Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Rehabilitation Medicine

Eight Weeks of Mat Pilates Training on Balance and Falls in Elderly Nepalese Women

Rusha Pradhan[1], Ying Liu[2], Gang Liu[3*]

[1]Department of Rehabilitation Medicine, Southern Medical University Nanfang Hospital, Guangzhou, 510515, China
[2]Department of Rehabilitation Medicine, Southern Medical University Nanfang Hospital, Guangzhou, 510515, China
[3]Department of Rehabilitation Medicine, Southern Medical University Nanfang Hospital, Guangzhou, 510515, China

DOI: 10.36347/sjams.2023.v11i06.009 | **Received:** 28.04.2023 | **Accepted:** 05.06.2023 | **Published:** 09.06.2023

***Corresponding author:** Gang Liu
Department of Rehabilitation Medicine, Southern Medical University Nanfang Hospital, Guangzhou, 510515, China

Abstract **Original Research Article**

Although exercise with the Pilates method may improve balance and prevent falls in the elderly, results from previous studies are not conclusive, more so, among elderly Asian women. Thus, this study sought to compare the effect of mat Pilates training (with a Pilates ring) and outdoor walking on the frequency of falls that occur due to imbalance among Nepalese women above 60 years. Sixty elderly Nepalese women aged 60 years or older were randomly assigned to one of the two groups (i.e., Pilates and control groups) via conceal allocation method. The Intervention took place 60 min/session, two times a week for 8 weeks. The Pilates Group (PG) (n=30) underwent a supervised Mat-Pilates program with a Pilates ring; whereas the Control Group (CG) (n=30) did outdoor walking at a comfortable pace. The functional performance was evaluated by Unipedal Stance Test (UST), Timed Up and Go Test (TUG), and Berg Balance Scale (BBS). The number of falls within 12 weeks before and after the study was compared and evaluated. The Pilates intervention presented significant improvement in balance compared to outdoor walking ($P<0.001$). Specifically, participants in the Pilates group showed improvement in mobility, stability, static and dynamic balance ($P < 0.05$). A documented number of falls within 3 months after the study showed a significant reduction (78%) in mat Pilates training ($P = 0.004$), whereas the relationship between outdoor walking and the number of falls was null. Eight weeks of Mat Pilates exercise is effective in improving the balance and reduce the frequency of falls in elderly females for at least 12 weeks after the training.
Keywords: Pilates- based exercise, Women, Postural Balance, Accidental Falls, Walking, elderly adults.
Copyright © 2023 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution **4.0 International License (CC BY-NC 4.0)** which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

BACKGROUND

Advancement in medical service and technology has contributed to an increased life expectancy of many people globally. According to World Health Organization (WHO), 1 in 6 people will be aged 60 years by 2030, whiles those aged 80 and above in 2020 will triple by 2050 (WHO, 2022), but not without the potential increase in age-related challenges such as falls. As age increases body is dominated by a decline in anatomical and physiological changes. These changes further causes to decrease in joint position sensitivity, neural conductivity, decrease in proprioception and sarcopenia leading to delayed response, postural instability, imbalance and fall (Shepard, Telian, Smith-Wheelock, & Raj, 1993; Sieber, 2017). . Indeed, falls are a major public health concern, particularly among older adults, and can lead to serious injuries, reduced mobility, and decreased quality of life (Al-Aama, 2011). In most cases, 30% of individuals who had fallen are prone fall again, taken as "post-fall" anxiety syndrome (Ang, Low, & How, 2020). A report from the WHO suggests that fall is responsible for over 684,000 fatal injuries annually, making them the second leading cause of unintentional injury death worldwide, with over 80% of this occurring in low and middle-income countries (WHO, 2021). Thus, it is necessary to develop and design intervention programs that are specifically tailored to counteract age-related imbalances and falls.

"Walking" as an aerobic exercise is considered effective and inexpensive for the elderly. It has traditionally been suggested to improve health and build strength in the lower limb (Kubo *et al.,* 2008). However, the effectiveness of walking to reduce the frequency of falls is still not clear. Pilates, on the other hand, has been widely implemented for core stability, posture, and flexibility in various age groups (Irez, Ozdemir, Evin, Irez, & Korkusuz, 2011). Specifically, unlike other forms of exercise, Pilates aims to maintain a mind-body connection (Bird, Hill, & Fell, 2012; Latey, 2001) with the synchronization of the movement, focusing on the powerhouse of the body and breathing patterns (Granacher, Gollhofer, Hortobágyi, Kressig, & Muehlbauer, 2013). However, the effect of Pilates on the reduction of falls specifically in elderly women is limited (Aibar-Almazán *et al.*, 2019). Moreover, no prospective studies have been conducted making the comparison between the effectiveness of mat Pilates exercise and outdoor walking in terms of balance and prevention of falls among Asian populations.

Nepal is a lower-middle-income country with a rapidly increasing proportion of the elderly population (Bhandari, 2020). Despite this, there is a lack of research on the effectiveness of Pilates for improving balance and preventing falls in elderly Nepali individuals, more so among women. Since women are more susceptible to falls due to imbalance in comparison to men (Chang & Do, 2015), this study sought to determine and compare the effectiveness of mat Pilates exercises and outdoor walking among the elderly Nepali women population.

The result of this study could be beneficial in the field of rehabilitation and physiotherapy to specify better easily available exercises to improve balance to reduce falls in elderly women. This study gives broader insight into the effects of Pilates outside the developed areas which could contribute to fill the gap of effectiveness of Pilates to due economic bias (Długosz-Boś *et al.,* 2021).

