The Effect of Yoga on Balance in Community-Dwelling Older Adults With Knee Osteoarthritis

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Abstract
This study aims to assess yoga's potential to improve balance in older adults with knee Osteoarthritis (OA). The Hatha yoga intervention consisted of an 8-week, two 60 minutes in-person yoga sessions per week. Outcomes measured: Berg Balance Scale (BBS), Short Physical Performance Battery (SPPB), Single Leg Stance (SLS), 6 Minute Walk Test (6-MWT). The yoga group (n=12) statistically improved their 6-MWT mean of -67.92 ± 60.76 p = .003, SPPB score saw a median of 1 p = .010. SLS test left leg lifted the mean of -5.45 ± 5.63 p = .006 and with eyes closed mean of -0.88 ± 0.63 p = .001. Elements of the SPPB test were analysed further resulting in a statistical improvement: The 5 repeated timed sit-to-stand resulted in a mean of 3.30 ± 4.09 p = .017, and the 2.44 MWT saw a median of 0,22 p = .005. There was a slight improvement in the BBS median of 1.5 p = .42. SLS right leg lifted mean of -5.37 ± 9.33 p = .071, eyes closed mean of -0.96 ± 1.51 p = .049. The study's single pilot design indicated that the tailored 8-week yoga intervention positively influenced balance and functional mobility outcomes in older adults with knee OA.

Keywords: Knee Osteoarthritis, Yoga, Balance, Mobility, Older Adults

Introduction

Osteoarthritis

The most common form of chronic joint disease in older adults is a clinical condition called osteoarthritis (OA), which is characterized by joint pain, swelling, stiffness and dysfunction brought on by the breakdown of tissue in and around the synovial joint (Buckwalter et al.,2004). Osteoarthritis is the most prevalent form of arthritis, affecting the knees, hips, hands, and spine. 1 in 3 people over the age of 60 years old are reported to suffer from this disease, studies show that prevalence is higher in women over the age of 50 years compared to men (Oliveria et al., 1995).

Living with knee OA can be challenging, as individuals often experience debilitating pain, stiffness, swelling and obstructed joint range of motion. These symptoms can lead to gait changes, functional decline, and loss of independence. The impact on physical functioning decreases a person's willingness and ability to ambulate, and experience fewer social interactions, while impeding their ability to perform activities of daily living (ADL) and notably a decreased perception of quality of life (Bradley et al., 2004).

According to the American College of Rheumatology, the clinical criteria for the diagnosis of Knee OA consists of being over 50 years of age and having three or more of the following conditions: Knee pain most days of the week, knee stiffness in the morning lasting no longer than 30 minutes, Joint crepitus, bony tenderness, or enlargement (Altman et al., 1986).

Both the American Geriatrics Society (AGS) and the American College of Rheumatology recommend physical activity as a key component in the prevention and management of knee OA. Exercise provides many benefits to people with knee osteoarthritis, however, physical activity is not entirely risk-free (Bennell et al, 2011). Therefore, an exercise prescription that is safe and well tolerated is essential for the treatment of knee OA. Unfortunately, there are reports from the 2001 Behavioural Risk Factor Surveillance Survey (BRFSS) that indicate 24% of adults with arthritis do not adhere to the recommended public health physical activity guidelines of 30 minutes of moderate activity a day on 5 or more days a week, or 20 minutes of vigorous activity on 3 or more day a week (Chmelo et al., 2013). Physical inactivity can lead to a decline in functional mobility, balance, muscle strength, muscle mass, endurance and cognitive function and can impact a person’s overall quality of life. Since most people with knee OA are over the age of 60, sedentary older adults may be at a higher risk of falling and developing comorbid conditions, which may further limit their functional abilities.

Yoga

Yoga is an ancient mind-body practice that originates in Indian culture and can be traced as far back as 2200 years ago (Singh, 2010). The word "yoga" is a Sanskrit word when translated to English meaning "yoke" referring to a union or connection. The union of the mind and spirit through movement (poses) brings balance and harmony to the body and promotes healing (Garfinkel et al, 2000).

Yoga is an exercise that emphasises mindful movement, integrating breathing, selfawareness, and muscular activity. In contrast to traditional exercise, yoga offers a foundation of static poses and dynamic movement that engages muscular activation to resist the force of gravity while maintaining alignment and stability (Singh, 2010).

