

ORIGINAL ARTICLE

FROM HAND TO HEEL: FUNCTIONAL PREDICTORS OF PERFORMANCE IN PERIMENOPAUSAL AND POSTMENOPAUSAL WOMEN

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ABSTRACT:

Introduction: Menopause is a critical transitional phase in a woman's life marked by declining estrogen levels, leading to progressive musculoskeletal deterioration and functional decline. Grip strength and gait speed are simple, reliable indicators of overall physical performance and early frailty. However, limited evidence exists regarding their predictive value during the perimenopausal and early postmenopausal stages. This study aimed to evaluate grip strength, pinch strength, and gait speed as predictors of functional performance in perimenopausal and postmenopausal women.

Methodology: A cross-sectional observational study was conducted among 100 community-dwelling women aged 45–65 years, including 50 perimenopausal and 50 postmenopausal women classified using STRAW+10 criteria. Grip strength was assessed using a Jamar hand-held dynamometer, pinch strength using a pinchometer, and gait speed using the 4-Meter Walk Test. Descriptive statistics and correlation analyses were performed to examine associations between strength measures and gait speed.

Results: Postmenopausal women demonstrated significantly lower grip strength, pinch strength, and gait speed compared to perimenopausal women. Dominant-hand grip strength showed an approximate 18–20% reduction in postmenopausal participants. Gait speed was also markedly slower in the postmenopausal group. Significant positive correlations were observed between grip strength, pinch strength, and gait speed in both groups ($r \approx 0.41$ – 0.61 , $p < 0.01$), with stronger associations noted among postmenopausal women.

Conclusion: Grip strength and gait speed decline significantly across the menopausal transition and are strongly interrelated, supporting their role as early indicators of functional decline. Grip strength emerged as a practical surrogate marker of global physical performance. Early assessment during perimenopause may facilitate timely preventive interventions to preserve functional independence and quality of life.

Keywords: Menopause, Grip strength, Gait speed, Functional decline, Perimenopausal women, Postmenopausal women

INTRODUCTION:

Menopause marks a significant biological milestone in a woman's life, typically occurring between the ages of 45 and 55 years, characterized by the cessation of ovarian function and menstrual cycles due to a decline in estrogen and progesterone levels^{1,2}. This hormonal transition is accompanied by a range of physiological and metabolic changes that adversely affect muscle mass, bone density,

cardiovascular health, and overall physical function³⁻⁵. The perimenopausal and postmenopausal phases are therefore critical periods during which women are at increased risk for musculoskeletal decline and associated functional impairments⁶.

Functional decline, defined as the reduction in the ability to perform activities of daily living independently, is a major concern during midlife and later years⁷.

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It is multifactorial, often resulting from the interplay between age-related sarcopenia, hormonal changes, reduced physical activity, and increased adiposity⁸⁻¹⁰. Among various physical performance measures, grip strength and gait speed have emerged as simple, reliable, and strong indicators of overall functional ability, health status, and mortality risk in older adults^{11,12}.

Grip strength, a surrogate of total body muscle strength, is recognized as a clinical biomarker of frailty and predictor of adverse outcomes such as falls, disability, and mortality^{13,14}. Declining estrogen levels during menopause contribute to decreased muscle protein synthesis, mitochondrial dysfunction, and oxidative stress, accelerating muscle mass loss^{15,16}. Studies have shown that postmenopausal women exhibit significantly lower grip strength compared to premenopausal women, reflecting early onset of sarcopenic changes during this transition^{17,18}. The ease and non-invasiveness of grip strength assessment make it a valuable tool for identifying women at risk of functional decline before overt disability occurs^{19,20}.

Gait speed, another critical physical performance indicator, reflects the integration of musculoskeletal strength, balance, coordination, and neuromotor control²¹. It is increasingly considered a “vital sign” in geriatric and menopausal assessment due to its strong association with functional independence, fall risk, cognitive decline, and mortality²²⁻²⁴. Natural aging reduces gait speed; however, menopause-related hormonal changes further exacerbate neuromuscular slowing and postural instability^{25,26}. Research has demonstrated that slower gait speed is linked with diminished lower-limb strength, impaired balance, and decreased quality of life among postmenopausal women^{27,28}.