METHODS

Study Design and Sampling

This prospective study was a randomized controlled trial conducted in Kathmandu, Nepal, approved by the Clinical Research Ethics Committee of Shunde Hospital of Southern Medical University, registered in the clinical trial registry (Approval number: 20210603), China and the Nepal Health Research Council (Ethical Approval number/registration number: 451/2022 MT). The demographic details and written informed consent were collected from the subjects before the collection of baseline detail.

The convenience sampling method was used to recruit participants through advertisement via pamphlet distribution at the rehabilitation center in Kathmandu, Nepal, from November 2021 to April 2022. After describing the study process 71 healthy elderly women were interested to participate. The inclusion criteria were: healthy elderly female above 60 years without assistive devices, who has a normal body mass index (BMI); who was not involved in any recreational activity, and who has experienced falls or has a fear of falls. On the other hand, the exclusion criteria were elderly females who have a poor mental state; have undergone any surgery or fracture within a year; presented with a cardiac, neurological, or musculoskeletal problem; cannot perform daily activity independently; or are contraindicated to physical activity. After verifying the inclusion and exclusion criteria, 60 participants were enrolled.

Randomization

The 60 eligible participants were randomly assigned to receive one of the two interventions; that is the Pilates group (PG =30) or the Control group (CG =30) via conceal allocation method. The randomization was conducted using the tool provided on www.randomization.com. The Consolidated Standards of Reporting Trials (CONSORT) statement was set as a standard (Schulz, Altman, & Moher, 2010) (Figure 1). Participants and the examiner both were blinded during allocation. The assignments were made using sealed opaque envelopes, consecutively numbered.

Data Collection

The study was conducted at a rehabilitation center. All participants went through the Mini-Mental State Examination (MMSE). MMSE consists of 30 scores, designed as a screening test to evaluate cognitive impairment in adults with scores of 24 or above indicating no cognitive impairment (Arevalo-Rodriguez *et al.*, 2015). All enrolled participants scored above 24 on the MMSE test indicating no cognitive impairment.

Further, all the individual's heights and weights were measured using a Martin anthropometer (Seritex, New York, NY, USA) and a Tanita scale (Tanita Corporation, Tokyo, Japan), respectively. BMI was calculated using weight in kilograms divided by the square of height in meters. Individuals were then categorized into underweight (< 18.5kg/m^2), normal-weight (18.5 – 24.9 kg/m^2), overweight (25 – 29.9 kg/m^2), or obese (≥ 30 kg/m^2). Individuals in the normal category were selected for the study. The arithmetic mean of BMI was recorded for evaluation. The group characteristics are reported in Table 1.

Participants were asked to record the number of falls or intend to fall if any between May 2022 and July 2022. The training was carried out for 8 weeks from August 2022 and September 2022. Further, after the training period, participants were asked to record the falls and intend to fall from October 2022 to December 2022.

