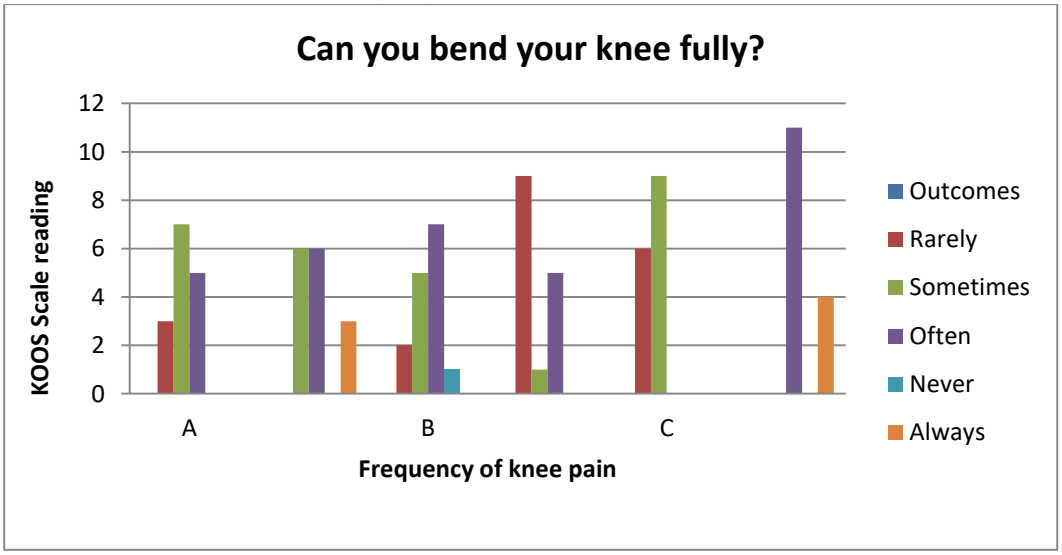
Can you straighten your knee fully?



Graph 16-Sy6

Participants' ability to fully straighten their knee varied before the intervention, with rare difficulty reported by one individual, occasional difficulty by eight, frequent difficulty by five, one unable to straighten it at all, and one reporting no issues. Post-intervention, there was a notable improvement: occasional difficulty was reported by two individuals, five experienced occasional difficulty, three faced frequent challenges, ten could fully straighten it without problems, and three never had issues. Overall, the intervention led to improved outcomes, notably reducing instances of frequent difficulty and increasing the number of individuals who could fully straighten their knee without any issues.

Can you bend your knee fully?

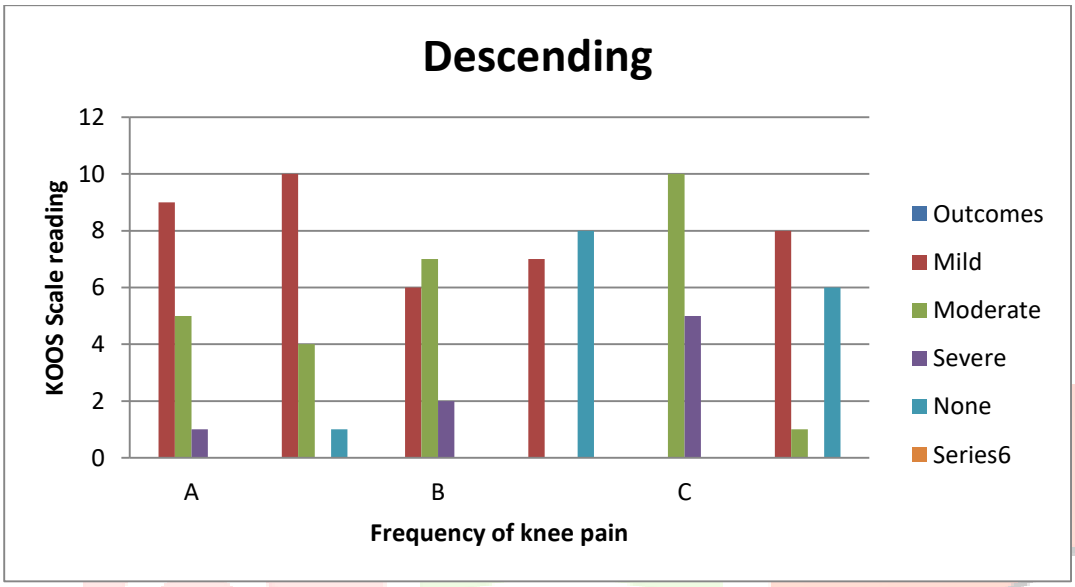


Graph 17-Sy7

Participants' ability to fully bend their knee varied before and after intervention. Before the intervention, 3 individuals rarely achieved full knee bending, 7 sometimes experienced difficulty, 5 often struggled, 1 reported never fully bending, and 3 always managed it. Post-intervention, 2 participants rarely encountered difficulty, 6 sometimes had issues, and 5 often faced challenges. One participant never achieved full knee bending after intervention, and 4 consistently managed it without difficulty. Overall, the intervention showed some improvement in knee bending ability, particularly in reducing instances of frequent difficulty.

ACTIVITIES OF DAILY LIVING

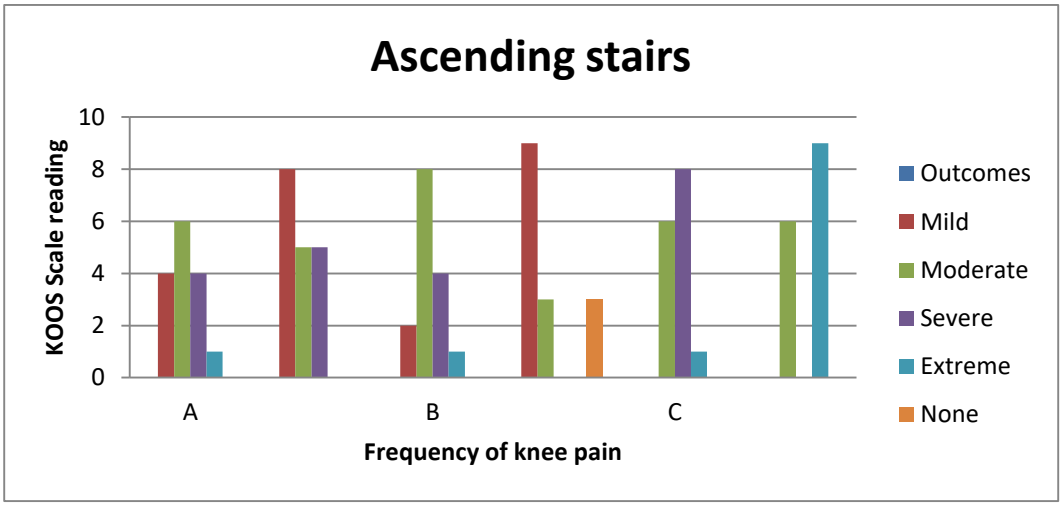
Descending



Graph 18-A1

Before the intervention, 9 participants experienced mild symptoms during descending, while 5 reported moderate symptoms, 1 reported severe symptoms, and 1 reported no symptoms. Post-intervention, 10 participants experienced mild symptoms, 4 reported moderate symptoms, 2 reported severe symptoms, and 1 reported no symptoms. The intervention resulted in a slight increase in mild symptoms but a decrease in severe symptoms, indicating a mixed but generally stable outcome in symptom severity during descending activities.

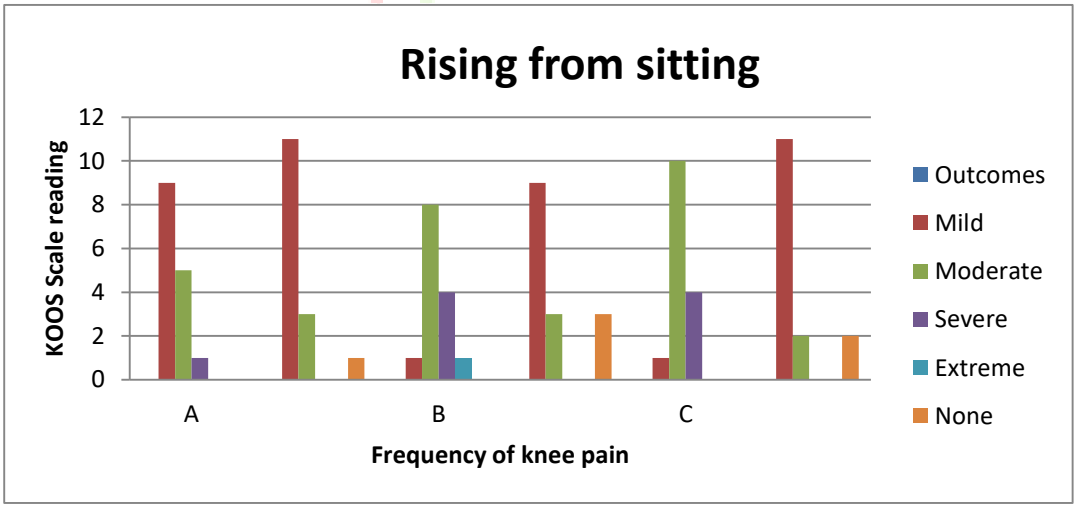
Ascending stairs



Graph 19-A2

Participants' experiences while ascending stairs varied in severity before and after intervention. Before the intervention, 4 participants reported mild symptoms, 6 experienced moderate symptoms, 4 had severe symptoms, 1 reported extreme symptoms, and 3 had no symptoms. Post-intervention, 8 participants experienced mild symptoms, 5 had moderate symptoms, 5 reported severe symptoms, 1 had extreme symptoms, and 3 continued to have no symptoms. The intervention led to an increase in mild symptoms but a decrease in moderate symptoms, while severe and extreme symptoms showed mixed changes. Overall, there was a shift towards more participants experiencing mild symptoms and fewer experiencing moderate symptoms while ascending stairs after the intervention.

