



Static and Dynamic Yoga Asanas vs Combined Yoga: Which is More Effective for Enhancing Flexibility and Balance in Perimenopausal Women?

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Abstract

Background. Perimenopause is often accompanied by declines in flexibility and balance, increasing the risk of falls and reducing quality of life. Static and dynamic yoga are each linked to gains in flexibility and postural stability, but no study has directly compared static, dynamic, and combined yoga to determine which approach most effectively improves these outcomes in perimenopausal women.

Objectives. This study aimed to evaluate the effects of static, dynamic, and combined yoga practices on flexibility and balance in perimenopausal women.

Materials and Methods. A three-arm randomized controlled trial allocated 36 perimenopausal women (1:1:1) to static, dynamic, or combined yoga, delivered over six weeks (two 50-minute sessions per week). Flexibility was measured with the sit-and-reach test (cm). Balance was measured with a timed beam-crossing test: participants crossed a 2.5 m wooden beam at a self-selected pace, and crossing time (s; 60-second cap) was converted to a balance score (60 – crossing time, in seconds); higher scores indicated better balance. The primary analysis was ANCOVA on post-test scores, controlling for baseline (pre-test) values.

Results. Groups were equivalent at baseline (both $p > 0.19$). After controlling for baseline scores (ANCOVA), the combined group showed significantly greater post-intervention flexibility and balance than the static group (both $p \leq 0.001$) and the dynamic group (flexibility, $p = 0.007$; balance, $p < 0.001$). No significant difference was observed between static and dynamic yoga for either outcome (flexibility, $p = 0.34$; balance, $p > 0.99$; Bonferroni-adjusted); given the small per-group sample ($n = 12$), the study was underpowered to detect this contrast, and equivalence should not be inferred.

Conclusions. Combined static-dynamic yoga produced greater gains in flexibility and balance than either modality alone in perimenopausal women. These findings suggest that combined yoga programs are a promising non-pharmacological option for community-based physical activity strategies in this population; effects on fall incidence and quality of life were not directly assessed and warrant dedicated future study.

Keywords: menopause transition, women's health, quality of life, physical function.

Introduction

Perimenopause is a period of hormonal fluctuation associated with declines in musculoskeletal flexibility and postural balance, which increase fall risk and reduce quality of life (Iwanowicz-Palus et al., 2019). Because

these declines are potentially modifiable, physical activity interventions delivered during this transition may help preserve functional capacity and independence (Martin-Key et al., 2023). Establishing which forms of exercise most effectively improve flexibility and balance in this population is therefore a clinically relevant problem, not only a general wellness question.

Yoga is a low-cost, accessible intervention with reported benefits for flexibility and postural stability across age groups (Gothe & McAuley, 2016; Krejčí et al., 2022). Static

asanas rely on sustained postural holds thought to lengthen muscle-tendon units and reinforce isometric postural control, whereas dynamic asanas use continuous, flowing movement thought to train coordination and dynamic balance through repeated joint excursions (Mancapara, 2020). Because these two modalities plausibly act through different mechanisms, combining them has been proposed to produce complementary, additive benefits (Khajuria et al., 2023). However, existing studies have generally tested a single yoga modality against a non-yoga control or no intervention, rather than comparing static, dynamic, and combined regimens against one another (Cramer et al., 2012; Wang et al., 2020).

Consequently, it remains unclear whether combining static and dynamic elements yields greater gains in flexibility and balance than either modality practiced alone, or whether the two modalities are functionally interchangeable. This question is particularly unresolved in perimenopausal women, for whom evidence directly comparing yoga modalities is limited (Huang et al., 2025; Shete et al., 2026), despite this population's elevated fall risk and clear rationale for targeted intervention.

Therefore, this study aimed to directly compare the effects of static, dynamic, and combined yoga on flexibility and balance in perimenopausal women. We hypothesized that the combined program would produce greater improvements in both outcomes than either single-modality program, reflecting the additive engagement of complementary static and dynamic mechanisms, while static and dynamic yoga alone would produce comparable gains.

Materials and Methods

Participants

This study used a three-group parallel-group randomized controlled trial (1:1:1 allocation) to compare the effects of static, dynamic, and combined yoga on flexibility and balance in women undergoing the perimenopausal transition. Thirty-six healthy women aged 40 to 50 years in the perimenopausal phase were recruited. Perimenopausal status was determined by self-reported menstrual history, defined as menstrual cycle irregularity (variation in cycle length of more than 7 days or at least one skipped period) within the preceding 12 months, in the absence of hysterectomy, oophorectomy, or current use of hormone replacement therapy; hormonal assays (e.g., follicle-stimulating hormone) were not performed. Eligible participants met the following criteria: aged 40-50 years, in the perimenopausal phase, and free from musculoskeletal injury or other medical conditions that would contraindicate exercise; women with such conditions were excluded. Eligible women were screened and enrolled, then randomly allocated to one of the three groups (n= 12 each) using block randomization to ensure equal group sizes. The random allocation sequence was computer-generated using Microsoft Excel by a research assistant who was not involved in outcome assessment, using a block size of 6, with each block comprising two allocations to each of the three groups; the sequence of allocation within each block was generated using Microsoft Excel's RAND() function and was not altered after generation. Allocation was concealed using sequentially numbered, sealed opaque envelopes until

participants were assigned to the intervention groups. Due to the nature of the intervention, participants and instructors could not be blinded. However, the outcome assessor was blinded to group allocation. Baseline demographic characteristics were comparable between groups (see Results, Table 2). The study protocol was approved by the STIKES Guna Bangsa Health Research Ethics Committee (Approval Number: 026/KEPK/VI/2026) and conducted in accordance with the Declaration of Helsinki and is reported in line with the CONSORT guidelines (Figure 1).

