

Association Between Orthostatic Blood Pressure Changes, Falls Risk, and Functional Mobility Among Patients with Parkinson's Disease in Lahore, Pakistan: An Analytical Cross-Sectional Study.

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ABSTRACT

Background: Orthostatic blood-pressure reductions and mobility impairments may coexist in Parkinson's disease and contribute to falls. **Objective:** To examine associations between orthostatic blood-pressure changes, recorded falls, balance, and functional mobility in patients with Parkinson's disease in Lahore, Pakistan. **Methods:** An analytical cross-sectional evaluation was conducted during a six-month study period at the University of Lahore. Purposive sampling yielded 37 participants. Blood pressure was recorded at baseline and after 1 and 3 minutes of standing. Orthostatic hypotension was defined as a maximum systolic decrease of at least 20 mmHg or a diastolic decrease of at least 10 mmHg. Recorded falls, modified Hoehn-Yahr stage, Timed Up and Go, Berg Balance Scale, and gait speed were analyzed. **Results:** Orthostatic hypotension occurred in 12/37 patients (32.4%). At least one fall was recorded in 10/12 (83.3%) with and 11/25 (44.0%) without orthostatic hypotension (odds ratio 6.36, 95% CI 1.15–35.23; Fisher $p=0.035$). After adjustment for age and disease stage, the association was inconclusive (odds ratio 3.92, 95% CI 0.61–25.28; $p=0.151$). Mean Timed Up and Go, balance and gait-speed differences by orthostatic status were not statistically significant. **Conclusion:** Orthostatic hypotension was frequent and associated with recorded falls in un analysis, but independent associations with falls and mobility were not established. **Keywords:** Parkinson's disease; orthostatic hypotension; falls; balance; gait speed; functional mobility; Lahore.

INTRODUCTION

Parkinson's disease is a progressive neurodegenerative condition characterized by motor impairment and diverse non-motor manifestations. Cardiovascular autonomic dysfunction, particularly orthostatic hypotension, can compound motor disability through standing-related light-headedness, presyncope, and reduced tolerance of upright activities. Contemporary reviews and meta-analyses document clinically important variability in the frequency and functional consequences of orthostatic hypotension in Parkinson's disease (1-3).

Orthostatic hypotension is conventionally identified by a reduction in systolic blood pressure of at least 20 mmHg or diastolic blood pressure of at least 10 mmHg within three minutes of standing. Longitudinal studies show that postural blood-pressure abnormalities may emerge or change over the course of Parkinson's disease, while more recent evidence has examined their relationship with walking performance. Transient changes and delayed recovery introduce additional complexity because intermittent cuff measurements may not capture the full early orthostatic response (4-6).

Falls arise through interacting motor, autonomic, medication-related, environmental, and behavioral pathways. Postural instability, reduced gait adaptability, freezing of gait, and disease progression are established contributors, while orthostatic symptoms may aggravate instability at transfers or during walking. Prevention frameworks consequently favor multidomain assessment rather than reliance on a single physiological or motor measure (7-9).

Fear of falling and freezing of gait may further restrict activity and alter mobility. Prospective and longitudinal investigations have linked these features to future falls or functional decline, while systematic review evidence emphasizes that mobility reflects both motor and non-motor determinants. A combined assessment of physiological and functional factors therefore has potential clinical value (10-12).

The Berg Balance Scale is a recognized measure of balance performance, including a psychometrically evaluated Urdu version in patients with Parkinson's disease. Nevertheless, no single clinical scale entirely captures fall susceptibility. Orthostatic measurement protocols also influence case identification, and the distinction between neurogenic and non-neurogenic hypotension requires information beyond a single threshold-based standing test (13-16).

Against this background, the present study examined the association of orthostatic blood-pressure changes with recorded falls, balance, and functional mobility among patients with Parkinson's disease at the University of Lahore,

Lahore, Pakistan. The primary comparison was between participants meeting and not meeting the prespecified orthostatic hypotension criterion; disease-stage gradients and related clinical features were assessed as complementary factors.