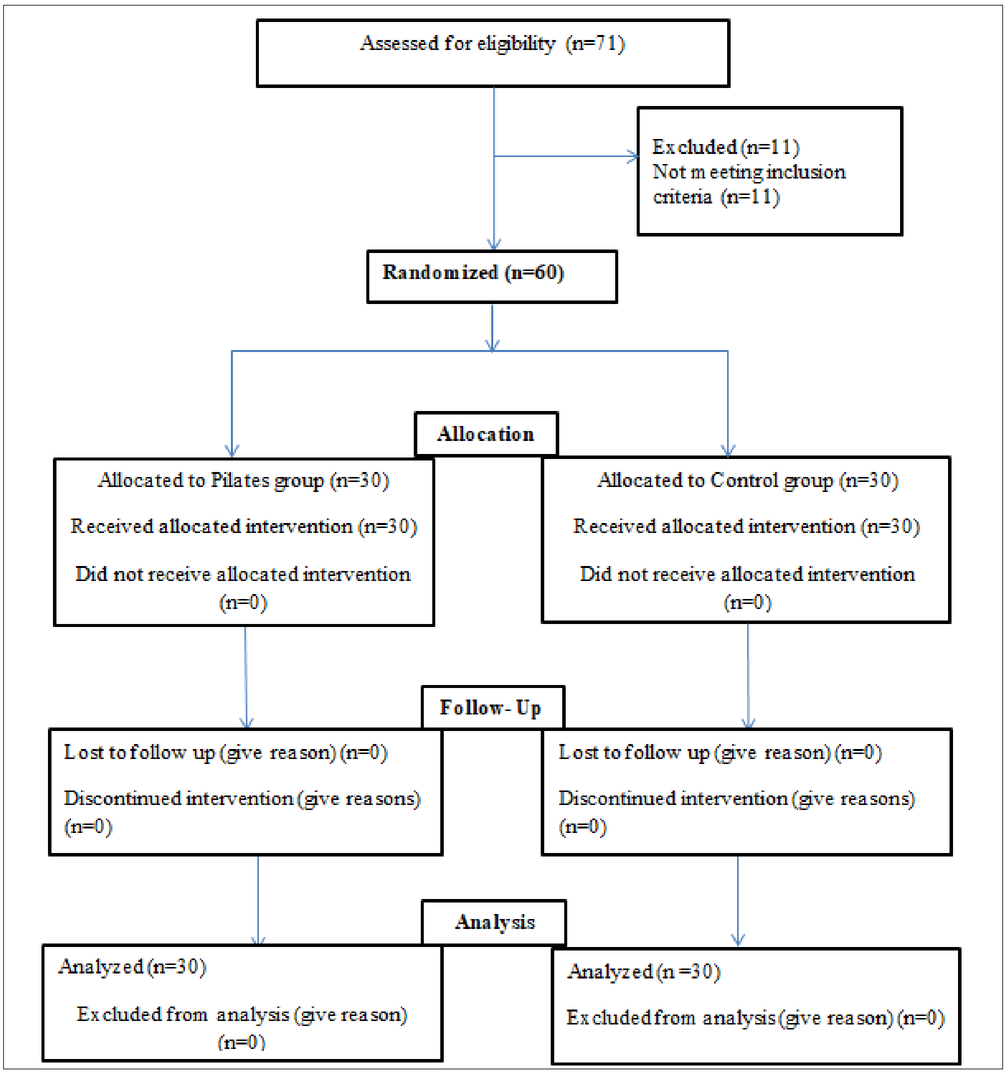


Figure 1: Randomization

Table 1: Special Characteristics

Groups		**Minimum**	**Maximum**	**Mean± SD**	**Std. Error**
Interventional Group(IG) (n=30)	Age	60	87	71.53± 6.86	1.25
	Weight(kg)	50	73	59.77± 6.38	1.16
	Height(cm)	151	174	162.13 ± 6.44	1.36
	BMI	19.25	24.86	22.52 ± 1.64	0.30
	MMSE	28	29	28.27 ± 0.45	0.82
Control Group(CG) (n=30)	Age	60	88	68.57 ± 8.64	1.57
	Weight(kg)	46	73	56.37 ± 5.91	1.08
	Height(cm)	152	178	158.63 ± 6.49	1.31
	BMI	18.94	24.38	22.36 ± 1.37	0.25
	MMSE	28	29	28.30 ± 0.46	0.85

Mean ± standard deviation(SD)
BMI: Body Mass Index
MMSE: Mini mental Scale Examination

Outcomes Measures

The Berg Balance Scale (BBS) is a test that evaluates functional balance through 14 tasks with a total possible score of 56 (0–4 for each task). The scores below 45 indicate an increased risk of falls. The Berg balance test is thought to be reliable for assessing elderly people's balance (Downs, Marquez, & Chiarelli, 2013; Lusardi *et al.*, 2017; Shumway-Cook, Baldwin, Polissar, & Gruber, 1997).

The Time Up and Go test (TUG) is a functional mobility test based on the gait speed and

© 2023 Scholars Journal of Applied Medical Sciences | Published by SAS Publishers, India

dynamic balance of older adults. This test has been considered reliable to measure functional fitness and the risk of falls (Akbari & Mousavikhatir, 2012; Barry, 2020). The score was based on the time taken by the participant to complete the task. During this test, timing begins on command “go”, the subject rise from a chair, walks for 3 meters (marked on the floor) turns around, walks back and timing stops when the subject sits down on the chair (starting point) (Lusardi *et al.,* 2017; Valenzuela *et al.,* 2020). Elderly people who take longer than 13.5 seconds to complete the task are thought to be at a high risk of falling. (Shumway-Cook, Brauer, & Woollacott, 2000).

The Unipedal stance test (UST) is a test for measuring the stability on a plane surface and testing the ability to transfer one’s body weight into a single leg. The Participant is asked to stand on one leg (barefoot) with the other leg raised next to the calf of the stance limb. The participant is instructed to look straight in front of him/her whiles a stopwatch is used to measure the time. The time is stopped when the subject loses their balance (Domínguez-Carrillo, Arellano-Aguilar, & Leos-Zierold, 2007) (Springer, Marin, Cyhan, Roberts, & Gill, 2007). The test is performed on both legs individually (da Silva, Bilodeau, Parreira, Teixeira, & Amorim, 2013). The ability to maintain balance on one leg for 30 seconds or more indicates a low risk of fall.

Intervention

The intervention started after the pre-evaluation of the BBS, TUG, and UST of participants. The control group (CG) and the Pilates group (PG) both took part 2 sessions a week for 8 weeks, with each session being scheduled for an hour which consisted of 10 minutes of a warm-up, 40 minutes of the main program, and 10 minutes of cool-down. Both the groups performed warm-up and cool-down exercises as mentioned in Table 2.

The participants in the CG walked outdoors at a comfortable pace for 40 minutes as their main program. Whereas the PG performed a mat Pilates exercises program following its principles supervised by a physiotherapist. The Pilates exercises started with the familiarization of participants in the intervention group with the principle of Pilates. From the first session to the eleventh session, participants continued with mat exercises without accessories. The Pilates ring was included from the eleventh sessions to the sixteen sessions. All exercises were performed on a rubber mat of 10 millimeters thick. The Pilates mat program is illustrated in Table 2. In total 20 exercises were performed in two sets of five repetitions which transitioned fluently from one to another. Some exercises were modified to ensure safety for the elderly. The Pilates exercises were delivered to a maximum of three participants at a time.