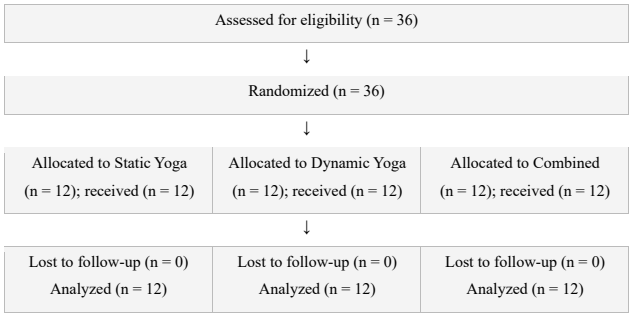


Fig. 1. CONSORT 2010 participant flow diagram.

Study Organization

The yoga intervention lasted for six weeks with two sessions per week, each lasting 50 minutes. Following baseline assessments, the six-week yoga intervention was administered. Each group underwent a different type of yoga intervention: the static yoga group performed a sequence of asanas with static movements (poses held) according to traditional yoga principles, the dynamic yoga group practiced asanas in a flowing sequence of movements, and the third group received a combined yoga regimen that alternated between static and dynamic asanas. For the static yoga group and combined yoga group postures (static part) of each asana, The hold is maintained for 10–20 seconds during weeks 1–2 and increased to 10–30 seconds from weeks 3 to 6, followed by proper breathing technique. In the case of the dynamic yoga group and the combined yoga group (dynamic part), the posture of asanas was performed continuously with a range of 3 to 10 rounds (Dynamic Group 5-10 rounds, Combined group 3-6 rounds). A round is counted when the participants perform each asana once, one after another, in a sequence. Details of the intervention programs are presented in Table 1.

In the first and second weeks, the static yoga group focused on maintaining postures for extended periods, such as Vajrasana, Supta Vajrasana, and Tadasana, and other mentioned asanas aimed at enhancing flexibility and body balance by elongating muscles and stabilizing posture, while the dybamic yoga group performed, the same asanas in a continuous manner without holding the postures. The continuous lengthening and shortening of muscles attached to various joints focussed on improving blood circulation, body strength, agility, and balance. The combined yoga group included both static and dynamic elements, performing asanas like Vajrasana, Supta Vajrasana, and Trikonasana, which mixed static and dynamic movements to improve balance and flexibility. In the third and fourth weeks, the

Table 1. 6-week yoga programs for perimenopausal women

Week	Part of training	Core Movement Types per Group		
		Static Yoga	Dynamic Yoga	Combined Yoga
1 – 2	Warming up: 10 min	Stretching and bending exercises (Toe bending, Ankle bending, Wrist stretching, Finger stretching, Elbow stretching).	Stretching and bending exercises (Toe bending, Ankle bending, Wrist stretching, Finger stretching, Elbow stretching).	Stretching and bending exercises (Toe bending, Ankle bending, Wrist stretching, Finger stretching, Elbow stretching).
	Main Part: 30 – 40 min	Sitting: Vajrasana, Supta Vajrasana, Pascimottanasana Standing: Tadasana, Trikonasana, Parshvakonasana Lying on back: Pavanamuktasana, Padottanasana Round= 1-3 times Holding time=10-20 sec. in each asana*	Sitting: Vajrasana, Supta Vajrasana, Pascimottanasana Standing: Tadasana, Trikonasana, Parshvakonasana Lying on back: Pavanamuktasana, Padottanasana Round = 5-10 times * Holding time=Nil (continuously)	Sitting: Vajrasana, Supta Vajrasana, Pascimottanasana Standing: Tadasana, Trikonasana, Parshvakonasana Lying on back: Pavanamuktasana, Padottanasana For Static part Round= Once Holding time= 10-20 sec. in each asana* + For Dynamic part Round= 3-6 times* Holding time= Nil (continuously)
	Cooling down: 5 – 6 min	Loosening & Sabasana	Loosening & Sabasana	Loosening & Sabasana
3 – 4	Warming up: 10 min	Stretching and bending exercises (Toe bending, Ankle bending, Wrist stretching, Finger stretching, Elbow stretching).	Stretching and bending exercises (Toe bending, Ankle bending, Wrist stretching, Finger stretching, Elbow stretching).	Stretching and bending exercises (Toe bending, Ankle bending, Wrist stretching, Finger stretching, Elbow stretching).
	Main Part: 30 – 40 min	Sitting: Janusirsasana, Upavistakonasana Standing: Tadasana, Poorvatanasana Lying on back: Pavanamuktasana, Padottanasana Round = 1-3 times* Holding time=10-30 sec. in each asana*	Sitting: Janusirsasana, Upavistakonasana Standing: Tadasana, Poorvatanasana Lying on back: Pavanamuktasana, Padottanasana Repetition 5-10* times Holding time= Nil (continuously)	Sitting: Janusirsasana, Upavistakonasana Standing: Tadasana, Poorvatanasana Lying on back: Pavanamuktasana, Padottanasana For Static part Round= Once Holding time= 10-30 sec. in each asana* + For Dynamic part Round = 3-6 times* Holding time= Nil (continuously)
	Cooling down: 5 – 6 min	Loosening & Sabasana	Loosening & Sabasana	Loosening & Sabasana
5 – 6	Warming up: 10 min	Stretching and bending exercises (Toe bending, Ankle bending, Wrist stretching, Finger stretching, Elbow stretching).	Stretching and bending exercises (Toe bending, Ankle bending, Wrist stretching, Finger stretching, Elbow stretching).	Stretching and bending exercises (Toe bending, Ankle bending, Wrist stretching, Finger stretching, Elbow stretching).
	Main Part: 30 – 40 min	Sitting: Baddhakonasana, Ashvinimudra Standing: Tadasana, Parshvakonasana Lying on stomach: Bhujangasana, Shalabhasana Round= 1-3 times* Holding time=10-30 sec. in each asana*	Sitting: Baddhakonasana, Ashvinimudra Standing: Tadasana, Parshvakonasana Lying on stomach: Bhujangasana, Shalabhasana Round = 5-10* times Holding time= Nil (continuously)	Sitting: Baddhakonasana, Ashvinimudra Standing: Tadasana, Parshvakonasana Lying on stomach: Bhujangasana, Shalabhasana For Static part Round= Once Holding time=10-30 sec. in each asana* + For Dynamic part Rounds = 3-6 times* Holding time= Nil (continuously)
	Cooling down: 5 – 6 min	Loosening & Sabasana	Loosening & Sabasana	Loosening & Sabasana