Yoga is not well-researched as a physical activity for older adults with knee OA despite its popularity. Recent studies have shown yoga can benefit older adults with poor mobility and balance (Youkhana et al., 2016). An 8-week pilot study carried out by Cheung et al. (2014) specifically for women with knee OA demonstrated using the Western Ontario and McMaster University Osteoarthritis Index an improvement in perceived pain (p=.01), physical function and mobility performances (p=.03) compared to the waitlist control group. This demonstrated the favourable results that yoga has over a short period. Another 8-week study investigated the effects of a Hatha-based yoga program in adults with knee OA or rheumatoid arthritis compared to a waitlist control group. The yoga group demonstrated greater improvements in pain, physical function and quality of life compared to the control group. The improvement gained during the study could still be seen after nine months of finishing the study. This shows that yoga can have a prolonged and lasting positive effect on alleviating the symptoms associated with this condition (Moonaz et al, 2015).

Physiologically, yoga promotes joint movement which helps to decrease the inflammation at the joint by decreasing interleukin-1 involved in the process of cartilage breakdown. This leads to decreased fluid pressure in the joint which helps to preserve the cartilage tissue (Srivastava, et al., 2015). A 12-week yoga program designed to strengthen the quadriceps that focused on minimising the knee adduction moment (KAM) for women with knee OA showed an improvement in mobility performance during the walking (p=.001) and sit-to-stand (p=.006) tasks. The study focused on biomechanical loading using poses to minimising KAM while strengthening the quadriceps These postures included squats and lunge variations, while the study suggested the single-leg stance would produce lower muscle activation and higher KAM load (Brennerman et al., 2015).

There has been evidence that yoga increases strength, endurance, gait, and flexibility in the lower limbs (Cheung et al., 2016). A review of the literature also suggests that yoga can have a positive outcome on physical health, fitness, quality of life, pain, sleep, energy, and mood for people with arthritis (Cheung et al,.2014, Moonaz et al., 2015). No adverse effects were reported in the studies and practising yoga did not increase joint symptoms suggesting that yoga is a safe and effective intervention (Moonaz et al., 2015, Srivastava et al., 2015).

Materials and Methods

Recruitment

Recruitment took place in June 2023. Participants were recruited through poster advertisements around the community in places such as the local supermarkets, community hall, the GP'S office and the Killarney Sports and Leisure Centre. A social media post went out to the local community pages such as the sporting events Kerry, Killarney Sports and Leisure Centre and Killarney Today pages. Inclusion in the study required an individual to be between 60 to 75 years of age. Clinical diagnosis of knee OA within the last 6 months and not currently taking part in yoga or Pilates classes. In addition, no potential risk was identified in the PAR-Q. Participants were excluded if they had symptoms of joint locking or instability indicated by chronic use of a knee brace, cane, walker or wheelchair. Knee surgery or the use of corticosteroids, or hyaluronic acid injection within the last 6 months. Individuals with severe medical conditions that are contraindications to exercise such as uncontrolled high blood pressure or diagnosed high blood pressure within the last 6 months, acute systemic infection, uncontrolled metabolic disease, and unstable angina (ACSM, 2017).

Interested participants were sent via email an information sheet and a consent form which informed them about the nature of the research, inclusion and exclusion criteria, information regarding assessments and protocol procedure, information regarding the yoga intervention, the location and time commitment to the study, their obligations, insuring that all information kept is anonymous as they will be given a unique code, what the data is used for, how the data is being stored and for how long. Researcher information to get in contact if interested after which they were given the time (2 weeks) needed to consider if they wanted to take part in the study. When the researcher received the consent form, the researcher called the participants to cover the inclusion and exclusion criteria and according to the American College of Rheumatology guidelines the clinical presentation of knee OA (Altman et al. 1986), any concerns or questions they may have with regards the tests and study protocol. A time was allocated for the participant to do the pre-test measures at the Killarney Sports & Leisure Centre. A total of 15 participants volunteered for the study.

All data that was collected was non-identifiable using the participant's anonymized code, participants were allowed to withdraw from the study at any time. Anonymity and confidentiality were maintained throughout the research. The researcher followed the University of Galway's ethical procedure and data protection. Therefore, all the data that was collected was stored on a One Drive data storage by the University of Galway only accessed by the researcher and the supervisor. Research data will be stored for 5 years in line with the University of Galway data retention policy.