Table 2: Exercises Performed

<table>
<tr><td colspan="3">Mat Pilates exercises (5 repetitions / 2 sets)</td></tr>
<tr><td></td><td>Sessions</td><td>Mat Pilates exercise</td></tr>
<tr><td rowspan="2">Breathing exercises
intercostal breathing

Warm up
wrist circle,
arm rotation, shoulder rotation
Pelvic tilt,
leg circle,
ankle rotation

Cool down
Self-stretching
Sternocleidomastoid,
Trapezius, Rhomboids,
Pectoralis major,
Biceps,
Triceps
Hamstring,
Piriformis,
Gastrocnemius,
Quadriceps
Quadratus lumborum
Cobra stretch</td><td>Session 1st to 10th
(5 weeks)

Mat Pilates exercises
(without Pilates ring)</td><td rowspan="2">Bridging
Hundred
Single leg raise
Single leg circle
Knee to chest
Table top position
Double abdominal press
Side lying adduction and abduction
Prone knee bend
Cat and camel
Quadruped alternate arm and leg raise
Standing on toe
Tandem standing
Single leg standing

With Pilates ring:
Bridging
Supine lying leg raise
Side lying adduction
Prone knee bend
Standing (adduction)
Standing (abduction)</td></tr>
<tr><td>Session 11th to 16th
(3 weeks)

Mat Pilates exercise
(without and with Pilates ring)</td></tr>
</table>

Statistical Analysis

Microsoft Excel was used to tabulate the data, and the Windows-bd SPSS-16 statistical analysis program was used for statistical analysis. Data were presented by means ± standard deviation (SD). The Shapiro-Wilk test was used to assess sample normality, with an alpha level of 0.05.

The PG and CG distribution were sufficiently normal to conduct a t-test (i.e., skew <2.0 and kurtosis <9.0). The paired t-test was used for the comparison of the variables (within the group). To test the hypothesis of whether the Pilates group (PG) and control group (CG) were associated with a statistically significantly different mean value of each of the tests, an independent sample t-test was performed, with (Critical value(58) = ± 1.627). The Levene's-F test was used to assess the homogeneity of variance. The student t-test critical value was used to estimate the significant difference between the measurements. In addition, the Mann-Whitney *U* test was used for the independent variable, when appropriate to analyze the significant differences between the groups. Effect size was calculated using Cohen's *d*. Effect size with a difference of <0.2 is considered minor, ≥0.2 but ≤0.5 a small, ≥0.5 but ≤0.8 a moderate, and ≥0.8 large (Cruz-Díaz *et al.*, 2015). Further analysis was done using Bonferroni correction, to avoid false positive results, since 3 outcome measures were used; the *P* value 0.017 with a 95% confidence interval (CI) was used to analyze significance.

The recorded data of fall three months prior to the trail was compared with three months after the trial for both PG and CG using the paired t test.

RESULTS

The baseline characteristics of the two groups are shown in Table 1. In Table 3 analysis of variables before and after the interventions is shown. Here in the results "*M*" indicate Mean value and "*SD*" indicates standard deviation.

The result of the BBS for PG showed a 4% increase in mean value before (*M* = 46.70, *SD*=1.66) to after (*M* = 48.57, *SD*= 1.89), *t* (29) = -9.52, *P* < 0.001, indicating the post-study mean value was statistically higher than pre-training. Cohend'd been estimated at 1.73 which is considered a large effect. The CG, BBS score showed a decrease in mean value by 0.4%, *t* (29) = 0.733, *P* = 0.470, with small effect size (*d*) 0.13.

In TUG test, a decrease in the mean value of post-test compared to the pretest signifies a decrease in the time taken by participants to complete the task. According to the result of the TUG test, PG indicated a 14% decrease in mean value before (*M*=10.76, *SD*= 0.81) to after (*M*=9.43, SD= 0.97), *t*(29)=7.99, *P* <0.001, signifying the post mean value was statistically lower than pre mean value with large effect size (*d*) 1.49. The CG, TUG test showed improvement in mean value before (*M*= 10.90, *SD*= 0.93) to after (*M*=10.70, *SD*= 0.74), *t* (29) =1.36, *P* = 0.184, with effect size (*d)* 0.23.

The UST for both legs was analyzed separately. Based on the result of the UST test of the right leg, PG showed an increase in mean value before (*M*= 16.65, *SD* = 4.75) to (*M* 23.63, *SD* = 4.69), *t*(29) = -9.92, *P*<0.001, with largest effect size (*d)*1.85. Similarly, CG, TUG also indicated an increase in mean value before (*M*= 15.94, *SD*= 3.32) to after (*M*= 16.97, *SD* = 3.04), *t*(29) = -4.368, *P*<0.001, with medium effect size (*d*) 0.85.

According to the result of the UST test of the left leg, PG showed an increase in mean value before (*M*= 13.89, *SD*= 3.30) to after (*M*= 17.10, *SD*=3.67), *t*(29) = -5.40, *P*<0.001, with large effect size (*d*) 0.98. The CG, UST also showed an increase in mean value before (*M*= 13.48, *SD*= 3.26) to after (*M* =14.24, *SD*= 3.33), *t*(29)= -3.65, *P*<0.001, with small effect size (*d*) 0.07.

According to the comparison of the frequency of falls pre and post-study in both the groups, PG showed decrease in mean values by 78.6% before (*M*= 1.23, *SD*=0.62) to after (*M*= 0.27, *SD*= 0.45), *t*(29)= 9.52, *P*<0.001, with large effect size(*d*) 1.73. The CG, fall frequency also decreases by a mean value of 4.68% before (*M*=1.43, *SD*= 0.81) to after (*M*=1.37, *SD*=0.61), *t*(29)= 0.40, *P*= 0.69, with small effect size(*d*) 0.07 (Table 3) (Figure 2).

