Research Article

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Effects of Barre Fitness Training on Handgrip Strength and Leg Press Performance in Physically Inactive Perimenopausal Women: A Randomized Controlled Trial

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Abstract

Perimenopause is accompanied by hormonal fluctuations that accelerate loss of muscle strength and unfavorable changes in body composition, increasing susceptibility to musculoskeletal vulnerability and functional impairment. Barre fitness combines low-to-moderate impact resistance exercises, ballet conditioning, and isometric holds. This study aimed to investigate the effects of an 8-week structured Barre fitness intervention on body mass index (BMI), handgrip strength, and lower-body isometric strength in physically inactive perimenopausal women. In this parallel-group randomized controlled trial, 55 inactive perimenopausal women (aged 38–53 years) were randomly assigned to an experimental group (EG, n = 33; 8-week supervised Barre fitness, 3 sessions/week, 24 total sessions) or a control group (CG, n = 22; maintained usual daily activities). Primary outcomes assessed pre- and post-intervention included BMI, maximal dominant and non-dominant handgrip strength, and isometric leg press performance. Statistical evaluation comprised independent and paired-samples t-tests and univariate analysis of variance (ANOVA). Following 8 weeks, the EG demonstrated significant within-group strength gains in dominant handgrip (26.16 ± 4.65 to 29.66 ± 2.99 kg, $p < 0.001$), non-dominant handgrip (24.86 ± 4.04 to 27.09 ± 3.04 kg, $p = 0.014$), and leg press performance (18.30 ± 3.73 to 21.09 ± 5.90 kg, $p = 0.020$). In contrast, the CG exhibited no significant within-group changes ($p > 0.05$). Post-test between-group comparisons revealed significantly higher strength values in EG compared to CG for dominant handgrip and non-dominant handgrip ($p < 0.001$), and leg press performance ($p = 0.028$). The reported ANOVA indicated significant main group effects for dominant handgrip, $F = 6.08$, $p = 0.017$, non-dominant handgrip, $F= 5.80$, $p = 0.020$, and leg press, $F= 5.19$, $p = 0.027$. No statistically significant between-group effect was observed for BMI ($p = 0.72$). An 8-week supervised Barre fitness program was associated with improvements in upper- and lower-body muscular strength in physically inactive perimenopausal women, with no significant between-group difference in BMI. These findings suggest that Barre fitness may be a promising exercise option for improving muscular strength during the menopausal transition. Further research is needed to establish the long-term effects and clinical relevance of these improvements.

Keywords: Barre fitness; perimenopause; muscular strength; handgrip strength; leg press; body mass index; resistance training.

1. INTRODUCTION

Perimenopause is a transitional stage in a woman's life, characterized by considerable hormonal fluctuations and a gradual decline in ovarian hormone secretion that may adversely affect body composition, muscular strength, and overall functional health [1, 2]. The menopausal transition is associated with increased fat mass and reduced lean body mass, while hormonal changes may contribute to the development of sarcopenia [3]. These changes, together with increased metabolic and skeletal vulnerability during and after menopause, may affect physical function, independence, and quality of life as women age [3, 4]. Exercise is widely recognized as a key non-pharmacological strategy for mitigating age- and menopause-related declines in physical function. In particular, resistance training and other appropriately structured exercise interventions may help preserve or improve muscle performance and functional capacity in women across different reproductive stages [2, 5]. Handgrip and lower-body strength are important indicators of muscular function and have been associated with health outcomes, including all-cause mortality in women [6, 7].

Barre fitness is an exercise modality that combines ballet-inspired movements, postural control, Pilates-based principles, and targeted muscular conditioning [8, 9]. When performed with external resistance, such as dumbbells, elastic bands, and small exercise props, Barre training may provide a muscular stimulus through prolonged time under tension (TUT), repetitive pulses, and sustained isometric holds, potentially contributing to strength-related adaptations [8, 10]. Its emphasis on controlled movements and sustained muscular engagement may make it an alternative to conventional resistance-training approaches, although its effects on joint loading and musculoskeletal safety require further investigation [2, 11]. Earlier work examined the relationship between ballet barre exercises and center work in dance education [12]. This provides historical context for ballet-based movement rather than direct evidence of strength adaptations in perimenopausal women. Research specifically addressing Barre fitness has examined women in early adulthood [8], while evidence concerning muscular strength in midlife and perimenopausal women remains limited. Assessing outcomes such as handgrip strength and lower-body strength may help clarify the potential relevance of Barre training for muscular function during the menopausal transition [8, 13, 14].

