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Clinical Implications of Prolonged Squat Sitting on Balance in Healthy Young Adults

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Abstract

Background: Prolonged squat sitting remains a common sitting position in many occupational and domestic settings, especially in Asian populations. Although these deep flexion sitting postures are considered functionally convenient and culturally familiar, they can put substantial mechanical load on the knee and ankle joints, impact lower-limb muscle activity and disturb proprioceptive input. The effects of prolonged squat sitting on balance remain clinically important yet less focused in research studies although impaired balance may increase the risk of instability, slips, falls and work related injury. **Objective:** To examine the immediate effects of prolonged squat sitting on static and dynamic balance in healthy young adults. **Methods:** This pre-post experimental study recruited 30 asymptomatic participants aged 17–25 years from Karachi, Pakistan, using convenient sampling. Participants were made to maintain a deep squat sitting position for 30 minutes per day for three consecutive days. Static balance on each leg was assessed using Stork Stand Test (SST), and dynamic balance was assessed through Star Excursion Balance Test (SEBT). Pre- and post-intervention scores were analyzed in SPSS version 21 using descriptive statistics and within-subject comparisons. Statistical significance was

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set at $p < 0.05$. **Results:** The mean age of the sample was 20.53 ± 1.43 years; 56.7% were males and 43.3% were females. Static balance improved slightly after squat sitting, increasing from 21.50 to 23.28 seconds on the right leg and from 18.52 to 19.04 seconds on the left leg. On the other hand, dynamic balance declined across most SEBT directions after the intervention. For the right leg, normalized reach distance decreased in seven of eight directions while for the left leg, similar reductions in reach were observed in most directions, with only minimal directional improvement in the medial plane. Percentage summaries showed an overall decline of 6.34% for the right leg and 6.78% for the left leg. The source analysis reported statistically significant pre-post differences for static balance and all dynamic balance directions. **Conclusion:** Prolonged squat sitting appears to compromise dynamic balance more consistently than static balance in healthy young adults. Even when absolute changes are modest, the observed decline in dynamic balance has practical implications for occupations as well as daily activities that require repeated or sustained deep flexion sitting postures. Regular posture variation, task modification and conditioning of lower-limb endurance and balance should be incorporated to minimize functional instability.

Keywords: squat sitting, static balance, postural control, dynamic balance, sitting postures

Introduction

Prolonged floor level and deep flexion sitting postures are still frequently adopted in many work and home conditions, particularly in South Asia and other regions where squat sitting, kneeling or floor sitting remain embedded in occupational tasks and daily living activities. Construction work, agriculture jobs, crafting works, manual handling, domestic chores, and toileting often require prolonged sitting with full knee and hip flexion or unsupported sitting near floor level. These postures can be practical, but they do expose the knee, hip, ankle, and lumbopelvic region to persistent mechanical overloading that has usually been associated with discomfort, osteoarthritic changes and work related functional limitations (Mehmood et al., 2025; Tjosvoll et al., 2022; Palme, 2012; Jensen et al., 2010).

Balance control depends on effective integration of visual, vestibular and somatosensory information, alongwith adequate neuromuscular responsiveness and joint mobility. When a posture is maintained for a longer period, muscular perfusion may decline leading to muscle activity patterns shifts and proprioceptive acuity can be compromised. These changes can affect movement coordination as well as postural stability, particularly during dynamic activities that challenge the base of support. Experimental and ergonomic studies suggest that posture type influences trunk muscle activation, alignment of vertebral column, respiratory mechanisms and perceived stability; all of which may contribute to compromised balance after a sustained static task (Kim et al., 2025; Min et al., 2024; Hosseinimehr et al., 2010).

Extended sitting or stationary postures have been linked with adverse metabolic and cardiovascular outcomes, decreased venous return, lower extremity edema, and generalized physical deconditioning (Bennett & Christie, 2007; Dunstan et al., 2010; Matthews et al., 2012). From a physiotherapy perspective, prolonged squat sitting is particularly relevant because it comprises of sustained static loading with substantial knee and hip flexion, which may fatigue the lower limb musculature and disturb the sensory-motor strategies required for safe single leg support and reach tasks.

The clinical question is therefore not only whether squat sitting is mechanically stressful, but also whether it produces a measurable deterioration in balance and postural performance on short term basis. This issue is important especially in conditions where an individual may need to stand, walk, reach or change direction immediately after completing prolonged squat sitting tasks. The review of literature resulted in expression of this potential gap in available evidence in this specific problem. Hecne, this study was planned in an effort to put some useful part in this gap. Dynamic balance test “Star Excursion Balance Test” (SEBT) are sensitive to subtle reductions in postural control, while static test “Stork Stand Test” (SST) can help determine whether the effect is generalized or task-specific (Beaulieu, 2012; Knox, 1969).