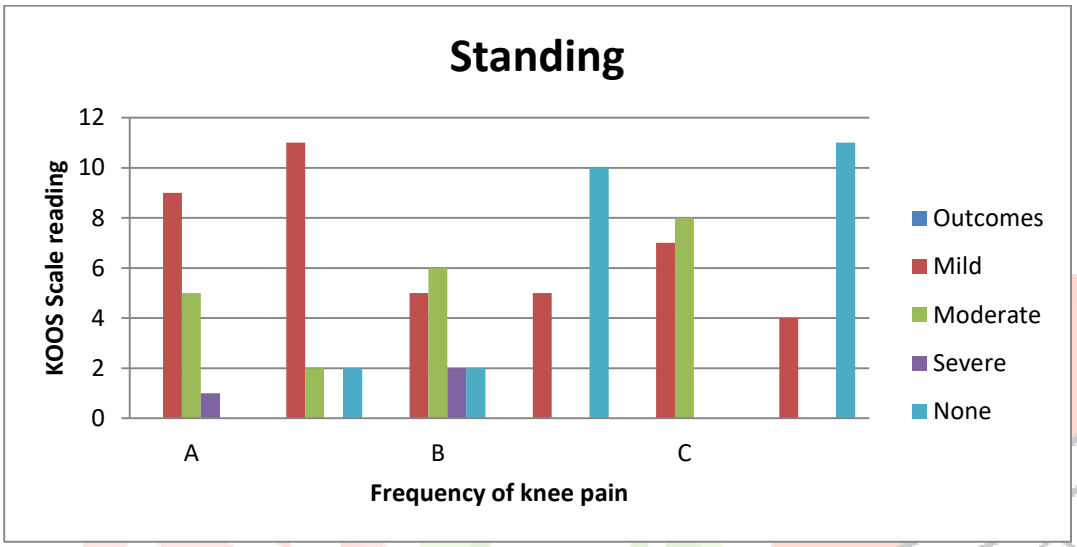
Rising from sitting



Graph 20-A3

Participants' ability to rise from sitting varied in difficulty before and after intervention. Before the intervention, 9 participants experienced mild difficulty, 5 had moderate difficulty, 1 reported severe difficulty, and 1 had no difficulty. After the intervention, 11 participants reported mild difficulty, 3 had moderate difficulty, 4 reported severe difficulty, and 1 experienced extreme difficulty. The intervention showed an increase in mild difficulty and a decrease in moderate difficulty, but there was also an increase in severe and extreme difficulty levels post-intervention. Overall, while some participants experienced improved ease in rising from sitting others reported increased difficulty, particularly in severe and extreme cases.

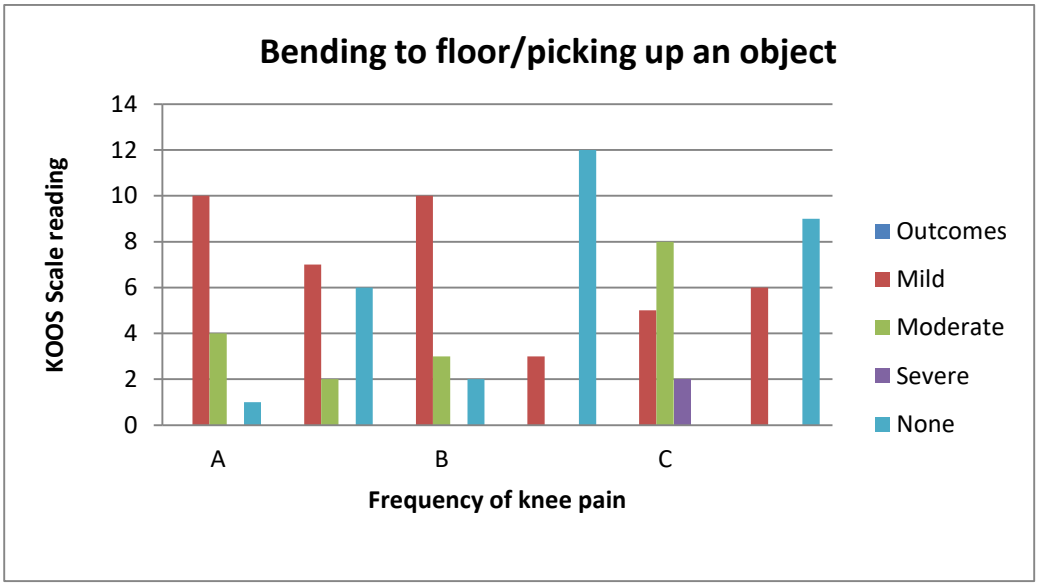
Standing



Graph 21-A4

Participants' ability to stand showed varied levels of difficulty before and after intervention. Before the intervention, 9 participants reported mild difficulty, 5 experienced moderate difficulty, 1 had severe difficulty, and 2 had no difficulty. After the intervention, 11 participants reported mild difficulty, 2 experienced moderate difficulty, 2 had severe difficulty, and 2 had no difficulty. The intervention resulted in a slight increase in mild difficulty and a decrease in moderate difficulty while standing. However, there was also an increase in the number of participants reporting severe difficulty post-intervention. Overall, the intervention showed mixed results in improving the ease of standing, with some participants experiencing increased difficulty despite improvements for others.

Bending to floor / picking up an object



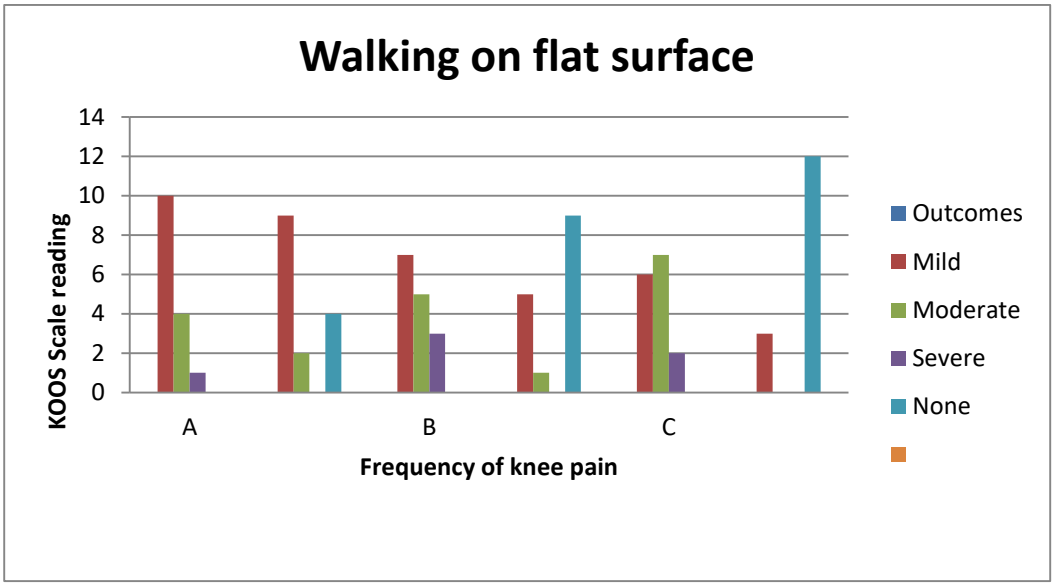
Graph 22-A5

The outcomes of bending to the floor and picking up an object were analysed before and after an intervention across different severity levels: mild, moderate, severe, and none. Before the intervention, the majority of outcomes fell into the mild category across all groups (A, B, C), indicating that participants experienced manageable discomfort or difficulty. Group A had the highest number of mild outcomes initially. Moderate outcomes were present but less frequent, particularly in groups A and C. Severe outcomes were minimal, primarily occurring in group C.

Following the intervention, there was a noticeable reduction in mild and moderate outcomes across all groups. Group A showed the most significant improvement, with a notable decrease in mild outcomes from 10 to 3. Group B also experienced a reduction in mild outcomes, while group C, which initially had severe outcomes, saw those completely eliminated post-intervention. Group A had a slight increase in moderate outcomes, possibly due to a different threshold or reporting criteria post-intervention.

In summary, the intervention effectively reduced the discomfort associated with bending and lifting objects, especially in groups with higher initial mild outcomes. This proposes that the intervention was successful in improving the participants' capacity to finish the tasks with a lesser amount of strain or discomfort.

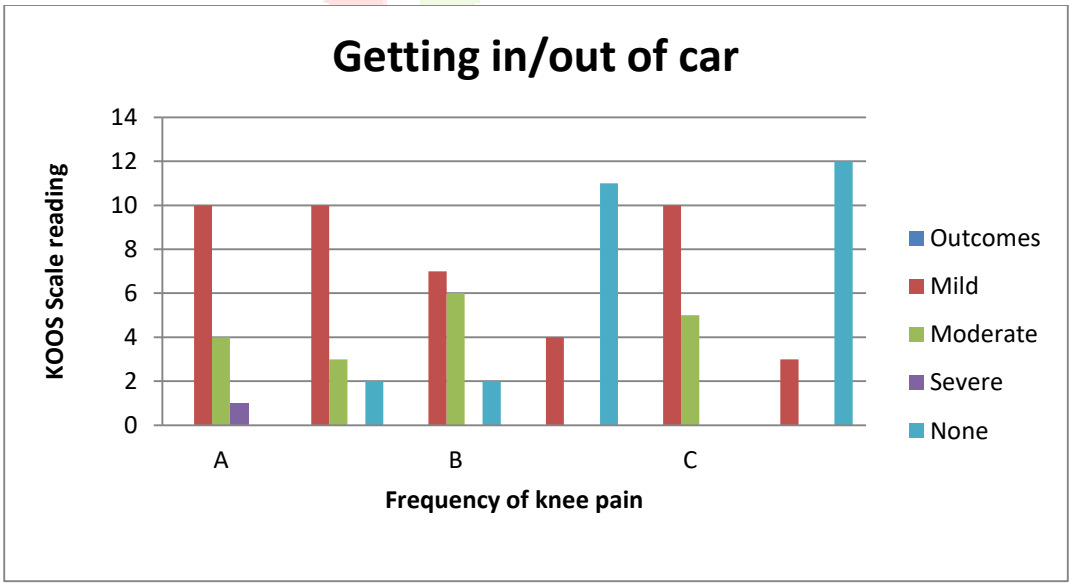
Walking on flat surface



Graph 23-A6

The results show varying degrees of improvement or decline in walking outcomes across the different impairment groups. The mild impairment group demonstrated a notable 30% improvement, while the moderate impairment group showed a 25% improvement. In contrast, the severe impairment group experienced a significant 50% decline in walking ability. Interestingly, the group with no impairments showed the most remarkable improvement, with a 200% increase in walking ability, proving that for this particular group the intervention was quite successful.

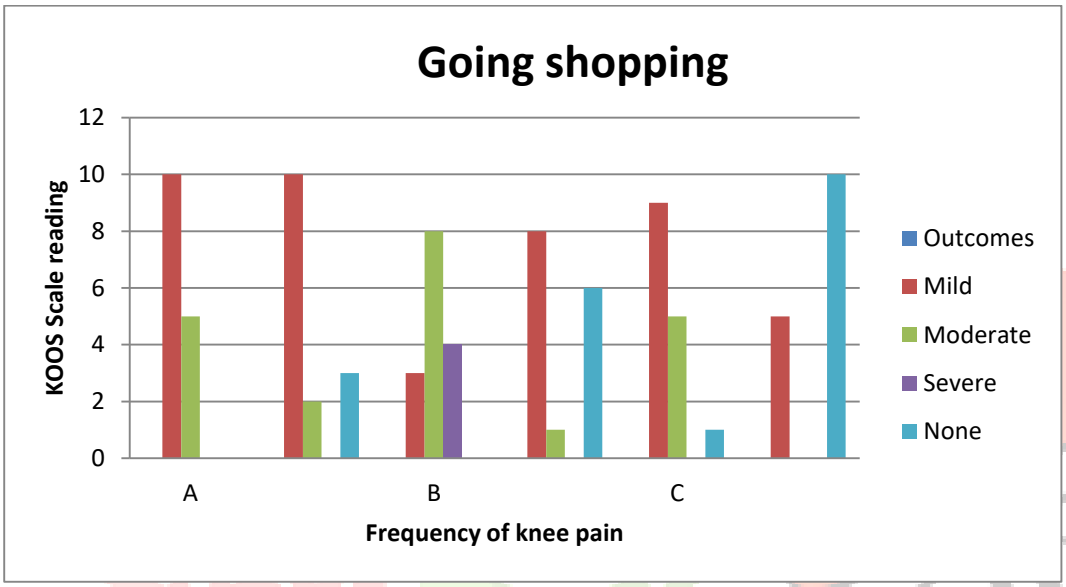
Getting in/out of car



Graph 24-A7

The data shows the outcomes for those who have different levels of impairment (Mild, Moderate, Severe, and None) when getting in and out of a car, measured at pre and post intervention/values (A, B, C). The Mild impairment group showed improvement, average scores falling from 10 to 7 and 4 to 3, indicating greater ease in entering and leaving the vehicle. The Moderate impairment group also demonstrated growth, with scores changing from 4 to 6 and 3 to 5. In contrast, the Severe impairment group showed no improvement, with scores remaining at 1. Notably, the group with no impairments (None) demonstrated considerable progress, as measured by scores rising from 2 to 11 and 2 to 12, suggesting that the intervention proved to be very successful for this group.

