AATCC Review

28 July 2025: Received
18 September 2025: Revised
25 September 2025: Accepted
24 October 2025: Available Online

https://aatcc.peerjournals.net/

Review Article Open Access

# Assessment of demographic predictors of awareness on health effects and preventive measures of indoor air pollution

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## ABSTRACT

*Indoor air pollution (IAP) is a critical but often overlooked environmental health issue, particularly in urban households. This study assessed the awareness of 150 respondents in Dharwad city, Karnataka, regarding the health effects of IAP and their preventive practices, along with the influence of socio-demographic factors. Data were collected using a self-structured, pre-tested interview schedule and analysed through descriptive statistics, weighted mean scores, chi-square test, correlation and ANOVA. The study faced challenges such as reliance on self-reported data, difficulty in assessing respondent's perceptions of long-term health effects of indoor air pollution and this study does not report the sources of IAP. Findings revealed that respondents were well aware of immediate health effects of IAP, such as asthma, eye irritation, coughing, and headaches, but had limited awareness about long-term impacts, including cardiovascular disease, lung problems and cognitive decline. Preventive practices were largely confined to low-cost, visible measures such as maintaining cleanliness, ventilation, and avoiding indoor smoking, while the adoption of eco-friendly products, indoor plants, and air purifiers remained low. Education, occupation, income, and socio-economic status significantly influenced both awareness and preventive measures, whereas age and family type had no notable impact. The study highlights the need for targeted awareness programs and affordable interventions to bridge knowledge gaps and promote sustainable practices for mitigating IAP. The study contributes empirical evidence on demographic predictors of IAP awareness and highlights the need for targeted awareness programmes to fill the gap between awareness and practice to mitigate indoor air pollution.*

***Keywords:*** *Indoor air pollution, awareness, health effects, preventive measures, socio-demographic factors, knowledge, household environment*

## INTRODUCTION

Indoor air pollution (IAP) is one of the most pressing environmental and public health challenges, with impacts ranging from respiratory irritation to chronic diseases. Unlike outdoor air pollution, IAP is less visible yet often more dangerous due to prolonged exposure in enclosed spaces. The World Health Organisation (2018) estimates that nearly 3 billion people worldwide rely on unclean fuels for cooking and heating, exposing them to harmful indoor pollutants. Indoor environments are contaminated by a combination of physical (temperature, humidity and particulate matter), chemical (formaldehyde, volatile organic compounds, carbon monoxide and nitrogen oxides) and biological agents (bacteria, fungi). Sources include combustion, building materials, furnishings, cleaning products and household activities. The U.S. EPA notes that indoor pollutant levels can be up to 100 times higher than outdoors (10). Health impacts of IAP are wide-ranging, from acute effects such as eye irritation, headaches, and asthma to long-term outcomes including cardiovascular disease, chronic obstructive pulmonary disease (COPD) and certain cancers (15).

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*DOI: https://doi.org/10.21276/AATCCReview.2025.13.04.944*


Women and children are especially vulnerable due to their longer exposure times in domestic environments. Understanding public knowledge about IAP and the adoption of preventive measures is essential for designing effective interventions. This study, therefore, assesses respondents' awareness of health effects, their preventive practices and the role of socio-demographic factors in shaping these behaviours.

## MATERIALS AND METHODS

A descriptive research design was adopted to assess respondents' awareness of health effects and preventive measures of indoor air pollution (IAP). The study was conducted in Dharwad city, Karnataka, India, across three localities: Gandhinagar, Saptapur and Gulgonjikoppa, with a total sample of 150 respondents selected through simple random sampling (50 from each area). A self-structured interview schedule was developed based on literature, pre-tested in a non-sample area and finalized after necessary modifications. The schedule collected general information (age, gender, family type, family size, education, occupation, income, and socio-economic status assessed using the Modified Kuppuswamy Scale, 2023) and specific information on awareness of health effects and preventive measures of IAP using three-point Likert scale. Data collection was carried out using personal interviews in an informal atmosphere to ensure accuracy. The data were analysed using descriptive statistics, Weighted Mean Score (WMS), chi-square test, correlation (Karl Pearson's r) and Analysis of Variance (ANOVA).

