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Effect of Stair-Climbing Micro-Bouts on Cardiovascular and Psychosocial Health in Sedentary Office Staff: A Pre-Post Interventional Study

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Abstract

Background: Sedentary work patterns among office staff are associated with increased cardiovascular risk, fatigue, and psychological stress. Brief, intermittent physical activity performed during working hours may offer a feasible strategy to counteract the adverse health effects of prolonged sitting. **Objective:** To evaluate the effects of stair-climbing micro-bouts on blood pressure, resting heart rate, perceived fatigue, and perceived stress among sedentary office staff. **Methods:** A pre–post interventional study was conducted among 36 office employees at Khyber Medical University, Peshawar, Pakistan. Participants performed stair-climbing micro-bouts lasting 1–2 minutes every two hours during working hours, five days per week, for two weeks. Resting systolic and diastolic blood pressure, resting heart rate, perceived fatigue, and perceived stress (PSS-10) were assessed before and after the intervention. Pre- and post-intervention outcomes were compared using paired statistical tests, and effect sizes were calculated. **Results:**

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Following the intervention, significant reductions were observed in systolic blood pressure (−4.9 mmHg), diastolic blood pressure (−3.2 mmHg), and resting heart rate (−3.4 bpm) (all $p < 0.001$). Perceived fatigue decreased by 0.9 units, and perceived stress scores decreased by 2.8 points ($p < 0.001$ for both). Effect sizes ranged from moderate to large (Cohen's d = 0.47–0.83). More than half of participants achieved clinically meaningful improvements across cardiovascular and psychosocial outcomes. **Conclusion:** Short, repeated stair-climbing micro-bouts integrated into the workday significantly improved cardiovascular and psychosocial health markers among sedentary office staff. This low-cost, time-efficient intervention represents a practical workplace strategy for reducing cardiometabolic risk and improving employee well-being in resource-limited settings.

Keywords: Stair climbing; Workplace physical activity; Sedentary behavior; Blood pressure; Fatigue; Stress

Introduction

Sedentary behavior has emerged as a major public health concern, particularly among office-based workers who spend prolonged periods seated during working hours. Extended sedentary time is independently associated with adverse cardiometabolic outcomes, including elevated blood pressure, impaired glucose metabolism, increased cardiovascular risk, and heightened levels of fatigue and psychological stress, even among individuals who meet recommended physical activity guidelines outside work hours.[1-3] The modern office environment, characterized by prolonged screen time and limited opportunities for movement, has therefore become a critical target for preventive health interventions.

Hypertension remains one of the leading modifiable risk factors for cardiovascular disease globally, contributing substantially to morbidity and premature mortality.[4] Even modest reductions in systolic and diastolic blood pressure at the population level have been shown to significantly reduce the risk of stroke and coronary heart disease.[5] Workplace-based physical activity interventions have gained increasing attention as feasible strategies to improve cardiovascular health, given the amount of time adults spend at work and the relative ease of reaching large populations through occupational settings.[6]

In recent years, the concept of exercise micro-bouts very short, intermittent bouts of physical activity performed multiple times throughout the day has gained traction as a practical alternative to traditional continuous exercise sessions.[7] These brief activity breaks are particularly appealing in occupational settings, as they require minimal time commitment, do not necessitate specialized equipment, and can be integrated seamlessly into daily routines. Emerging evidence suggests that interrupting prolonged sitting with short bouts of moderate-intensity activity can lead to improvements in blood pressure regulation, autonomic function, and subjective measures of fatigue and well-being.[8,9]

Stair climbing represents a highly accessible and time-efficient form of incidental physical activity that can be easily incorporated into office environments. It elicits relatively high metabolic demands compared to level walking and has been associated with improvements in cardiorespiratory fitness, blood pressure, and lipid profiles.[10-12] Importantly, stair climbing does not require structured exercise facilities and can be performed in short bouts, making it particularly suitable for workplace interventions targeting sedentary employees.

Beyond cardiovascular parameters, occupational fatigue and psychological stress are increasingly recognized as important determinants of work productivity, job satisfaction, and overall quality of life. Chronic work-related fatigue and stress have been linked to increased absenteeism, reduced performance, and higher risk of mental health disorders.[13,14] Physical activity has consistently been shown to exert beneficial effects on fatigue perception and stress regulation, potentially through neuroendocrine mechanisms, improved autonomic balance, and enhanced mood regulation.[15] However, evidence regarding the impact of very brief, repeated physical activity bouts during the workday on these psychosocial outcomes remains limited, particularly in low- and middle-income countries.