Subsequently, the difference between the performances of the group was evaluated. The Levene's test showed that the variances for the BBS, TUG and UST for left leg in post-intervention comparisons were equal, *P* >0.05. However, homogeneity of variance was violated for UST of the right leg, *P* <0.05. At the baseline evaluation, there was no significant difference between the groups (Table 4). However, the intervention significant difference was observed between the groups (Table 5).

To narrow down the improvements in outcome measures after the intervention, the effect size of post-intervention was measured. An effect size of significant changes is listed in table 4. The largest effect size was noticed in UST of the right leg (Cohen's *d*=1.33) in between the group comparison post intervention. Furthermore the result indicated significant difference between PG and CG after the Bonferroni correction was approached (*P*<0.017).

Table 3: Presents the results of the variables studied, before and after intervention

Group	Outcome Measure	Pretest	Posttest	Cohen's *d* Effect size	*P* value
Pilates Group (n=30)	BBS	46.70 ± 1.66	48.57± 1.89	1.73	0.001
	TUG	10.76 ± 0.81	9.43 ± 0.97	1.49	0.001
	UST (Right Leg)	16.65 ± 4.75	23.63 ± 4.69	1.85	0.001
	UST (Left Leg)	13.89 ± 3.30	17.10 ± 3.67	0.98	0.001
	Fall	1.23 ± 0.62	0.27 ± 0.45	1.73	0.001
Control group (n=30)	BBS	46.43 ± 1.52	46.23 ± 1.45	0.13	0.470
	TUG	10.90 ± 0.93	10.70 ± 0.74	0.24	0.184
	UST (Right Leg)	15.94 ± 3.32	16.97 ± 3.04	0.85	0.001
	UST (Left Leg)	13.48 ± 3.26	14.24 ± 3.33	0.68	0.001
	Fall	1.43 ± 0.81	1.37 ± 0.61	0.07	0.69

notes: mean ± standard deviation
BBS - Berg Balance Scale (score/56)
TUG - Time Up and GO test (second)
UST - Unipedal Stance Test (second)
Number in bolds represent significant *P*-values ($P<0.05$), numbers in underlines represent significant P-value after Bonferroni correction ($P < 0.017$).
Fall record 12 weeks prior to study compared with 12 weeks after the study

Table 4: Baseline analysis of variables between groups

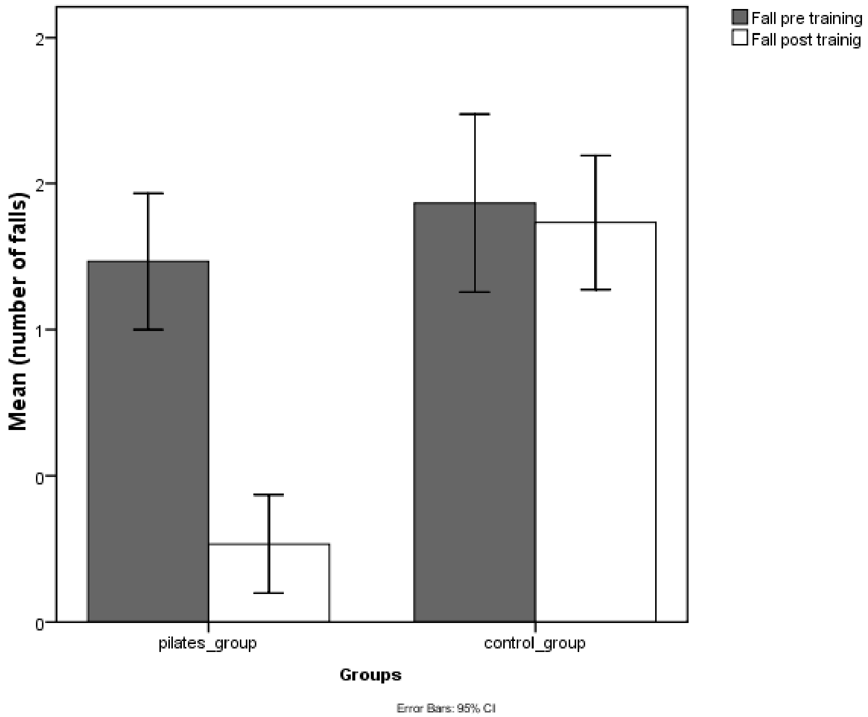
Outcome measures	Pilates group (PG)	Control group (CG)	*P*	Mean difference	Std. effect/ Cohen's D
BBS*	46.70± 1.66	46.43 ± 1.52	0.52	0.26	0.26
TUG*	10.76 ± 0.81	10.90 ± 0.92	0.56	-0.13	-1.33
UST(right Leg)*	16.65 ± 4.75	15.94 ± 3.32	0.50	0.71	0.71
UST(left Leg)*	13.89 ± 3.30	13.48 ± 3.26	0.63	0.41	0.41

Data are represented as: mean ± standard deviation
BBS- Berg Balance Scale (score/56);
TUG - Time Up and Go (second);
UST- Unipedal Stance Test (second)
Number in bolds represent significant P-values ($P<0.05$),
*Student *t* test

Table 5: Post-intervention analysis of variables between groups

Outcome Measures	Pilates Group(PG)	Control Group (CG)	*P*	Mean difference	Std. effect/ Cohen's D
BBS*	48.57± 1.85	46.23 ± 1.45	0.001	2.33	1.15
TUG*	9.43 ± 0.97	10.70 ± 0.75	0.001	-1.26	-1.18
UST(right Leg)**	23.62 ± 4.69	16.97 ± 3.04	0.001	6.65	0.06
UST(left Leg)*	17.01 ± 3.67	14.24 ± 3.33	0.001	2.76	0.83

Data are represented as: mean ± standard deviation
BBS- Berg Balance Scale (score/56);
TUG - Time Up and Go (second);
UST- Unipedal Stance Test (second)
Number in bolds represent significant P-values ($P<0.05$),
*Student *t* test
**Mann-Whitney *U* test
Numbers in underlines represent significant P-value after Bonferroni correction ($P< 0.017$).