## RESULTS AND DISCUSSION

### Demographic profile of the respondents

The majority of the respondents were in the age group of 37 to 55 years (60.70%) followed by above 55 years (27.30%) and below 37 years age group (12.00%). Regarding family type, highest proportion was from nuclear family (69.30%) followed by joint family (30.70%), while none reported from extended family, reflecting modern urban structures (12). Graduates formed the largest educational group (29.33%) followed by primary education (16.68%), middle school (16.00%), illiterate (12.00%), high school (11.33%), PUC/diploma (9.33%) and least per cent of the respondents were post graduates (5.33%) suggesting a moderate education level that may support awareness of indoor environments (6). As for the occupation, majority was housewives (68.00%) followed by the service sector (28.67%) and self employed (3.33%), indicating their key role in household environmental practices (2). The annual income of the majority of the respondents ranged between Rs. 282,423 to 630,378 (48.00%) followed by above Rs. 630,379 (28.67%) and below Rs. 282,423 (23.33%) as their annual income showed fair economic diversity (1) (14). Regarding the socio-economic status of the selected respondents, a higher percentage of them belonged to the upper lower class (39.33%) and upper middle class (32.00%) followed by lower-middle class (25.33%), while the least percentage belonged to the upper class (3.33%) and none were in the lower class (Table 1). The predominance of respondents in the middle-income brackets indicates a balanced representation of working-class families, which could influence their environmental awareness and priorities in household practices (2).

### Knowledge on health effects of indoor air pollution

The majority (90.70%) of the respondents reported asthma (WMS 2.91) as a major health problem due to poor indoor air quality, followed by headache (87.30%, WMS-2.84) and eye irritation (84.70%, WMS-2.79). More than 70 per cent of the respondents perceived skin allergies (76.70%), cold and cough (76.00%), and reduced oxygen intake (70.70) as health issues. The higher awareness for common health problems might be due to the reason that these are short-term effects which can be easily affected and observed (4) (9) (11). Over 60 per cent agreed that indoor pollution causes fatigue (66.70%), increases lung problems (60.00%) and it doesn't affect sleep quality (60.70%) which indicates the knowledge gap. More than half of the respondents were aware that IAP increases the risk of allergies (57.30%), effects mental well-being (55.30%) and causes heart problems (54.70%) with WMS ranging from 2.23 to 2.75. Less than half of the respondents reported that air pollution doesn't reduce cognitive function (47.30%) and only 15.30 per cent agreed that IAP doesn't affect children's health, depicting their high awareness regarding this aspect. The respondent's average awareness regarding long-term health effects and poor awareness with respect to above mentioned psychological problems highlights the awareness gap about long-term health effects of indoor air pollution (5) (Table 2).

### Knowledge on preventive measures to combat indoor air pollution

The findings from Table 6 highlight that the respondents had exhibited higher agreement for certain visible and culturally reinforced practices such as avoiding indoor smoking (95.30%), maintaining cleanliness (92.00%), keeping windows open (86.70%), using non-toxic paints (80.00%) and ensuring proper ventilation measures that are low-cost and simple to implement (1). These actions are likely driven by immediate health concerns and traditional household norms. However, a notable gap exists in the adoption of measures that involve higher knowledge or behavioural shifts such as the use of eco-friendly products &fuels (47.30% and 45.30%), indoor plants (32.70%) and minimizing the use of chemical cleaners (46.00%) (7). Minimising the use of synthetic fragrances, use of candle or incense in indoors and reducing the use of air fresheners was practiced by 48.00, 44.00 and 36.00 per cent of the respondents, respectively. Despite of proven benefits, the relatively low practice of using indoor plants or eco-friendly cleaning agents indicates a lack of information, perceived inconvenience or cost barriers. The less frequent use of air purifiers (13.33%) and HVAC maintenance (38.70%) suggests that their higher costs might limit regular usage. Regardless of good knowledge on associated health effects of IAP, respondents were not practicing measures to mitigate IAP, probably due to their busy lifestyles or unavoidable usage of gadgets, cleaning products, etc (Table 3).

