



COMPARATIVE EVALUATION OF AUTONOMIC NERVOUS SYSTEM ACTIVITY IN SHIFT VERSUS NON-SHIFT EMPLOYEES: A CROSS-SECTIONAL ANALYSIS

Microbiology

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ABSTRACT

Background: Shift work is indispensable in modern healthcare but disrupts endogenous circadian rhythms, activating the hypothalamic-pituitary-adrenal axis and altering autonomic tone. However, specific data on subclinical autonomic dysfunction among Indian healthcare workers remain sparse. This study intends to compare the autonomic function parameters between shift and regular non-shift employees and to identify any significant change in the autonomic tone. **Methods:** This cross-sectional study included 100 male employees (aged 20–45 years) from a tertiary care centre, comprising 50 shift workers and 50 day workers. Autonomic function was non-invasively assessed using the lying-to-standing ratio, deep breathing E:I ratio, Valsalva ratio, handgrip-induced diastolic pressure change, and cold pressor-induced systolic pressure change. Group comparisons were performed using independent t-tests, with significance set at $p < 0.05$. **Results:** No significant intergroup differences were observed for the lying-to-standing ratio ($p=0.684$), deep breathing E:I ratio ($p=0.391$), handgrip response ($p=0.762$), or cold pressor response ($p=0.729$). However, the Valsalva ratio was significantly lower in shift workers (1.32 ± 0.15) compared to day workers (1.43 ± 0.26 , $p=0.014$), indicating selective parasympathetic and baroreflex impairment. **Conclusion:** Shift work is associated with early, subclinical parasympathetic dysfunction, specifically captured by the Valsalva ratio, even when other autonomic indices remain unaffected. This simple, non-invasive test could serve as a practical early screening biomarker in occupational health settings for preventive interventions.

KEYWORDS

Autonomic Dysregulation, Autonomic Function Test, Autonomic Nervous System, Shift Work.

INTRODUCTION

In today's healthcare, industrial, and service sectors - especially in fast-growing nations like India - shift work is indispensable. Tertiary care centres rely heavily on night shifts and rotating rosters to maintain round-the-clock services. While this ensures continuous operations, it comes at a cost: it throws the body's natural circadian rhythm out of sync. That internal clock governs many vital functions - sleep-wake cycles, hormone release, cardiovascular activity, and metabolic balance. Prolonged circadian disruption is widely seen as a serious occupational hazard, affecting autonomic nervous function, metabolic health, and general well-being. It actively disrupts how the autonomic nervous system works leading to measurable health consequences.¹

Irregular working hours impose physiological strain that stimulates the HPA axis, resulting in elevated secretion of cortisol and catecholamines². Sustained activation of these stress pathways is known to contribute to endothelial damage, impaired glycemic control, and low-grade systemic inflammation.^{3,4} To evaluate autonomic function, established protocols such as the lying-to-standing test, deep breathing test, Valsalva maneuver, hand grip test, and cold pressor test are widely employed to gauge both sympathetic and parasympathetic reactivity.⁵ These assessments offer valuable information about cardiovascular reflex competence and can reveal subclinical autonomic dysfunction before overt pathology develops.^{1,5} Consequently, applying these tests to shift-working populations is critical for the early recognition of physiological alterations. Circadian rhythm disturbances are known to alter autonomic tone, often resulting in sympathetic overactivity and reduced parasympathetic modulation.⁶⁻⁸

In light of the increasing reliance on shift-based employment and the well-documented health implications of circadian rhythm disturbance,^{3,4} the present investigation was designed to evaluate and contrast autonomic function parameters among shift workers and their regular day-worker counterparts, aged 20 to 45 years. The overarching

objectives were to produce comprehensive, contextually relevant evidence for occupational health surveillance in India and to identify subclinical physiological alterations that may place shift workers at increased risk of enduring health consequences.

Methodology

This comparative cross-sectional study was conducted in the Department of Physiology from May 2024 to December 2025 after being reviewed and approved by the Institutional Ethics Committee. Written informed consent was obtained from each participant prior to enrolment with every participant having the right to withdraw from the study at any stage. Participant's confidentiality was strictly maintained and all the data generated was securely maintained.

