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ASSESSMENT OF POSTURAL STABILITY AND MUSCULOSKELETAL FLEXIBILITY ACROSS MENOPAUSAL STAGES: A CROSS-SECTIONAL STUDY OF WOMEN AGED 40–55.

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ABSTRACT

BACKGROUND: Menopause is a significant physiological transition marking the end of a woman's reproductive phase, often accompanied by multifaceted physical and psychological changes. The decline in estrogen levels during this period is associated with various musculoskeletal and functional changes.

OBJECTIVE: This study aimed to assess and compare balance and flexibility—two critical components of physical functioning—among peri- and post-menopausal women.

METHODS: An observational study was conducted among women in the age group of 40–55 years. Participants were categorized into Group-A (Peri-menopausal) and Group-B (Post-menopausal) groups. The primary outcomes assessed were postural stability (balance) and range of motion (flexibility). Data collection involved standardized clinical assessment tools to evaluate these physical biomarkers across the menopausal transition.

OUTCOME MEASURES: 1) The Menopausal Rating scale (MRS), 2) Flexibility (Sit-and-Reach Test); 3) Static Balance (Single-Leg Stance Test)

RESULTS: The study observed changes in physical performance metrics, specifically noting how menopausal status influences balance and flexibility in midlife women.

CONCLUSION: The transition from peri-menopause to post-menopause is associated with measurable changes in physical functioning. These findings highlight the importance of assessing musculoskeletal health during midlife to implement early interventions that maintain functional independence and reduce the risk of mobility-related issues in later years.

KEY WORDS: Menopause transition; Postural stability; Musculoskeletal flexibility; Peri-menopausal; post-menopausal.

INTRODUCTION:

Menopause is the natural and permanent cessation of menses resulting from estrogen deficiency that is not associated with a pathologic process. Amenorrhea lasting for 12 consecutive months marks the end of a woman's reproductive time[1]. In India, menopause typically occurs between ages 45 and 50, with an average age of approximately 46.2 to 47.2 years. As women live longer, they spend roughly 40%of their lives in the postmenopausal years, which equates to more than 30 years for most women. Most women experience vasomotor symptoms, but menopause can affect many other organ systems, such as urogenital, psychogenic, and cardiovascular.[2]

The etiology of menopause involves the age-related exhaustion of ovarian follicles. As the follicular reserve diminishes, the population of granulosa cells declines, leading to a significant reduction in **estradiol, inhibin B**, and **Anti-Müllerian hormone (AMH)**[3,4]. This hormonal drop disrupts the negative feedback loop of the **hypothalamic-pituitary-ovarian axis**, causing a compensatory rise in

Follicle-Stimulating Hormone (FSH) and Luteinizing Hormone (LH). The resulting state of permanent hypoestrogenism is the primary driver of the physiological and musculoskeletal changes observed during the transition from peri- to post-menopause.[5],[6]

Although more than 80% of women experience menopausal symptoms, there is much variation in women's personal experiences of menopausal changes. Many factors can play into the physiologic processes of menopause. These include diet, smoking, ethnicity, medical problems, exercise, socioeconomic background, body mass index, and overall gynecologic health.[5]

Clinical Presentation of Menopause (Stat Pearls (Peacock et al., 2023)[7]

The symptoms of menopause primarily stem from systemic **estrogen deficiency**, affecting multiple organ systems:

- **Vasomotor Symptoms (75–80% of women):** The most prevalent symptoms, including hot flashes (lasting 3–4 minutes), night sweats, palpitations, and migraines. These typically persist for 1–6 years but can last up to 15 years in 10–15% of cases.
- **Genitourinary Syndrome (50–75% of women):** Characterized by vaginal atrophy (thinning mucosa, reduced elasticity), dryness, and irritation. Estrogen receptor depletion in the bladder and urethra often leads to urinary frequency, urgency, and recurrent UTIs.
- **Psychogenic Symptoms (Up to 70% of women):** Fluctuating estrogen levels affect mood-regulating brain regions, leading to anxiety, irritability, depression, and loss of concentration. Sleep disturbances (insomnia, apnea) are also frequently reported.
- **Bone Health:** Estrogen deficiency disrupts the remodeling cycle by increasing **osteoclastic resorption** over osteoblastic production, leading to accelerated bone mineral density loss and increased osteoporosis risk.