In Pakistan, rapid urbanization and increasing adoption of sedentary office-based occupations have contributed to a growing burden of non-communicable diseases, including hypertension and stress-related disorders.[16] Despite this, workplace physical activity interventions remain underexplored within the local context. There is a clear need for culturally appropriate, low-cost, and scalable strategies that can be

implemented within existing institutional infrastructures, such as universities and public-sector workplaces.

Therefore, the present study aimed to evaluate the effects of a two-week stair-climbing micro-bout intervention on resting blood pressure, resting heart rate, perceived fatigue, and perceived stress among office staff at Khyber Medical University, Peshawar, Pakistan. By focusing on short, frequent bouts of stair climbing integrated into the workday, this study seeks to provide evidence for a practical workplace intervention that may improve both cardiovascular and psychosocial health outcomes in sedentary office workers.

Methodology

Study Design and Setting

This study employed a pre and post interventional design conducted at Khyber Medical University (KMU), Peshawar, Pakistan. The intervention was implemented within the university's administrative and academic office departments, where staff typically engage in prolonged sedentary desk-based work. The study was carried out over a two-week intervention period, excluding baseline assessments.

Participants

Office staff members from KMU were recruited through convenience sampling. Eligible participants included male and female employees aged 20–55 years who were engaged in predominantly sedentary office work (⩾6 hours/day of desk-based activity). Participants who were full-time office staff at KMU, with a sedentary occupational role, who had the ability to climb and showed willingness to participate and comply with the intervention protocol were all included in this study.

While those with known cardiovascular, respiratory, or musculoskeletal disorders limiting stair climbing, diagnosed hypertension requiring medication adjustment during the study period, had tested positive for pregnancy and those who engaged in regular structured exercise (>150 minutes/week of moderate activity) were all excluded from the study. All participants provided written informed consent before enrolment.

Sample Size Considerations

As this was a pilot interventional study, a pragmatic sample size was adopted based on feasibility and prior workplace physical activity studies. A sample of 36 participants was

considered adequate to detect meaningful within-subject changes in cardiovascular and fatigue-related outcomes over a short intervention period.

Intervention Protocol

Stair-Climbing Micro-Bouts

Participants were instructed to perform stair-climbing micro-bouts lasting 1–2 minutes every 2 hours during working hours, five days per week, for two consecutive weeks. The stair-climbing activity involved continuous ascent and descent of stairs at a self-selected moderate intensity. The existing staircases within KMU buildings were used. No running or skipping steps were allowed to minimize injury risk. Participants were encouraged to maintain their usual diet and daily routines and were advised not to initiate any new exercise programs during the study period. Compliance was reinforced through verbal reminders and brief daily check-ins.

Outcome Measures

Resting systolic and diastolic blood pressure (SBP, DBP) were measured using a calibrated automated sphygmomanometer. Measurements were taken in a seated position, after 5 minutes of rest, with the arm supported at heart level. Two readings were recorded, and the average was used for analysis.

Resting heart rate (RHR) was measured simultaneously with blood pressure recordings using the same automated device. RHR was used as an indicator of cardiovascular autonomic adaptation to repeated short bouts of physical activity.

Perceived fatigue was assessed using a validated fatigue questionnaire (Fatigue Severity Scale or a comparable Likert-based fatigue score). Participants rated their fatigue based on their typical workday experience over the preceding week. Higher scores indicated greater fatigue severity.

Psychological stress levels were assessed using the Perceived Stress Scale (PSS-10), a widely validated tool for evaluating stress perception over the past month. The scale consists of 10 items rated on a 5-point Likert scale, with higher scores reflecting greater perceived stress.

Data Collection Procedure

Baseline measurements for all outcome variables were recorded before initiation of the intervention. Post-intervention assessments were conducted at the end of the two

weeks under identical conditions and time of day to minimize diurnal variability. Participants were instructed to avoid caffeine, smoking, and strenuous activity for at least 30 minutes before measurements.

Statistical Analysis

Data were analyzed using SPSS (version 24.0. Normality of continuous variables was assessed using the Shapiro-Wilk test. Pre- and post-intervention values were compared using paired *t*-test for normally distributed variables. Wilcoxon signed-rank test for non-normally distributed variables. Effect sizes were calculated where appropriate. A *p*-value <0.05 was considered statistically significant.