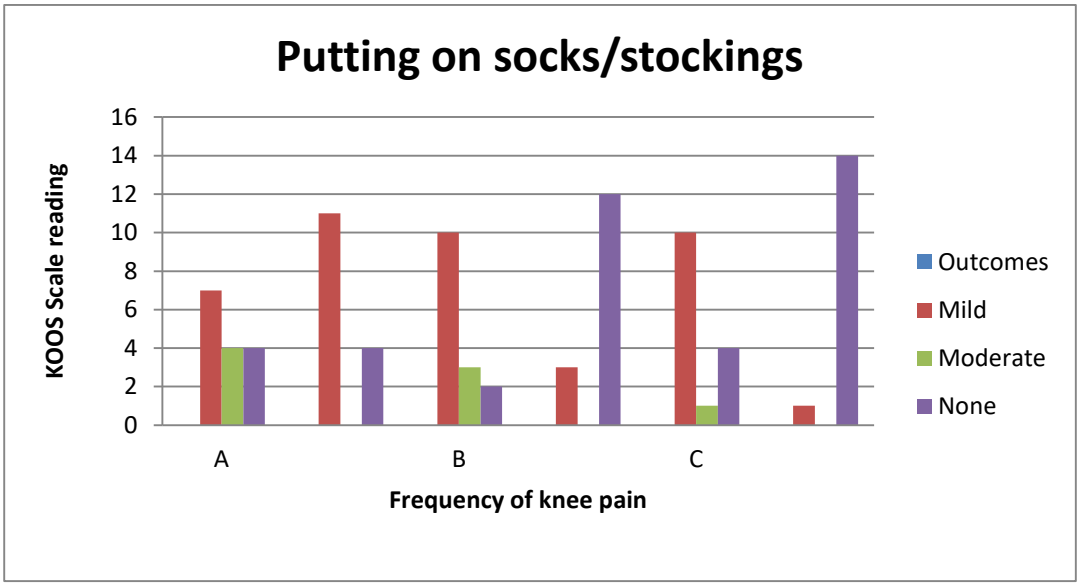
Going shopping



Graph 25-A8

The data shows the outcomes for individuals with different levels of impairment (Mild, Moderate, Severe, and None) when going shopping, measured at pre and post intervention/values (A, B, C). The Mild impairment group showed considerable growth, with declining average scores from 10 to 3 and 10 to 5, indicating greater ease and independence in shopping. The Moderate impairment group also showed improvement, with scores changing from 5 to 8 and 2 to 5. In contrast, the Severe impairment group showed no improvement, with scores remaining at 4. Notably, the group with no impairments (None) demonstrated, considerable progress, as measured by scores rising from 3 to 1 and 6 to 10, suggesting that the intervention proved to be very successful for this group.

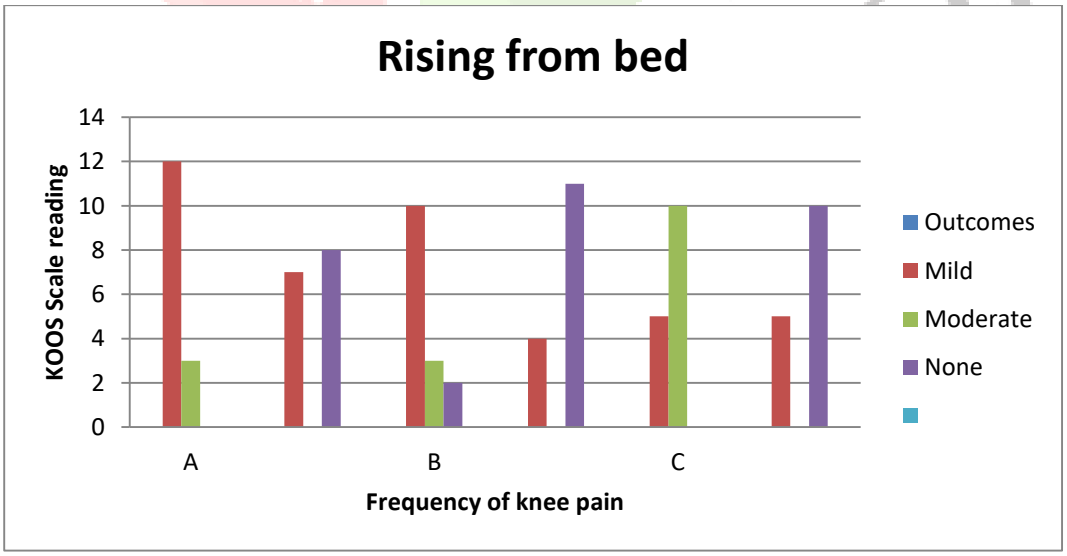
Putting on socks / stockings



Graph 26-A9

The data shows the outcomes for individuals with different amounts of impairment (Mild, Moderate, and None) when putting on socks or stockings, measured at pre and post intervention/values (A, B, C). The Mild impairment group showed growth, average scores falling from 7 to 3 and 11 to 1, indicating greater ease and independence in putting on socks or stockings. The Moderate impairment group also showed improvement, with scores changing from 4 to 1. In contrast, the group with no impairments (None) demonstrated considerable progress, as measured by scores rising from 4 to 12 and 4 to 14, suggesting that the intervention proved to be very successful for this group.

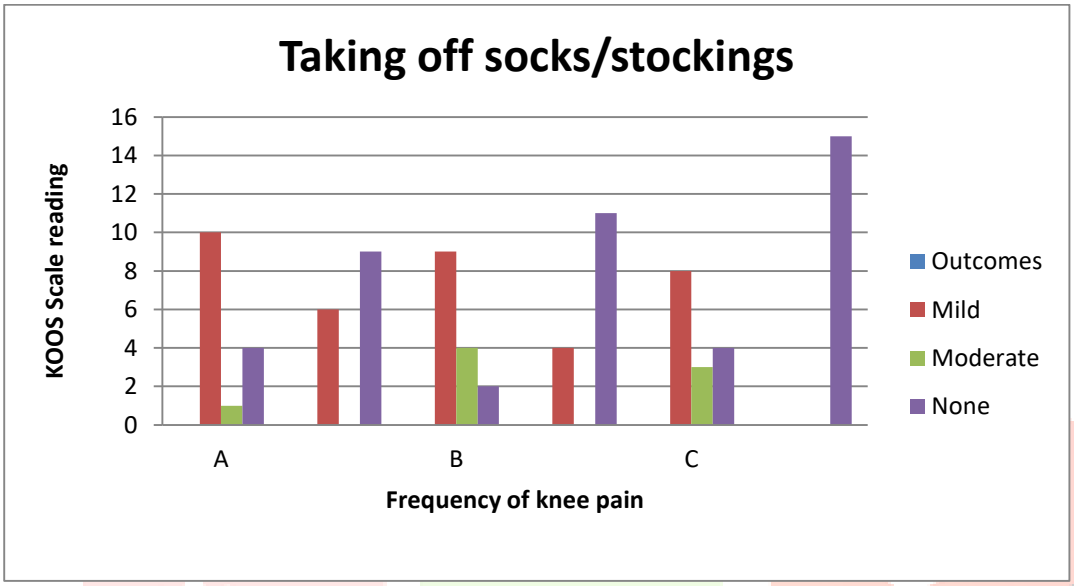
Rising from bed



Graph 27-A10

The data shows the outcomes for individuals with different amounts of disability (Mild, Moderate, and None) when rising from bed, measured at pre and post intervention/values (A, B, C). The Mild impairment group displayed a substantial improvement, average scores falling from 12 to 4 and 7 to 5, indicating greater ease and independence in rising from bed. The Moderate impairment group showed little change, with scores remaining relatively consistent. In contrast, the group with no impairments (None) demonstrated substantial progress, with scores rising from 8 to 10 and 2 to 11, proving that for this particular group, the intervention was very successful.

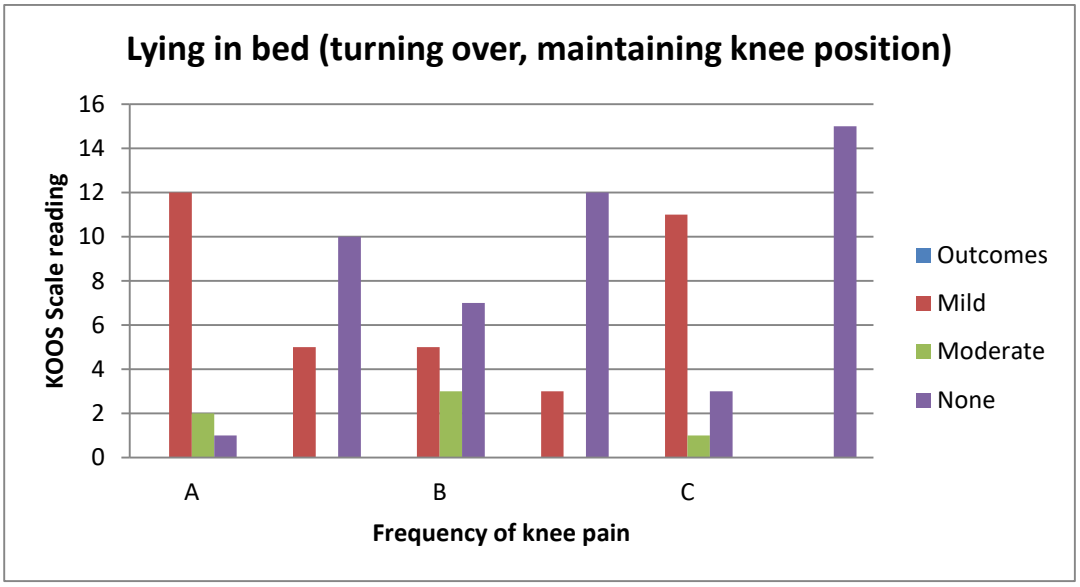
Taking off socks / stockings



Graph 28-A11

The data shows the outcomes for people with varying amount of disability (Mild, Moderate, and None) when taking off socks or stockings, measured at pre and post intervention/values (A, B, C). The Mild impairment group showed considerable growth, average scores falling from 10 to 4 and 6 to 8, indicating greater ease and independence in removing socks or stockings. The Moderate impairment group showed little change, with scores remaining relatively consistent. In contrast, the group with no impairments (None) showed a notable improvement, going from 4 to 11 and 9 to 15, indicating that The intervention proved to be highly effective for this group.