Physical Examination Findings

- **Vitals & Anthropometrics:** Potential elevation in blood pressure due to arterial vasoconstriction. Women gain an average of **2 kg** during the transition. A decrease in height may indicate osteoporotic vertebral changes.
- **Musculoskeletal:** Gradual loss of muscle mass and strength (**sarcopenia**) and joint pain (**arthralgia**) are common clinical findings.
- **Tissue Changes:** Increased fatty deposition in breast tissue and visible urogenital atrophy.

Stages of Menopause[7]

The transition to the cessation of menstruation occurs in three distinct phases:

1. **Perimenopause ("Menopause Transition"):** Often beginning in the 40s, this stage can last several months to 10 years. Ovarian estrogen production gradually declines, leading to symptoms such as irregular periods, hot flashes, and mood swings.
2. **Menopause:** A specific clinical milestone defined by **12 consecutive months** without a menstrual period. At this point, the ovaries cease releasing eggs and estrogen production is significantly reduced.
3. **Post menopause:** The lifelong phase following the 12-month mark. While most symptoms subside, low estrogen levels increase the long-term risk for **osteoporosis** and **heart disease**.

Premature vs. Early Menopause[7]

While "natural" menopause typically occurs between ages 45 and 55, earlier onset is categorized as follows:

- **Early Menopause:** Occurs before the age of 45.
- **Premature Menopause:** Occurs at age 40 or younger. When this happens without a surgical or medical cause, it is clinically termed **Primary Ovarian Insufficiency (POI)**[5]

The clinical prognosis for menopausal symptoms is generally favorable, as most symptoms eventually dissipate naturally. However, the transition is prolonged, with vasomotor symptoms like hot flashes persisting for an average of **7.4 years**. While the majority of women transition smoothly, data from the **SWAN study** reveals that **10% to 20%** face intolerable symptom severity.[5]

The diagnosis of menopause is established clinically and confirmed retrospectively after a woman has experienced 12 consecutive months of amenorrhea without an underlying pathological cause. While a detailed menstrual and symptomatic history is usually sufficient for women over age 45, laboratory evaluation of Follicle-Stimulating Hormone (FSH) can support the diagnosis in ambiguous cases, where levels exceeding 30 mIU/mL typically indicate the exhaustion of the ovarian follicular reserve.[5]

The clinical assessment further involves identifying secondary physical markers of hypoestrogenism, such as vasomotor instability, urogenital atrophy, and changes in mood or sleep patterns. It is essential for clinicians to differentiate natural menopause from other potential causes of secondary amenorrhea, including thyroid dysfunction, hyperprolactinemia, or pregnancy, to ensure an accurate diagnosis and appropriate management plan for the transition.[5]

Chronic estrogen deficiency poses severe long-term risks, primarily **cardiovascular disease** and **osteoporosis**. Estrogen loss impairs arterial function and alters lipid profiles, doubling or tripling the risk of coronary heart disease. Simultaneously, accelerated bone loss (3%–5% annually) drastically increases fracture risk.

Effective management relies on lifestyle modifications and pharmacological support, including **calcium supplementation**, **antiresorptives** (e.g., bisphosphonates), or **anabolic therapies** to preserve vascular and skeletal integrity.[5]

Optimal menopausal management utilizes a **multidisciplinary approach** to balance immediate symptom relief with long-term disease prevention. **Hormone Replacement Therapy (HRT)** remains the gold standard for vasomotor symptoms, provided it is used at the lowest effective dose for the shortest duration.

Parallel to pharmacological treatment, **physiotherapy** is vital for counteracting musculoskeletal decline. Clinicians prioritize weight-bearing exercises to combat bone loss, alongside the specific balance and flexibility protocols highlighted in this study to prevent falls and preserve joint mobility.

By integrating individualized medical treatment with structured lifestyle modifications and nutritional support, an interprofessional team can effectively reduce morbidity from cardiovascular disease and osteoporosis while preserving functional independence.