Although exercise is widely recognized as an effective strategy for maintaining muscular strength and physical function during and after the menopausal transition, the effects of specific exercise modalities in physically inactive perimenopausal women remain insufficiently understood. A systematic review and meta-analysis by Khalafi et al. [15] demonstrated that exercise interventions can improve muscular strength, including handgrip and lower-body strength, in postmenopausal women. However, these findings do not establish whether similar benefits can be achieved through Barre fitness training or whether its effects extend to women in the perimenopausal stage. Parhonlakan and Masodsai [10] reported improvements in lower-limb and core muscle strength and endurance following an eight-week Barre exercise intervention in sedentary female office workers. Nevertheless, these findings cannot be directly generalized to perimenopausal women, and the effects of Barre training on handgrip strength and leg press performance in this population remain unclear. In particular, evidence from randomized controlled trials investigating the effects of Barre fitness on both upper- and lower-body muscular strength in physically inactive perimenopausal women remains limited.

Therefore, this randomized controlled trial aimed to investigate the effects of an 8-week supervised Barre fitness intervention on body mass index (BMI), dominant and non-dominant handgrip strength, and isometric leg press performance in physically inactive perimenopausal women. We hypothesized that participants assigned to the Barre fitness group (experimental group) would demonstrate greater improvements in muscular strength and more favorable changes in BMI than participants in the control group.

2. METHODS

This 8-week, parallel-group randomized controlled trial examined the effects of a structured Barre fitness intervention on body mass index (BMI), maximal handgrip strength, and lower-body isometric strength in physically inactive perimenopausal women. The study protocol adhered to the ethical principles of the Declaration of Helsinki, received formal approval from the Ethics Committee of the Faculty of Physical Education and Sport, University of Banja Luka (protocol no. 11/1.1030/24), and used as its reporting framework the Consolidated Standards of Reporting Trials (CONSORT) 2010 guidelines [16]. Participants were randomly assigned to either the experimental group (EG, n = 33) or the control group (CG, n = 22). Simple randomization was executed electronically using a computer-generated random number sequence (www.randomizer.org) prepared by an independent researcher who was completely uninvolved in participant recruitment, baseline testing, intervention delivery, or outcome evaluations.

A total of 67 perimenopausal women aged 38 to 53 years from the Banja Luka region were initially screened for eligibility. Of these, 12 women were excluded prior to allocation (7 did not meet the eligibility criteria, 3 declined to participate, and 2 were excluded for other personal reasons). Consequently, 55 eligible participants provided written informed consent and were enrolled in the study.

To be eligible for inclusion, participants were required to meet the following criteria:

(1) female sex, aged 38–53 years;

(2) perimenopausal status (classified into early or late perimenopause) determined by age and self-reported menstrual cycle irregularity (specifically cycle variability and amenorrhea duration) in alignment with the STRAW+10 framework [1] and recommended methodological standards for research on female populations [17], though objective hormonal staging was not performed;

(3) physically inactive status, defined for this study as engaging in less than 120 minutes of moderate-to-vigorous physical activity per week;

(4) naive to Barre fitness or any similar structured, group-based exercise programs; and

(5) absence of musculoskeletal injuries, severe chronic diseases (including major cardiovascular events, stroke, cancer, or severe neuromuscular disease), or medication use and contraindications that could substantially influence body composition, neuromuscular performance, or exercise tolerance.

Following baseline assessments, the 55 eligible participants were randomized into either the experimental group (EG, n = 33) or the control group (CG, n = 22). An unequal allocation ratio (1.5:1) was deliberately implemented to account for anticipated attrition in EG driven by the stringent attendance threshold required for final analysis (>95% of the 24 prescribed exercise sessions). Allocation concealment was rigorously maintained using sequentially numbered, opaque, sealed envelopes (SNOSE) prepared by an independent researcher. Envelopes were opened strictly in numerical order by the study coordinator only after a participant had completed all baseline evaluations. While blinding of participants and training instructors was not feasible due to the nature of a supervised exercise intervention, outcome assessors and data analysts were fully blinded to group assignments throughout all testing procedures and statistical analyses.

Participants assigned to EG completed a supervised Barre fitness intervention conducted three times per week for 8 weeks (a total of 24 sessions). Participants assigned to CG were instructed to maintain their usual daily activities and refrain from initiating any new structured exercise programs during the intervention period. Additionally, participants in both groups were explicitly instructed to maintain their habitual dietary intake throughout the entire study period.

All allocated participants (33 in EG and 22 in CG) completed the 8-week protocol and follow-up assessments, achieving a 100% retention rate with no dropouts or loss to follow-up (Figure 1). Attendance in the experimental group exceeded the prespecified threshold of 95% of scheduled exercise sessions. Complete datasets were available for all 55 participants; therefore, no missing data handling or imputation procedures were required.