Note: Pilates group (PG) p<0.05, Control group (CG) p>0.05

Figure 2: Comparison of number of falls

DISCUSSION

This study aimed to analyze the effectiveness of mat Pilates exercises and walking outdoors on balance and fall rates among 60 healthy elderly women who have experienced falls previously.

We found mat Pilates exercises with a Pilates ring twice a week for eight weeks to significantly improve balance and reduce falls in elderly Nepalese women; whereas the corresponding effectiveness of walking on these outcomes showed significant improvement only in static balance analyzed by UST test, suggesting that the introduction of mat Pilates exercise among the elderly women population will significantly improve static, dynamic balance and reduce the risk of accidental falls compared to walking outdoors.

Previous studies have demonstrated the beneficial effect of Pilates training on improving stability and reducing falls in comparison with other forms of exercise. For instance, in a sample of 41 elderly individuals who were followed for 13 weeks, Patti and colleagues found Pilates exercise to improve balance and reduce falls more than the control group with no specific physical activity (Patti *et al.*, 2021). Specifically, they found an inverse correlation between BBS, the criterion standard in measuring fall risk, and ellipse surface area (r = -0.75) in 18 participants in the intervention group. Similarly, in a 4-week follow-up study by Mesquita and colleagues, women (n = 20) who undertook Pilates exercise were found to perform better on the BBS test compared to controls (Mesquita, de Carvalho, Freire, Neto, & Zângaro, 2015). Our results on the BBS from 30 participants enrolled in the intervention group with 12 weeks follow-up corroborate these findings, suggesting that Pilates exercise could implement to prevent falls among the elderly more than walking outdoors, particularly, among elderly women. It is noteworthy to mention that although a reduction in falls was observed in both groups in our study, only PG showed a significant decrease in the frequency of imbalance and falls. The CG showed improvement in stability although it was not statistically significant, underscoring the advantage of Pilates training over walking outdoors.

With regards to the TUG and single-leg stand test, the study showed a decrease in time used to perform the TUG test and participants were able to stand longer duration in one leg after the post-intervention. This observation was in line with previous studies conducted by Bertoli *et al.*, Mesquita *et al.*, and Mokhtari *et al.*, in which they also noticed an improvement in the TUG test after doing Pilates exercise (Bertoli, Biduski, & de la Rocha Freitas, 2017; Mesquita *et al.*, 2015; Mokhtari, Nezakatalhossaini, &

Esfarjani, 2013). Furthermore, the result of our study agrees with the literature conducted by Vieira *et al.*, where the UST score increased from 53% to 71% in 21 subjects in the intervention group after the Pilates training period (Vieira *et al.*, 2017). However, some literature reported contrary findings (Bergamin *et al.*, 2015; Donath, Roth, Hürlimann, Zahner, & Faude, 2016; Gabizon, Press, Volkov, & Melzer, 2016), which could be due to the heterogeneity of daily activities followed by counts and sets of exercises (Watanabe, Madarame, Ogasawara, Nakazato, & Ishii, 2014).

Studies have shown that muscle strength is related to stability and balance; however, as one age, the functional ability of muscles that carry out these functions diminishesincreasing susceptibility to falls due to weakness and balance instability (Patti *et al.*, 2021).

The uses of the Pilates ring in this study have assisted with additional resistance. This study agrees with Petrofsky *et al.*, who observed mat Pilates is more effective for balance when resistance is included (Petrofsky *et al.*, 2005). Pilates ring initiates isometric contraction of muscles of the distal extremity, focusing on abdominal strength. Furthermore, the Pilates exercise program is designed to strengthen the muscles that maintain balance and stability among populations with a high potential for falls. Thus, the observed improvement in balance and a significant reduction in the fall rate among the PG group compared to those in the CG.

In this study, the follow-up was conducted for only 12 weeks; a longer duration would help recognize the long-term effect of Pilates on fall risk among elderly women. Secondly, in this study, there could be errors in listing the number of falls, as it was recorded by the participants themselves. Furthermore, CG was not supervised to the same degree as those in the PG, which might have caused some bias.

CONCLUSION

In conclusion, although both Pilates exercises and outdoor walking, twice a week for 8 weeks appeared to reduce the number of falls for at least 12 after 8 weeks of training, Pilates exercises appeared to be more beneficial in that regard compared to outdoor walking. Therefore, Pilates exercise should be incorporated into health promotion and preventive activities targeting elderly women. We recommend that future studies conduct a parallel analysis, the result of which will help in clinical practice and reduce the risk of falls in the elderly.

In summary, this original research on the comparison between Pilates and outdoor walking on a balance of elderly women can provide important insights into preventive measures to improve balance and reduce fall risk.

Clinical Relevance

- This research can provide valuable insights into preventive measures that can be taken to reduce the risk of falls and inform healthcare practitioners and policy-makers on effective interventions to improve balance and mobility.
- This original research on the comparison between Pilates and outdoor walking is a comparison of cost-effective and easily available exercises, implying this effective exercise can help improve balance and reduce accidental falls in elderlies even in rural areas.
- This research can encourage elderly females and inform the possibility to promote balance and mobility by practicing independently after being trained by the specialist.
- This original research has a significant benefit to the public and health care and provides important insights into preventive measures to reduce fall risk.