Current literature suggests that menopausal transition involves a sharp **estrogen decline** that shifts body composition toward increased fat and decreased bone/muscle mass. This loss of structural integrity results in a fall rate **three times higher** than in age-matched men.

By objectively quantifying deficits in balance and flexibility among women aged 40–55, this study identifies early functional declines. These data provide the clinical rationale for targeted interventions to prevent fragility fractures and preserve long-term independence.

This study aims to assess flexibility and balance in peri and post-menopausal women. The transition into menopause marks a critical biological shift where the sharp decline in **estrogen** triggers a cascade of musculoskeletal changes can lead to 3 times higher risk of fall mostly in the age of 45-55 years. Flexibility (joint range of motion) and postural stability (balance) are the two most vital determinants of a woman's ability to perform daily activities. Early detection of decline in these areas is essential to prevent a transition from "healthy" to "frail." If **objective physical decline** often goes unnoticed until a fragility fracture occurs. This study provides the necessary evidence to advocate for targeted physiotherapy and strength protocols during the perimenopausal phase.

METHODOLOGY:

- **Sample Size & Study Design & Method:** An Observational study with total sample of 68 **female participants** allocation was conducted using a **simple randomization method** conducted over 6 months in Pune city. Group A- Peri- N=34, Group B- Post- N=34

- **Participants:** Peri- And Post- menopausal women with age 40-55years.
- **Inclusion Criteria:** 1) Healthy menopausal women; 2) Age 40-55 years; 3) Perimenopause with at least period of more than 3 month and less than 12 months; 4) post-menopause with absence of menstruation at least 1 full year.
- **Exclusion Criteria:** 1) History of any neurological and musculoskeletal disorder; 2) Pregnant women; 3) Women with hearing impairment; 4) Women with abnormal vision; 5) Women with history of frequent fall in 1 year; 6) Hysterectomy; 7) Women who were on hormonal replacement therapy.
- **Material required:** 1) Wooden box; 2) Stop watch**;** 3) Data collection sheet; 4) Paper**;** 5) Pen

- **Procedure:** Ethical clearance was taken from the ethical committee of Jayantrao College of Physiotherapy, TMV, Pune prior to the commencement of the study.

- Subjects were taken according to the inclusion and exclusion criteria.

The study procedure is a systematic, sequential process designed to evaluate the physiological impact of the menopausal transition on functional mobility. Following ethical clearance and informed consent, the methodology follows four distinct phases:

1. Participant Classification and Demographic Profiling: Participants are initially screened and categorized via face-to-face interviews into two cohorts: perimenopausal (3 to 12 months of amenorrhea) and postmenopausal (over 12 months of amenorrhea). The demographic assessment captures critical variables including age, obstetric history, and menstrual age to establish a comprehensive baseline for each subject.

2. Symptom Severity Assessment (MRS): Subjects complete the Menopause Rating Scale (MRS) to quantify the frequency and intensity of their symptoms. This standardized questionnaire provides a subjective health-related quality of life score that serves as a clinical correlate for the subsequent physical performance tests.

3. Physical Performance Testing:

- Static Balance (Single-Leg Stance Test): Conducted barefoot with hands on hips, participants flex one knee to 90 while maintaining a vertical thigh position. A physiotherapist records the duration of the stance using a stopwatch, stopping if the lifted foot touches the floor or the hands move. The best of three trials for each leg is averaged for the final score.

- Flexibility (Sit-and-Reach Test): Participants sit with knees locked flat and feet against the measurement box. They perform a slow, controlled reach forward with palms down, holding the maximum extension for 1-2 seconds. The average of three trials is documented to determine lower back and hamstring flexibility.
- **STATISTICAL ANALYSIS:**

Statistical analysis will be performed using **SPSS version 25.0** (IBM Corp., Armonk, NY). Initially, descriptive statistics, including **means and standard deviations (SD)**, will be calculated for all demographic variables and outcome measures (MRS scores, SLS times, and Sit-and-Reach distances).