The primary outcome measures were BMI, maximal handgrip strength, and lower-body strength assessed by leg press performance. All measurements were performed before and after the 8-week intervention under standardized conditions at the Institute of Sport, Faculty of Physical Education and Sport, University of Banja Luka.

Body mass was assessed using a TANITA BC-418MA III body composition analyzer (Tanita Corp., Tokyo, Japan), height was recorded for each participant, and BMI was calculated as body mass in kilograms divided by height in meters squared. Measurements were conducted in the morning, with participants barefoot and wearing light sports clothing. Standardized instructions regarding hydration, sleep, and dietary consistency were provided before each testing session.

Maximal isometric handgrip strength was assessed using a strain-gauge tensiometric probe (Isometrics SMS, All4Gym, Belgrade, Serbia), with force acquisition sampled at 500 Hz and analyzed using Isometrics software (version 3.1.1). Participants were tested in a seated position with the arm relaxed alongside the body and the elbow in slight flexion, according to the standardized handgrip procedure described in the study protocol and in accordance with the need for controlled testing positions highlighted in the handgrip methodology literature [18]. This methodological reference supports the need for consistent measurement conditions; it does not establish that different dynamometers or elbow positions yield interchangeable strength values. Three maximal voluntary contractions were performed for each hand, with sufficient rest between trials to minimize fatigue. The highest value obtained for the dominant and non-dominant hand was used for statistical analysis and expressed in kilograms.

Lower-body strength was assessed as maximal isometric leg press force under laboratory conditions. Testing was performed on a horizontal leg press (VGym, Nantong, China), with the platform fixed in a static position and a force dynamometer attached; data were recorded with the Globus Ergo Tesys System 1000 software. Participants lay supine on the backrest with their feet placed hip-width apart on the platform. The knee joint angle was set to 110° (180° = full knee extension) and verified with a manual goniometer before each trial. The same backrest position, body position and foot placement were used for every attempt and for all participants. After a standardized warm-up and familiarization with the test, each participant performed three maximal voluntary isometric contractions lasting 3–5 s, with 1 min of rest between attempts. Participants were instructed to push against the platform “as hard and as fast as possible” and received standardized verbal encouragement. The highest peak force of the three attempts was retained for statistical analysis. Force was recorded by the software in newtons (N) and converted to the kilogram values reported in the results (kg). Measurement of maximal isometric muscle force with a strain-gauge dynamometer has shown high reliability and reproducibility. Correlation coefficients between consecutive trials within the same session range from 0.96 to 1.00, and between-session intraclass correlation coefficients range from 0.80 to 0.92. The reliability of rate of force development

indices ranges from fair to good (ICC 0.6–1.0) [19–21]. Related laboratory work has examined isometric force at specified knee angles as a predictor of maximal leg press effort in male students [22]. That study provides methodological context rather than population-specific validation in perimenopausal women.

The Barre fitness intervention lasted 8 weeks and consisted of three supervised sessions per week, for a total of 24 sessions. Each session was scheduled to last approximately 60 min and was performed during evening hours outside regular working time. The intervention was developed according to the Barre Fitness 3rd Edition curriculum (IBBFA Level 1 framework) and incorporated ballet-inspired movements, low- to moderate-load resistance exercises, isometric holds, pulsing movements, posture-focused sequences, and core stabilization tasks (Table 1). The programme was structured into four two-week phases: Intro (weeks 1–2), Build (weeks 3–4), Intensive (weeks 5–6), and Peak (weeks 7–8). These phase names reflected the intended gradual increase in training demands throughout the eight-week intervention. Progression involved increases in repetitions, time under tension, and exercise complexity, together with changes in external resistance. Equipment included exercise mats, mini balls, elastic bands, dumbbells, and a ballet barre. Additional modifications indicated in parentheses in Table 1, such as an extra set, increased resistance, longer time under tension, or increased movement speed, were optional and applied at the instructor's discretion to increase exercise intensity. Each training session included a warm-up (8–10 min), a main exercise phase (approximately 45 min), and a cool-down with stretching (5–10 min). The program was specifically adapted for perimenopausal women, with emphasis on postural alignment, posterior-chain activation, core stability, and low- to moderate-impact movement patterns.

Exercise intensity was monitored using the Borg category-ratio 0–10 rating of perceived exertion scale (Borg CR10), which is a recognized instrument for estimating perceived exercise intensity and physical exertion [23, 24]. Target effort during the sessions corresponded approximately to values of 6–8, representing the prescribed perceived-effort range on the CR10 scale rather than a directly measured metabolic-intensity category. Attendance was recorded at every session, and participants in the experimental group were instructed not to engage in additional structured exercise during the intervention period. No structured exercise was prescribed for the control group, which continued usual daily activities.