The single group hatha yoga study for 8 weeks with two 60-minute classes each week was approved by the University of Galway ethics committee, to assess the effectiveness of a specifically designed yoga program on balance performance in older adults with knee OA. Repeated measures were obtained at baseline and postintervention after 8 weeks.

The Killarney Sports and Leisure Centre provided the facility for this study, allocated within 5 minutes of the town with sufficient car parking. Data collection contained a health questionnaire form using the Physical Activity Readiness Questionnaire (PAR-Q), Outcomes measured the 6-minute walk test (6MWT), the Short Physical Battery Performance (SPPB) Single leg stance test (SLS) and the Berg Balance Scale (BBS) . The total collection time lasted 30 minutes per individual. The researcher collected all the data on each of the participants, the researcher was also involved in the yoga intervention and was not blinded.

Intervention

The yoga program consisted of two 60-minute Hatha-style yoga classes per week for 8 weeks. Time was given before the start of each class for an informal conversation on the well-being of each participant and how they are finding the level of difficulty, Attendance was also kept with reasons for missed classes. Sessions started with mindfulness meditation that focused attention to areas around the body, pranayama breathing techniques which were full belly breathing, 3-stage yogic breathing and alternative nostril breathing. Breath awareness was carried out throughout the class., Then moved into a seated series of movements to mobilise the joints called Pawanmuktasana, This sequence started with ankle rotation, leg extension, hip opening, spinal articulation, wrist and shoulder circles, arm circles, side stretch and forward fold. From there into standing poses that focused on balance (tree pose progressing to warrior 3), strengthening (Sit-to-stand, squats wide/narrow, high lunges, warrior 2) and stretching (leg extension, sitting/lying pigeon, supported bound angle) slowly progressing time and intensity each week.

When in the yoga poses attention was focused on proper alignment emphasis on reducing KAM with cueing from the instructor. When going from a seated position to standing, the focus is on the posterior chain of the body by placing the majority of the weight on the heels so as to engage the glutes and the hip abductors in order to stabilise the hips and knees. Attention is also drawn to the position of the knees, to keep them in line with the second and third toe so as not to let them fall inwards. If the participant cannot keep their knee's in line a yoga block is placed between the knees in order to try and engage the muscles needed to support this transition. When in a standing position attention was drawn to their feet, placing weight onto the four corners of the feet, to lift up through the inner arches activating the hip adductor muscles. Also, attention to the knee, keeping it in line with the second and third toe. Proper alignment targets the muscles that are needed in the pose while reducing the knee adduction movement placed on the knee.

Classes were designed by the researcher who is a registered yoga instructor using the knowledge gained from previous studies (strengthening quadriceps, hip abductors, stretching hamstrings and quadriceps muscles while reducing KAM). The yoga program designed was specifically for older adults with knee OA. The sample size of 15 participants was determined due to having only one yoga instructor to give each participant the individual attention needed to modify poses and on recruitment feasibility over the time frame for this study.

The postures were modified when needed using the props provided such as yoga blocks, chairs, yoga straps and blankets. The postures performed started with light intensity postures such as mountain pose (standing with feet side by side) with eyes open, slowly building confidence and proprioception awareness to standing with eyes closed. The single-leg balance with the support of the chair progressed to being able to place hands on the hips. The goal at the end of the 8 weeks was that all participants would be able to perform the balance postures with minimal upper body support.

Outcomes Measured

Balance was measured using the Berg Balance Scale, a commonly used and clinically relevant assessment tool that can be downloaded via online, it uses a 14-item physical performance measure of static and dynamic balance assessing functional balance. The tasks used involves sitting, standing and dynamic balance. The sitting task requires the participant to sit unsupported. The standing task requires a participant to stand unsupported, with eyes closed, with feet together, single leg balance, turning and looking behind them, being able to bend down and grab an object from the floor, reaching forward with arms out in front, balance with feet in tandem position. The last couple of tasks focus on dynamic balance, sitting to standing, standing to sitting, turning 360 degrees, transferring and stepping onto the step and back down. The task is marked on a 5 point ordinal scale ranging from 0 to 4. The score of 0 is when a participant is unable to do the task and the score of 4 is when they can do the task completely. Time is also a factor that can affect the points and if the participant needs assistance to complete it. The test scores were from 0 to 56, with the higher scores indicating better balance. A score of $\leq$36 is considered a fall risk (Maeda et al., 2009). Very little equipment is needed to administer the test. It requires a stopwatch, measuring tape, a step, a chair, and an object that can be picked up. The test usually takes between 15 to 20 minutes.