MATERIALS AND METHODS

An analytical cross-sectional observational study was conducted at the University of Lahore, Lahore, Pakistan, during a six-month study period. A purposive sampling approach was used to recruit patients with Parkinson's disease presenting for clinical assessment. The supplied analytical dataset comprised 37 participants. Each participant contributed one set of demographic, clinical, orthostatic blood-pressure, fall-history, and mobility observations; the standing blood-pressure sequence represented measurements within the same assessment rather than repeated visits over six months.

Demographic and clinical variables included age, sex, height, weight, body mass index (BMI), duration of Parkinson's disease, modified Hoehn-Yahr stage, recorded antiparkinsonian therapy, time since medication, medication ON/OFF state, antihypertensive treatment, diabetes, hypertension, cardiovascular disease, and habitual walking-aid use. Height and weight were used to verify BMI consistency. The modified Hoehn-Yahr values in the supplied dataset comprised stages 1, 1.5, 2, 2.5, 3, 4, and 5.

Systolic and diastolic blood pressures and heart rate were recorded at baseline and at 1 and 3 minutes after standing. Dizziness at each standing assessment was recorded as present or absent. Maximum systolic and diastolic blood-pressure decreases were calculated separately by subtracting the lowest respective standing measurement at either interval from the baseline value. Orthostatic hypotension was defined as a systolic decrease of ≥ 20 mmHg or a diastolic decrease of ≥ 10 mmHg within three minutes. This operational definition identifies orthostatic hypotension on the available measurements but does not, on its own, establish a neurogenic mechanism or exclude an earlier transient response (2,3,15,16).

Recorded fall count was treated as a discrete history variable and categorized as zero versus at least one recorded fall. Functional mobility measures included the Timed Up and Go test (seconds), Berg Balance Scale (0–56 points), and gait speed (m/s). The Timed Up and Go test assesses the timed performance of a functional transfer and walking task; the Berg Balance Scale quantifies performance on balance tasks, with higher scores reflecting better balance ability. These instruments have been evaluated in Parkinson's disease populations, including local-language balance-scale validation (13,14,17,18). Fear of falling, freezing of gait, and use of an aid during assessment were analyzed as recorded binary clinical variables.

Continuous variables were summarized as mean $\pm$ standard deviation, and categorical variables as count and percentage. Between-group comparisons of continuous measures used Welch's two-sample t test with mean-difference 95% confidence intervals; Mann-Whitney tests were examined as distribution-robust supplementary analyses. Categorical comparisons used Fisher's exact test when appropriate. Logistic regression assessed the association between orthostatic hypotension and having at least one recorded fall, first un and then adjusting for age and modified Hoehn-Yahr stage. Exploratory linear regressions examined Timed Up and Go time, Berg Balance Scale score, and gait speed as outcomes adjusting for age and stage, with heteroscedasticity-robust standard errors. The significance level was set at 0.05, interpreted in light of the small sample and exploratory multiple comparisons. SPSS version 26.0 was the stated analysis platform; numerical estimates in the supplied study dataset were independently checked using reproducible statistical computation.

The available dataset was assessed for duplicates, missing values, physiologically plausible ranges, BMI consistency, and agreement between recorded and recalculated orthostatic classifications. Complete observations were used separately for each analysis; one patient with stage 5 disease had no Timed Up and Go or gait-speed entry, reducing those analyses to 36 participants. Ethical approval was obtained from the University of Lahore, Lahore, Pakistan, and informed consent was obtained from participants.

RESULTS

All 37 supplied records were included. Mean age was 70.8 ± 5.6 years, mean disease duration was 6.9 ± 2.1 years, and the mean modified Hoehn-Yahr stage was 2.69 ± 0.97 . The sample included 20 men (54.1%), 16 women (43.2%), and one participant recorded as another gender (2.7%). Nineteen participants (51.4%) had recorded hypertension, and 21 (56.8%) had at least one recorded fall (Table 1).

Mean baseline systolic and diastolic pressures were 135.3 ± 10.0 and 77.6 ± 6.6 mmHg, respectively. Average systolic pressure decreased to 121.9 ± 12.6 mmHg after one minute and 121.5 ± 12.1 mmHg after three minutes. Mean maximum systolic and diastolic decreases were 16.6 ± 9.1 and 7.7 ± 4.4 mmHg. Twelve participants (32.4%) met the orthostatic hypotension criterion. Recalculated maximum decreases and orthostatic status agreed with the dataset's recorded values for all participants (Table 2).