Table 1. *Structure and Progression of the Barre Fitness Intervention*

Phase (weeks)	Primary target area	Exercise	Equipment	Prescription / progression	Description and primary muscles
1–2 (Intro)	Lower body	Plié in 1st/2nd position	Mat (for balance), Barre	2 × 8–12 reps per side	Demi plié with turn-out; glutes, quadriceps, core stability.
		Tendu front/side/back	None	2 × 10 reps per side	Stretch with point; inner/outer thighs, balance.
	Upper body/Core	Port de bras + fondu	Small ball	2 × 20 s hold + 8 pulses	Arm lines + knee bend; shoulders, core.
	Cardio	Relevé pulses	Band around knees	2 × 20 s	Rise on toes; calves, stability.
3–4 (Build)	Lower body	Rond de jambe + fondu	Band (ankle)	3 × 12–15 reps per side (+4 reps)	Circular motion; hip rotators, hamstrings (+band resistance).
		Arabesque hold, single-arm plank holds	Mat (under hand); dumbbells	3 × 20–30 s per side (+10 s)	Leg lifts back; glutes, back, posterior chain.
	Upper body/Core	Retiré with ball	Small ball between thighs	3 × 10 reps + hold 10 s	Knee lift; hip flexors, adductors (+squeeze).
	Cardio	Small plié jumps	None	3 × 20 s (+intensity)	Explosive plié; cardio, legs.
5–6 (Intensive)	Lower body	Grand battement + lunge	Band + small ball	3 × 12–15 reps (+variation: lunge)	Kick + prop for depth; quadriceps, glutes (+TUT).
		Side fondu	Mat	3 × 30 s per side (+10 s)	Lateral bend; abductors.
	Upper body/Core	Port de bras with band	Band (arms)	3 × 12 reps (+resistance)	Arm extensions; upper back, deltoids.
	Cardio	Tabata relevé + plié	Band	4 × 20 s on/10 s off (+speed)	HIIT style; endurance.
7–8 (Peak)	Full body	Combination: plié-tendu-arabesque	All equipment	4 × 15 reps + 30 s hold (+set, TUT)	Circuit: 1 min per exercise; full body overload.
		Floor core (on mat): C-curl with ball	Small ball	4 × 20 reps (+squeeze)	Abdominals; core activation.
	Upper body	Biceps/triceps pulses with band	Band	4 × 15 reps (+TUT 2 s down)	Arms; endurance.
	Cardio	Barre burns sequence	None	4 × 30 s (+max ROM)	High intensity blasts.

Note: TUT—time under tension; HIIT—high-intensity interval training; ROM—range of motion. "Reps" denotes repetitions, and "s" denotes seconds. A prescription of "2 × 8–12" indicates two sets of 8–12 repetitions, while "per side" indicates that the prescribed volume is performed separately on each side of the body. "Hold" denotes maintaining the specified isometric position, whereas "pulses" denotes repeated small-amplitude movements within the specified exercise which lead to muscular fatigue. For interval-based exercises, "20 s on/10 s off" indicates 20 seconds of exercise followed by 10 seconds of rest. Additional instructions provided in parentheses (e.g., +set, +resistance, +TUT, and +speed) represent optional modifications that the instructor may apply at their discretion to increase exercise intensity.

Statistical analyses were performed using SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk, NY, USA). Descriptive data are presented as mean ± standard deviation (M ± SD). Prior to inferential statistical testing, departures from normality for all continuous outcome variables were assessed using the Shapiro-Wilk test, complemented by visual inspection of Q-Q plots and evaluation of skewness and kurtosis values. Because no statistically significant departure from normality was detected for any variable ($p > 0.05$ on the Shapiro-Wilk test), parametric statistical procedures were applied

throughout. Baseline differences between the experimental and control groups were initially examined using independent samples t-tests. To evaluate the intervention effects, within-group pre- to post-intervention changes were assessed using paired-samples t-tests, while between-group differences at post-test were examined using independent-samples t-tests. In addition, univariate analysis of variance (ANOVA) was conducted to examine overall group effects across the 8-week intervention period, in accordance with the analytical plan. The level of statistical significance was set at $p < 0.05$, with exact p-values reported (and reported as $p < 0.001$ where applicable). Effect sizes were quantified using Cohen's d and interpreted according to standard thresholds as small (0.2), medium (0.5), and large (0.8). Failure to reject a normality test was not interpreted as proof that the underlying distributions were exactly normal. The reported group comparisons and within-group tests address different contrasts and should therefore be interpreted separately.