Ethical Considerations

The study protocol was approved by the Institutional Review Board of Khyber Medical University, Peshawar. All procedures were conducted in accordance with the Declaration of Helsinki. Participant confidentiality and anonymity were strictly maintained.

Results

Participant Characteristics

A total of 36 office staff members completed the study and were included in the final analysis. Baseline demographic and clinical characteristics of the participants are summarized in Table 1. The mean age of the participants was 34.6 ± 7.8 years, with a higher proportion of males (58.3%) compared to females (41.7%). Participants had a mean body mass index of 24.2 ± 3.1 kg/m^2, indicating a predominantly normal to slightly overweight population.

At baseline, the mean resting systolic and diastolic blood pressure values were 124.8 ± 9.6 mmHg and 79.6 ± 6.8 mmHg, respectively. The mean resting heart rate was 76.2 ± 7.4 bpm. Participants also reported moderate levels of perceived fatigue (4.8 ± 1.1 units) and perceived stress (18.7 ± 4.3 on the PSS-10 scale) prior to the intervention (Table 1).

Table 1: *Baseline Demographic and Clinical Characteristics of Participants*

Variable	Mean ± SD / n (%)
Age (years)	34.6 ± 7.8
Gender	
– Male	21 (58.3%)

– Female	15 (41.7%)
Body Mass Index (kg/m²)	24.2 ± 3.1
Resting Systolic BP (mmHg)	124.8 ± 9.6
Resting Diastolic BP (mmHg)	79.6 ± 6.8
Resting Heart Rate (bpm)	76.2 ± 7.4
Fatigue Score (units)	4.8 ± 1.1
Perceived Stress Score (PSS-10)	18.7 ± 4.3

Changes in Cardiovascular and Psychosocial Outcomes

Following the two-week stair-climbing micro-bout intervention, significant improvements were observed across all assessed outcomes (Table 2). Resting systolic blood pressure decreased significantly by a mean of 4.9 mmHg (95% CI: −6.8 to −3.0; $p < 0.001$), while resting diastolic blood pressure decreased by 3.2 mmHg (95% CI: −4.6 to −1.8; $p < 0.001$). These reductions were associated with moderate effect sizes (Cohen's $d = 0.52$ for systolic BP and 0.49 for diastolic BP).

Resting heart rate also showed a significant reduction, decreasing by 3.4 bpm (95% CI: −4.8 to −2.0; $p < 0.001$), with a moderate effect size ($d = 0.47$), suggesting favorable cardiovascular autonomic adaptations following the intervention (Table 2). In terms of psychosocial outcomes, perceived fatigue demonstrated a substantial reduction, with mean fatigue scores decreasing by 0.9 units (95% CI: −1.2 to −0.6; $p < 0.001$). This change corresponded to a large effect size (Cohen's $d = 0.83$). Similarly, perceived stress levels, as measured by the PSS-10, decreased significantly by 2.8 points (95% CI: −3.9 to −1.7; $p < 0.001$), with a moderate-to-large effect size ($d = 0.68$) (Table 2).

Table 2: *Pre- and Post-Intervention Changes in Outcome Measures*

Outcome Measure	Baseline Mean ± SD	Post-Intervention Mean ± SD	Mean Change (95% CI)	*p*-value	Effect Size (Cohen's *d*)
Systolic BP (mmHg)	124.8 ± 9.6	119.9 ± 8.7	−4.9 (−6.8 to −3.0)	<0.001	0.52

Diastolic BP (mmHg)	79.6 ± 6.8	76.4 ± 6.1	−3.2 (−4.6 to −1.8)	<0.001	0.49
Resting Heart Rate (bpm)	76.2 ± 7.4	72.8 ± 6.9	−3.4 (−4.8 to −2.0)	<0.001	0.47
Fatigue Score	4.8 ± 1.1	3.9 ± 1.0	−0.9 (−1.2 to −0.6)	<0.001	0.83
Perceived Stress (PSS-10)	18.7 ± 4.3	15.9 ± 3.8	−2.8 (−3.9 to −1.7)	<0.001	0.68

The proportion of participants achieving clinically meaningful improvements across outcome measures is presented in Table 3. More than half of the participants experienced a reduction of at least 5 mmHg in systolic blood pressure (52.8%) and 3 mmHg in diastolic blood pressure (58.3%). Improvements in resting heart rate of ⩾3 bpm were observed in 50.0% of participants.

Psychosocial outcomes showed the highest response rates, with 66.7% of participants reporting a reduction of at least 1 point in fatigue score, and 55.6% demonstrating a reduction of ⩾3 points in perceived stress (Table 3).