REFERENCES

- Aibar-Almazán, A., Martínez-Amat, A., Cruz-Díaz, D., De la Torre-Cruz, M. J., Jiménez-García, J. D., Zagalaz-Anula, N., . . . & Hita-Contreras, F. (2019). Effects of Pilates on fall risk factors in community-dwelling elderly women: A randomized, controlled trial. *Eur J Sport Sci, 19*(10), 1386-1394. doi: 10.1080/17461391.2019.1595739
- Akbari, M., & Mousavikhatir, R. (2012). Changes in the muscle strength and functional performance of healthy women with aging. *Med J Islam Repub Iran, 26*(3), 125-131.
- Al-Aama, T. (2011). Falls in the elderly: spectrum and prevention. *Can Fam Physician, 57*(7), 771-776.
- Ang, G. C., Low, S. L., & How, C. H. (2020). Approach to falls among the elderly in the community. *Singapore Med J, 61*(3), 116-121. doi: 10.11622/smedj.2020029
- Arevalo-Rodriguez, I., Smailagic, N., Roqué, I. Figuls M., Ciapponi, A., Sanchez-Perez, E., Giannakou, A., . . . & Cullum, S. (2015). Mini-Mental State Examination (MMSE) for the detection of Alzheimer's disease and other dementias in people with mild cognitive impairment (MCI). *Cochrane Database Syst Rev, 2015*(3), CD010783. doi: 10.1002/14651858.CD010783.pub2
- Barry, D. (2020). 217 - Sarcopenia. In J. E. Pizzorno & M. T. Murray (Eds.), *Textbook of Natural Medicine (Fifth Edition)* (pp. 1781-1803.e1719). St. Louis (MO): Churchill Livingstone.

- Bergamin, M., Gobbo, S., Bullo, V., Zanotto, T., Vendramin, B., Duregon, F., . . . & Ermolao, A. (2015). Effects of a Pilates exercise program on muscle strength, postural control and body composition: results from a pilot study in a group of post-menopausal women. *Age (Dordr), 37*(6), 118. doi: 10.1007/s11357-015-9852-3
- Bertoli, J., Biduski, G. M., & de la Rocha Freitas, C. (2017). Six weeks of Mat Pilates training are enough to improve functional capacity in elderly women. *J Bodyw Mov Ther, 21*(4), 1003-1008. doi: 10.1016/j.jbmt.2016.12.001
- Bhandari, Kamala. (2020). Trends in Age Structure and Ageing Population in Nepal. *Journal of Population and Development, 1*(1), 103-114. doi: 10.3126/jpd.v1i1.33109
- Bird, M. L., Hill, K. D., & Fell, J. W. (2012). A randomized controlled study investigating static and dynamic balance in older adults after training with Pilates. *Arch Phys Med Rehabil, 93*(1), 43-49. doi: 10.1016/j.apmr.2011.08.005
- Chang, Vicky C., & Do, Minh T. (2015). Risk Factors for Falls Among Seniors: Implications of Gender. *American Journal of Epidemiology, 181*(7), 521-531. doi: 10.1093/aje/kwu268
- Cruz-Díaz, D., Martínez-Amat, A., Manuel, J., Casuso, R. A., de Guevara, N. M. L., & Hita-Contreras, F. (2015). Effects of a six-week Pilates intervention on balance and fear of falling in women aged over 65 with chronic low-back pain: A randomized controlled trial. *Maturitas, 82*(4), 371-376. doi: https://doi.org/10.1016/j.maturitas.2015.07.022
- Da Silva, R. A., Bilodeau, M., Parreira, R. B., Teixeira, D. C., & Amorim, C. F. (2013). Age-related differences in time-limit performance and force platform-based balance measures during one-leg stance. *Journal of Electromyography and kinesiology, 23*(3), 634-639. doi: https://doi.org/10.1016/j.jelekin.2013.01.008
- Długosz-Boś, M., Filar-Mierzwa, K., Stawarz, R., Ścisłowska-Czarnecka, A., Jankowicz-Szymańska, A., & Bac, A. (2021). Effect of Three Months Pilates Training on Balance and Fall Risk in Older Women. *Int J Environ Res Public Health, 18*(7). doi: 10.3390/ijerph18073663
- Domínguez-Carrillo, L. G., Arellano-Aguilar, G., & Leos-Zierold, H. (2007). [Unipedal stance time and fall risk in the elderly]. *Cir Cir, 75*(2), 107-112.
- Donath, L., Roth, R., Hürlimann, C., Zahner, L., & Faude, O. (2016). Pilates vs. Balance Training in Healthy Community-Dwelling Seniors: a 3-arm, Randomized Controlled Trial. *Int J Sports Med, 37*(03), e6-e6. doi: 10.1055/s-0035-1569339
- Downs, S., Marquez, J., & Chiarelli, P. (2013). The Berg Balance Scale has high intra- and inter-rater reliability but absolute reliability varies across the scale: a systematic review. *J Physiother, 59*(2), 93-99. doi: 10.1016/s1836-9553(13)70161-9
- Gabizon, H., Press, Y., Volkov, I., & Melzer, I. (2016). The effects of pilates training on balance control and self-reported health status in community-dwelling older adults: a randomized controlled trial. *Journal of aging and physical activity, 24*(3), 376-383. doi: 10.1123/japa.2014-0298
- Granacher, U., Gollhofer, A., Hortobágyi, T., Kressig, R. W., & Muehlbauer, T. (2013). The importance of trunk muscle strength for balance, functional performance, and fall prevention in seniors: a systematic review. *Sports Med, 43*(7), 627-641. doi: 10.1007/s40279-013-0041-1
- Irez, G. B., Ozdemir, R. A., Evin, R., Irez, S. G., & Korkusuz, F. (2011). Integrating pilates exercise into an exercise program for 65+ year-old women to reduce falls. *J Sports Sci Med, 10*(1), 105-111.
- Kubo, K., Ishida, Y., Suzuki, S., Komuro, T., Shirasawa, H., Ishiguro, N., . . . & Fukunaga, T. (2008). Effects of 6 months of walking training on lower limb muscle and tendon in elderly. *Scand J Med Sci Sports, 18*(1), 31-39. doi: 10.1111/j.1600-0838.2007.00654.x
- Latey, P. (2001). The Pilates method: history and philosophy. *Journal of Bodywork and Movement Therapies, 5*(4), 275-282. doi: https://doi.org/10.1054/jbmt.2001.0237
- Lusardi, M. M., Fritz, S., Middleton, A., Allison, L., Wingood, M., Phillips, E., . . . & Chui, K. K. (2017). Determining Risk of Falls in Community Dwelling Older Adults: A Systematic Review and Meta-analysis Using Posttest Probability. *J Geriatr Phys Ther, 40*(1), 1-36. doi: 10.1519/jpt.0000000000000099
- Mesquita, L. S., de Carvalho, F. T., Freire, L. S., Neto, O. P., & Zângaro, R. A. (2015). Effects of two exercise protocols on postural balance of elderly women: a randomized controlled trial. *BMC Geriatr, 15*, 61. doi: 10.1186/s12877-015-0059-3
- Mokhtari, M., Nezakatalhossaini, M., & Esfarjani, F. (2013). The Effect of 12-Week Pilates Exercises on Depression and Balance Associated with Falling in the Elderly☆. *Procedia - Social and Behavioral Sciences, 70*, 1714-1723.
- Patti, A., Zangla, D., Sahin, F. N., Cataldi, S., Lavanco, G., Palma, A., & Fischietti, F. (2021). Physical exercise and prevention of falls. Effects of a Pilates training method compared with a general physical activity program: A randomized controlled trial. *Medicine (Baltimore), 100*(13), e25289. doi: 10.1097/md.0000000000025289
- Petrofsky, J. S., Morris, A., Bonacci, J., Hanson, A., Jorritsma, R., & Hill, J. (2005). Muscle use during exercise: A comparison of conventional weight equipment to pilates with and without a resistive exercise device. *Journal of Applied Research, 5*, 160-173.