A single-leg stance test is used to assess postural stability and balance control. The test is performed with eyes open and with eyes closed. This test requires the participant to stand with one leg unsupported (hands on the hips). The timer starts when the foot lifts off the

ground and stops when the foot is back on the ground or if the participant uses their hand for support. The norms for this age group range from 29. 9 seconds to 18.3 seconds. Eyes closed norms range from 4.8 seconds to 2 seconds. It is reported (Bailey, 2022) that if the participant is unable to stand for more than 5 seconds, they are at a greater fall's risks. The equipment needed is a stopwatch.

Short Physical Performance Battery test is a performance mobility assessment tool testing lower limb strength and functional mobility, 5 repeated timed chair sit-to-stand done as quickly as possible, the timer starts as the participant is lifting off the chair and stops when they are back on the chair after 5 repetitions. and gait speed walking 2.44 meters at a normal pace, the participant walks to a mark on the floor. The three standing balance positions include standing with feet side by side, feet in semi-tandem and tandem position for 10 seconds each. The sum of time to stand in the three positions was up to a maximum of 30 seconds. The score ranges from 0 to 4, 0 indicates a longer time to finish the tasks while 4 indicates a fast time relative to the task. A final score is then calculated ranging from 0 indicating severe performance impairment to 12 which is optimal physical performance. A score of <7 can indicate a moderate to severe impairment. It was developed by the National Institute on Aging specifically for older adults (Guralnik et al., 1994). The equipment needed for this assessment is a chair, stopwatch, and measuring tape.

The 6 MWT was used to test mobility as it reflects activities of daily living. Data collected from this test is the participant's blood pressure, heart rate and oxygen saturation pre and post-test. Post-test Borg dyspnoea score where 0 represents no difficulty in breathing to 10 finding breathing very difficult. and the rate of perceived exertion (RPE) the numbers rate the difficulty they find the activity. 0 is nothing and 10 is very difficult. The participant is encouraged to walk as far as they can in 6 minutes. Cones are placed at either end of a lap which is a 30-meter stretch, with a chair positioned on either side along the walkway for if they need to rest. The average distance covered by a healthy older adult range from 514 ± 71 meters (Casanova et al., 2011). Equipment needed is a stopwatch, measuring tape, 30-meter walkway, two cones, chairs, pulse oximeter to measure SpO2, heart rate monitor to measure blood pressure and heart rate, Borg dyspnoea scale and rate of perceived exertion scale.

These outcomes are supported by the literature (A systematic review and meta-analysis by Youkhana et al. 2016, A systematic review and meta-analysis by Sivaramkrishnan et al. 2019)) for this cohort and were found to be reliable for measuring balance and mobility outcomes. Also, they are cost-effective and require no specialised equipment and no specialised training to carry out.

Statistical Analysis

Statistical analyses of data were performed using SPSS IBM version 27 for Mac OS. The data are presented as mean, standard deviation (SD) and median. A Shapiro-Wilks test was carried out to assess the normality of the outcomes.

In the comparison of the values obtained pre-and post-intervention, paired samples *t*-test was used if data showed a normal distribution, if there was skewness and the data does not fall within the normal distribution then a Wilcoxon signed-rank test was used and HodgesLehmann method to estimate the median differences and the 95% CI. The Wilcoxon signed rank test and the Hodges-Lehmann method were used for ordinal data variables. Cohens d was used to measure the effect size which ranged from small r = 0.2, medium r =

0.5 and large r = o.8 and greater. In all statistics, the gold standard *p* values less than .05 were accepted as statically significant.

Results

12 participants (1 male, 11, female) completed the follow-up assessments.

The Shapiro-Wilk test showed that data for the outcome measure of the Single leg stance, 6 minute walk test and the Short Physical Performance Battery test was normally distributed. The Berg Balance Scale was not normally distributed. Elements of the SPPB were further analysed such as the timed 5 repeated sit-to-stand was normally distributed and the 2.44meter walk which was not normally distributed.

Table 1: Summary of the Shapiro-Wilks test, change in score between baseline and 8 weeks. Difference (Post-test – Pre-test) and significance.