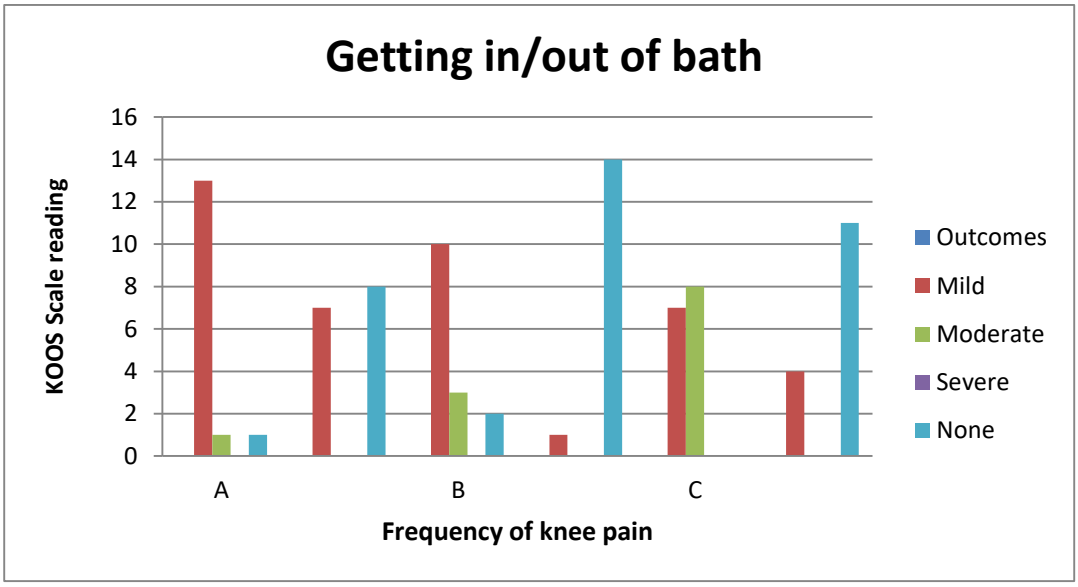
Lying in bed (turning over, maintaining knee position)



Graph 29-A12

The data shows the outcomes for individual with different kinds of disability (Mild, Moderate, and None) when lying in bed, specifically when turning over and maintaining knee position, measured at pre and post intervention/values (A, B, C). The Mild impairment group demonstrated a substantial improvement, average scores falling from 12 to 3 and 5 to 11, indicating greater ease and independence in turning over and maintaining knee position in bed. The Moderate impairment group showed little change, with scores remaining relatively consistent. In contrast, the group with no impairments (None) showed a notable improvement, going from 1 to 12 and 10 to 15, indicating that the group responded quite well to the intervention.

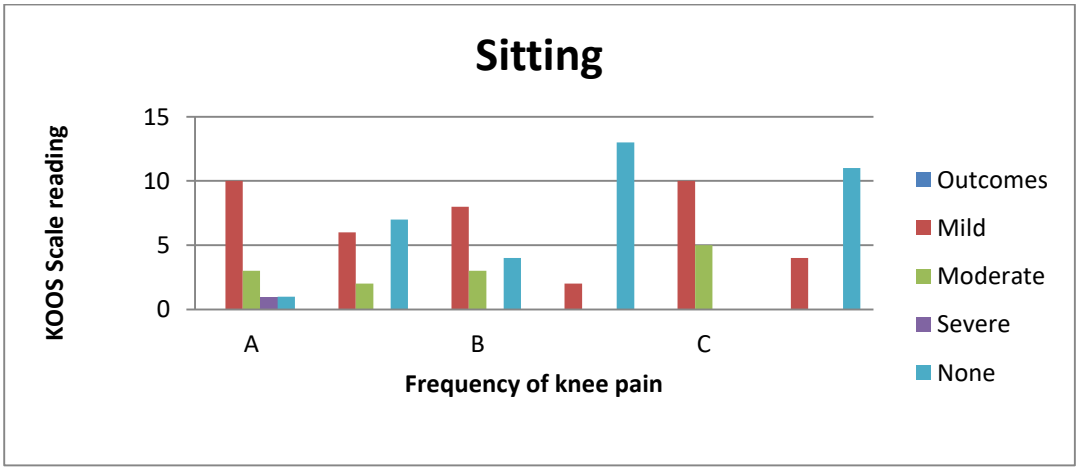
Getting in/out of bath



Graph 30-A13

The data shows the outcomes for People who exhibit differing levels of disability (Mild, Moderate, Severe, and None) when getting in and out of a bath, measured at pre and post intervention/values (A, B, C). The Mild impairment group showed notable advancement, average score falling from 13 to 1 and 7 to 4, demonstrating more comfort and independence when entering and exiting the bathtub. With scores ranging from 1 to 8, the group with moderate impairments demonstrated some improvement. The Severe impairment group showed no improvement, with scores remaining at None. With scores rising from 1 to 14 and 8 to 11, respectively, the group with no impairments (None), on the other hand, showed a notable improvement, indicating that the intervention was quite successful for this group.

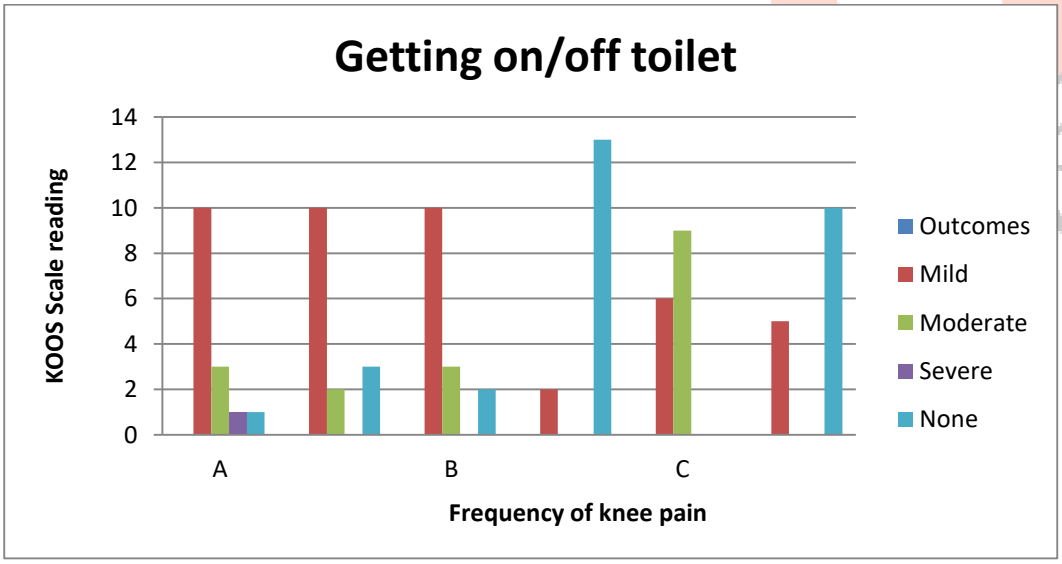
Sitting



Graph 31-A14

The data displays the results of sitting assessments at pre- and post-intervention/values (A, B, C) for those with none, mild, moderate, and severe impairment. Significant progress was seen by the mild impairment group, whose average scores dropped from 10 to 2 and from 6 to 4, indicating more comfort and independence when sitting. With scores moving from 3 to 5, the group with moderate impairments shown some improvement. With scores staying at 1, the group with severe impairments did not show any improvement. With scores rising from 1 to 13 and 7 to 11, respectively, the group with no impairments (None), on the other hand, showed a notable improvement, indicating that the intervention was quite successful for this group.

Getting on/off toilet

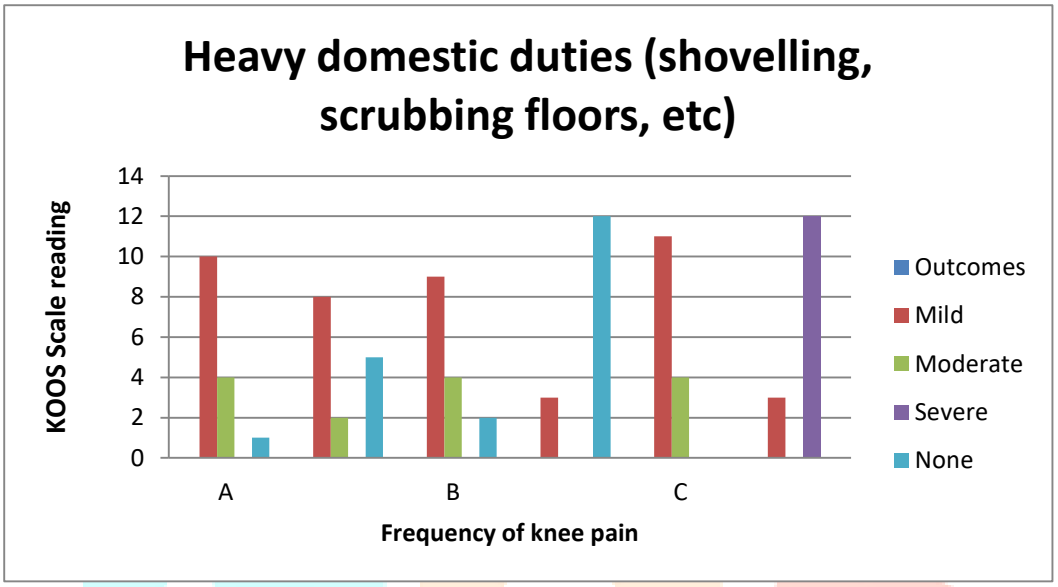


Graph 32-A15

The data shows the outcomes, for those who use the restroom at different levels of impairment (Mild, Moderate, Severe, and None), assessed at pre- and post-intervention values (A, B, C). With average ratings falling from 10 to 2 and 10 to 5, the mild impairment group demonstrated a notable increase in ease and independence when using the restroom. With ratings ranging from 3 to 9, the group with moderate impairments shown some improvement. With scores staying at 1, the group with severe impairments did not

show any improvement. However, the group that was not impaired (None) showed a notable improvement, as evidenced by their scores rising from 1 to 13 and from 3 to 10, indicating that The approach proved to be highly effective for them.