At least one recorded fall occurred in 10 of 12 participants with orthostatic hypotension (83.3%) compared with 11 of 25 without orthostatic hypotension (44.0%; un odds ratio [OR] 6.36, 95% CI 1.15–35.23; Fisher's exact $p=0.035$). The mean fall count was 2.00 ± 1.35 versus 0.92 ± 1.35 (mean difference 1.08, 95% CI 0.10–2.06; Welch $p=0.033$). Freezing of gait was recorded in 11 of 12 (91.7%) versus 11 of 25 (44.0%; OR 14.00, 95% CI 1.56–125.61; Fisher $p=0.011$). One-minute dizziness was recorded in 7 of 12 (58.3%) versus 3 of 25 (12.0%; $p=0.006$), and three-minute dizziness in 5 of 12 (41.7%) versus 2 of 25 (8.0%; $p=0.025$). These secondary findings were exploratory (Table 3).

Mean Timed Up and Go time was 17.43 ± 6.38 seconds among those with orthostatic hypotension ($n=11$) and 16.05 ± 9.16 seconds among those without ($n=25$), with a mean difference of 1.38 seconds (95% CI –4.07 to 6.83; $p=0.608$). Mean Berg Balance Scale scores were 36.92 ± 12.07 versus 42.40 ± 10.55 points (difference –5.48, 95% CI –14.00 to 3.03; $p=0.194$). Mean gait speeds were 0.709 ± 0.260 and 0.846 ± 0.313 m/s (difference –0.137 m/s, 95% CI –0.345 to 0.070; $p=0.184$). None of these un functional comparisons reached the conventional significance threshold (Table 4).

Table 1. Demographic and clinical characteristics of participants ($n=37$)

Characteristic	Total ($n=37$)
Age, years	70.8 ± 5.6
Sex: male	20 (54.1%)
Sex: female	16 (43.2%)
Sex: other	1 (2.7%)
BMI, kg/m ²	25.7 ± 4.1
Parkinson's disease duration, years	6.9 ± 2.1
Modified Hoehn–Yahr stage	2.69 ± 0.97
Hypertension	19 (51.4%)
Diabetes	8 (21.6%)
Cardiovascular disease	3 (8.1%)
Receiving BP medication	14 (37.8%)
Medication state: ON	31 (83.8%)
Habitual walking aid: none	16 (43.2%)
Habitual walking aid: cane	8 (21.6%)
Habitual walking aid: walker	6 (16.2%)
Habitual walking aid: other	7 (18.9%)
At least one recorded fall	21 (56.8%)

Continuous values are mean $\pm$ SD; categorical values are n (%).

Table 2. Orthostatic blood pressure and symptom measurements

Measure	Value ($n=37$)
Baseline SBP, mmHg	135.3 ± 10.0
Baseline DBP, mmHg	77.6 ± 6.5
One-minute standing SBP, mmHg	121.9 ± 12.6
One-minute standing DBP, mmHg	71.6 ± 9.0
Three-minute standing SBP, mmHg	121.5 ± 12.1
Three-minute standing DBP, mmHg	71.1 ± 9.1
Maximum within-visit SBP decrease, mmHg	16.6 ± 9.1
Maximum within-visit DBP decrease, mmHg	7.7 ± 4.4
Dizziness at one minute	10 (27.0%)
Dizziness at three minutes	7 (18.9%)
Orthostatic hypotension	12 (32.4%)

SBP, systolic blood pressure; DBP, diastolic blood pressure. Maximum decrease at either one or three minutes calculated separately for SBP and DBP.

Table 3. Recorded falls and exploratory clinical features by orthostatic status

Measure	OH ($n=12$)	No OH ($n=25$)	Un OR (95% CI)	Fisher p
At least one recorded fall	10 (83.3%)	11 (44.0%)	6.36 (1.15–35.23)	0.035
Freezing of gait	11 (91.7%)	11 (44.0%)	14.00 (1.56–125.61)	0.011
Fear of falling	4 (33.3%)	2 (8.0%)	5.75 (0.88–37.62)	0.073
Dizziness at one minute	7 (58.3%)	3 (12.0%)	10.27 (1.94–54.27)	0.006
Dizziness at three minutes	5 (41.7%)	2 (8.0%)	8.21 (1.30–51.99)	0.025

OH, orthostatic hypotension; OR, odds ratio; CI, confidence interval. Fisher p values are two-sided; secondary comparisons are exploratory.