The **normality of the data distribution** will be assessed using the **Shapiro-Wilk test**. Based on the results of the normality testing, the following inferential statistics will be applied:

- **Between-Group Analysis:** To compare the differences between the perimenopausal and postmenopausal groups, an **Independent Samples t-test** will be utilized for normally distributed data. For data that does not meet the assumption of normality, the **Mann-Whitney U test** will be employed.
- **Within-Group Analysis:** For comparisons within the same group (e.g., comparing Right vs. Left limb performance in the SLS test), a **Paired t-test** will be used for parametric data, while the **Wilcoxon Signed-Rank test** will be used for non-parametric data.
- **Normality Testing:** Before running the main tests, a **Shapiro-Wilk** or **Kolmogorov-Smirnov** test will be performed to determine which path (parametric or non-parametric) to follow.

Statistical significance for all tests will be set at **$p < 0.05$** with a **95% confidence interval**. Data will be presented in tabular and graphical formats to illustrate the functional differences between the two stages of the menopausal transition.

Outcome Measures:

1) The **Menopause Rating Scale (MRS)** is globally used is a validated and highly reliable (0.73–0.86), 11-item self-assessment questionnaire used to measure the severity of physical and mental aging symptoms in women. It covers three dimensions—psychological, somato-vegetative (physical), and urogenital—with total scores indicating symptom severity from none (0) to very severe (up to 44).

2) **Sit And Reach Test-** Its standardized physical assessment that measures the flexibility of the lower back and hamstring muscles. Participants sit on the floor with legs straight and reach forward, measuring how far they can extend beyond their toes, with typical results falling between 15–27 cm for adults. It is crucial to hold the position for 2–3 seconds without bouncing to ensure accuracy. The maximum distance reached is recorded. It is often recommended to perform the test 2–3 times and record the best result. Any reach that does not reach the toes is often recorded as negative, and any reach past the toes is positive, with a higher score indicating better flexibility. It has high test-retest reliability ($r = 0.89$), and validity for estimating hamstring flexibility, with correlation coefficients typically ranging from ($r = 0.46$ to 0.76). It is a poor measure of general low-back flexibility, having low validity for assessing lumbar spinal mobility (r = 0.16–0.35)

- **Typical Score Ranges**
- **Males:** 15–25 cm is generally considered average.
- **Females:** 17–27 cm is generally considered average.

- **Excellent Score:** >46.5cm for males, >45.5cm for females.

3) **Single Leg Stance Test-** The Single Leg Stance (SLS) test is a simple, static balance assessment used to measure postural control, fall risk, and neuromuscular aging. It involves timing how long a person can stand on one leg (eyes open, hands-on hips) before lifting the foot, touching the ground, or moving their arms. Times under 5–10 seconds indicate higher fall risk, while <10 seconds in older adults is associated with significantly higher mortality risk. Setup: Stand on a flat surface, with eyes open, hands-on hips, and one leg lifted. Timing: Start the timer when the foot leaves the floor and stops when the lifted foot touches the ground; the hands move off the hips, or a maximum of 45–60 seconds is reached. Repetition: Test both legs, often for 3 trials each.

- **Age-Related Decline:** Adults under 60 should generally maintain the pose for 30+ seconds. Performance declines to roughly 45 seconds in the 50s and 26 seconds in the 70s.
- **Fall Risk:** Inability to stand for >5 seconds indicates an increased risk of falls.
- **Health Indicator:** Inability to stand for 10 seconds (ages 51–75) is linked to a 118% higher risk of death.

RESULT: Table no. 1- Age- Group A participants (perimenopausal) have a mean age of **44.38± 2.46** years, while Group B (postmenopausal) has a mean age of **52.09 ±2.15** years. Symptom Severity: Both groups show high MRS mean scores (>16), which generally indicates "severe" symptoms according to standard MRS grading. Variation: Group B shows a wider range of symptoms (Minimum 9.0 to Maximum 31.0) compared to Group A, suggesting more varied experiences in the postmenopausal phase**:** Group B reported a higher mean MRS score (**19.09**) than Group A (**17.50**), indicating an increase in symptom burden as women progress through the menopausal transition. **not statistically significant** ($p = 0.189$)

Flexibility Decline: The most significant difference is observed in the Sit-and-Reach test, where flexibility dropped from a mean of **38.29 cm** in perimenopause to **24.77 cm** in postmenopausal. There is a **highly significant decline** in flexibility from the perimenopausal to the postmenopausal stage ($p < 0.001$).