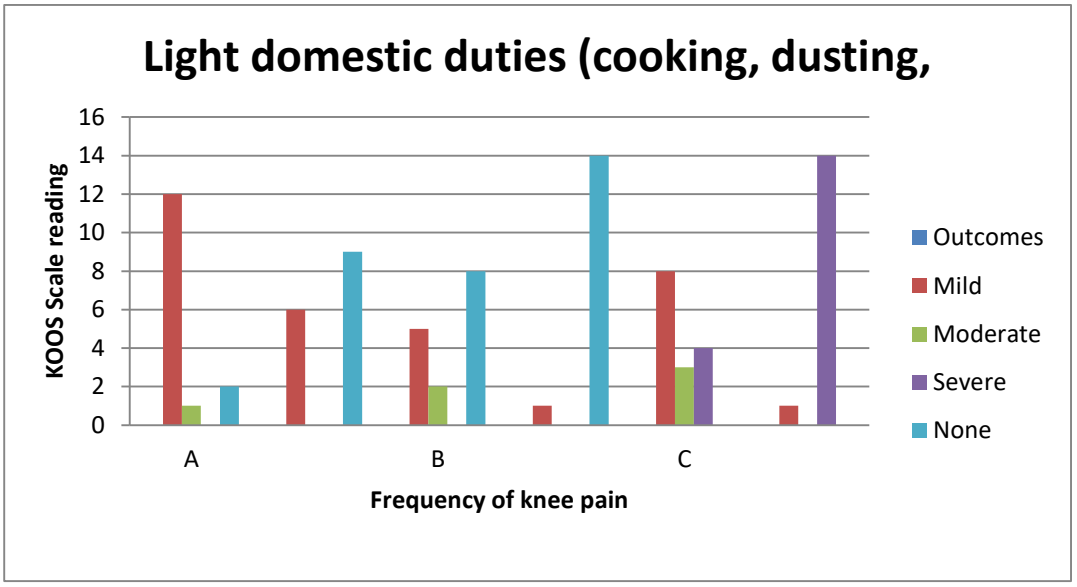
Heavy domestic duties (shovelling, scrubbing floors, etc)



Graph 33-A16

The data shows the results for those who have distinct level of impairment (Mild, Moderate, Severe, and None) when performing heavy domestic duties such as shovelling and scrubbing floors, measured at pre and post intervention/values (A, B, C). The Mild impairment group showed substantial growth, average scores lowering from 10 to 3 and 8 to 3, indicating greater ease and independence in performing heavy domestic duties. The Moderate impairment group showed some improvement, with scores changing from 4 to 4. The Severe impairment group showed no improvement, with scores remaining at 12. In contrast, the group with no impairments (None) showed a notable improvement, going from 1 to 12, indicating that the approach proved to be highly effective for this particular group.

Light domestic duties (cooking, dusting, etc)

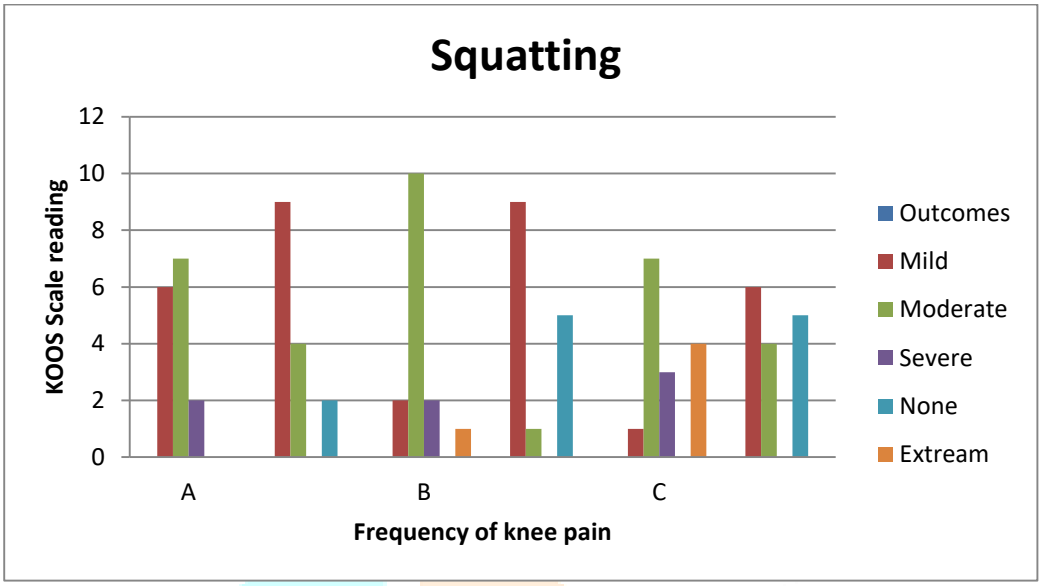


Graph 34-A17

The data shows the results for those who have distinct level of impairment (Mild, Moderate, 0Severe, and None) when performing light domestic duties such as cooking and dusting, measured at pre and post intervention/values (A, B, C). The Mild impairment group displayed a substantial improvement, with average scores decreasing from 12 to 1 and 6 to 1, indicating greater ease and independence in performing light domestic duties. The Moderate impairment group showed some improvement, with scores changing from 1 to 3. The Severe impairment group showed no improvement, with scores remaining at 4 and even increasing from 14 to None (possibly indicating worsening of symptoms). In contrast, the group with no impairments (None) demonstrated substantial growth, with scores rising from 2 to 14 and 9 to 14, suggesting that the approach proved to be highly effective for this particular group.

SPORT AND RECREATION FUNCTION

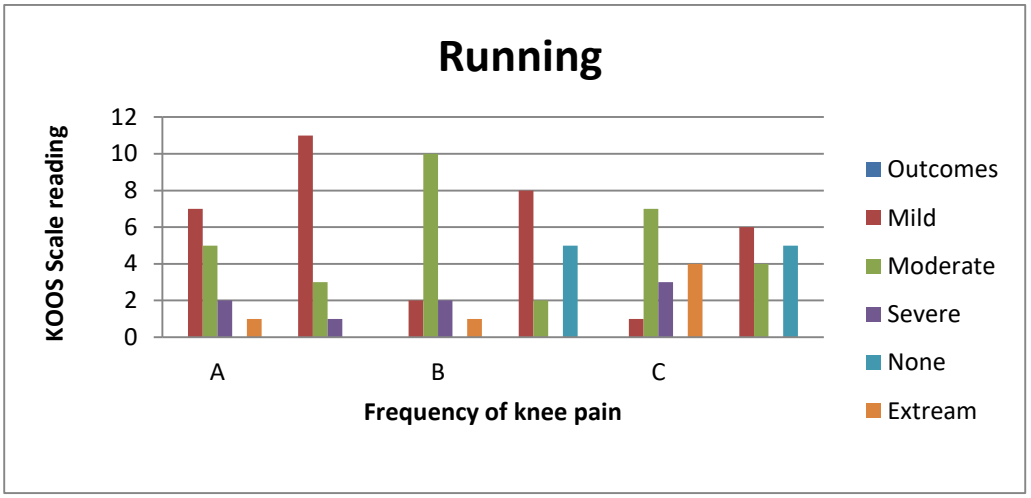
Squatting



Graph 35-Sp1

The data shows the outcomes measured at pre and post intervention/values (A, B, C) those who have distinct level of impairment (Mild, Moderate, Severe, None, and Extreme) during squatting. With average scores dropping from 6 to 1 and 9 to 6, the group with mild impairments demonstrated a considerable improvement in their ability to squat independently and with greater ease. Scores for the group with moderate impairments improved somewhat, going from 7 to 4 and 4 to 7. The ratings for the group with severe impairments remained largely unchanged. With scores rising from 2 to 5, the group with no impairments (None) showed notable improvement. With scores ranging from 1 to 4, the Extreme impairment group demonstrated some improvement.

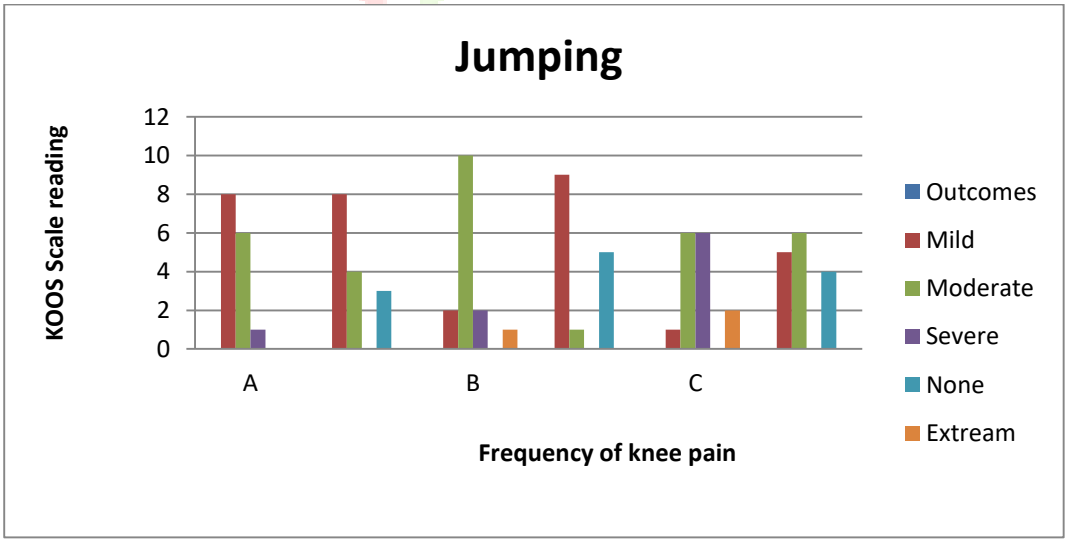
Running



Graph 36-Sp2

The data shows the outcomes for those who have distinct level of impairment (Mild, Moderate, Severe, None, and Extreme) when running, measured at pre and post intervention/values (A, B, C). The Mild impairment group displayed a substantial improvement, in general scores reducing from 7 to 1 and 11 to 6, indicating greater ease and independence in running. The Moderate impairment group showed some improvement, with scores changing from 5 to 4 and 3 to 7. The Severe impairment group showed little change, with scores remaining relatively consistent. The group with no impairments (None) demonstrated no change, with scores remaining at 5. The Extreme impairment group showed some improvement, with scores changing from 1 to 4.