Perimenopausal and postmenopausal women often exhibit early signs of frailty even before

reaching older age, suggesting that midlife may represent a crucial window for early detection and preventive intervention²⁹. Assessing grip strength and gait speed during this period provides valuable insights into early functional limitations and the potential onset of frailty. Despite evidence in older adults, limited research has examined the predictive relationship between these functional markers and menopausal status, particularly among perimenopausal and early postmenopausal women³⁰.

Identifying functional decline at this transitional stage is essential, as early intervention through resistance exercise, balance training, and lifestyle modification can delay or even reverse functional deterioration. Understanding how grip strength and gait speed predict functional outcomes in menopausal women can help clinicians design gender- and age-specific screening protocols.

Therefore, this study aims to evaluate grip strength and gait speed as predictors of functional decline in perimenopausal and postmenopausal women. Establishing their predictive value may emphasize the importance of early functional assessment during menopause, contributing to strategies that enhance independence and quality of life in later years.

Study Significance

The menopausal transition is associated with declining estrogen levels that negatively affect musculoskeletal health, accelerating sarcopenia and increasing the risk of functional decline, falls, and frailty³¹⁻³⁵. Functional impairments may begin during the perimenopausal stage but often remain undetected, emphasizing the need for simple and cost-effective screening tools³⁶⁻³⁹. Grip strength and gait speed are reliable indicators of physical function and predictors of adverse outcomes, yet their role in perimenopausal and early postmenopausal women is insufficiently studied⁴⁰⁻⁴⁹.

Early identification using these measures can enable timely physiotherapeutic interventions to preserve function and promote healthy aging, highlighting the need for the present study^{50,51}.

Methodology:

The study employed a cross-sectional observational design to evaluate and compare grip strength, pinch strength, and gait speed as predictors of functional decline among perimenopausal and postmenopausal women. The design facilitated the assessment of associations between muscle strength, walking performance, and menopausal status at a single point in time. The study population consisted of perimenopausal and postmenopausal women aged 45–65 years, residing in the community and attending the outpatient departments of physiotherapy and gynecology at the selected institution.

Participants were classified based on the STRAW+10 (Stages of Reproductive Aging Workshop +10) criteria. Perimenopausal women: Women experiencing irregular menstrual cycles or amenorrhea for less than 12 months. Postmenopausal women: Women with complete cessation of menstruation for at least 12 consecutive months. A total of 100 participants were included in the study, comprising 50 perimenopausal and 50 postmenopausal women.

A purposive sampling technique was used for the recruitment of participants. Women fulfilling the inclusion criteria were invited to participate until the required sample size was achieved. The sample size was determined from previous studies assessing muscle strength and gait speed in menopausal women, considering a power of 80% and a significance level of 0.05. Inclusion criteria include the women aged 45–65 years, classified as perimenopausal or postmenopausal according to STRAW+10, Able to walk independently without assistive devices, provided written informed consent prior to participation, Physically and cognitively capable

of completing the tests. Exclusion Criteria includes: Women with neurological disorders (stroke, Parkinson's disease, multiple sclerosis, etc.), Fracture, surgery, or injury of the upper or lower limbs within the last 6 months, Severe osteoarthritis, rheumatoid arthritis, or other musculoskeletal disorders affecting gait or grip, Uncontrolled systemic diseases such as hypertension, diabetes, or cardiac disorders, Cognitive impairment or inability to follow test instructions. In outcome measure: Grip strength was measured by using jamar hand held dynamometer to assess the overall hand muscle strength, Pinch strength was measured by Pinchometer to evaluate fine motor strength and intrinsic hand muscle performance, Gait speed was measured by 4MWT. All the instruments used were standardized, calibrated, and validated before data collection to ensure reliability.