Balance Impairment: Group A performed significantly better in static balance for both the right leg (**Mean: 39.56**) and left leg (**Mean: 37.06**). Group B exhibited much lower mean scores of **24.62** for the right leg and **19.82** for the left leg, suggesting a heightened fall risk and decreased postural stability in postmenopausal women. Static balance performance showed a **highly significant deterioration** in both legs ($p < 0.001$). Group B (postmenopausal) demonstrated a much shorter stance duration, particularly on the left leg (Mean: 19.82 sec), compared to Group A (Mean: 37.06 sec). This suggests that postural stability is severely compromised post-menopause, potentially increasing fall risk.

Variable	Group	Mean	StDev	Range (Min-Max)	P-Value
Age (Years)	Group A (n=34) Peri	44.38	2.462	40.00 - 48.00	
	Group B (n=34) Post	52.09	2.151	49.00 - 55.00	
MRS Score	Group A (n=34) Peri	17.5	4.136	11.00 - 27.00	0.189
	Group B (n=34) Post	19.09	5.61	9.00 - 31.00	
Flexibility (cm)	Group A (n=34) Peri	38.29	4.435	28.00 - 47.00	<0.001**
	Group B (n=34) Post	24.77	4.459	17.00 - 32.00	
Balance - Right Leg (sec)	Group A (n=34) Peri	39.56	6.2	25.00 - 48.00	<0.001**
	Group B (n=34) Post	24.62	5.56	15.00 - 37.00	
Balance - Left Leg (sec)	Group A (n=34) Peri	37.06	5.027	27.00 - 46.00	<0.001**
	Group B (n=34) Post	19.82	5.67	10.00 - 31.00	

Table-2: Somatic Dominance: Joint and muscle discomfort is the most prevalent severe symptom in both groups, with 61.76% of perimenopausal and 52.94% of postmenopausal women reporting moderate to severe levels. This correlates with the significant decline in objective flexibility ($p < 0.001$) noted in the physical tests.

Worsening Vasomotor and Urogenital Trends: While many symptoms remain stable, the frequency of "moderate to severe" hot flashes increases from 14.71% in perimenopause to 26.47% in post menopause. Similarly, moderate to severe bladder problems nearly double, rising from 17.65% to 32.35%.

Psychological Stability: Symptoms of anxiety and depression show remarkable consistency between the groups, with moderate to severe depression affecting exactly 23.53% of participants in both phases.

The transition to postmenopausal is characterized by a stable but high burden of psychological and urogenital distress, accompanied by a notable intensification of vasomotor symptoms (hot flashes) and bladder-related issues.

Feature	**Severity**	**Perimenopausal (n=34)**	**Postmenopausal (n=34)**
Somatic Symptoms		**n (%)**	**n (%)**
Hot flashes	No symptoms	5 (14.71%)	5 (14.71%)
Hot flashes	Moderate to severe	5 (14.71%)	9 (26.47%)
Joint & muscle discomfort	No symptoms	0 (0.00%)	4 (11.76%)
Joint & muscle discomfort	Moderate to severe	21 (61.76%)	18 (52.94%)
Sleep disturbances	Moderate to severe	10 (29.41%)	10 (29.41%)
Psychological Symptoms			
Anxiety	Moderate to severe	7 (20.59%)	10 (29.41%)
Depression	Moderate to severe	8 (23.53%)	8 (23.53%)
Urogenital Symptoms			
Vaginal dryness	Moderate to severe	9 (26.47%)	9 (26.47%)
Bladder problem	Moderate to severe	6 (17.65%)	11 (32.35%)

DISCUSSION-

The present study was meticulously designed to evaluate and compare the balance and flexibility of peri- and postmenopausal women aged 40-55 years, a period marked by significant physiological shifts primarily driven by the reduction in estrogen levels. The findings revealed a striking dissociation between subjective symptom perception and objective physical performance. While the Menopause Rating Scale (MRS) scores indicated that symptom burden remained relatively stable between the two groups ($p = 0.189$), the objective markers of flexibility and balance underwent a highly significant deterioration ($p < 0.001$). This suggests that while women may not perceive a drastic worsening in their daily "feelings" as they move into post menopause, their physical foundation is actually experiencing a rapid collapse.