Table 4. Functional measures by orthostatic hypotension status

Outcome	OH	No OH	Mean difference (95% CI)	Welch p
Timed Up and Go, s	17.43 ± 6.38 (n=11)	16.05 ± 9.16 (n=25)	1.38 (-4.07 to 6.83)	0.608
Berg Balance Scale, points	36.92 ± 12.07 (n=12)	42.40 ± 10.55 (n=25)	-5.48 (-14.00 to 3.03)	0.194
Gait speed, m/s	0.709 ± 0.260 (n=11)	0.846 ± 0.313 (n=25)	-0.137 (-0.345 to 0.070)	0.184
Recorded fall count	2.00 ± 1.35 (n=12)	0.92 ± 1.35 (n=25)	1.08 (0.10 to 2.06)	0.033

Mean difference = OH minus no OH; values are mean ± SD unless stated otherwise; Welch tests are exploratory.

Table 5. Clinical gradients by modified Hoehn-Yahr stage

Measure	Stages 1-2 (n=13)	Stages 2.5-3 (n=17)	Stages 4-5 (n=7)
Orthostatic hypotension, n (%)	3 (23.1%)	6 (35.3%)	3 (42.9%)
At least one recorded fall, n (%)	4 (30.8%)	12 (70.6%)	5 (71.4%)
Timed Up and Go, s	10.49	15.59	31.92
Berg Balance Scale, points	50.08	41.24	21.57
Gait speed, m/s	1.096	0.736	0.365

Stage bands are descriptive only. Timed Up and Go and gait speed available in n=6 of 7 participants at stages 4-5.

Table 6. Regression analyses for falls and functional mobility

Outcome	OH estimate	95% CI	p
Any recorded fall, crude OR	6.36	1.15-35.23	0.034
Any recorded fall, OR	3.92	0.61-25.28	0.151
Timed Up and Go, β (s)	-0.45	-2.73 to 1.83	0.700
Berg Balance Scale, β (points)	-0.82	-2.81 to 1.18	0.423
Gait speed, β (m/s)	-0.071	-0.169 to 0.028	0.159

models include age and modified Hoehn-Yahr stage. OR from logistic regression; linear regression β estimates use HC3 robust 95% confidence intervals. Crude logistic-regression p differs slightly from the exact Fisher p.