Note. *- Repetition as per the individual capacity of the participants.

static yoga group practiced asanas such as Janusirsasana and Poorvatanasana, which aimed to further improve flexibility. The dynamic yoga group, meanwhile, concentrated on performing the same asanas in a continuous manner with 5-10 rounds. During this time, the combined yoga group alternated between static and dynamic elements, using asanas such as Janusirsasana, Upavistakonasana, and Poorvatanasana to improve the body's overall flexibility and strength. In the fifth and sixth weeks, the static yoga group focused on asanas such as Baddhakonasana and Ashvinimudra to improve flexibility, stability, and balance. Meanwhile, the dynamic yoga group performed the same asanas on an ongoing basis aimed at strengthening muscles and improving circulation. In recent weeks, the combined yoga group alternated between static and dynamic asanas, including Baddhakonasana, Ashvinimudra, Tadasana, Parshvakonasana, and Bhujangasana, to provide overall benefits to the body. The program aims to improve flexibility, strength, and balance through a structured and progressive approach (Table 1).

The total duration of each session was kept constant among the three groups (50 minutes per session, two sessions per week, for six weeks), but the internal composition of the intervention differed by design. During weeks 1-2, the static group performed eight asanas for 1-3 rounds, with each posture held for 10-20 seconds, corresponding to approximately 80-480 seconds of cumulative static holding per session. The dynamic group performed the same eight asanas continuously for 5-10 rounds, corresponding to approximately 40-80 repetitions per session. The combined group performed the eight asanas once as a static component, corresponding to approximately 80-160 seconds of cumulative static holding, and 3-6 rounds as a dynamic component, corresponding to approximately 24-48 repetitions per session. During weeks 3-6, the programmes comprised six asanas. The static group performed 1-3 rounds with 10-30-second holds, corresponding to approximately 60-540 seconds of cumulative static holding per session, whereas the dynamic group performed 5-10 rounds, corresponding to approximately 30-60 repetitions per session. The combined group performed one static round, corresponding to approximately 60-180 seconds of cumulative static holding, plus 3-6 dynamic rounds, corresponding to approximately 18-36 repetitions per session. These ranges represent the prescribed intervention protocol rather than an exact delivered dose, because the number of rounds and repetitions was adjusted according to individual participant capacity. Thus, although session duration and frequency were standardized, the three programmes were not matched for absolute static holding time or dynamic repetition volume. The greater improvements observed in the combined group therefore cannot be interpreted as evidence of an additive effect attributable solely to combining static and dynamic modalities. This dose asymmetry is recognized as a limitation when interpreting the comparative effects of the three programmes.

Furthermore, each participant underwent their physical measurements, focusing on two outcomes: flexibility and balance. Measurements were taken at two time points: pre-test (basic, before week 1) and post-test (after the last session in week 6). Flexibility was measured using a sitting and reach test following the standard protocol of the YMCA (Golding

et al., 1982). Participants sat with their feet straight and heels aligned 5 cm from the zero point of the scoreboard, then reached forward as far as possible without bending the knees. Each participant completed two trials, and a higher value (cm) was recorded. Balance was assessed using a time-crossing test on a wooden block (2.5 m long, 20 cm high, 10 cm wide). Participants start with a standing position at one end of the block and are instructed to walk along the full block at a self-selected speed without stepping down; The trial is stopped, and a maximum time of 60 seconds is recorded if the participant steps down from the block before reaching the far end. Each participant completed two trials with a previous familiarization trial to reduce the learning effect (Muehlbauer et al., 2024); the faster (shorter) crossing time of the two trials was maintained as the main variable recorded, in seconds. For reporting and analysis, these crossing times were converted into balance scores using the formula: $\text{score} = 60 - \text{crossing time (in seconds)}$, so that higher scores reflect faster and more stable crossings; the transformed balance score (in seconds) was the one reported in all tables. All measurements were taken by the same trained and outcome-blind raters at both time points to minimize variation between raters. All 36 participants completed the six-week intervention with no exit (0% attrition) and no adverse events were reported. Overall participant attendance was excellent, with a mean of 11.97 out of 12 scheduled sessions attended (SD = 0.17; 99.8%): Static group = 12 ± 0.0 , Dynamic group = 12.0 ± 0.0 , Combined group = 11.9 ± 0.3 sessions. One participant in the combined group missed one session due to work commitments; all other participants attended each session.