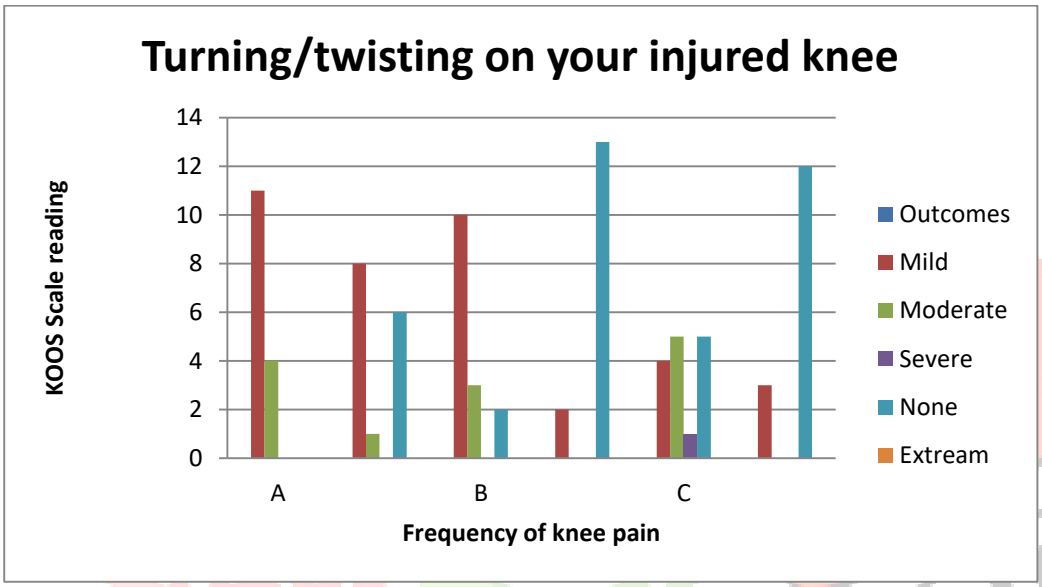
Jumping



Graph 37-Sp3

The data shows the results of jumping activity at pre- and post-intervention/values (A, B, C) for individuals with differing levels of disability (Mild, Moderate, Severe, None, and Extreme). With average scores falling from 8 to 1 and 8 to 5, the mild impairment group demonstrated a notable improvement in ease and independence of jumping. The Moderate impairment group showed some improvement, with scores changing from 6 to 6 and 4 to 6. The Severe impairment group showed some improvement, with scores changing from 1 to 6. The group with no impairments (None) demonstrated little change, with scores remaining relatively consistent. The Extreme impairment group showed some improvement, with scores changing from 1 to 2.

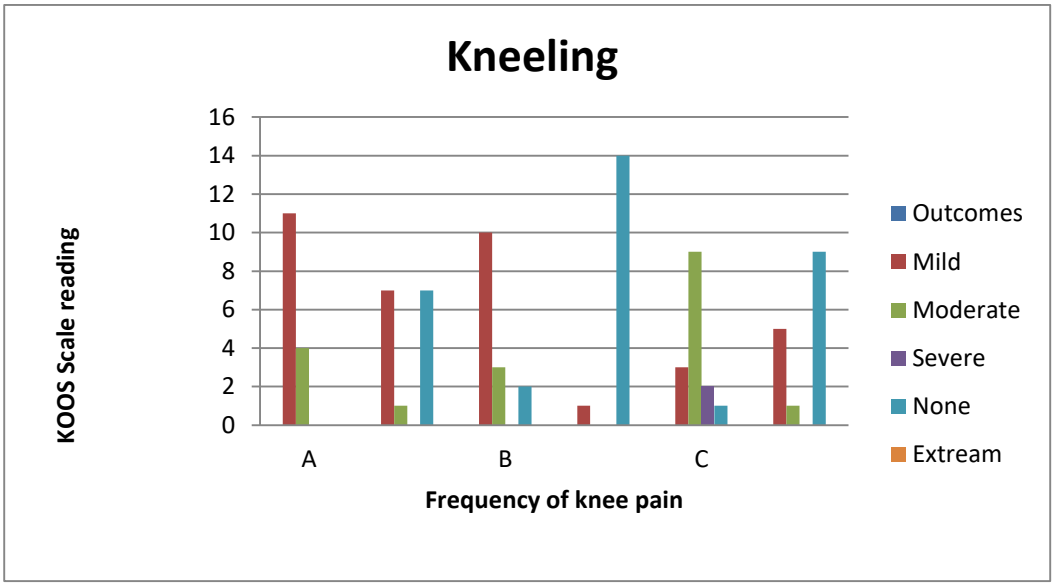
Turning/twisting on your injured knee



Graph 38-Sp4

The data shows the outcomes Those with varying degrees of disability (Mild, Moderate, Severe, None, and Extreme) when turning or twisting on their injured knee, measured at pre and post intervention/values (A, B, C). The Mild impairment group demonstrated a considerable improvement, in general scores falling from 11 to 2 and 8 to 3, indicating greater ease and independence in turning/twisting on their injured knee. The Moderate impairment group showed some improvement, with scores changing from 4 to 5. The Severe impairment group showed no improvement, with scores remaining at 1. The group with no impairments (None) showed a notable increase, going from a score of 6 to a 13 and a score of 2 to a 12. The Extreme impairment group failed to present any information, indicating that they were not capable of performing this action at all.

Kneeling

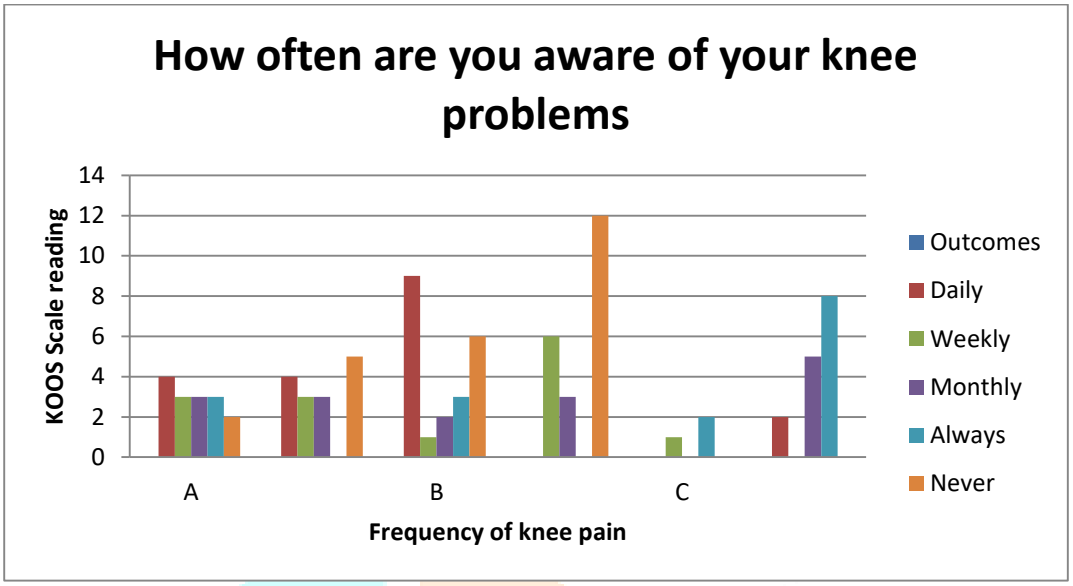


Graph 39-Sp5

The outcomes of kneeling for individuals with distinct amounts of impairment (Mild, Moderate, Severe, None, and Extreme) are displayed in the data, both before and after the intervention, at values (A, B, and C). With average scores falling from 11 to 1 and 7 to 5, the group with mild impairments demonstrated a notable improvement in their ability to kneel with increased ease and independence. There was some improvement in the Moderate impairment group; scores went from 4 to 9 and from 1 to 1. The group with severe impairments did not demonstrate any improvement; their scores remained at 2. With scores rising from 7 to 14 and 2 to 9, the group with no disabilities (None) showed notable progress. The Extreme impairment group failed to present any information, indicating that they were not capable of performing this action at all.

KNEE RELATED QUALITY OF LIFE

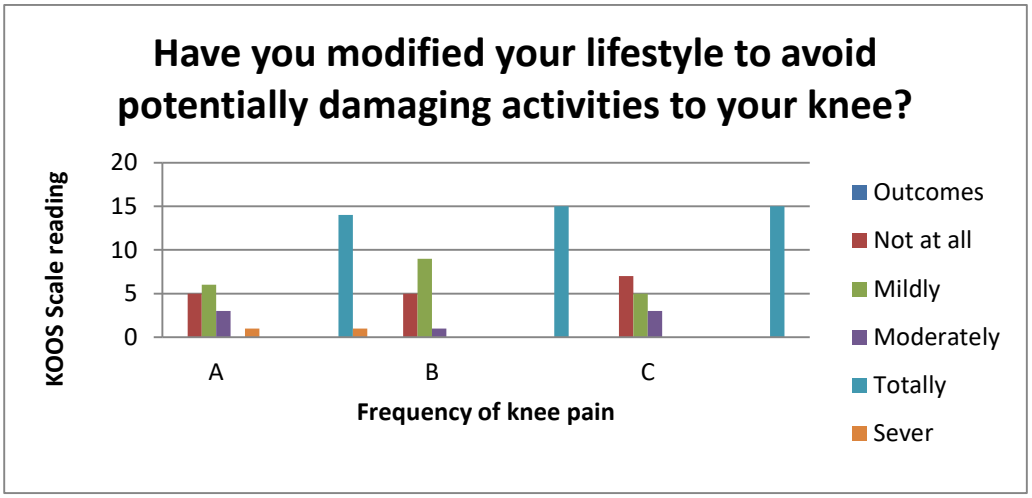
How often are you aware of your knee problems



Graph 40-Q1

The data shows a decrease in the frequency of awareness of knee problems across all categories, indicating improvement. Individuals who were previously aware of their knee problems daily, weekly, monthly, or always, showed a decrease in awareness, suggesting their knee issues became less prominent. But more people than ever before are ignorant of their knee problems, which supports the idea that their condition has improved. Overall, the results indicate a significant reduction in the regularity of consciousness of knee problems, suggesting effective management or recovery from knee issues.

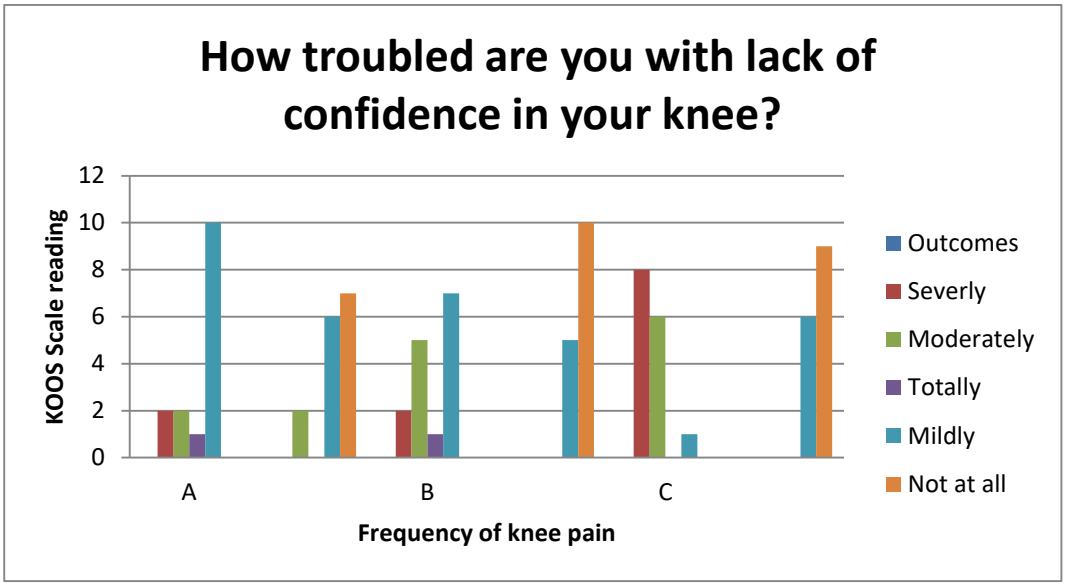
Have you modified your lifestyle to avoid potentially damaging activities to your knee?