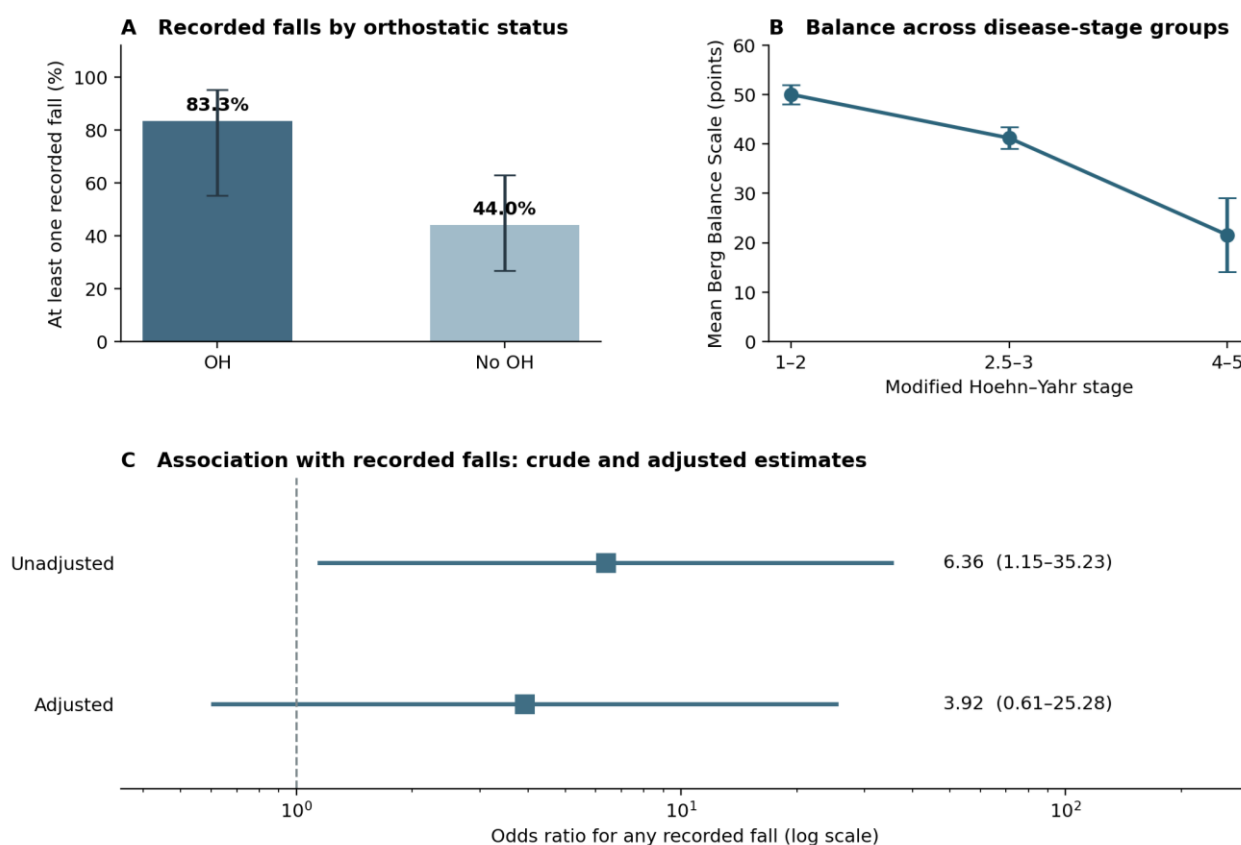


Figure 1. (A) Proportion of participants with at least one recorded fall by orthostatic hypotension status, with Wilson 95% confidence intervals. (B) Mean Berg Balance Scale scores by modified Hoehn-Yahr stage, with t-based 95% confidence intervals. (C) Un and age-/stage- odds ratios for recorded falls, with 95% confidence intervals. OH, orthostatic hypotension.

Disease-stage gradients were pronounced. Mean Timed Up and Go time was 10.49 seconds in stages 1-2, 15.59 seconds in stages 2.5-3, and 31.92 seconds in stages 4-5. Corresponding Berg Balance Scale scores were 50.08, 41.24, and 21.57 points, while gait speeds averaged 1.096, 0.736, and 0.365 m/s. Hoehn-Yahr stage showed strong rank correlations with Timed Up and Go time (Spearman $\rho=0.915$), Berg score ($\rho=-0.969$), and gait speed ($\rho=-0.954$), each $p<0.001$. The disease-stage groupings are descriptive and are not a temporal progression analysis (Table 5; Figure 1).

When age and modified Hoehn–Yahr stage were included in logistic regression, the association between orthostatic hypotension and at least one recorded fall was attenuated and statistically inconclusive (OR 3.92, 95% CI 0.61–25.28; $p=0.151$). In age- and stage- linear models, orthostatic hypotension was not significantly associated with Timed Up and Go time ($\beta=-0.45$ seconds, 95% CI -2.73 to 1.83 ; $p=0.700$), Berg Balance Scale score ($\beta=-0.82$ points, 95% CI -2.81 to 1.18 ; $p=0.423$), or gait speed ($\beta=-0.071$ m/s, 95% CI -0.169 to 0.028 ; $p=0.159$). Estimates were imprecise, particularly for the fall outcome (Table 6).

DISCUSSION

The present analysis identifies orthostatic hypotension in approximately one-third of assessed patients with Parkinson's disease and demonstrates an un association with recorded falls. However, adjustment for age and disease stage reduced the precision and strength of the fall association, and orthostatic status was not independently associated with measured functional mobility. The results distinguish a clinically relevant crude association from an unproven independent effect.

The proportion meeting the orthostatic hypotension threshold is broadly consistent with the variable prevalence described in contemporary systematic and clinical literature (1–3,16). Parkinsonian autonomic dysfunction can limit compensatory vasoconstriction during standing, while hydration status, medication exposure, and other comorbidities may contribute to the observed blood-pressure response. Because the present classification relied on intermittently recorded blood pressure and did not incorporate a validated autonomic reflex assessment, it cannot distinguish neurogenic from non-neurogenic orthostatic hypotension. Likewise, intermittent measurements cannot reliably characterize brief initial hypotensive episodes (2,3,6,15).