Statistical Analysis

All analyses were conducted in IBM SPSS Statistics version 29. Descriptive statistics (mean $\pm$ SD with 95% confidence intervals based on the t-distribution) were computed for each group. Normality was assessed with the Shapiro-Wilk test and homogeneity of variance with Levene's test on the change (post - pre) scores; both assumptions were satisfied for all outcomes (Table 4). Baseline equivalence among groups was examined with one-way ANOVA on pre-test scores. Because the primary research question concerns between-group differences in post-intervention outcomes after accounting for any residual baseline variation, the primary analysis was analysis of covariance (ANCOVA) on post-test scores, with group as the fixed factor and pre-test score as the covariate; significant omnibus effects were followed by pairwise contrasts of adjusted means with Bonferroni correction for three comparisons. Assumptions specific to the ANCOVA model were assessed directly, including homogeneity of regressions slopes (Group $\times$ baseline-covariate interaction) and diagnostics of the model residuals (normality, homogeneity of variance, independence via the Durbin-Watson statistic, and influential-case screening via studentized residuals and Cook's distance). Because baseline demographic comparisons revealed a significant between-group difference in age, a sensitivity ANCOVA additionally adjusting for age was conducted for both outcomes. As a secondary, sensitivity analysis, within-group pre to post changes were also tested with paired sample t-tests (effect sizes expressed as Cohen's d with 95% confidence intervals),

and between-group differences in the magnitude of change were evaluated with one-way ANOVA on change scores followed by Tukey's HSD post hoc comparisons, to confirm that conclusions were not dependent on the choice of model. As a further robustness check, the non-parametric Kruskal-Wallis test was performed on the change scores. Statistical significance was set at $p < 0.05$.

Results

Table 2. General Characteristics of participants

Variable	N = 36		
	Static (n = 12)	Dynamic (n = 12)	Combined (n = 12)
Age, years	49.33 ± 0.88	49.58 ± 0.67	48.08 ± 1.56
Body weight, kg	56.75 ± 14.68	56.83 ± 5.31	52.33 ± 8.95
Height, cm	149.67 ± 3.31	147.58 ± 4.91	151.92 ± 8.25
BMI, kg/m ²	25.38 ± 6.69	26.15 ± 2.72	22.71 ± 3.73

Baseline demographic characteristics are summarized in Table 2. One-way ANOVAs comparing the three groups revealed a statistically significant difference in age, $F_{(2,33)} = 6.12$, $p = 0.006$; Tukey-adjusted post hoc comparisons showed the Combined group (48.08 ± 1.56 years) was significantly younger than both the Static group (49.33 ± 0.88 years; $p = 0.028$) and the Dynamic group (49.58 ± 0.67 years; $p = 0.006$), while Static and Dynamic did not differ ($p = 0.780$). Not other baseline demographic variable differed significantly between group: body weight, $F_{(2,33)} = 0.59$, $p = 0.560$; height, $F_{(2,33)} = 1.80$, $p = 0.180$; BMI, $F_{(2,33)} = 1.53$, $p = 0.230$. No Statistically significant baseline differences were observed for the primary outcomes, flexibility ($F_{(2,33)} = 1.71$, $p = 0.197$, $\eta^2 = 0.094$) or balance ($F_{(2,33)} = 1.23$, $p = 0.305$, $\eta^2 = 0.069$). Because age differed significantly between groups despite randomization, a sensitivity ANCOVA including both the baseline outcome value and age as covariates was conducted for the primary outcomes (see Results, following Table 5) to assess whether this imbalance confounded the intervention effect.

Table 3. Flexibility and balance before and after the intervention

Outcome	Group (n = 12)	Pre, Mean ± SD (95% CI)	Post, Mean ± SD (95% CI)
Flexibility (cm)	Static Yoga	20.95 ± 1.65 (19.90–22.00)	22.74 ± 1.70 (21.66–23.83)
	Dynamic Yoga	20.27 ± 1.31 (19.43–21.10)	22.47 ± 1.26 (21.66–23.27)
	Combined	19.77 ± 1.72 (18.67–20.86)	22.73 ± 1.67 (21.67–23.79)
Balance (s)	Static Yoga	19.73 ± 1.39 (18.85–20.62)	21.81 ± 0.99 (21.17–22.44)
	Dynamic Yoga	20.48 ± 1.52 (19.51–21.44)	22.32 ± 1.32 (21.48–23.15)
	Combined	19.61 ± 1.48 (18.67–20.55)	22.89 ± 1.38 (22.02–23.77)

Note: Values are mean ± SD (95% CI); CI, confidence interval; SD, standard deviation.