Table 3: *Proportion of Participants Demonstrating Clinically Meaningful Improvements After the Intervention*

Outcome Measure	Criterion for Meaningful Improvement	n (%) Improved
Systolic BP	⩾5 mmHg reduction	19 (52.8%)
Diastolic BP	⩾3 mmHg reduction	21 (58.3%)
Resting Heart Rate	⩾3 bpm reduction	18 (50.0%)
Fatigue Score	⩾1-point reduction	24 (66.7%)
Perceived Stress (PSS-10)	⩾3-point reduction	20 (55.6%)

The pre- and post-intervention changes across all cardiovascular and psychosocial outcomes are visually illustrated in Figure 1. The bar graph highlights consistent reductions in systolic and diastolic blood pressure, resting heart rate, fatigue, and perceived stress following the intervention, with all comparisons reaching statistical significance ($p < 0.001$). Error bars representing standard deviations indicate relatively low variability in responses across participants (Figure 1).

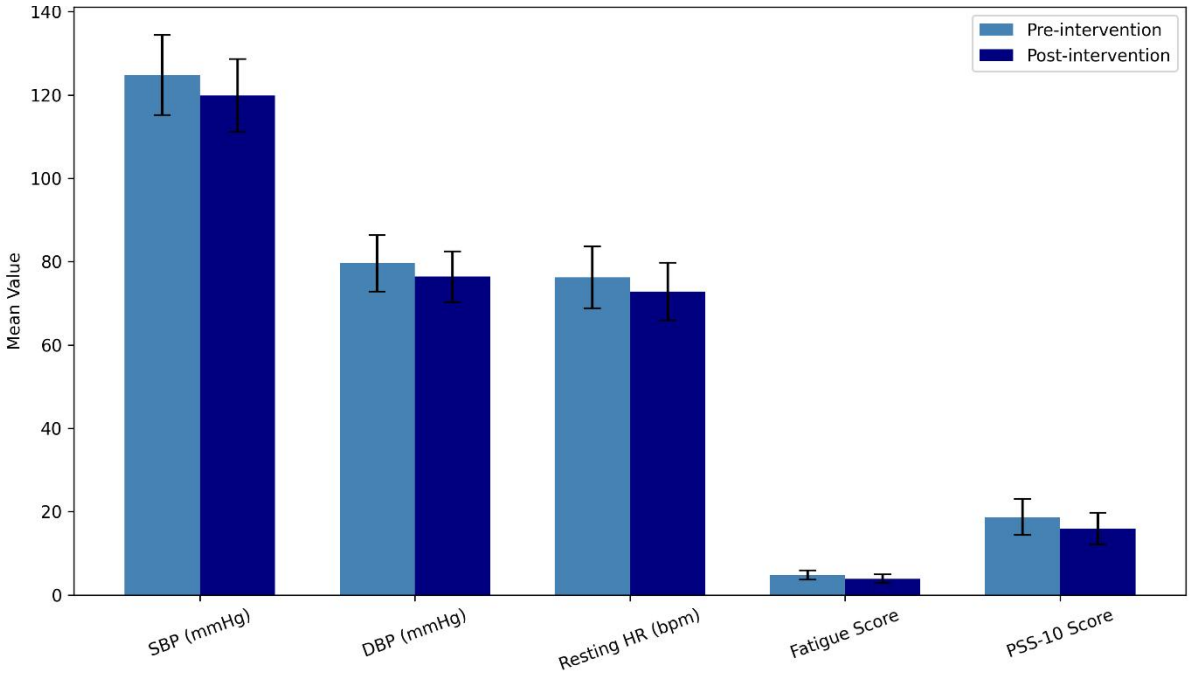


Figure 1. Pre–Post Changes in Cardiovascular and Psychosocial Outcomes Following Stair-Climbing Micro-Bout Intervention

Bar graph showing changes in resting systolic blood pressure (SBP), diastolic blood pressure (DBP), resting heart rate (RHR), fatigue score, and perceived stress score (PSS-10) before and after a two-week stair-climbing micro-bout intervention. All outcomes demonstrated statistically significant improvements post-intervention ($p < 0.001$ for all comparisons). Values are expressed as mean ± SD.