Variables	**Baseline (Mean ± SD)**	**8 week (Mean ± SD)**	**Mean Difference (Mean ± SD)**	**Significance P- Value**
6 Minute walk test (meters)	539 ± 2.83	595.5 ± 44.54	56.5 ± 47.37	.342*
BBS (0-56)	51 (85%)	53 (93%)	1.5 (8%)	.001
SPPB (0-14)	12 (91%)	13.5 (95%)	1 (4%)	.051*
5 repeated sitto-stand (seconds)	15.9 ± 14	10.85 ± 2.37	-5.07 ± 11.67	.158*
2.44 meter walk (seconds)	1.6 ± 0.02	1.61 ± 0.08	0.005 ± 0.06	.006
SLS Left leg lifted eyes open (seconds)	10.2 ± 12.94	8.70 ± 8.09	-1.54 ± 4.84	.836*
SLS Right leg lifted eyes open (seconds)	8.6 ± 11.11	9.32 ± 10.85	0.70 ± 0.26	.371*
SLS Left leg lifted eyes closed (seconds)	2.3 ± 1.62	3.38 ± 2.87	1.08 ± 1.24	.501*
SLS Right leg lifted eyes closed (seconds)	1.5 ± 0.68	3.52 ± 3.52	2.05 ± 2.84	.138*

Note: The Shapiro-Wilks test rejects the hypothesis of normality when the p-value is < 0.05. Significant comparisons are denoted with an asterisk (*).

Table 2: Summary of SPSS results

Variables	Mean ± Standard deviation, Median	Effect size (r)	P Value
6 Minute walk test (meters)	-67.92 ± 60.76	.79	.003*
BBS (0-56)	1.5		.042*
SPPB (0-14)	1		.010*
5 repeated sit-tostand (Seconds)	3.30 ± 4.09	.72	.017*
2.44 meter walk (seconds)	0.22		.005*
SLS Left leg lifted eyes open (seconds)	-5.45 ± 5.63	.78	.006*
SLS Right leg lifted eyes open (seconds)	-5.37 ± 9.33	.29	.071
SLS Left leg lifted eyes closed (seconds)	-0.88 ± 0.63	.81	.001*
SLS Right leg lifted eyes closed (seconds)	-0.96 ± 1.51	.33	.049*

Note: Significant comparisons are denoted with an asterisk (*)

Discussion

Current literature is deficient in research exploring the relationship between a yoga-based exercise prescription specific to balance outcomes for older adults with knee OA. The current study aimed to address this research gap by investigating the effects of a yoga-based exercise program for knee OA, designed specifically for strength, balance, and mobility and to minimise the KAM and consequently reduce the risk of falls in this population. It is important, however, for an older adult with knee OA to keep physically active, as discussed, an exercise prescription that does not progress the disease even further is a vital part of treatment. The following discussion elaborates on the findings, implications, limitations, feasibility, and conclusion of the study.

Adherence

A total of 15 people (1 male, 14 female) were initially screened for the study, and 12 participants (1 male, 11 female) completed the follow-up assessments. The study dropout was 20%, two participants dropped out due to having a fall at home and one participant dropped out due to hospital admission not relating to participating in the study. The number of classes

attended ranged from 10 to 16 with the mean class attendance 14 out of 16. Most of the participants (n=12) attended ≥ 81% of classes with common barriers during the summer months including going on holidays and family commitments. The average duration of the yoga session was 100 minutes out of 120 minutes each week. Participants did not report any related adverse events or injuries due to partaking in the yoga intervention.

Results

Following the 8-week hatha-style yoga program, participants experienced significant improvement in various outcomes related to balance, gait speed and functional mobility.

These findings are consistent with earlier research (Youkhana et al. 2016, Cheung et al.2014, Brennerman et al. (2015). The study observed substantial effect sizes (r-values) for these improvements, as evidenced by statistically significant improvement (p-values) between pretest and post-test results, SLS (*r*=.78), 5 repeated sit-to-stand (r = .72) and the 6-minute walk test (*r* = .79).