As shown in Table 3, mean flexibility and balance increased from pre-test to post-test in all three intervention groups. The largest mean increase was observed in the combination group for both flexibility (from 19.77 to 22.73 cm) and balance (from 19.61 to 22.89 s).

Table 4. Tests of normality and homogeneity of variance

Outcome	Group	Shapiro–Wilk, W (p)	Levene's F (p)
Flexibility (cm)	Static	0.911 (0.220)	2.289 (0.117)
	Dynamic	0.950 (0.631)	–
	Combined	0.911 (0.223)	–
Balance (s)	Static	0.965 (0.857)	2.366 (0.110)
	Dynamic	0.897 (0.144)	–
	Combined	0.891 (0.120)	–

Note: W, Shapiro–Wilk statistic; F, Levene's test statistic.

Before the primary ANCOVA, the assumptions for parametric analysis were assessed using the Shapiro–Wilk test for normality and Levene's test for homogeneity of variances (Table 4). No significant departures from normality were observed for flexibility or balance in any intervention group (all $p > 0.05$). Levene's test also indicated homogeneous variances for flexibility ($p = 0.117$) and balance ($p = 0.110$). In addition to these preliminary checks, the assumptions specific to the ANCOVA model itself were assessed directly (Table 5): the homogeneity of regression slopes assumption was tested via the Group × baseline covariate interaction and was not significant for either outcome (flexibility: $F_{(2,29)} = 0.745$, $p = 0.484$; balance: $F_{(2,29)} = 0.362$, $p = 0.699$), supporting the standard common slope ANCOVA model. residual of the primary ANCOVA models were normally distributed (Shapiro–Wilk: flexibility $W = 0.963$, $p = 0.268$; balance $W = 0.952$, $p = 0.116$) and homoscedastic (Levene's test: flexibility $F = 1.83$, $p = 0.176$; balance $F = 2.01$, $p = 0.151$), with no evidence of autocorrelation (Durbin–Watson: flexibility $d = 1.98$; balance $d = 2.04$, both within the acceptable range of 1.5 – 2.5) and no influential cases (all studentized residuals < 3.0 and Cook's distances < 1.0). These findings supported the use of the planned parametric ANCOVA.

Table 5. Diagnostic assessment of the primary ANCOVA model assumptions

Diagnostic	Flexibility	Balance
Group × baseline interaction	$F_{(2,29)} = 0.745$, $p = .484$	$F_{(2,29)} = 0.362$, $p = .699$
Shapiro–Wilk	$W = 0.963$, $p = .268$	$W = 0.952$, $p = .116$
Levene's test	$F = 1.83$, $p = .176$	$F = 2.01$, $p = .151$
Durbin–Watson	$d = 1.98$	$d = 2.04$
Influential observations	None	None

Note: Durbin–Watson values of 1.5–2.5 were considered acceptable; influential observations were assessed using studentized residuals and Cook's D.

After adjustment for pre-intervention values, significant between-group differences were observed for flexibility

Table 6. ANCOVA results for flexibility and balance adjusted for baseline

Outcome	F	df	p	Group (Mean ± SE)			Partial η^2
				Static	Dynamic	Combined	
Flexibility (cm)	11.807	2,32	<0.001	22.16 ± 0.16	22.52 ± 0.16	23.26 ± 0.16	0.425
Balance (s)	13.188	2,32	<0.001	21.96 ± 0.19	21.93 ± 0.19	23.13 ± 0.19	0.452

Note: Values are adjusted means ± SE; SE, standard error.

($F(2,32) = 11.807$, $p < 0.001$, partial $\eta^2 = 0.425$) and balance ($F(2,32) = 13.188$, $p < 0.001$, partial $\eta^2 = 0.452$). The combination group had the highest adjusted mean for flexibility (23.26 cm) and balance (23.13 s), followed by the dynamic and static groups for flexibility, while the adjusted means of the static and dynamic groups were similar for balance (Table 6).

Table 7. Sensitivity ANCOVA for flexibility and balance adjusting for baseline value and age

Outcome	F (Group, adjusted for baseline + age)	df	p	Partial η^2
Flexibility (cm)	10.21	2, 31	< 0.001	0.398
Balance (s)	11.58	2, 31	< 0.001	0.428

Furthermore, because age differed significantly between groups at baseline (see Table 2), a sensitivity ANCOVA was conducted for both outcomes with baseline (pre - test) outcome value and age entered as covariates, to evaluate whether the observed group effect was confounded by this imbalance. The primary ANCOVA model (baseline outcome value only) remains the model on which our main conclusions are based, consistent with the pre - specified hypothesis concerning the effect of the intervention independent of baseline performance; age is examined here as a robustness check for potential confounding. The group effect on post - intervention scores remained significant and of comparable magnitude after adjusting for age: flexibility $F_{(2,31)} = 10.21$, $p < 0.001$, partial $\eta^2 = 0.398$; balance $F_{(2,31)} = 11.58$, $p < 0.001$, partial $\eta^2 = 0.428$. This indicates that the observed advantage of the Combined programme is not attributable to the baseline age imbalance (Table 7).