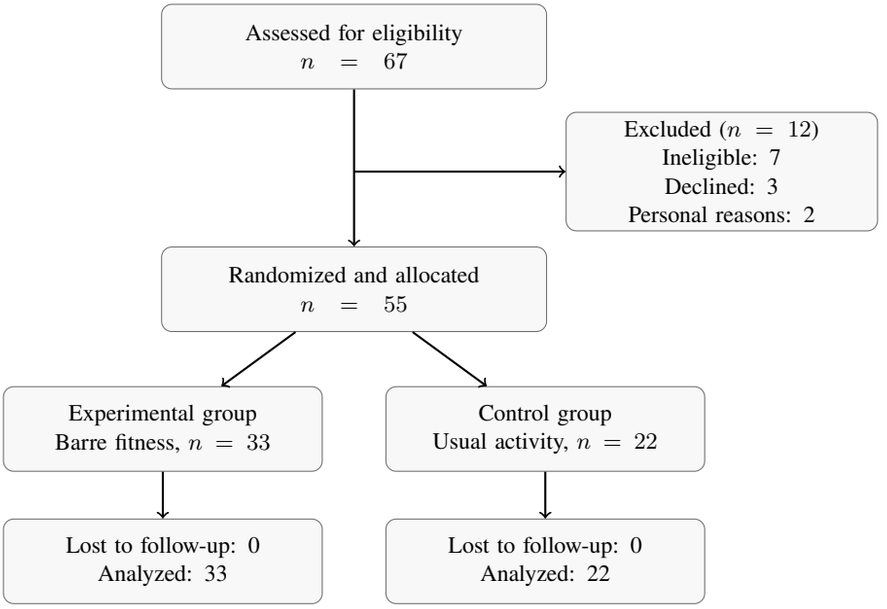


Figure 1. *Participant Flow Through the Study*

3. RESULTS

All enrolled participants completed the trial, with complete retention (100%) in both groups and attendance exceeding 95% in the experimental group. Baseline demographic and anthropometric characteristics, together with the initial muscular strength measurements for both groups, are presented in Table 2.

Table 2. *Baseline Characteristics of the Experimental and Control Groups*

Variable	EG (M ± SD)	CG (M ± SD)	t	p	d	Effect size
Age (years)	44.48 ± 4.08	44.38 ± 3.05	0.09	0.92	0.03	trivial
BMI (kg/m^2)	24.49 ± 3.72	23.05 ± 2.57	1.76	0.08	0.43	small
Dominant handgrip strength (kg)	26.16 ± 4.65	26.54 ± 5.34	-0.28	0.78	-0.08	trivial
Non-dominant handgrip strength (kg)	24.86 ± 4.04	23.34 ± 5.94	1.05	0.30	0.31	small
Leg press performance (kg)	18.30 ± 3.73	16.80 ± 2.77	1.77	0.08	0.44	small

Note: EG = Experimental Group; CG = Control Group; M = Mean; SD = Standard Deviation; BMI = Body Mass Index; t = independent-samples t-test statistic; p = statistical significance level; Cohen's d = effect size measure (0.2 = small, 0.5 = medium, 0.8 = large).

Independent-samples t-tests revealed no statistically significant differences between the experimental group (EG, n = 33) and the control group (CG, n = 22) at baseline regarding age, body mass index (BMI), dominant handgrip strength, non-dominant handgrip strength, or leg press performance (all $p > 0.05$). These results indicate that the specified tests did not detect baseline differences between the two study arms before the exercise intervention; they do not establish statistical equivalence or exclude potentially relevant initial imbalances.

Table 3. *Between-Group Post-Intervention Comparisons*

Variable	EG (M ± SD)	CG (M ± SD)	t	p	d	Effect size
BMI (kg/m^2)	23.24± 2.69	22.99± 1.95	0.36	0.72	0.10	trivial
Dominant handgrip strength (kg)	29.66±2.99	25.01±4.46	4.54	<0.001	1.29	large
Non-dominant handgrip strength (kg)	27.09±3.04	22.69±3.97	4.54	<0.001	1.29	large
Leg press performance (kg)	21.09±5.90	17.81±3.36	2.26	0.028	0.64	medium

Note: EG = Experimental Group; CG = Control Group; M = Mean; SD = Standard Deviation; BMI = Body Mass Index; t = independent-samples t-test statistic; p = statistical significance level; Cohen's d = effect size measure.

Between-group comparisons following the 8-week intervention period are summarized in Table 3. At post-test, no statistically significant difference was observed between groups for BMI (t = 0.36, p = 0.72, Cohen's d = 0.10). Conversely, the experimental group achieved statistically significantly higher values compared to the control group in all measured strength parameters: dominant handgrip strength (t = 4.54, p < 0.001, Cohen's d = 1.29), non-dominant handgrip strength (t = 4.54, p < 0.001, Cohen's d = 1.29), and leg press performance (t = 2.26, p = 0.028, Cohen's d = 0.64). Corresponding effect sizes were large for both dominant and non-dominant handgrip strength and medium for leg press performance.