The effect sizes observed in this study surpassed those reported in comparable research. For instance, a systematic review and meta-analysis by Youkhana et al. (2016) who's results found a small effect on balance performance (r = 0.40), and a medium effect on physical mobility, gait speed and timed sit-to-stand (r = 0.50) and an 8-week study by Cheung et al. (2014) found a small effect size with the timed sit-to-stand (r =.37). In contrast to these studies, Brennerman et al. (2015) 12-week yoga program resulted in a statistical improvement in walking endurance p = .001 and sit to stand p = .006 compared to the current study p = .003, p = .017 respectively. These previous studies ranged in frequency, intensity, and duration, when compared to the current study it shows that 8 weeks of two 60-minute sessions at low to moderate intensity a week is an effective exercise prescription while also addressing the benefits of yoga as a physical activity.

The most significant improvements seen in the test performance were for the 6-minute walk test (595.5 ± 44.54, p .003) and the single leg stance (8.70 ± 8.09, p .001), previous research has determined (Bailey, 2022) that if the participant is unable to stand for more than 10 seconds, they are at a greater fall's risks and the 6-minute walk test can indicate a better functional ability (>514 ± 71 meters, Casanova et al., 2011). The improvement demonstrated in the sit-to-stand (10.85 ± 2.37, p .017) assessment suggests an improved functional balance and lower limb strength suggesting one can expect a decrease in the risk of fall's (Guralnik et al., 1994).

Overall, this study demonstrated significant findings in balance and mobility in terms of their ability to walk further during their 6-minute walk test.

The baseline assessment for SPPB overall score was 91% and this was due to the 3 balance tests (feet together, semi tandem, full tandem) where all participants reached 10 seconds, the BBS was 85% these results leave little room for improvement. This resulted in a ceiling effect and the reason there was very little change after the intervention. While mobility performance showed an improvement during the 6-minute walk test and the repeated chair sit-to-stand tasks, it is possible that this positive finding reflects training specificity as the participants completed squats, lunges, and chair sit-to-stand movements during the yoga sessions. Inconsistent with the alternate hypothesis, the single-leg stance with the right leg lifted did not demonstrate an improvement between baseline and follow-up (eyes open *r* =

.295, p .071 and eyes closed r = .33, p .049). This could be due to the left leg being weaker because of the severity of knee OA leading to a floor effect with the test.

Limitations

There are however several limitations to this study, the small sample size limiting generalisability as the study had only one male to twelve females. The study did not utilise a randomised controlled trial design with a control group, it cannot be ruled out that other confounding variables could be responsible for the statistical improvement observed between baseline and 8-week assessment. The study did not allow for blinding which may have resulted in attention bias. Since the study participants had to drive themselves to the study location, this may have ruled out the participation of less mobile elderly, making it difficult to translate the findings to frailer older adults with knee OA. Additionally, since yoga classes were provided to study participants at no cost, the high adherence rates may have been skewed by the cost-effectiveness of these classes, as the cost is one of the most common barriers to exercise adherence (Tiedemann et al., 2013), However, this study was intended as a pilot study to evaluate the feasibility of a yoga program for older adults with knee OA and to evaluate the impact on balance as the primary aim. The study has met these objectives.

The strengths of the study were well-defined inclusion and exclusion criteria, the yoga program was specifically designed by a highly qualified yoga instructor with over 15 years of experience working with older adults in the community. The yoga protocol can be easily followed by other qualified yoga teachers and researchers. The yoga poses included in the program were gentle and adaptable for older adults with knee OA who have functional limitations. Additionally, the participants that took part in this study were recruited from the community setting with various levels of knee OA symptoms and comorbidities, demonstrating the ability of the yoga program to meet the needs and demands of older adults with a range of abilities and medical histories. Furthermore, the outcomes measures included are validated measures of fall risk that are commonly used to assess mobility and balance in older adults. These measures were purposefully chosen to explore the potential for yoga to reduce the risk of falls.

Feasibility

The significant finding of this single-design pilot study was that this 8-week specifically designed yoga program was a safe, feasible and enjoyable exercise for older adults with knee OA. The yoga program's feasibility was demonstrated by its ease of recruitment over a short time. Participants attended 81% or more of the yoga sessions, demonstrating that the program was feasible. This indicates that the yoga program was appropriate to the abilities of the participants, enjoyable, and easy to follow, and the participants felt the physical and mental benefits after each session. The feasibility of the yoga program should not be underestimated as research states there is poor adherence to exercise among older adults.