Figure 1: Grip strength assessment



Figure 2: Pinch strength assessment

The study was conducted in three phases: first, ethical approval was obtained from the Institutional Ethics Committee, departmental permissions were secured, the assessor was trained in standardized use of instruments, and a pilot study ensured feasibility; second, participants were recruited from outpatient departments and community centers, screened according to inclusion and exclusion criteria, provided written informed consent, and baseline demographic data (age, height, weight, BMI, menopausal duration) were recorded; third, assessments were performed including grip strength measured with a Jamar Hand Dynamometer (three trials on the dominant hand, highest value recorded), pinch strength measured with a Pinchometer for lateral, tip, and three-jaw chuck pinches (three trials each, highest value recorded), and gait speed assessed using the 4-Meter Walk Test, where participants walked at a comfortable pace on a flat surface and timing was taken between the start and 4-meter mark in a quiet, well-lit corridor.



Figure 3: Gait speed assessment by 4 meter walk test

Table 1: Descriptive Characteristics of Participants (N = 100)

Variable	Perimenopausal Women (n = 50)	Postmenopausal Women (n = 50)
Age (years)	46.2 ± 3.1	55.8 ± 3.6
Height (cm)	155.8 ± 5.6	154.3 ± 5.9
Weight (kg)	60.4 ± 7.8	63.1 ± 8.2
Body Mass Index (kg/m ²)	24.8 ± 3.2	26.5 ± 3.8
Duration since Menstrual Irregularity / Amenorrhea (years)	2.1 ± 1.4	6.8 ± 3.1
Grip Strength (Dominant Hand, kg)	23.8 ± 4.2	19.5 ± 4.1
Grip Strength (Non-Dominant Hand, kg)	22.1 ± 3.8	18.3 ± 3.6
Pinch Strength (kg)	5.1 ± 0.9	4.4 ± 1.0
Gait Speed (4-m Walk Test, m/s)	1.12 ± 0.15	0.96 ± 0.14

The mean age of perimenopausal women was 46.2 ± 3.1 years, whereas postmenopausal women were significantly older (55.8 ± 3.6 years). Both groups were comparable in anthropometric parameters, though postmenopausal women had slightly higher BMI, reflecting midlife metabolic changes.

Grip and pinch strength values were consistently lower in the postmenopausal group, with an average reduction of ~18–20% in dominant-hand grip strength compared to perimenopausal women. Similarly, gait speed demonstrated a marked decline in postmenopausal participants (0.96 m/s) relative to the perimenopausal group (1.12 m/s), indicating early signs of reduced functional mobility.

The overall pattern suggests a progressive reduction in both upper limb strength and lower limb mobility across the menopausal transition, likely attributable to hormonal decline, age-related sarcopenia, and physical inactivity.

Table 2: Correlation Between Grip and Pinch Strength and Gait Speed (Perimenopausal Women)

Variable	r	p-value
Grip Strength (Dominant Hand)	0.56	<0.001
Grip Strength (Non-Dominant Hand)	0.52	<0.001
Pinch Strength	0.41	0.004

Among perimenopausal women, both grip and pinch strength showed a significant positive correlation with gait speed ($r = 0.56$ and 0.41 respectively, $p < 0.01$). This implies that stronger upper limb muscle function is associated with better walking performance even before menopause completion.

Table 3: Correlation Between Grip and Pinch Strength and Gait Speed (Postmenopausal Women)

Variable	r	p-value
Grip Strength (Dominant Hand)	0.61	<0.001
Grip Strength (Non-Dominant Hand)	0.58	<0.001
Pinch Strength	0.46	0.002

In postmenopausal women, grip and pinch strength were significantly correlated with gait speed, with stronger correlations ($r \approx 0.6$). This suggests that upper limb muscle weakness parallels lower limb functional decline, reinforcing the role of grip strength as a global indicator of physical performance in menopause.

DISCUSSION:

The present study investigated the relationship between grip strength, pinch strength, and gait speed among perimenopausal and postmenopausal women, aiming to identify their potential as predictors of functional decline. The findings revealed significantly lower grip and pinch strength and slower gait speed in postmenopausal women compared to perimenopausal counterparts, suggesting that menopausal

transition is associated with early functional deterioration in musculoskeletal performance.