- Schulz, K. F., Altman, D. G., & Moher, D. (2010). CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *PLoS Med, 7*(3), e1000251. doi: 10.1371/journal.pmed.1000251
- Shepard, N. T., Telian, S. A., Smith-Wheelock, M., & Raj, A. (1993). Vestibular and balance rehabilitation therapy. *Ann Otol Rhinol Laryngol, 102*(3 Pt 1), 198-205. doi: 10.1177/000348949310200306
- Shumway-Cook, A., Baldwin, M., Polissar, N. L., & Gruber, W. (1997). Predicting the probability for falls in community-dwelling older adults. *Phys Ther, 77*(8), 812-819. doi: 10.1093/ptj/77.8.812
- Shumway-Cook, A., Brauer, S., & Woollacott, M. (2000). Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. *Phys Ther, 80*(9), 896-903.
- Sieber Cornel, C. (2017). Frailty – From concept to clinical practice. *Experimental Gerontology, 87*, 160-167. doi: https://doi.org/10.1016/j.exger.2016.05.004
- Springer, B. A., Marin, R., Cyhan, T., Roberts, H., & Gill, N. W. (2007). Normative values for the unipedal stance test with eyes open and closed. *J Geriatr Phys Ther, 30*(1), 8-15. doi: 10.1519/00139143-200704000-00003
- Valenzuela, P. L., Maffiuletti, N. A., Saner, H., Schütz, N., Rudin, B., Nef, T., & Urwyler, P. (2020). Isometric Strength Measures are Superior to the Timed Up and Go Test for Fall Prediction in Older Adults: Results from a Prospective Cohort Study. *Clin Interv Aging, 15*, 2001-2008. doi: 10.2147/cia.s276828
- Vieira, N. D., Testa, D., Ruas, P. C., Salvini, T. F., Catai, A. M., & de Melo, R. C. (2017). The effects of 12 weeks Pilates-inspired exercise training on functional performance in older women: A randomized clinical trial. *J Bodyw Mov Ther, 21*(2), 251-258. doi: 10.1016/j.jbmt.2016.06.010
- Watanabe, Y., Madarame, H., Ogasawara, R., Nakazato, K., & Ishii, N. (2014). Effect of very low-intensity resistance training with slow movement on muscle size and strength in healthy older adults. *Clin Physiol Funct Imaging, 34*(6), 463-470. doi: 10.1111/cpf.12117
- WHO. (2021). Falls. Retrieved 02/05/23, 2023, from https://www.who.int/news-room/fact-sheets/detail/falls
- WHO. (2022, 1 October). Ageing and Health. Retrieved 11 October 2022, from https://www.who.int/news-room/fact-sheets/detail/ageing-and-health