The **Menopause Rating Scale (MRS)** tracks symptom progression during reproductive aging. In perimenopausal women, psychological symptoms (anxiety, exhaustion) peak due to estrogen fluctuations, while somatic symptoms typically remain "mild to moderate" with total scores between **9–15** (Pradhan & Dave, 2019). In postmenopausal women, the symptom profile shifts toward higher **somatic and urogenital** scores (Neha et al., 2019; Bab Eghbal et al., 2025). Muscle and joint discomfort affect up to **82.8%** of this group, while urogenital issues increase with chronic estrogen deficiency (Ahuja, 2016). Total MRS scores often exceed **16 points**, categorized as "severe." Research shows "severe" symptoms jump from **2.48%** in premenopausal women to **50.12%** in postmenopausal groups (Neha et al., 2019), validating that the menopausal transition is a primary driver of the musculoskeletal and postural instability observed in this present study.

The high prevalence of joint and muscle pain reported in the MRS across both cohorts—affecting over 60% of the perimenopausal group—is deeply consistent with the "Indian Menopause Profile." Research by Khatoon et al. (2018) and studies conducted by the Indian Menopause Society consistently highlight that Indian women report higher rates of somatic and musculoskeletal distress compared to Western cohorts, who often report more psychological or vasomotor symptoms. This musculoskeletal focus in the MRS directly correlates with the results of the Sit and Reach test, where postmenopausal women exhibited a mean reach nearly 14 cm shorter than their perimenopausal counterparts. This precipitous drop in flexibility likely stems from estrogen withdrawal, which Bondarev et al. (2018) identified as a key factor in the reduction of collagen content and water-binding capacity in connective tissues, leading to the joint stiffness and lumbar immobility observed in this study.

Furthermore, the deterioration in the Single Leg Stance (SLS) test—particularly the nearly 50% drop in balance duration on the left leg—presents a serious clinical concern. According to normative data provided by Springsteed et al., women in this age bracket should ideally maintain balance for approximately 35-40 seconds. While the perimenopausal group in this study met these healthy standards,

the postmenopausal group fell significantly below them, averaging only about 20-24 seconds. This decline in postural stability is a known consequence of both neuromuscular aging and the loss of estrogen's protective effect on the vestibular system. In the Indian context, where vitamin D deficiency and lower baseline muscle mass (sarcopenia) are prevalent, this loss of balance increases the vulnerability to falls much earlier than previously anticipated in clinical settings.

Ultimately, the present study underscores the fact that objective physical decline in flexibility and balance precedes a significant shift in subjective symptom reporting. As the MRS scores did not show a statistical increase, a woman might mistakenly believe her physical health is plateauing when it is, in fact, declining. This highlights a critical "window of opportunity" during perimenopause for targeted interventions. Healthcare providers should prioritize specialized exercise programs focusing on core stability and proprioceptive training during the perimenopausal stage to build a functional reserve. By addressing these objective markers before the transition to post menopause is complete, it is possible to mitigate the steep decline in mobility and enhance the long-term quality of life and independence for women as they navigate this critical biological stage.

The findings of this study demonstrate a clear divergence between the subjective experience of menopause and objective physical performance. While the perimenopausal group (Group A) and postmenopausal group (Group B) exhibited a noticeable trend in symptom severity via the Menopause Rating Scale (MRS)—with Group B reporting a higher mean score of 19.088 compared to 17.5 in Group A—the statistical analysis revealed that this difference was not significant ($p = 0.189$). This lack of significance suggests a substantial overlap in how women experience the menopausal transition, likely influenced by individualized factors such as genetics, lifestyle, and overall health. These results mirror the complexities noted by Espirito Santo and Aibar-Almazán, who found that while symptom severity varies, psychological symptoms specifically are often independently linked to poorer postural balance in postmenopausal populations[8]. This highlights that while the total symptom burden may appear stable, the underlying physiological impact is far more profound than subjective reports might suggest.

