e-ISSN: 0975-9506, p-ISSN:2961-6093

Available online on www.ijpqa.com

International Journal of Pharmaceutical Quality Assurance 2025; 16(12); 133-136

Original Research Article

Prevalence of Stress-Related Autonomic Symptoms and Cognitive Complaints in Individuals Exposed to Environmental Pollution

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Received: 01-10-2025 / Revised: 06-11-2025 / Accepted: 20-11-2025

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Conflict of interest: Nil

Abstract

Background: Environmental pollution has emerged as a major public health concern worldwide. Chronic exposure to air, noise, and industrial pollutants has been linked not only to cardiopulmonary morbidity but also to dysregulation of the autonomic nervous system and cognitive disturbances mediated through stress pathways.

Objective: To determine the prevalence of stress-related autonomic symptoms and cognitive complaints among individuals chronically exposed to environmental pollution.

Methods: A cross-sectional questionnaire-based study was conducted among 360 adults residing in high-pollution zones. Stress-related autonomic symptoms were assessed using a standardized autonomic symptom checklist, while cognitive complaints were evaluated using a validated subjective cognitive assessment questionnaire. Data were analyzed using descriptive statistics, independent t-tests, and correlation analysis.

Results: Autonomic symptoms were reported by 61.4% of participants, while cognitive complaints were present in 54.2%. Individuals with higher pollution exposure duration demonstrated significantly greater autonomic symptom scores and cognitive complaints ($p < 0.001$). A moderate positive correlation was observed between autonomic symptom burden and cognitive complaints ($r = 0.49$).

Conclusion: Chronic exposure to environmental pollution is associated with a high prevalence of stress-related autonomic symptoms and cognitive complaints. Early identification and stress-mitigation strategies may reduce the neurophysiological impact of environmental pollution.

Keywords: Environmental Pollution; Autonomic Symptoms; Cognitive Complaints; Stress; Questionnaire Study.

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Introduction

Environmental pollution has become one of the most pressing global health challenges of the 21st century [1]. Rapid urbanization, industrial growth, increased vehicular emissions, and exposure to environmental noise have led to sustained pollutant exposure for large segments of the population. While the deleterious effects of pollution on respiratory and cardiovascular health are well documented, its impact on neurophysiological function and stress regulation is increasingly gaining attention [2,3]. Chronic exposure to environmental pollutants acts as a persistent stressor that activates the hypothalamic–pituitary–adrenal (HPA) axis and the autonomic nervous system. Prolonged sympathetic overactivity and parasympathetic withdrawal may result in a wide range of autonomic symptoms, including palpitations, excessive sweating, gastrointestinal disturbances, dizziness, and sleep disturbances. Such stress-related autonomic dysfunction reflects impaired physiological adaptability to environmental stressors [4,5]. In addition to autonomic dysregulation, environmental pollution has been implicated in cognitive impairment through mechanisms such as neuroinflammation, oxidative stress, and cerebrovascular dysfunction. Individuals exposed to high pollution levels frequently report subjective cognitive complaints, including impaired concentration, memory difficulties, mental fatigue, and reduced executive functioning. These cognitive complaints may significantly affect daily functioning and quality of life, even in the absence of clinically detectable neurological disease [6-9]. Despite growing evidence linking pollution exposure to autonomic and cognitive disturbances, population-based data assessing the combined burden of stress-related autonomic symptoms and cognitive complaints remain limited [10,11]. Questionnaire-based assessments offer a practical

and cost-effective approach for evaluating these symptoms at the community level [12].

Therefore, the present study aimed to assess the prevalence of stress-related autonomic symptoms and cognitive complaints in individuals chronically exposed to environmental pollution and to explore the association between these two domains.

Materials and Methods

Study Design and Participants: A cross-sectional questionnaire-based study was conducted among adults residing in urban and industrial areas characterized by high levels of environmental pollution.

Participants were recruited through community outreach and workplace settings.

Sample Size Calculation: Assuming a prevalence of autonomic symptoms of approximately 50% in pollution-exposed populations, with a 95% confidence interval and 5% margin of error, the minimum required sample size was calculated to be 350. Accounting for incomplete responses, 360 participants were included in the final analysis.