Table 4. *Within-Group Changes in the Experimental and Control Groups*

Experimental Group (n = 33)

Variable	Pre-test (M ± SD)	Post-test (M ± SD)	t (p)	d
BMI (kg/m^2)	24.49 ± 3.72	23.24 ± 2.69	1.60 (0.11)	0.38
Dominant handgrip (kg)	26.16 ± 4.65	29.66 ± 2.99	3.73 (< 0.001)	0.89
Non-dominant handgrip (kg)	24.86 ± 4.04	27.09 ± 3.04	2.61 (0.014)	0.62
Leg press performance (kg)	18.30 ± 3.73	21.09 ± 5.90	2.46 (0.020)	0.56

Control Group (n = 22)

Variable	Pre-test (M ± SD)	Post-test (M ± SD)	t (p)	d
BMI (kg/m^2)	23.05 ± 2.57	22.99 ± 1.95	0.08 (0.93)	0.03
Dominant handgrip (kg)	26.54 ± 5.34	25.01 ± 4.46	0.99 (0.32)	0.31
Non-dominant handgrip (kg)	23.34 ± 5.94	22.69 ± 3.97	0.41 (0.68)	0.13
Leg press performance (kg)	16.80 ± 2.77	17.81 ± 3.36	-1.05 (0.29)	-0.33

Note: M = Mean; SD = Standard Deviation; BMI = Body Mass Index; t = paired-samples t-test statistic; p = statistical significance level; Cohen's d = within-group effect size measure.

Within-group pre- to post-intervention adaptations are detailed in Table 4. Participants in the experimental group demonstrated significant improvements in dominant handgrip strength (t = 3.73, p < 0.001), non-dominant handgrip strength (t = 2.61, p = 0.014), and leg press performance (t = 2.46, p = 0.020). A reduction in BMI was observed in the experimental group (from 24.49 ± 3.72 to 23.24 ± 2.69 kg/m^2), but this change did not reach statistical significance (t = 1.60, p = 0.11). In contrast, the control group exhibited no statistically significant within-group changes across the 8-week period for BMI (t = 0.08, p = 0.93), dominant handgrip strength (t = 0.99, p = 0.32), non-dominant handgrip strength (t = 0.41, p = 0.68), or leg press performance (t = -1.05, p = 0.29).

Table 5. *One-Way ANOVA Results for Main Group Effects*

Outcome	F (df)	p	η_p^2	Effect size
Dominant handgrip strength	6.08 (1,53)	0.017	0.103	medium EG
Non-dominant handgrip strength	5.80 (1,53)	0.020	0.099	medium EG
Leg press performance	5.19 (1,53)	0.027	0.089	medium EG
Body Mass Index (BMI)	1.85 (1,53)	0.179	0.034	small EG

Note: EG = Experimental Group; F (df) -values and degrees of freedom; η_p^2= partial eta squared; p - value = statistical significance level (p < .05);

To evaluate overall main group effects across the 8-week intervention period, a univariate analysis of variance (ANOVA) was conducted (Table 5). The analysis indicated statistically significant main group effects for dominant handgrip strength, F = 6.08, p = 0.017, η_p^2 = 0.103, non-dominant handgrip strength, F = 5.80, p = 0.020, η_p^2 = 0.099, and leg press performance, F= 5.19, p = 0.027, η_p^2 = .089, with partial eta-squared values indicating medium-to-large effect sizes favoring the experimental group. In contrast, the main group effect for BMI was not statistically significant, F = 1.85, p = 0.179, η_p^2 = 0.034.

4. DISCUSSION

The main finding of this study is that an 8-week Barre fitness intervention significantly improved upper- and lower-body muscular strength in physically inactive perimenopausal women—as evidenced by increased dominant and non-dominant handgrip strength and enhanced isometric leg press performance—whereas no statistically significant between-group effect was observed for body mass index (BMI). These findings suggest that Barre fitness may be a promising exercise modality for improving muscular strength in physically inactive perimenopausal women, even when short-term changes in BMI are not observed [2, 5].