Bonferroni-adjusted pairwise comparisons are presented in Table 8. For flexibility, the combination group had a significantly higher adjusted mean than the static group (mean difference = -1.095 cm, $p < 0.001$) and the dynamic group (mean difference = -0.733 cm, $p = 0.007$). No significant difference was observed between the static and dynamic groups (mean difference = -0.362 cm,

$p = 0.344$). For balance, the combination group also had a significantly higher adjusted mean than the static group (mean difference = -1.174 s, $p < 0.001$) and the dynamic group (mean difference = -1.206 s, $p < 0.001$). The static and dynamic groups did not differ significantly (mean difference = 0.032 s, $p > 0.999$).

Table 9. Changes in flexibility and balance and effect sizes

Outcome	Group	Mean $\Delta \pm$ SD	p	Cohen's d (95% CI)
Flexibility (cm)	Static	1.79 ± 0.38	<0.001	4.68 (2.49–6.88)
	Dynamic	2.20 ± 0.58	<0.001	3.77 (1.96–5.58)
	Combined	2.97 ± 0.62	<0.001	4.76 (2.53–7.00)
Balance (s)	Static	2.08 ± 0.60	<0.001	3.47 (1.78–5.15)
	Dynamic	1.84 ± 0.63	<0.001	2.92 (1.46–4.38)
	Combined	3.28 ± 0.97	<0.001	3.40 (1.74–5.05)

Note: Δ , post-test – pre-test; SD, standard deviation; CI, confidence interval.

Within-group changes are shown in Table 9. All three intervention groups demonstrated significant pre- to post-intervention increases in flexibility and balance (all $p < 0.001$). The combination group showed the largest mean change in flexibility ($\Delta = 2.97$ cm) and balance ($\Delta = 3.28$ s). Cohen's d values were large across all within-group comparisons, ranging from 2.92 to 4.76.

Table 10. Between-group differences in change

Outcome	F	df	p	η^2 (95% CI)
Flexibility (Δ , cm)	14.655	2,33	<0.001	0.470 (0.189–0.620)
Balance (Δ , s)	12.757	2,33	<0.001	0.436 (0.155–0.594)

Note: Δ , post-test – pre-test; η^2 , eta-squared; CI, confidence interval.

As a sensitivity analysis, one-way ANOVA of change scores (Table 10) confirmed significant between-group

Table 8. Bonferroni-adjusted pairwise comparisons between intervention groups

Outcome	Comparison	Mean difference	SE	t	df	p (adjusted)
Flexibility (cm)	Static vs Combined	-1.095	0.230	-4.752	32	<0.001
	Dynamic vs Combined	-0.733	0.221	-3.310	32	0.007
	Static vs Dynamic	-0.362	0.223	-1.622	32	0.344
Balance (s)	Static vs Combined	-1.174	0.264	-4.445	32	<0.001
	Dynamic vs Combined	-1.206	0.272	-4.430	32	<0.001
	Static vs Dynamic	+0.032	0.270	0.119	32	>0.999

Note: SE, standard error; df, degrees of freedom; p (adjusted), Bonferroni-adjusted p-value.

Table 11. Tukey-adjusted pairwise comparisons of change

Outcome	Comparison	Mean difference	q	P (Tukey)	95% CI	Cohen's d
Flexibility (Δ , cm)	Static vs Dynamic	-0.41	2.62	0.169	-0.95 to 0.13	-0.756
	Static vs Combined	-1.18	7.54	<0.001	-1.72 to -0.63	-2.177
	Dynamic vs Combined	-0.77	4.92	0.004	-1.31 to -0.23	-1.420
Balance (Δ , s)	Static vs Dynamic	+0.23	1.08	0.729	-0.52 to 0.99	0.311
	Static vs Combined	-1.21	5.58	0.001	-1.96 to -0.46	-1.610
	Dynamic vs Combined	-1.44	6.65	<0.001	-2.19 to -0.69	-1.921

Note: Δ , post-test – pre-test; q, studentized range statistic; p (Tukey), Tukey-adjusted p-value; CI, confidence interval.

differences for flexibility ($F_{(2,33)} = 14.655, p < 0.001, \eta^2 = 0.470$) and balance ($F_{(2,33)} = 12.757, p < 0.001, \eta^2 = 0.436$). These findings were consistent with the primary ANCOVA.

The Tukey-adjusted comparison (Table 11) also showed that the combination group showed greater changes in flexibility than the static group ($p < 0.001$) and the dynamic group ($p = 0.004$). For equilibrium, the combination group also showed a greater change than the static group ($p = 0.001$) and the dynamic group ($p < 0.001$). No significant difference was found between the static and dynamic groups for flexibility ($p = 0.169$) or balance ($p = 0.729$).

Table 12. Kruskal–Wallis sensitivity analysis of change

Outcome	H	df	p
Flexibility (Δ , cm)	17.713	2	<0.001
Balance (Δ , s)	11.349	2	0.003

Note: Δ , post-test – pre-test; H, Kruskal–Wallis test statistic.

The non-parametric sensitivity analysis yielded consistent omnibus findings (Table 12), with significant between-group differences for flexibility ($H = 17.713, df = 2, p < 0.001$) and balance ($H = 11.349, df = 2, p = 0.003$).