Graph 41-Q2

The data shows a significant shift towards modifying way of life to prevent potentially harmful activities to the knee. At the pre-intervention stage, only 14 individuals reported totally modifying their lifestyle, while 5 reported not modifying their lifestyle at all. Post-intervention, the number of individuals totally modifying their lifestyle increased to 15, while those not modifying their lifestyle at all decreased to 1. Additionally, the number of individuals moderately modifying their lifestyle increased from 3 to 15, while those mildly modifying their lifestyle decreased from 6 to 5. This suggests that a great deal of lifestyle modification has occurred to prevent possibly harmful behaviours and have grown more conscious of the need of safeguarding their knee health.

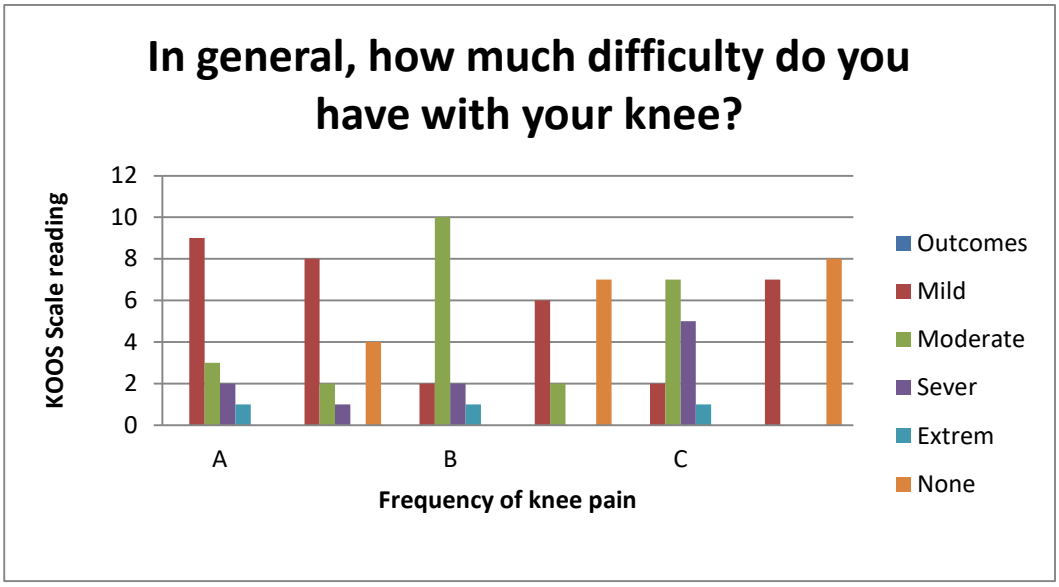
How troubled are you with lack of confidence in your knee?



Graph 42-Q3

The data demonstrates a noteworthy decrease in the amount of difficulties people encounter as a result of their knee's lack of confidence. At the pre-intervention stage, 2 individuals reported being severely troubled, 2 reported being moderately troubled, and 10 reported being mildly troubled. Post-intervention, the number of individuals severely troubled decreased to 8, while those moderately troubled decreased to 5. Encouragingly, the number of individuals not troubled at all increased from 7 to 9. This suggests that the intervention has successfully boosted confidence in knee health, leading to a decrease in trouble and concern among individuals.

In general, how much difficulty do you have with your knee?



Graph 43-Q5

The data shows a significant improvement in knee health, with a decrease in difficulty levels across all categories. At the pre-intervention stage, 9 individuals reported mild difficulty, 3 reported moderate difficulty, 2 reported severe difficulty, and 1 reported extreme difficulty. Post-intervention, the number of individuals with mild difficulty decreased to 2, moderate difficulty decreased to 2, severe difficulty decreased to 5, and extreme difficulty decreased to 1. Encouragingly, the number of individuals with no difficulty increased from 4 to 8. This suggests that the intervention has successfully improved knee health, leading to a significant reduction in difficulty and improvement in overall knee function.

ANOVA

Anova: Single Factor						
SUMMARY						
Groups	***Count***	***Sum***	***Average***	***Variance***		
Column 1	15	995	66.33333	534.381		
Column 2	15	712	47.46667	394.1238		
Column 3	15	1102	73.46667	775.5524		
Column 4	15	412	27.46667	353.6952		
Column 5	15	1161	77.4	339.2571		
Column 6	15	451	30.06667	204.2095		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between	35963.83	5	7192.767	16.59091	2.29E-	2.323126

Groups					11	
Within Groups	36417.07	84	433.5365			
Total	**72380.9**	**89**				

The ANOVA results reveal a notable variation between the six groups' means, with an F-value of 16.59 and a p-value of 2.29E-11, indicating a highly significant difference. The means of the groups range from 27.47 (Column 4) to 77.4 (Column 5), with Column 1, 3, and 5 having means above 66. The variance within groups is relatively low, indicating that the groups are distinct and separate. These findings indicate that the means of the six groups differ noticeably from one another, and more research can be done to determine which groups vary most clearly from the others. Overall, the results indicate a significant UZ effect of the independent variable on the dependent variable.

CHAPTER 9

DISCUSSION

This study's objective was to investigate how ladies with osteoarthritis in their knees responded to four weeks of yoga (Surya namaskar). The results demonstrated a substantial difference in the pre- and post-intervention scores for pain, symptoms, daily tasks, recreational and athletic endeavours, and standard of living in the yoga group. While pain and symptoms significantly decreased (P = 2.29), routine tasks, hobbies and sports, and standard of living were significantly improved.

In a 2012 study, Ebnezar et al. examined how yoga poses affected 250 individuals with osteoarthritis in regards to pain, stiffness in the morning, and anxiety. The group doing the experiment received both physical therapy and yoga, while the control group only received physical therapy. They discovered that concurrent yoga and Physical therapy alone is not as beneficial as physical treatment. The patients from the trial group had a bigger reduction in pain, stiffness in the morning, and anxiety, in accordance with the results. In a similar vein, the results of our study demonstrate how beneficial yoga is in easing knee osteoarthritis pain and symptoms.

Ebnezar (2011) investigates how yoga poses affect patients' quality of life in individuals with osteoarthritis in the knee. The experimental group's quality of life improved more, according to the data (yoga and physical therapy). Our study's findings support the beneficial effects of yoga on patients with osteoarthritis in their knees' improved quality of life [24].

Similar findings were found in Sled et al.'s (2010) study on the impact of a home regimen for strengthening the hip abductors on osteoarthritis in the knee. They insisted that individual who is having osteoarthritis in their knees face less pain and more function when they perform at-home workouts that strengthen their hip abductors. Similar to this, yoga poses significantly reduced pain and improved function for patients in our study's experimental group as well [25].

In research by Lee et al., 44 patients with OA knee were given tai chi exercise for eight weeks. Before and after the intervention, patients completed WOMAC and quality of life questionnaires. The findings demonstrated that the experimental group's scores on both surveys increased following the intervention. Similar to this, in our study, the KOOS questionnaire's items measuring symptoms, everyday tasks, sports and recreational pursuits, and standard of living showed a substantial improvement in the experimental group [33].

Wang et al. investigated the effects of tai chi activities on people who have osteoarthritis in their knees for a duration of 12 weeks in another study. Our findings, which additionally showed improvement in the items tested by KOO's questionnaire and decreased pain in VAS, are consistent with the results obtained from the WOMAC questionnaire [26].

In research comparing intra-articular injection and home exercise regimen, Kawasaki et al. discovered that the efficacy of both treatments was equal in lowering pain and improving function in OA knee patients. We observed a considerable increase in daily activity and a significant decrease in pain in our study [20].

In their study, Hinman et al. examined the benefits of an eight-week training regimen in the water on subjects suffering from osteoarthritis in the knee and hip. They found that the intervention improved the patients' quality of life, physical function, and physical activity while also reducing pain. Their conclusions are consistent with what we found, suggesting that exercise helps individuals with knee osteoarthritis feel less pain and have better function and quality of life [34].

After researching the benefits of Iyengar yoga and resistive exercises on patients with knee osteoarthritis, Bukowski et al. found that patients' pain decreased and their flexibility, strength, and overall quality of life and function rose. Their conclusion agrees with what we discovered, which after a period of Surya namaskar demonstrated a decrease in pain and symptoms and an improvement in daily activities, sports, and leisure activities, as well as standard of living [17].

CHAPTER 10

CONCLUSION

Findings of our research showed that the standard of living, sports and leisure activities, everyday activities, pain, and symptoms had no significant differences before and after intervention in group A and little difference in group B. In the yoga group C, we had a significant decrease in pain and symptoms and a significant increase in the standard of living, sports, leisure activities and everyday activities, After treatment, there was no substantial change between the control groups (P = 2.29).

Generally, we can state that *Surya namaskar* is an important non-medicinal method in rehabilitation of OA knee individuals and will result in a significant decrease in pain and symptoms and a significant increase in standard of living, sports, leisure activities and everyday activities. So, we recommend using these exercises in addition to usual treatments to slow down the incapacitating process of knee osteoarthritis.

CHAPTER 11

LIMITATIONS OF THE STUDY

- Only middle-aged females diagnosed with osteoarthritis in the knee have been included in this research, as more older females were unable to perform Surya namaskar and less common in males.
- Sample size is less due to time constraint.

CHAPTER 12

FUTURE RECOMMENDATIONS

- In future study researcher can study on upper - other lower limb joints and related difficulties among females.
- They can focus on treatment aspect of pain and an increase in the standard of living in OA patients.
- Comparative study between male and female who have knee osteoarthritis can be done in future studies.

CHAPTER 13

REFERENCES

1. Ghasemi GA, Golkar A, Marandi SM. Effects of hata yoga on knee osteoarthritis. Int J Prev Med. 2013 Apr;4(Suppl 1):S133-8. PMID: 23717763; PMCID: PMC3665019.

2. Lin CW, Taylor D, Bierma-Zeinstra SM, Maher CG. Exercise for osteoarthritis of the knee. Phys Ther. 2010; 90:839–42. [PubMed] [Google Scholar]

3. Geetanjali, Geetanjali & Sharma, Arushi & Ajitkumar, S & Wahane, Ajitkumar. (2023). THE IMPACT OF SURYA NAMASKAR (SUN SALUTATION) ON BODY FLEXIBILITY AND ENDURANCE OF HEALTHY INDIVIDUAL: ANATOMICAL PERSPECTIVE". World Journal of Pharmacy and Pharmaceutical Sciences. 12. 852. 10.20959/wjpps20235-24758.

4. Tahmasebi M, Motaghi A, Shahrezaee M. Total knee arthroplasty in patients with osteoarthritis: Results of 34 operations. Tehran Med J. 2009; 67:146–50. [Google Scholar]

5. Pal CP, Singh P, Chaturvedi S, Pruthi KK, Vij A. Epidemiology of knee osteoarthritis in India and related factors. Indian J Orthop. 2016 Sep;50(5):518-522. doi: 10.4103/0019-5413.189608. PMID: 27746495; PMCID: PMC5017174.