The muscular strength gains observed in the present trial are consistent with broader evidence demonstrating that resistance-oriented exercise preserves and improves muscle function in women across the menopausal transition [2, 5, 11]. In our protocol, Barre fitness emphasized precise technical execution, controlled small-range movements, and deliberately prolonged time under tension (TUT), supplemented by external resistance from small props (elastic bands, small balls, light dumbbells) to bring target muscle groups close to fatigue. By integrating repeated low-to-moderate-load muscular contractions, sustained isometric holds, and high movement frequency within structured sequences, this format provided a sufficiently robust neuromuscular stimulus to induce strength improvements without reliance on conventional heavy external loads [8, 11]. These characteristics may make Barre an exercise option worth investigating in midlife women, although lower-impact movement alone does not establish joint safety or suitability for every participant [2]. From a behavioral and psychosocial perspective, the combination of ballet-inspired movement patterns, posture-focused sequences, rhythmic control, and supervised group participation may appeal to some women who are unfamiliar with structured resistance exercise. However, attractiveness, confidence, perceived accessibility, and preferences for particular forms of training differ between individuals. The present trial did not compare participants' experiences of Barre with their experiences of conventional resistance exercise, and it cannot establish that one environment is less intimidating or more motivating than another. Such interpretations require direct participant-reported evidence collected with clearly described measures. It is therefore appropriate to distinguish the observed attendance and retention from explanations about why participants remained engaged. In addition to its physical demands, Barre fitness incorporates coordinated movement sequences, posture-focused exercises, and group-based participation, which may make it an appealing option for some previously inactive women. The 100% retention rate and attendance exceeding 95% observed in the present study indicate high participation throughout the intervention. However, because participants' motivation, enjoyment, and perceptions of the exercise modality were not directly assessed, the extent to which these characteristics contributed to adherence remains uncertain. Future studies should examine the behavioral factors that may influence participation and long-term engagement in Barre-based exercise programs.

A particularly notable finding was the statistically significant improvement in both dominant and non-dominant maximal isometric handgrip strength following the intervention. Handgrip strength is widely recognized in the literature as a robust proxy for upper-body muscular function and overall physical vitality, serving as a proposed "vital sign" in midlife and clinical populations [14]. This outcome carries specific clinical relevance during the menopausal transition, given that menopausal status and selected hormonal exposures have been associated with differences in grip strength among women aged 45–69 years [25]. However, because direct functional or systemic health outcomes were not evaluated in the present trial, these findings should be interpreted strictly as evidence of enhanced localized isometric force production rather than as definitive proof of broader systemic or clinical health improvements.

Similarly, the significant improvement in isometric leg press performance provides objective evidence of enhanced lower-extremity muscular strength following the Barre fitness intervention, despite the program not being designed as a conventional high-load resistance regime [11]. This gain likely reflects the cumulative neuromuscular stimulus generated by Barre-specific training characteristics, including repetitive pulses, small-range lower-limb movements, sustained isometric holds, and prolonged TUT which may have contributed to the observed improvements in lower-extremity force production [8]. Although maintenance of muscle strength is relevant to physical function during aging and after menopause [3], functional mobility and activities of daily living were not directly evaluated in the present study. Consequently, while these strength adaptations highlight the physiological efficacy of the intervention, they should be interpreted strictly within the scope of measured force production rather than as empirical proof of improvements in unmeasured functional outcomes.

An important contribution of the present study is the simultaneous assessment of handgrip strength and isometric leg press performance, providing complementary information on muscular function in physically inactive perimenopausal women. While handgrip strength is commonly used as an indicator of upper-body strength and general muscular function, lower-body strength is particularly relevant to the physical demands of everyday activities. The concurrent improvements observed in both outcomes suggest that Barre fitness may provide a broad muscular stimulus rather than adaptations restricted to a single muscle group or functional region. This interpretation is consistent with evidence that structured exercise interventions can improve both upper- and lower-body strength in postmenopausal women [15], as well as findings demonstrating improvements in lower-limb and core muscle strength following Barre training in sedentary female office

workers [10]. Nevertheless, differences in participant characteristics, intervention protocols, and strength assessment methods limit direct comparisons across studies. Because the present trial did not include a conventional resistance-training comparison group, it also remains unclear whether Barre fitness produces strength adaptations comparable to those achieved through traditional resistance training. Future randomized trials should compare these exercise modalities directly and examine whether the observed strength improvements translate into measurable gains in functional performance and long-term physical activity participation.

From a physiological perspective, the strength gains observed alongside nonsignificant between-group BMI differences are compatible with several mechanisms, including neural adaptation and changes in muscle morphology that BMI cannot distinguish. The absence of a BMI difference does not establish that hypertrophy was absent or that neural mechanisms predominated. In low-to-moderate load protocols such as Barre fitness, movement execution heavily relies on continuous verbal cueing, sustained time under tension, and targeted isometric contractions, which may facilitate enhanced motor unit recruitment and firing frequency [26]. While neuromuscular activation and neural drive were not directly quantified in this trial (e.g., via surface electromyography or motor unit decomposition), early-phase strength gains in short-term resistance interventions are frequently discussed in relation to neural adaptations, although their relative contribution depends on the task, training stimulus, and assessment method [27]. Therefore, enhanced neuromuscular efficiency represents a plausible physiological explanation accounting for the measured force improvements, though direct neurophysiological assessments are required to confirm this mechanism. Evidence from low-impact resistance training indicates that strength and lean-mass improvements can occur without a corresponding between-group difference in total body mass [11]. This distinction supports assessing body composition directly rather than inferring it from BMI alone.