Accordingly, the present study examined the effects of prolonged squat sitting on static and dynamic balance in healthy young adults. It was hypothesized that a sustained squatting exposure would have a greater negative effect on dynamic balance than on static balance.

Methodology

A single-group pre-post experimental study was conducted to examine the immediate effects of prolonged squat sitting (SS) on static and dynamic balance. A convenience sample of 30 asymptomatic young adults aged 17-25 years was recruited from the general population of Karachi, Pakistan. Both male and female participants were included. Individuals were eligible if they were willing to participate and could safely assume a deep squat sitting position for 30minutes. Participants having any metabolic disease, systemic illness, musculoskeletal disorder, neurological disorder or any other condition that could interfere with balance performance were excluded.

Procedure

After informed consent had been signed by each participant, demographic information was recorded. Participants were then instructed to maintain a deep squat sitting (SS) position with feet flat on the ground and the buttocks positioned closest to but not in contact with floor. The position was maintained for 30 minutes per day on three consecutive days, with 24-hour intervals between sessions. Balance testing was performed before first session and immediately after last session of adoption of the position. This protocol was designed to simulate the sustained deep flexion postures frequently observed in domestic and occupational settings (Hewes, 1953).

Outcome Measures

Static balance was assessed with SST. Participants stood on the dominant leg with the hands placed on the hips while maintaining balance on the ball of the foot. Three trials were performed for each recording and longest holding time in seconds was recorded. Dynamic balance was assessed using the SEBT. Limb length was measured from the anterior superior iliac spine (ASIS) to the medial malleolus and reach distance was tested in eight directions; anterior, anteromedial, medial, posteromedial, posterior, posterolateral, lateral, and anterolateral. Three trials were completed in each direction and normalized reach distance was calculated as [(excursion distance / limb length) × 100]. The mean normalized value was used for statistical analysis (Knox, 1969; Beaulieu, 2012).

Statistical Analysis

Data was analyzed using SPSS version 21.0. Descriptive statistics were calculated for age, sex, static balance and dynamic balance. Pre and post-exposure values were compared using within-subject analysis and $p < 0.05$ was considered statistically significant.

Results

Thirty participants completed the study. The mean age was 20.53 ± 1.43 years (range 17–23 years). Seventeen participants (56.7%) were males and thirteen (43.3%) were females.

Static balance showed only small absolute changes after the ST exposure. On the right side, mean SST time score increased from 21.50 ± 17.0 seconds pre-intervention to 23.28 ± 21.0 seconds post-intervention. On the left side, the mean score increased from 18.52 ± 11.4 seconds to 19.04 ± 16.0 seconds. The analysis reported statistically significant pre-post differences for both limbs. Table-1

Dynamic balance, measured with the SEBT, demonstrated an adverse response. For the right leg, normalized reach distance declined in the anterior, anteromedial, posteromedial, posterior, posterolateral, lateral and anterolateral directions after intervention while medial direction showed a slight numerical increase. For the left leg, most directions also decreased after squatting, whereas the anteromedial and medial directions showed minimal numerical preservation or improvement. Despite the small

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magnitude of some directional changes, the analysis reported statistically significant pre-post differences in all right and left leg directions and ($p < 0.001$). (Table-2,3)
Percentage summaries indicated an overall decline in dynamic balance of 6.34% for right leg and 6.78% for left leg following squat sitting. Conversely, percentage change in static balance suggested slight post-intervention improvement (8.0% on right and 2.7% on left), indicating that prolonged squatting affected dynamic postural control more clearly than static balance on single leg. (Table-4)

Table 1: *Static balance (Pre and Post Squat Sitting Position)*

Measure	Right leg pre-intervention (M±SD)	Right leg post-intervention (M±SD)	Left leg pre-intervention (M±SD)	Left leg post-intervention (M±SD)	p value
SST Holding Time	21.50 ± 17.0	23.28 ± 21.0	18.52 ± 11.4	19.04 ± 16.0	Right: 0.001 Left: <0.001

Table 2: *Right-leg dynamic balance (SEBT) before and after prolonged Squat Sitting*

Direction	Pre-intervention	Post-intervention	p value
Anterior	92 ± 13.5	91 ± 12	<0.001
Anteromedial	92 ± 12.7	89 ± 9	<0.001
Medial	86 ± 16.8	87 ± 15	<0.001
Posteromedial	95 ± 16	94 ± 14.7	<0.001
Posterior	102 ± 15.7	101 ± 16	<0.001
Posterolateral	100 ± 16	99 ± 13.7	<0.001
Lateral	95 ± 14	95 ± 13	<0.001
Anterolateral	93.7 ± 11.8	93 ± 11	<0.001

Table 3: *Left-leg dynamic balance (SEBT) before and after prolonged Squat Sitting*