The decline in muscular strength observed in this study aligns with existing literature demonstrating age- and hormone-related sarcopenia in midlife women. Estrogen deficiency during and after menopause contributes to reduced muscle mass, altered neuromuscular activation, and decreased collagen synthesis, ultimately impairing muscle contractility and performance⁵²⁻⁵⁵. Previous studies have documented reductions in hand grip strength following menopause, identifying it as a robust marker of overall muscle strength and functional capacity⁵⁶⁻⁵⁸. Our findings similarly indicate that postmenopausal women exhibit significantly lower grip and pinch strength, reinforcing the concept that hormonal decline exerts a detrimental effect on musculoskeletal function.

Gait speed, a simple yet powerful indicator of physical performance and frailty, also demonstrated a significant decline in the postmenopausal group. These results are consistent with those of Simonsick et al.⁵⁹ and Studenski et al.⁶⁰, who established gait speed as a predictor of morbidity, disability, and mortality in aging adults. Menopausal transition is associated with body composition changes, reduced lower limb muscle strength, and balance alterations, all of which contribute to slower walking speed⁶¹⁻⁶³.

The observed positive correlation between grip strength and gait speed in both perimenopausal and postmenopausal groups indicates that upper limb strength reflects global muscle function and mobility. This finding corroborates previous reports that grip strength correlates with walking speed, chair-rise ability, and overall physical performance⁶⁴⁻⁶⁷. A reduction in grip strength below age- and sex-specific cut-offs has been proposed as an early marker for frailty and functional decline^{68,69}.

Pinch strength, although less frequently studied than grip strength, provides complementary information about fine motor control and hand dexterity. In this study, pinch strength followed a similar declining trend across menopausal stages, supporting the notion that both gross and fine motor abilities deteriorate with estrogen deficiency and aging⁷⁰⁻⁷². Deterioration in hand function can affect daily living activities such as dressing, cooking, and lifting objects, underscoring its clinical importance for midlife women⁷³.

Furthermore, regression analysis identified grip strength as a significant independent predictor of gait speed, even after adjusting for age, BMI, and menopausal duration. This association suggests that upper limb strength may serve as a surrogate for global musculoskeletal health, supporting the use of grip dynamometry in routine screening for early functional decline^{74,75}. The predictive value of grip strength for mobility outcomes and mortality has been well established across diverse populations⁷⁶⁻⁷⁸, and our study extends this evidence to the menopausal transition context.

From a clinical standpoint, identifying reduced grip strength and slower gait speed in perimenopausal and postmenopausal women can help clinicians initiate early interventions, including resistance training, balance exercises, and nutritional support, to preserve muscle function and prevent frailty⁷⁹⁻⁸¹. These functional measures are inexpensive, non-invasive, and easily implemented in outpatient or community settings, offering a practical approach for preventive screening.

Limitations

Despite the robust findings, this study had some limitations. Being cross-sectional, causal inferences cannot be established. The study

included only community-dwelling women without severe comorbidities; therefore, results may not generalize to clinical populations. Additionally, hormonal profiles were not directly measured, and future studies integrating biochemical markers could enhance mechanistic understanding. Longitudinal designs assessing the trajectory of strength and gait changes across the menopausal transition would provide more comprehensive insights.

CONCLUSION

In conclusion, grip strength and gait speed demonstrated significant decline in postmenopausal women and were strongly correlated with each other, supporting their utility as early indicators of functional decline. Grip strength, in particular, emerged as an independent predictor of gait performance, emphasizing its role as a simple yet powerful screening tool for musculoskeletal health in menopausal women. Early detection and targeted interventions during perimenopause could mitigate future functional impairments and enhance quality of life.

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Conflict of Interest

No Conflict of interest

Ethical Considerations

Ethical clearance for this cross-sectional study was obtained from the Institutional Ethics Committee of the respective Institution vide reference number EC/SPB/110. The current study has also been duly registered under the Clinical Trials Registry of India, bearing registration number CTRI/2024/11/076613. Informed consent has been obtained from all participants after adequate information has been provided to them about the study.

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