The un fall association accords with reports linking orthostatic intolerance and clinically important events in Parkinson's disease, although direct numerical comparisons are limited by differences in ascertainment, symptoms, disease stage, and follow-up structure (5–9). In this dataset, the OR remained above unity but its confidence interval crossed 1 and was wide. This finding should not be interpreted as either proof or refutation of an independent contribution: the study was small, covariate adjustment was limited, and current blood-pressure findings were compared with recorded falls rather than prospectively observed incident falls.

Unexpectedly, between-group differences in Timed Up and Go, Berg score, and gait speed were modest relative to their variability and were not significant. Recent work suggests that the relationship between orthostatic hypotension and gait may depend on the specific motor task and physiologic context; combining clinical performance assessments with detailed mobility testing may be more informative than either in isolation (5,19). Furthermore, the strong correlations between modified Hoehn–Yahr stage and all three functional outcomes indicate that motor disease severity accounted for a substantial gradient in mobility in this sample. A balance-confidence study has also highlighted the potential relevance of symptoms, which may not align perfectly with cuff-based BP thresholds (20).

Freezing of gait and dizziness were more frequently recorded in participants meeting the orthostatic hypotension criterion. These co-occurrences are plausible within a multifactorial disability model; however, the small numbers, multiple exploratory tests, and absence of temporally linked episodes prevent firm mechanistic conclusions. Reviews of freezing of gait emphasize heterogeneous triggers and measurement approaches, while clinical management literature recommends a broad evaluation of motor, autonomic, pharmacologic, and environmental influences when assessing falls (21–24).

The strengths of this study include participant-level verification of two timed standing blood-pressure measurements, a prespecified 20/10 mmHg orthostatic classification, and concurrent assessment of falls, disease stage, balance, and mobility. Important limitations include purposive recruitment at a single Lahore institution, a modest sample, sparse outcome events for multivariable modeling, incomplete Timed Up and Go and gait-speed data for one advanced-stage participant, and no directly observed longitudinal fall outcome. Falls were recorded as a count without a documented observation window in the supplied extract; recall and reverse-temporality biases may therefore influence associations. Supine-rest duration, measurement device, hydration conditions, and detailed medication timing relative to mobility testing could not be independently validated from the supplied data. Consequently, the findings should be interpreted as exploratory cross-sectional associations rather than evidence of progression, prognosis, or causation. Clinically, the coexistence of postural blood-pressure changes, symptoms, and impaired mobility supports a comprehensive fall-risk assessment in Parkinson's disease. Such assessment should consider orthostatic vital signs alongside disease stage, freezing, mobility performance, and medication review. Larger longitudinal cohorts with

standardized blood-pressure protocols and prospectively recorded falls are needed to determine whether orthostatic hypotension adds predictive information beyond motor disease severity (8,21,22).

CONCLUSION

Among 37 patients with Parkinson’s disease, orthostatic hypotension was present in 32.4% and was associated with a higher frequency of recorded falls in un analysis. The association was inconclusive after adjustment for age and disease stage, and independent differences in Timed Up and Go performance, balance score, and gait speed were not demonstrated. Concurrent assessment of orthostatic blood pressure and motor function remains clinically relevant, although the present cross-sectional findings do not establish causal or prospective fall-risk relationships.

DECLARATIONS

Authors’ Contributions:	Concept: RI; Design: RI, AK; Data Collection: AK; Analysis: RI; Drafting: RI, AK.
Ethical Approval:	The institution responsible for ethical review was Riphah International University, Lahore, Pakistan
Informed Consent:	Written informed consent was obtained from all participants before enrolment.
Conflict of Interest:	The authors declare no conflict of interest.
Funding:	No external funding was received for this study.
Data Availability:	De-identified data may be available from the corresponding author on request, subject to participant consent and institutional confidentiality requirements.
Acknowledgments:	None.
AI Declaration:	Generative AI tools were used solely for language and grammatical refinement. The authors verified the final manuscript and remain fully responsible for its accuracy, integrity, and scientific content.

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