Discussion

The present study investigated the effects of brief, repeated stair-climbing micro-bouts performed during working hours on cardiovascular and psychosocial outcomes among office staff at Khyber Medical University. The findings demonstrate that a simple, two-week intervention consisting of 1-2 minutes of stair climbing every two hours resulted in significant reductions in resting systolic and diastolic blood pressure, resting heart rate, perceived fatigue, and perceived stress. These results suggest that even very short bouts of physical activity, when accumulated throughout the workday, can yield meaningful health benefits in sedentary office workers.

The observed reductions in resting systolic (~5 mmHg) and diastolic (~3 mmHg) blood pressure are clinically relevant, particularly considering the short duration and low intensity of the intervention. Epidemiological evidence indicates that a population-wide reduction of as little as 2 mmHg in systolic blood pressure can substantially lower the risk of stroke and ischemic heart disease.[17] The magnitude of blood pressure reduction observed in this study is comparable to, or greater than, that reported in longer-duration workplace physical activity interventions.[18,19]

Stair climbing is known to impose a relatively high cardiovascular demand compared to level walking, leading to acute increases in heart rate and blood pressure followed by post-exercise hypotensive effects.[20] Repeated exposure to such stimuli throughout the day may enhance endothelial function, improve vascular compliance, and promote favorable autonomic adaptations, thereby contributing to sustained reductions in resting blood pressure.[21] The significant reduction in resting heart rate observed in the present study further supports the notion of improved autonomic balance, with a possible shift toward increased parasympathetic activity.[22]

In addition to cardiovascular benefits, the intervention produced substantial improvements in perceived fatigue and stress, with moderate-to-large effect sizes. Occupational fatigue is a common complaint among office workers and has been linked to prolonged sitting, mental workload, and insufficient physical movement during the workday.[23] Interrupting sedentary time with short bouts of activity may counteract both physical and mental fatigue by enhancing cerebral blood flow, increasing alertness, and reducing musculoskeletal discomfort associated with prolonged sitting.[24]

The reduction in perceived stress observed in this study aligns with existing evidence that physical activity exerts anxiolytic and stress-buffering effects through neuroendocrine mechanisms, including modulation of the hypothalamic–pituitary–adrenal axis and increased release of endorphins and monoamines.[25] Importantly, the use of micro-bouts may reduce perceived barriers to exercise, such as lack of time or fatigue, thereby enhancing psychological acceptance and adherence compared to traditional exercise prescriptions.[26]

The findings of this study add to a growing body of literature supporting the efficacy of exercise snacking or micro-bout physical activity as a pragmatic approach to improving

health outcomes.[27] Unlike structured exercise programs that require dedicated time and facilities, stair-climbing micro-bouts can be easily integrated into existing workplace infrastructure with minimal cost and disruption. This is particularly relevant for institutional settings such as universities, where staircases are readily available and work schedules are often rigid.

The responder analysis further highlights the practical significance of the intervention, with more than half of participants achieving clinically meaningful improvements across multiple outcomes. This inter-individual variability is consistent with prior workplace intervention studies and underscores the importance of personalized and flexible activity strategies.[28]

In Pakistan, the burden of hypertension, stress-related disorders, and sedentary lifestyles is rising, particularly in urban and professional populations.[29] Workplace health promotion initiatives remain limited, and most physical activity recommendations emphasize leisure-time exercise, which may not be feasible for many working adults. The present study provides locally generated evidence supporting a low-cost, scalable intervention that can be implemented within public-sector institutions without the need for additional resources or policy changes. By demonstrating benefits across both physiological and psychosocial domains, this intervention aligns well with holistic models of occupational health that emphasize worker well-being, productivity, and long-term disease prevention.[30]

Key strengths of this study include its real-world workplace setting, high feasibility, use of validated outcome measures, and assessment of both cardiovascular and psychosocial outcomes. However, several limitations should be acknowledged. The pre–post design without a control group limits causal inference, and the relatively short intervention duration precludes assessment of long-term sustainability. Self-reported measures of fatigue and stress may also be subject to reporting bias.

Future studies should incorporate randomized controlled designs, longer follow-up periods, and objective measures of physical activity to further elucidate dose–response relationships and long-term effects. Additionally, exploring the impact of such interventions on work productivity and absenteeism may provide valuable insights for institutional policymakers.

Conclusion

In conclusion, the findings of this study suggest that incorporating brief stair-climbing micro-bouts into the workday is an effective and feasible strategy for improving blood pressure, cardiovascular autonomic function, fatigue, and perceived stress among sedentary office staff. These results support the integration of short, frequent physical activity breaks into workplace health promotion programs, particularly in resource-limited settings.

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