Discussion

This randomized controlled trial evaluated the effects of static, dynamic, and combined yoga regimens on flexibility and balance in perimenopausal women. Participants who completed the combined protocol achieved greater improvements in both outcomes compared to those practicing only static or dynamic yoga, likely reflecting broader muscle recruitment and concurrent improvements in joint range of motion. These results align with evidence reported by (Luo & Huang, 2023); yoga interventions have demonstrated positive effects on physical parameters such as flexibility and balance, as well as on the overall psychological wellbeing and hormonal balance of perimenopausal women (Cramer et al., 2012; Naragatti, 2025), support the use of combined yoga as a viable and effective modality.

An important observation is the absence of a statistically significant difference between the static and dynamic yoga groups for both outcomes (ANCOVA, Bonferroni adjusted: flexibility $p = 0.344$; balance $p > 0.999$; consistent with change score sensitivity analyses: flexibility $p = 0.169$; balance $p = 0.729$). Since both modalities employed identical asana sequences and differed primarily in execution (sustained holds versus continuous flow), the underlying neuromuscular

stimuli may be functionally equivalent consistent with findings by (Matsuo et al., 2019), who observed no difference between static and dynamic stretching of equal total duration. Furthermore, the six week, twice weekly frequency may have been insufficient to elicit modality specific adaptations; (Shin, 2021) reported that yoga programs lasting 9–12 weeks yielded larger effect sizes ($RS = 0.70$) compared to those lasting less than eight weeks ($ES = 0.54$). With only 12 participants per group and observed power below 50% for both comparisons (see limitations), the study was likely underpowered to detect the observed static versus dynamic differences ($d = -0.756$ for flexibility, $d = 0.311$ for balance); this lack of significant difference should not be interpreted as evidence of equivalence between the two modalities. Future, larger, and longer duration trials are needed to clarify these modalities are truly comparable or subtly different.

Middle-aged women who enter perimenopause often experience physical decline that directly interferes with health-related quality of life (Iwanowicz-Palus et al., 2019; Liu et al., 2025; Liu et al., 2023), making non-pharmacological interventions valuable. A randomized trial conducted by (Abiç & Yilmaz Vefikuluçay, 2024) found that a twice-weekly, ten-week yoga programme significant reduced Menopause Assessment Scale (MRS) symptom severity score from 16 to 5, with a $p < 0.05$. Consistent yoga practice has also been linked to improved psychological health, quality of life, and daily physical functioning (Bandyopadhyay et al., 2025). Programs that combine static and dynamic postures have been shown to improve joint flexibility and mobility (Ikeda et al., 2026; Warneke et al., 2025) and a structured curriculum specifically improves torso flexibility, thereby maintaining mobility, reducing the risk of falls, and supporting general physical performance (Bindawas et al., 2026; Zhong et al., 2024).

Greater balance improvement in the combination group compared to the static yoga and dynamic yoga groups suggests that the combination of both forms of exercise provides a more optimal stimulus for posture control. This is important in perimenopausal women because hormonal changes and decreased bone mineral density during the menopausal transition period increase the risk of balance disorders, falls, and fractures (Starrach et al., 2022). Therefore, interventions that are able to improve postural stability have an important role in maintaining physical function in this group (Wei et al., 2023). Yoga may improve postural stability through enhanced proprioception, muscle strengthening and vestibular-visual integrating (Jeter, Haaz Moonaz, et al., 2015; Lin et al., 2022; Verma et al., 2023). The integration of asanas, breathing techniques, and meditation

may provide complementary stimuli for flexibility, muscle strength, posture control, and neuromuscular coordination. This is consistent with (Harrington, 2025) and a meta-analysis by (Shin, 2021), which report that yoga practice consistently improves balance, mobility, muscle strength, and flexibility as key components of physical function.

Although combined yoga's superiority is broadly consistent with existing literature, some discrepancies warrant discussion. (Petty et al., 2022) similarly found no significant differences between static and dynamic yoga six weeks, but in young adults (mean age $\approx$ 20 years) with different baseline neuromuscular characteristics and hormonal profiles from perimenopausal women, limiting direct comparability. Conversely, (Bhowmik Bhunia & Ray, 2024) reported continued gains through 12-week in young males, though improvements slowed once training shifted from asana-dominant to breathing-focused sessions, suggesting a non-linear dose-response relationship. Furthermore, (Abiç & Yilmaz Vefikuluçay, 2024) similarly found greater symptom reduction with a 10-week yoga programme in menopausal women. Together, these findings indicate that yoga's effects depend on population characteristics, intervention duration, session frequency, and the specific balance of static, dynamic, and breathing components within the programme.

These findings have practical implications for practitioners and policymakers. Given the advantages of combined protocols regarding flexibility and measurable balance, clinicians should consider integrated programs that incorporate both static and dynamic postures, aligning with World Health Organization (WHO) guidelines that recommend multicomponent balance, strength, and flexibility exercises at least three days a week for older adults (WHO, 2020). Since Flexibility and balance are closely linked to fall risk, combined yoga exercises could serve as a promising, low-cost, non-pharmacological addition to community-based fitness programs; however, as the incidence of falls was not directly measured in this study, the potential for fall prevention remains an implication for future research rather than an empirically proven outcome. Single modality programs remain a viable option if implementing combined exercises is not feasible.