Study population and sampling

The study population consisted of Male shift workers and regular day workers employed at the tertiary care center. A total of 100 apparently healthy male employees, aged 20-45 years, were recruited using a non-probability purposive sampling technique. Participants were screened through structured interviews and medical history reviews to exclude those with confounding illnesses or medication use. The sample was evenly distributed, with 50 shift workers comprising Group I and 50 regular day workers with fixed schedules forming Group II, ensuring balanced statistical comparison between exposed and non-exposed cohorts.

Autonomic function assessments—namely the lying-to-standing test, deep breathing test, Valsalva maneuver, hand grip test using a manual dynamometer, and cold pressor test—were conducted in a quiet, temperature-controlled laboratory environment to prevent extraneous influences on autonomic tone. Participants reported to the laboratory after an 8 to 10 hour overnight fasting; a thorough history and physical examination preceded the test sequence. All measurements for each individual were completed within a single visit to minimize diurnal or temporal variability. The study design, coupled with the availability of

specialized equipment (including a tilt table, sphygmomanometer, and dynamometer) within the tertiary care setting, ensured accurate and reliable physiological data collection. Recruitment, data acquisition, and verification were completed within the approved timeframe, and the resultant dataset of 100 participants was considered sufficient to detect meaningful intergroup differences in autonomic function parameters.

Data Collection

A custom structured proforma was used. Interviews were done to capture demographics, occupational, and medical history. Autonomic data was logged directly from equipment. Data was entered into MS Excel, double-checked for errors, and anonymized with unique IDs.

Data Analysis

Data was analyzed using Jamovi software version 2.6.44. Continuous variables were noted as mean ± SD; categorical as frequencies/percentages. Group comparisons were done using independent t-test (continuous, normal distribution) and chi-square (categorical). Significance was set at $p < 0.05$. Results are shown in tables.

RESULTS

Comparative analysis of autonomic function parameters revealed largely similar profiles between shift workers and regular day workers, with one notable exception (Valsalva ratio). No statistically significant differences were observed for the lying-to-standing ratio (shift: 1.32 ± 0.22 vs. day: 1.30 ± 0.15 ; $t = 0.409$, $p = 0.684$), the deep breathing E:I ratio (1.40 ± 0.25 vs. 1.44 ± 0.19 ; $t = -0.861$, $p = 0.391$), handgrip-induced Δ DBP (23.76 ± 9.95 vs. 24.32 ± 8.42 mmHg; $t = -0.304$, $p = 0.762$), or cold pressor-induced Δ SBP (23.80 ± 8.77 vs. 23.16 ± 9.61 mmHg; $t = 0.348$, $p = 0.729$). However, a significant intergroup difference emerged for the Valsalva ratio, with shift workers exhibiting markedly lower values (1.32 ± 0.15) than their day-working counterparts (1.43 ± 0.26), and this difference was statistically significant ($t = -2.507$, $p = 0.014$). This selective reduction suggests a specific impairment in parasympathetic or baroreflex-mediated autonomic regulation among shift workers.

Table I: Comparison of lying–standing ratio between shift workers and day workers

Parameter	Shift workers (n=50) Mean ± SD	Day workers (n=50) Mean ± SD	t value	p value
Lying–Standing Ratio	1.32 ± 0.22	1.30 ± 0.15	0.409	0.684

Table I shows that there was no statistically significant difference in the lying–standing ratio between shift workers and day workers ($t = 0.409$, $p = 0.684$).

Table II: Comparison of deep breathing expiration:inspiration (E:I) ratio between shift workers and day workers

Parameter	Shift Workers (n=50) Mean ± SD	Day Workers (n=50) Mean ± SD	t value	p value
Deep Breathing E:I Ratio	1.40 ± 0.25	1.44 ± 0.19	-0.861	0.391

Table II shows that there was no statistically significant difference in the deep breathing E:I ratio between shift workers and day workers ($t = -0.861$, $p = 0.391$).