Direction	Pre-intervention	Post-intervention	p value
Anterior	93 ± 12	92 ± 11	<0.001
Anteromedial	92 ± 10	92 ± 10	0.001
Medial	90 ± 11	92 ± 10	0.002
Posteromedial	99 ± 13.7	96 ± 13	<0.001
Posterior	104 ± 13.6	103 ± 14	<0.001
Posterolateral	100 ± 16	99 ± 14	<0.001
Lateral	94 ± 15	94 ± 14	<0.001
Anterolateral	94 ± 12	92 ± 11	<0.001

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Table 4: *Percentage change in balance after prolonged squatting*

Outcome	Right side	Left side
Static balance	+8.0%	+2.7%
Dynamic balance	−6.34%	−6.78%

Discussion

The principal findings of this study stated that prolonged squat sitting had a clearer adverse effect on dynamic balance than on static balance. Static single leg stance time increased only slightly after the intervention, whereas dynamic reach performance decreased across most SEBT directions. This suggests that prolonged deep flexion postures may not immediately destabilize quiet single leg standing to a clinically obvious extent. However, they may reduce the quality of sensorimotor control needed for more demanding dynamic balance tasks that involve reaching, weight shifting, and continuous postural readjustment.

A plausible for this is that sustained SS produces transient lower-limb fatigue, affects muscle activation and reduced proprioceptive input efficiency. Deep knee and hip flexion can challenge circulation and put prolonged load on the quadriceps, calf muscles, other soft tissues and mechanoreceptors around hip, knee and ankle joints. Fatigue related changes in neuromuscular recruitment have been found associated with reduced postural control in dynamic activities, even when static performance appears relatively preserved (Mehmood et al., 2023; Hosseinimehr et al., 2010). The present findings are therefore consistent with the concept that dynamic balance tests are more sensitive than static stance tests for identifying subtle post-exposure deficits.

The results of this study are also aligned with ergonomic and postural research on floor level sitting. Min et al. (2024) showed that different floor sitting styles affect trunk muscle fatigue and perceived postural stability, while Demura and Uchiyama (2005) reported altered postural control after traditional floor sitting. Similarly, Liu et al. (2025) demonstrated that floor sitting positions during smartphone use can adversely impact spinal and pelvic alignment. Although these studies examined somewhat different postures and outcomes, together they support the broader idea that prolonged constrained postures can derange neuromuscular efficiency as well as postural regulation.

From a clinical perspective, these findings are clinically meaningful. Workers in construction, agriculture, craft occupations and informal labor sectors may need transition rapidly from prolonged SS to standing, stepping or turning after some time in each posture. If dynamic balance is slightly reduced after such exposure, risk of missteps, instability and/or overloading of the lower extremities may increase. Prolonged kneeling and SS have also been linked with structural knee abnormalities and accelerated osteoarthritic changes over time (Palme, 2012; Jensen et al., 2010). Thus, the present results do add a functional perspective to an already evident risky musculoskeletal exposure.

The lack of a marked decline in static balance also deserves consideration. Static single leg stance may have been maintained probably because the participants were quite young, asymptomatic adults with expectedly adequate baseline neuromuscular reserve. Additionally, SST may be less sensitive than the SEBT to detect small changes after intervention exposure. It is therefore reasonable to interpret the present findings not as evidence that ST is harmless to postural function, but rather that its early effects may be more detectable during dynamic balance tasks than during static balance.

Limitations and Recommendations

This study has some limitations. The sample size was small, participants were recruited by convenience sampling from a single city and only healthy young adults were included, which limits generalizability to older adults, symptomatic individuals or subjects with long term exposure histories. The study also focused on short term response missing chronic adaptation chances. Future studies should include larger samples, occupationally exposed populations, instrumented balance assessment and comparison of different floor based postures and exposure durations.

Clinical Implications

The study also offers useful clinical implications along with limitations. Physiotherapists and ergonomists should consider advising workers and community members who frequently sit in squat position for longer periods to alter postures, use scheduled microbreaks and undertake lower limb endurance, mobility and balance promoting exercises.

Conclusion

Prolonged squat sitting appears to impair dynamic balance significantly while static balance is barely affected in healthy young adults. The findings suggest that sustained deep flexion postures may compromise dynamic postural control immediately and should therefore be considered in physiotherapy screening, ergonomic planning and injury prevention strategies.

Practical Recommendations

Posture variation during tasks that require prolonged squatting should be encouraged. Short recovery breaks, task redesign and maintenance of lower limb strength, endurance

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and balance capacity may help minimize transient instability and discomfort after sustained squatting.

Ethical Considerations

Participants were informed about the purpose and procedures of the study, written consent was signed by each participant and confidentiality of participants' data was maintained for research and publication purposes. Researchers also made it sure to align with the guidelines of Declaration of Helsinki.

Conflict of Interest

Authors declare no conflict of interest.

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