6. Silman AJ, Hochberg MC. 2nd ed. Oxford: Oxford University Press; 2001. Epidemiology of the Rheumatic Diseases. [Google Scholar]

7. Akinpelu AO, Alonge TO, Adekanla BA, Odole AC. Prevalence and pattern of symptomatic knee osteoarthritis in Nigeria: A community-based study. *Internet J Allied Health Sci Pract.* 2009;7:3. [Google Scholar]

8. Symmons D, Mathers C, Pfleger B. Global Burden of Osteoarthritis in year 2000: Global burden of disease 2000 study. *World health report.* 2002;5 Version 2. [Google Scholar]

9. Solomon L, Beighton P, Lawrence JS. Rheumatic disorders in the South African Negro. Patrt II. Osteo-arthrosis. *S Afr Med J.* 1975;49:1737–40. [PubMed] [Google Scholar]

10. Davis MA, Ettinger WH, Neuhaus JM, Hauck WW. Sex differences in osteoarthritis of the knee. The role of obesity. *Am J Epidemiol.* 1988;127:1019–30. [PubMed] [Google Scholar]

11. Carmona L, Ballina J, Gabriel R, Laffon A EPISER Study Group. The burden of musculoskeletal diseases in the general population of Spain: Results from a national survey. *Ann Rheum Dis.* 2001;60:1040–5. [PMC free article] [PubMed] [Google Scholar]

12. Felson DT. Epidemiology of hip and knee osteoarthritis. *Epidemiol Rev.* 1988;10:1–28. [PubMed] [Google Scholar]

13. Egan BA, Mentes JC. Benefits of physical activity for knee osteoarthritis: A brief review. J Gorontalo Nurs. 2010; 36:9–14. [PubMed] [Google Scholar]

14. Thomas A, Eichenberger G, Kempton C, Pape D, York S, Decker AM, et al. Recommendations for the treatment of knee osteoarthritis, using various therapy techniques, based on categorizations of a literature review. J Geriatr Phys Ther. 2009; 32:33–8. [PubMed] [Google Scholar]

15. Mahdibarzi D, Naseri M, Faghihzade S, Kamalinejad M, Bahrami M. Effect of articular ointment in patients with knee osteoarthritis. Med Daneshvar. 2008; 77:49. [Google Scholar]

16. Jamtvedt G, Dahm KT, Christie A, Moe RH, Haavardsholm E, Holm I, et al. Physical therapy interventions for patients with osteoarthritis of the knee: An over view of systematic reviews. Phys Ther. 2008; 88:123–36. [PubMed] [Google Scholar]

17. Bukowski EL, Conway A, Glentz LA, Kurland K, Galantino ML. The effect of iyengar yoga and strengthening exercises for people living with osteoarthritis of the knee: A case series. Int Q Community Health Educ. 2006–2007; 26:287–305. [PubMed] [Google Scholar]

18. Mangione KK, McCully K, Gloviak A, Lefebvre I, Hofmann M, Craik R. The effects of high-intensity and low-intensity cycle ergometry in older adults with knee osteoarthritis. J Gerontol A Biol Sci Med Sci. 1999;54:M184–90. [PubMed] [Google Scholar]

19. Marsh J, Hager C, Havey T, Sprague S, Bhandari M, Bryant D. Use of alternative medicines by patients with OA that adversely interact with commonly prescribed medications. Clin Orthop Relat Res. 2009; 467:2705–22. [PMC free article] [PubMed] [Google Scholar]

20. Kawasaki T, Kurosawa H, Ikeda H, Takazawa Y, Ishijima M, Kubota M, et al. Therapeutic home exercise versus intraarticular hyaluronate injection for osteoarthritis of the knee: 6-month prospective randomized open-labeled trial. J Orthop Sci. 2009; 14:182–91. [PubMed] [Google Scholar]

21. Hadian MR, Jahangard T, Poorkazemi F, Mazaheri H, Khaghkhagh A, Zadoorian M, et al. Comparing heat, exercise, laser and a combined method of heat, exercise and laser in patients with knee osteoarthritis. Novin Rehab. 2008; 2:3–8. [Google Scholar]

22. Richardson G, Hawkins N. Cost-effectiveness of a supplementary class-based exercise program in the treatment of knee osteoarthritis. Int J Technol Assess Health Care. 2006; 22:84–9. [PubMed] [Google Scholar]

23. Blackmon D. The effects of exercise on physical function individuals with knee osteoarthritis. MSc Thesis, University of South Carolina. 2011:4–10. [Google Scholar]

24. Ebnezar J, Nagarathna R, Yoghita B, Negendra HR. Effect of integrated yoga therapy on pain, morning stiffness and anxiety in osteoarthritis of the knee joint: A randomized control study. Int J Yoga. 2012; 5:28–36. [PMC free article] [PubMed] [Google Scholar]

25. Sled EA, Khoja L, Deluzio KJ, Olney SJ, Culham EG. Effect of home program of hip abductor exercises on knee joint loading, strength, function and pain in people with knee osteoarthritis: A clinical trial. Phys Ther. 2010; 90:895–904. [PubMed] [Google Scholar]

26. Wang C, Schmid C, Hibberd PL, Kalish R, Roubenoff R, Rones R, et al. Tai chi is effective in treating knee osteoarthritis: A randomized controlled trial. Arthritis Rheum. 2009; 61:1545–53. [PMC free article] [PubMed] [Google Scholar]

27. Bergotez B. How yoga heals. The Saturday Evening Post. 2011 [Google Scholar]

28. Lipton L. Using yoga to treat disease: An evidence-based review. JAAPA. 2008; 21:34–6. 38, 41. [PubMed] [Google Scholar]

29. Vallath N. Perspectives on yoga inputs in the management of chronic pain. Indian J Palliat Care. 2010; 16:1–7. [PMC free article] [PubMed] [Google Scholar]

30. Wojciechowski M. PT Practice setting: Yoga. PT Magazine. 2008; 16:28–33. [Google Scholar]

31. Fitzgerald G, Piva S, Gil AB, Wisniewski SR, Oddis VC, Irrgang JJ. Agility and perturbation training techniques in exercise therapy for reducing pain and improving function in people with knee osteoarthritis: A randomized clinical trial. Physi Ther. 2011; 91:452–69. [PMC free article] [PubMed] [Google Scholar]

32. Farr J, Going S, Mcknight PE, Kasel S, Cussler EC, Cornet M. Progressives resistance training improves overall physical activity levels in patients with early osteoarthritis of the knee: A randomized controlled trial. Phys Ther. 2010; 90:356–66. [PMC free article] [PubMed] [Google Scholar]

33. Lee H, Park H, Chae Y, Kim SY, Kim SN, Kim ST. Tai chi qigong for the quality of life of patients with knee osteoarthritis: A pilot, randomized, waiting list-controlled trial. Clin Rehabil. 2009; 23:504–11. [PubMed] [Google Scholar]

34. Hinman R, Heywood S, Day RA. Aquatic physical therapy for hip and knee osteoarthritis: Result of a single-blind randomized controlled trial. Phys Ther. 2007; 87:32–44. [PubMed] [Google Scholar].

35. Karadağ, Songül & Taşci, Sultan & Doğan, Nurhan & Demir, Hüseyin & Kılıç, Züleyha. (2019). Application of heat and a home exercise program for pain and function levels in patients with knee osteoarthritis: A randomized controlled trial. International Journal of Nursing Practice. 25. 10.1111/ijn.12772.

36. Gonçalves, R. S., Jan Cabri, J. P. Pinheiro, P. L. Ferreira, and Joao Gil. "Reliability, validity and responsiveness of the Portuguese version of the Knee injury and Osteoarthritis Outcome Score–Physical Function Short-form (KOOS-PS)." *Osteoarthritis and cartilage* 18, no. 3 (2010): 372-376.

37. Alghadir, Ahmad H., Shahnawaz Anwer, Amir Iqbal, and Zaheen Ahmed Iqbal. "Test–retest reliability, validity, and minimum detectable change of visual analog, numerical rating, and verbal rating scales for measurement of osteoarthritic knee pain." *Journal of pain research* (2018): 851-856.

38. Petrofsky J, Berk L, Bains G, Khowailed IA, Hui T, Granado M, Laymon M, Lee H. Moist heat or dry heat for delayed onset muscle soreness. J Clin Med Res. 2013 Dec;5(6):416-25. doi: 10.4021/jocmr1521w. Epub 2013 Oct 12. PMID: 24171053; PMCID: PMC3808259.

39. Vriens J, Appendino G, Nilius B. Pharmacology of vanilloid transient receptor potential cation channels. *Mol Pharmacol.* 2009;75(6):1262–1279. [PubMed] [Google Scholar]

40. 8. Chao CC, Hsieh SC, Tseng MT, Chang YC, Hsieh ST. Patterns of contact heat evoked potentials (CHEP) in neuropathy with skin denervation: correlation of CHEP amplitude with intraepidermal nerve fiber density. *Clin Neurophysiol.* 2008;119(3):653–661. [PubMed] [Google Scholar]

41. 9. Farage MA, Miller KW, Maibach HI. *Textbook of Aging Skin.* Berlin Heidelberg: Springer-Verlag; 2010. [Google Scholar]

42. Brederson JD, Kym PR, Szallasi A. Targeting TRP channels for pain relief. *Eur J Pharmacol.* 2013 [PubMed] [Google Scholar]

43. Verrill P. Does the gate theory of pain supplant all others? *Br J Hosp Med.* 1990;43(5):325. [PubMed] [Google Scholar]

44. Song QJ, Li YJ, Deng HW. Early and delayed cardioprotection by heat stress is mediated by calcitonin gene-related

peptide. *Naunyn Schmiedebergs Arch Pharmacol.* 1999;359(6):477–483. [PubMed] [Google Scholar]

45. 20. Goldsmith PC, Leslie TA, Hayes NA, Levell NJ, Dowd PM, Foreman JC. Inhibitors of nitric oxide synthase in human skin. *J Invest Dermatol.* 1996;106(1):113–118. [PubMed] [Google Scholar]

46. Charkoudian N. Skin blood flow in adult human thermoregulation: how it works, when it does not, and why. *Mayo Clin Proc.* 2003;78(5):603–612. [PubMed] [Google Scholar]

47. Charkoudian N. Mechanisms and modifiers of reflex induced cutaneous vasodilation and vasoconstriction in humans. *J Appl Physiol.* 2010;109(4):1221–1228. [PMC free article] [PubMed] [Google Scholar]

48. Phatama KY, Aziz A, Bimadi MH, Oktafandi IGNAA, Cendikiawan F, Mustamsir E. Knee Injury and Osteoarthritis Outcome Score: Validity and Reliability of an Indonesian Version. Ochsner J. 2021 Spring;21(1):63-67. doi: 10.31486/toj.20.0088. PMID: 33828426; PMCID: PMC7993429.