Table III: Comparison of Valsalva ratio between shift workers and day workers

Parameter	Shift Workers (n=50) Mean ± SD	Day Workers (n=50) Mean ± SD	t value	p value
Valsalva Ratio	1.32 ± 0.15	1.43 ± 0.26	-2.507	0.014

Table III shows that the Valsalva ratio was found to be significantly lower in shift workers compared to day workers ($t = -2.507$, $p = 0.014$).

Table IV: Comparison of handgrip Δ DBP (diastolic blood pressure) between shift workers and day workers

Parameter	Shift Workers (n=50) Mean ± SD	Day Workers (n=50) Mean ± SD	t value	p value
Handgrip Δ DBP (mmHg)	23.76 ± 9.95	24.32 ± 8.42	-0.304	0.762

Handgrip Δ DBP (mmHg)	23.76 ± 9.95	24.32 ± 8.42	-0.304	0.762
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Table V: Comparison of cold pressor Δ SBP (systolic blood pressure) between shift workers and day workers

Parameter	Shift Workers (n=50) Mean ± SD	Day Workers (n=50) Mean ± SD	t value	p value
Cold Pressor Δ SBP (mmHg)	23.80 ± 8.77	23.16 ± 9.61	0.348	0.729

Table IV shows that there was no statistically significant difference in handgrip Δ DBP between shift workers and day workers ($t = -0.304$, $p = 0.762$).

Table V shows that there was no statistically significant difference in cold pressor Δ SBP between shift workers and day workers ($t = 0.348$, $p = 0.729$).

DISCUSSION

This study demonstrated that most cardiovascular autonomic function parameters were comparable between shift workers and regular day workers. However, the Valsalva ratio was significantly lower in shift workers, indicating selective impairment of parasympathetic function and reduced baroreflex sensitivity.

This finding is in agreement with the systematic review and meta-analysis by Jelmini *et al.*, which concluded that extended shift work is associated with a shift away from parasympathetic dominance.⁴

Similarly, Skornyyakov *et al.* demonstrated that simulated night shift work significantly altered cardiac autonomic activity and highlighted the influence of circadian misalignment on vagal modulation and heart rate variability.⁹

The absence of significant differences in the lying-to-standing ratio, deep breathing E:I ratio, handgrip test, and cold pressor test suggests that overall autonomic function remained largely preserved. These findings suggest that parasympathetic dysfunction may precede overt sympathetic impairment.

Circadian rhythm disruption, sleep deprivation, and occupational stress associated with shift work are likely mechanisms underlying the observed reduction in the Valsalva ratio. A recent systematic review also identified sleep deprivation as an important contributor to autonomic dysregulation and reduced vagal activity, further supporting the present findings.¹⁰

Overall, the present study suggests that shift work is associated with early parasympathetic dysfunction, while other conventional autonomic function parameters remain unaffected. Early identification of these subtle autonomic changes may facilitate timely preventive interventions to reduce long-term cardiovascular risk.

CONCLUSION

This comparative study demonstrates that shift work, despite not affecting all autonomic indices, impairs the Valsalva response - reflecting subclinical parasympathetic and baroreflex dysfunction. The absence of significant differences in other tests suggests that autonomic derangement may be specific to certain reflex pathways in the early stages of circadian disruption. These results highlight that autonomic changes can precede overt clinical manifestations, making the Valsalva ratio a potential early marker of occupational health risk. We recommend integrating this simple, non-invasive test into routine periodic health assessments for shift workers, coupled with targeted interventions to counter the physiological toll of irregular schedules.

Limitations and recommendations

- Standardization of Testing Time: The Valsalva ratio and baroreflex sensitivity have a diurnal variation. Standardizing tests relative to each participant's dim-light melatonin onset (DLMO) would provide a more accurate picture of phase-dependent effects.
- Beyond Valsalva Ratio: Detailed analysis of the maneuver's four phases (e.g., pressure recovery time, late phase II blood pressure recovery) could offer deeper insights into the specific adrenergic and vagal components affected.
- Longitudinal Studies: Studies that track autonomic function in

individuals as they begin and continue shift work would be crucial to establish causality and determine if this selective Valsalva deficit is a reversible adaptation or a progressive, cumulative effect.

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