Conclusion

The single-design pilot study highlighted the positive impact of the yoga intervention on various balance and functional mobility outcomes in older adults with knee OA. The improvements observed in walking endurance, balance control, physical performance, and specific functional tasks indicate the potential of tailored yoga interventions to enhance overall physical well-being in this cohort. However, with the small study group caution needs

to be applied when analysing these results. Finally, the intervention was limited to 8 weeks of yoga, which is below the recommended 50+ hours of balance exercise training according to clinical guidelines (Tiedemann et al., 2013), which has been shown to reduce fall risk in older adults. While the results are promising, further research with larger cohorts and refined methodologies will provide a more comprehensive understanding of the intervention's effectiveness at reducing falls and its implications for enhancing the quality of life in older adults with knee OA.

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Disclosing Statement

The author reports there are no competing interests to declare.

Appendices

Appendix A: Yoga intervention
Appendix B: Description, modification, and progression of yoga poses

Appendix A: Yoga intervention

Component	*Duration and description*
Check-in	
	5 minutes Participants asked how they have been that week and if
	they had any injuries, flare-ups, pain, or limitations.
Centering	
Seated	10 minutes
	Body scan, meditation, and Breathing exercises (pranayama)
Warm-up	
Seated poses	15 minutes
	Pawanmuktasana sequence joint freeing series
Standing poses	
	15 minutes
	Sit to stand x 3 very slow lifting and lowering.
	Mountain pose progressing to eyes closed.
	Toe to Heel raises x 5
	Tree pose – starting at 10 seconds.
	Squats – narrow to wide x 5
	High lunge
	Warrior 2,

Seated poses	Warrior 3
Cool down	10 minutes
	Single leg forward fold.
	Pigeon
	Supported bound angle
	Gentle twist
Savasana	5 minutes – Body scan and closing meditation.

Appendix B: Description of yoga poses, modifications, and progression

Participants will be asked to take the level that they can achieve with good posture and balance.

Yoga Pose description	Modification	Progression
Seated Poses		
Pawanmuktasana sequence - Ankle circles - Leg extension - Hip opening/ open leg to side - Cat/cow spinal articulation - Wrist circles - Shoulder shrugs - Arm circles - Side stretch - Forward fold	Using chair, strap	Level 1
Standing poses		
Sit to stand. Sitting on a chair, feet hip width apart, lean forward to stand	Use chair to help stand. Hands crossed in front of chest	Level 1 Level 2

Mountain Pose Standing with feet hip width apart	Use wall or chair to help balance. Standing without any aid Standing with eyes closed	Level 1 Level 2 Level 3
Toe to Heel raises Standing feet hip width apart, lifting heels to stand on balls of feet. Slowly lower back down. Lift toes to lean back on heels slowly lower.	Use wall or chair to help balance Standing without any aid	Level 1 Level 2

Tree pose Standing on one leg while placing the opposite foot on ankle or shin. Bending knee to side.	Using wall or chair for balance Without the use of aids	Level 1 – foot just off floor Level 2 – hands to hips Level 3 – Hands overhead
Squat Standing feet hip width apart, bending knees, sitting back into heels. Single leg squat	Using wall/ chair for support No support used	Level 1 – Knees at 30 degrees Level 2- hands on hips, knee 30 degrees Level 3 – Hand in prayer position n front of chest, knees at 60 degrees

High Lunge Standing in a forward position. Knee bends while stepping the opposite foot back, placing the ball of the foot on the ground	Using wall/ Chair for support No support needed, hands on hips Hands overhead	Level 1 Level 2 Level 3
Warrior 2 Standing in a forward position, bending knee while stepping opposite foot back parallel to the front of the mat	Using wall/ chair for support No support needed, hands on hips Hands out on either side	Level 1 Level 2 Level 3
Warrior 3 Standing in a forward position. Extend one leg back while leaning the body forward.	Using wall/ chair for support No support needed, hands on hips Arms extended forward	Level 1 Level 2 Level 3
Seated poses		
Single leg fold Feet hip width apart, extend one leg in front, foot dorsi flexed, fold from the hip hands to ward foot.	Using a chair.	Level 1

Gentle twist Hand to heart, twist to one side and the other	Using a chair	Level 1
Bound angle Soles of feet together, opening knees out to the side	Using a chair	Level 1
Pigeon Feet hip width apart and place ankle on top of opposite knee. Or cross ankles	Using a chair	Level 1

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