A highly significant disparity was observed in musculoskeletal flexibility, as measured by the Sit and Reach Test ($p < 0.001$). The perimenopausal women maintained a mean flexibility of 38.294 cm, whereas the postmenopausal group dropped significantly to 24.765 cm. This nearly 14 cm decline represents a critical loss of mobility in the lower back and hamstring muscles. While Anadkat and Tanna previously suggested that flexibility might remain unaffected in the early postmenopausal period, the current findings align more closely with research attributing such declines to the withdrawal of estrogen[9]. Estrogen is essential for maintaining collagen production and connective tissue elasticity; as levels drop, the structural integrity of musculoskeletal tissues diminishes, leading to the stiffness and reduced range of motion observed in Group B[10,11].

The most critical functional decline was identified in postural stability, where the Single Leg Stance Test revealed a marked reduction in balance for both legs ($p < 0.001$). The perimenopausal group showed robust stability (Right: 39.56s; Left: 37.059s), while the postmenopausal group struggled to maintain balance (Right: 24.618s; Left: 19.824s). These findings are supported by Khangare et al., who observed that dynamic balance and bone density are significantly reduced in postmenopausal women[12]. The decline in estrogen during menopause impairs neuromuscular functions, including proprioception and the speed of information processing in the brain, which are vital for maintaining an upright posture. As noted in recent literature, the loss of estrogen's protective effect on muscle coordination and the sensory systems directly increases the risk of falls and subsequent fractures [13,14].

Ultimately, this study underscores that the transition from perimenopause to post menopause is characterized by an objective collapse in physical foundation—specifically balance and flexibility—even when subjective symptoms remain statistically similar. Because falls and reduced mobility can lead to a cycle of decreased self-confidence, morbidity, and loss of independence, there is an urgent need for targeted physical interventions. Regular exercise focusing on balance, proprioception, and flexibility training should be integrated into healthcare strategies for women aged 40–55. Such programs can mitigate the effects of estrogen deficiency, improve body composition, and enhance musculoskeletal health, ensuring that postmenopausal women can maintain their quality of life and physical autonomy throughout the aging process[10].

Correlation with Indian Research: This finding mirrors a study by Khatoon et al. (2018) in Northern India, which suggested that the symptomatic "peak" often occurs during the late perimenopausal phase and plateaus into early postmenopause. The Somatic Burden: Interestingly, Joint and Muscle Discomfort was the most prevalent severe symptom across your entire cohort (over 50–60%). This is highly consistent with the Indian Menopause Society (IMS) observations, where Indian women report higher somatic/musculoskeletal distress compared to Western cohorts, who often report more psychological symptoms.[16]

The most statistically profound finding in the present study shows the highly significant decline ($p < 0.001$) in flexibility, with postmenopausal women reaching nearly 14 cm less than their perimenopausal counterparts.

Research by Bondarev et al. (2018)[17] indicates that the rapid drop in estradiol leads to a decrease in collagen content and skin thickness. Present study suggests that in the Indian context, this biological decline may be compounded by lifestyle factors. While international studies often show a gradual 1–2% decline in flexibility per year, your data shows a "drop-off" effect. This suggests that the transition to post menopause acts as a catalyst for joint stiffness in present study population, far exceeding standard age-related expectations.

Neuromuscular Deterioration and Balance (SLS) in present results for the Single-Leg Stance (SLS) revealed a drastic reduction in balance, particularly on the left leg, which dropped from 37.06s to 19.82s. In comparison to Springsteed et al.[18], the normative balance time for women aged 50–55 is approximately 35 seconds. While your perimenopausal group met these standards, in present study postmenopausal group fell significantly below them.

Studies in The Journal of Physical Therapy Science have proposed that estrogen receptors in the vestibular system and muscle spindles play a role in postural control. Present study results provide strong evidence that the postmenopausal state in Indian women is associated with a heightened risk of instability, even before they reach "old age."[4]. The most critical takeaway from this present study is the Dissociation Phenomena. The women do not feel significantly worse as they move from perimenopause to post menopause (as shown by the stable MRS scores), their physical foundation—balance and flexibility—is collapsing.