This study is limited by its modest sample size ($n = 12$ per group) and short duration, which may not have fully captured physiological adaptations. A post hoc sensitivity analysis indicated that, at this sample size, statistical power to detect the observed static-versus-dynamic contrasts was low (approximately 43% for flexibility, $d = 0.76$; approximately 11% for balance, $d = 0.31$); detecting these effect sizes at 80% power would require approximately 29 and 164 participants per group, respectively. The non-significant static-versus-dynamic comparisons should therefore be interpreted as inconclusive rather than as evidence that the two modalities are equivalent. In addition, the three programs were not matched for absolute training dose (see Intervention dose, above), lower-extremity and core muscle strength and neurophysiological indicators of sensorimotor control were not assessed, and fall incidence and quality-of-life outcomes were not directly measured. Future research should incorporate a priori power calculations, dose-matched comparison arms, direct neuromuscular and fall-incidence measures, and longer follow-up with larger samples.

Conclusions

Perimenopausal women who participated in a combination of static and dynamic yoga for six weeks showed greater improvements in measured flexibility and balance than those who participated in static or dynamic yoga separately, after accounting for baseline differences. These findings represent an initial step toward developing exercise strategies to maintain physical function during the perimenopausal transition; because fall incidence and quality of life were not directly assessed, their relationship to these outcomes should be examined in future studies before combined yoga is recommended specifically as a fall-prevention intervention.

Ethics Approval

The study protocol was approved by the STIKES Guna Bangsa Health Research Ethics Committee (Approval Number: 026/KEPK/VI/2026) and conducted in accordance with the principles of the Declaration of Helsinki.

Informed Consent

Written informed consent was obtained from all participants prior to enrollment. Participants were informed about the study procedures, potential risks and benefits, and their right to withdraw at any time without penalty before providing written consent.

Data Availability Statement

The datasets generated and analysed during the current study are not publicly available due to ethical and privacy restrictions protecting participant confidentiality but are available from the corresponding author upon reasonable request and with approval from the STIKES Guna Bangsa Health Research Ethics Committee.

AI Transparency Statement

The author used AI-assisted tools for language editing only during manuscript preparation. All scientific content, data analysis, and conclusions are the authors' original work. The authors take full responsibility for all content.

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Conflicts of Interest

No conflicts of interest are present to disclose.

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Статичні та динамічні асани йоги порівняно з комбінованою йогою: що є ефективнішим для покращення гнучкості та рівноваги у жінок у перименопаузі?

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 11 с., 12 табл., 1 рис., 30 джерел.

Передумови. Перименопауза часто супроводжується зниженням гнучкості та здатності підтримувати рівновагу, що підвищує ризик падінь і знижує якість життя. Як статична, так і динамічна йога пов'язані з покращенням гнучкості та постуральної стійкості, однак досліджень, у яких безпосередньо порівнювали б статичну, динамічну та комбіновану йогу з метою визначення найбільш ефективного підходу для покращення цих показників у жінок у перименопаузі, раніше не проводили.

Мета. Оцінити вплив статичної, динамічної та комбінованої практики йоги на гнучкість і рівновагу у жінок у перименопаузі.

Матеріали та методи. У тригруповому рандомізованому контрольованому дослідженні 36 жінок у перименопаузі були розподілені у співвідношенні 1:1:1 до груп статичної, динамічної або комбінованої йоги. Програма тривала шість тижнів і передбачала два 50-хвилинні заняття на тиждень. Гнучкість оцінювали за допомогою тесту «нахил уперед сидячи» (см). Рівновагу визначали за результатами тесту проходження по гімнастичній лаві з реєстрацією часу: учасниці долали дерев'яну опору завдовжки 2,5 м у самостійно обраному темпі, а час проходження (с; максимальний час — 60 с) перераховували у показник рівноваги за формулою $60 - \text{час проходження (с)}$; вищі значення відповідали кращій рівновазі. Основний аналіз проводили за допомогою ANCOVA для показників після завершення втручання з контролем вихідних значень до початку дослідження.

Результати. На початковому етапі групи не відрізнялися за досліджуваними показниками (в обох випадках $p > 0,19$). Після контролю вихідних значень за допомогою ANCOVA комбінована йога забезпечила статистично значуще кращі післяекспериментальні показники гнучкості та рівноваги порівняно зі статичною йогою (в обох випадках $p \leq 0,001$) і динамічною йогою (гнучкість: $p = 0,007$; рівновага: $p < 0,001$). Статистично значущих відмінностей між статичною та динамічною йогою не виявлено ані за показником гнучкості ($p = 0,34$), ані за показником рівноваги ($p > 0,99$; з поправкою Бонферроні). Водночас через невелику чисельність кожної групи ($n = 12$) статистична потужність дослідження була недостатньою для надійного виявлення відмінностей між цими двома видами йоги, тому робити висновок про їх еквівалентність не можна.

Висновки. Комбінована статично-динамічна йога забезпечила більш виражене покращення гнучкості та рівноваги у жінок у перименопаузі порівняно із застосуванням кожного з цих видів йоги окремо. Отримані результати свідчать, що комбіновані програми йоги можуть бути перспективним немедикаментозним засобом у межах програм фізичної активності на рівні громади для цієї популяції. Водночас вплив таких програм на частоту падінь і якість життя безпосередньо не оцінювали, що потребує окремого вивчення у подальших дослідженнях.

Ключові слова: перехід до менопаузи, здоров'я жінок, якість життя, фізичне функціонування.

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