In contrast to the strength outcomes, BMI did not differ significantly between groups after 8 weeks. The distinction between strength outcomes and anthropometric outcomes is relevant when interpreting resistance-training evidence in middle-aged and postmenopausal women [2, 5]. A separate study of Tabata training in inactive women examined body fat reduction [28]; its body-composition outcome and training format differ from the BMI and strength measurements used here, limiting direct comparison. Because BMI is an aggregate measure that fails to differentiate between fat-free mass and fat mass, small concomitant shifts in body composition (e.g., modest increases in lean muscle tissue alongside slight reductions in fat mass) may occur without altering overall body weight. These findings underscore the importance of incorporating direct neuromuscular performance evaluations alongside standard anthropometric indices when assessing exercise efficacy in perimenopausal populations.

5. STUDY LIMITATIONS

Several limitations of the present study should be acknowledged. First, the 8-week intervention period and lack of a long-term follow-up assessment preclude conclusions regarding the durability and retention of the observed strength gains. Second, the reported anthropometric outcome was BMI, with body mass measured using a Tanita analyzer; no direct regional body-composition outcomes or advanced imaging measurements (such as DXA) were reported, preventing precise quantification of regional muscle hypertrophy or visceral fat changes. Third, functional mobility, balance, and activities of daily living were not directly measured; thus, the ecological validity of these strength gains regarding functional independence remains speculative. Fourth, direct neurophysiological measurements (e.g., surface electromyography) were not conducted, leaving the proposed neural mechanisms unconfirmed. Finally, participants were instructed to maintain their habitual diet, without laboratory control of energy intake. Perimenopausal status was determined from menstrual history rather than objective hormonal staging, and the small, geographically restricted sample limits generalization. The absence of a conventional resistance-training comparison group also prevents conclusions about the relative effectiveness of Barre against other exercise approaches.

Despite these limitations, this study provides valuable initial evidence supporting Barre fitness as an potentially useful, supervised exercise modality for countering muscular strength declines during perimenopause. By eliciting measured strength gains in both upper and lower limbs, Barre training offers a practical non-pharmacological strategy for preserving physical capacity in midlife women [11, 14]. Future research should employ longer intervention durations, incorporate dual-energy X-ray absorptiometry (DXA) assessments and electromyographic monitoring, and directly compare Barre fitness against traditional heavy resistance training to further elucidate its specific physiological role in healthy reproductive aging. Future studies should also document adverse events, participant-reported acceptability, and the resources required to deliver the intervention. These outcomes would help determine whether the observed participation can be sustained outside the closely supervised conditions of this trial.

6. CONCLUSION

An 8-week supervised Barre fitness intervention was associated with statistically significant improvements in upper- and lower-body muscular strength among physically inactive perimenopausal women, while no significant between-group

difference in body mass index was observed. These findings suggest that a program combining low-impact movements, isometric holds, and ballet-inspired exercises may provide an effective stimulus for improving muscular strength in this population. The high attendance rate (>95%) and complete participant retention (100%) indicate that the intervention was feasible under the supervised conditions of this study. However, these findings alone do not establish the long-term acceptability or sustainability of Barre fitness as an exercise modality. Further research involving larger samples, longer intervention periods, and follow-up assessments is needed to determine whether the observed strength improvements are maintained over time. Future studies should also incorporate direct body composition assessments, functional performance measures, and, where relevant, neuromuscular assessments to better understand the effects and potential mechanisms of Barre training during the menopausal transition.

Author Contributions

Conceptualization, A.LJ.; methodology, T.K., A.LJ., and R.P.; software, Ž.S. and N.Z.; validation, A.LJ. and B.P.; investigation, A.LJ., T.K., B.P., and R.P.; resources, B.P.; data curation, A.LJ. and Ž.S.; writing—original draft preparation, A.LJ.; writing—review and editing, A.LJ., R.P., and Z.K.; visualization, T.K.; supervision, A.LJ., R.P., and Z.K.; project administration, T.K.; funding acquisition, B.P. All authors have read and approved the final version of the manuscript for publication.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Faculty of Physical Education and Sport, University of Banja Luka (protocol 11/1.1030/24).

Data Availability Statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical restrictions related to participant privacy.

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Conflicts of Interest

The authors declare no conflict of interest.

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