CONCLUSION:

In conclusion, this study demonstrates that while subjective symptom severity remains statistically comparable between peri- and postmenopausal women, objective markers of physical performance undergo a significant decline. Specifically, postmenopausal status is associated with a highly significant deterioration in musculoskeletal flexibility ($p < 0.001$) and a marked reduction in unipedal balance for both the right and left legs ($p < 0.001$). These findings suggest that the withdrawal of estrogen during the menopausal transition acts as a catalyst for functional impairment, independent of the perceived severity of symptoms.

These results underscore the clinical necessity for early, tailored interventions—such as specialized flexibility and balance training—initiated during the perimenopausal phase to mitigate fall risks and maintain physical independence. While this cross-sectional analysis provides a clear snapshot of the functional "tipping point" in menopause, longitudinal research is warranted to further refine exercise protocols and long-term health strategies for this population.

Strengths of the Study

- **Objective Physical Profiling:** By utilizing validated functional tests like the Sit and Reach and Single Leg Stance, the study provides a quantitative baseline of physical decline that subjective scales (MRS) cannot capture.
- **Homogeneous Cohort:** The specific age range (40–55 years) effectively isolates the physiological transition period, reducing the impact of unrelated geriatric pathologies on the results.
- **Standardized Methodology:** The high statistical significance ($p < 0.001$) across all physical variables confirms that the functional differences between peri- and postmenopausal women are robust and not due to chance.

Limitations of the Study

- **Sample Size and Generalizability:** The relatively small sample size drawn from a specific geographic area may limit the generalizability of the results to a broader, more diverse population.
- **Cross-Sectional Design:** As a snapshot study, it cannot track individual physiological changes over time or establish definitive causal relationships between estrogen withdrawal and functional loss.
- **Lack of Confounding Controls:** The study did not account for variables such as nutritional status (Vitamin D/Calcium intake) or specific baseline activity levels (sedentary vs. active lifestyle), which could independently influence flexibility and balance.

Clinical Implications

The significant deterioration in balance and flexibility observed in postmenopausal women highlights a critical window for geriatric intervention. The reduction in estrogen leads to decreased muscle elasticity and compromised neuromuscular coordination, substantially increasing the risk of falls and subsequent fractures. This "dissociation" between what women feel (MRS scores) and how they perform physically means that healthcare providers must prioritize **objective functional screening** rather than relying solely on subjective reports.

- **Early Intervention:** Targeted exercise programs focusing on proprioception, core stability, and hamstring flexibility should be initiated during the perimenopausal phase to build a functional reserve.
- **Multimodal Programs:** Clinical practitioners should encourage activities such as yoga, tai chi, and Pilates, which are proven to enhance neuromuscular control and joint mobility.
- **Comprehensive Care:** Routine assessments of balance and flexibility should be integrated into standard postmenopausal health screenings to detect early functional loss, thereby preventing the cascade of health issues associated with falls and maintaining long-term independence.

Future Scope of the Study

The findings of this study provide a foundation for several critical avenues of future research aimed at preserving functional independence in aging women:

- **Expansion of Demographic Diversity:** Future studies should utilize larger, multi-centric cohorts encompassing diverse geographic, ethnic, and socioeconomic backgrounds. This would determine if the observed dissociation between subjective symptoms and objective physical decline is a universal phenomenon or influenced by regional lifestyle factors.
- **Longitudinal Monitoring:** Transitioning from cross-sectional to longitudinal designs is essential to map the exact trajectory of functional loss. Tracking participants from pre-menopause through late post-menopause would help identify the specific physiological "tipping point" for balance and flexibility.
- **Interventional Comparative Trials:** Research should pivot toward randomized controlled trials (RCTs) to evaluate the comparative efficacy of various modalities—such as Hormone Replacement Therapy (HRT), targeted resistance training, and proprioceptive exercises (e.g., Yoga or Tai Chi)—in mitigating musculoskeletal stiffness and fall risk.
- **Biometric Integration:** Exploring the correlation between objective physical performance and metabolic markers (e.g., Vitamin D levels, bone mineral density, and serum estradiol) would provide a more holistic understanding of the biochemical drivers behind neuromuscular decline.

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