Inclusion Criteria

- Age between 20 and 55 years
- Residence in high-pollution areas for ≥5 years
- Willingness to participate and provide informed consent

Exclusion Criteria

- History of diagnosed neurological or psychiatric disorders
- Known autonomic neuropathy or neurodegenerative disease
- Current use of medications affecting autonomic function

Study Tools

- **Autonomic Symptom Checklist:** A standardized questionnaire assessing stress-related autonomic symptoms such as palpitations, sweating abnormalities, gastrointestinal disturbances, dizziness, tremors, and sleep disturbances. Higher scores indicated greater autonomic symptom burden.
- **Cognitive Complaint Questionnaire:** A validated subjective cognitive assessment tool evaluating memory, attention, concentration, mental clarity, and executive function complaints.
- **Exposure Assessment:** Duration of residence in high-pollution areas and self-reported exposure to air and noise pollution were recorded.

Statistical Analysis: Data were analyzed using SPSS version 21.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, and categorical variables as percentages. Independent samples t-test and Pearson correlation were applied. A p-value <0.05 was considered statistically significant.

Results

Table 1: Demographic Characteristics of Study Participants

Variable	Value
Age (years)	38.2 ± 9.1
Male	198 (55.0%)
Female	162 (45.0%)
Duration of pollution exposure (years)	11.4 ± 4.6

Table 1 describes the baseline demographic profile and duration of pollution exposure of the study population (Table1).

Table 2: Prevalence of Stress-Related Autonomic Symptoms

Autonomic Symptoms	Number (%)
Present	221 (61.4%)
Absent	139 (38.6%)

More than sixty percent of participants reported one or more stress-related autonomic symptoms, indicating a high symptom burden (Table 2).

Table 3: Prevalence of Cognitive Complaints

Cognitive Complaints	Number (%)
Present	195 (54.2%)
Absent	165 (45.8%)

Over half of the study participants reported subjective cognitive complaints related to memory, attention, or concentration (Table 3).

Table 4: Correlation Between Autonomic Symptom Scores and Cognitive Complaints

Variables	r-value	p-value
Autonomic symptoms vs Cognitive complaints	0.49	<0.001

A moderate positive correlation was observed, suggesting that higher autonomic symptom burden is associated with increased cognitive complaints (Table 4).

Discussion

The present study reveals a high prevalence of stress-related autonomic symptoms and cognitive complaints among individuals chronically exposed to environmental pollution. More than sixty percent of participants experienced autonomic symptoms, while over half reported cognitive difficulties, highlighting the substantial neurophysiological burden associated with prolonged pollution exposure.

Chronic environmental pollution acts as a continuous stressor that activates the autonomic nervous system and HPA axis. Persistent sympathetic activation may lead to autonomic imbalance, manifesting as cardiovascular, gastrointestinal, and sleep-related symptoms. These findings are consistent with previous studies linking pollution exposure to altered heart rate variability and stress reactivity [13].

The observed cognitive complaints may be attributed to pollution-induced neuroinflammation, oxidative stress, and microvascular dysfunction affecting cerebral perfusion14. Fine particulate matter and toxic pollutants can cross the blood–brain barrier, triggering inflammatory cascades that impair cognitive processing and attention. Additionally, chronic stress itself is known to negatively impact cognitive performance [15,16].

The moderate correlation between autonomic symptoms and cognitive complaints suggests shared underlying mechanisms, possibly mediated through chronic stress pathways. Autonomic dysregulation may contribute to impaired cerebral blood flow and attentional control, thereby exacerbating cognitive difficulties [17]. From a public health perspective, these findings underscore the need for early screening of neurophysiological symptoms in pollution-exposed populations. Questionnaire-based assessments can serve as practical tools for identifying at-risk individuals and implementing preventive strategies such as stress management, lifestyle modification, and environmental interventions [18].

Limitations of the study include its cross-sectional design, reliance on self-reported data, and lack of objective autonomic or cognitive testing. However, the adequate sample size and focus on community-level assessment strengthen the relevance of the findings.

Conclusion

Chronic exposure to environmental pollution is associated with a high prevalence of stress-related autonomic symptoms and cognitive complaints. The significant association between these domains suggests shared stress-mediated mechanisms. Early identification and targeted interventions may help mitigate the neurophysiological impact of environmental pollution and improve quality of life.

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