### Relationship between demographic profile and knowledge level on indoor air pollution

Table 4 presents the association between respondents' demographic profiles and their awareness regarding the health effects of indoor air pollution (IAP) and corresponding preventive measures. The results indicate that age and family type did not show any significant association with either awareness of health effects or preventive measures, suggesting that awareness of IAP-related health issues is independent of these factors. In contrast, education demonstrated a strong positive association with both awareness of health effects ($\chi^2$ = 25.21, $p < 0.05$; F = 3.11, $p < 0.05$) and preventive measures ($\chi^2$ = 53.61, $p < 0.01$; F = 9.40, $p < 0.01$). This indicates that respondents with higher educational qualifications had better awareness of IAP risks and were more likely to implement preventive strategies (3). Occupation was significantly associated with awareness of preventive measures ($\chi^2$ = 16.45, $p < 0.05$; F = 9.68, $p < 0.01$) and marginally with awareness of health effects (F = 4.93, $p < 0.05$), suggesting that professional exposure or work environment might influence the understanding and adoption of mitigation practices (13). Similarly, annual income was significantly related to awareness of health effects ($\chi^2$ = 16.61, $p < 0.05$; F = 10.99, $p < 0.01$) and preventive measures ($\chi^2$ = 10.28, $p < 0.05$; F = 4.67, $p < 0.05$), indicating that financial capacity may enhance access to information and resources for reducing exposure. Socioeconomic class also demonstrated a strong association with both awareness of health effects ($\chi^2$ = 16.76, $p < 0.05$; F = 5.44, $p < 0.05$) and preventive measures ($\chi^2$ = 32.02, $p < 0.01$; F = 14.74, $p < 0.01$), further reinforcing the role of social and economic factors in shaping knowledge and behavior concerning indoor air quality (8). Table 5 illustrates the correlation between respondents' demographic profiles and their knowledge of indoor air pollution (IAP), focusing on awareness of health effects and preventive measures. The results indicate that age and family type exhibited very low and non-significant correlations with awareness of health effects (r = 0.099, 0.053) and preventive measures (r = 0.071, 0.007), suggesting that these demographic characteristics have minimal influence on respondents' understanding of IAP. In contrast, education demonstrated a significant positive correlation with awareness of health effects ($r = 0.296$, $p < 0.01$) and preventive measures ($r = 0.446$, $p < 0.01$).

This finding emphasises that higher educational attainment enhances understanding of both the risks associated with IAP and the actions necessary to mitigate them. Occupation also showed a significant positive correlation with knowledge of health effects ($r = 0.194$, $p < 0.05$) and preventive measures ($r = 0.307$, $p < 0.01$), indicating that professional background or work-related exposure may influence awareness levels. Similarly, annual income and socioeconomic status (SES) were positively and significantly correlated with knowledge of health effects ($r = 0.321, 0.262$; $p < 0.01$) and preventive measures ($r = 0.247, 0.442$; $p < 0.01$). These results suggest that financial capacity and social standing contribute to greater access to information and resources for reducing indoor air pollution exposure (16).

***Table 1: Demographic profile of the respondents*** ***n=150***

| Category | Frequency (f) | Percentage (%) |
|---|---|---|
| **Age** | | |
| Below 37 years | 18 | 12 |
| 37 to 55 years | 91 | 60.7 |
| Above 55 years | 41 | 27.3 |
| **Family type** | | |
| Nuclear | 104 | 69.3 |
| Joint | 46 | 30.7 |
| Extended | 0 | 0 |
| **Education** | | |
| Illiterate | 18 | 12 |
| Primary | 25 | 16.68 |
| Middle school | 24 | 16 |
| High school | 17 | 11.33 |
| PUC/Diploma | 14 | 9.33 |
| Graduate | 44 | 29.33 |
| Post graduate | 8 | 5.33 |
| **Occupation** | | |
| Housewife | 102 | 68 |
| Self employed/business | 5 | 3.33 |
| Service | 43 | 28.67 |
| **Annual income (in rupees)** | | |
| Below 282,422 | 35 | 23.33 |
| 282,422-630,378 | 72 | 48 |
| Above 630,378 | 43 | 28.67 |
| **Socio economic class** | | |
| Upper (I) | 5 | 3.33 |
| Upper middle (II) | 48 | 32 |
| Lower middle (III) | 38 | 25.33 |
| Upper lower (IV) | 59 | 39.33 |
| Lower (V) | 0 | 0 |

***Table 2: Knowledge of respondents regarding health effects of indoor air pollution*** ***n=150***

| Statement | Agree | | Neutral | | Disagree | | WMS |
|---|---|---|---|---|---|---|---|
| | f | % | f | % | f | % | |
| Causes asthma | 136 | 90.70 | 14 | 9.30 | 00 | 0.00 | 2.91 |
| Leads to skin allergies | 115 | 76.70 | 32 | 21.30 | 03 | 2.00 | 2.75 |
| Doesn't reduce cognitive function | 71 | 47.30 | 33 | 22.00 | 46 | 30.70 | 1.83 |
| Increases the risk of heart problems | 82 | 54.70 | 38 | 25.30 | 30 | 20.00 | 2.35 |
| Doesn't affect children's health | 23 | 15.30 | 19 | 12.70 | 108 | 72.00 | 2.56 |
| Causes eye irritation | 127 | 84.70 | 14 | 9.30 | 09 | 6.00 | 2.79 |
| Leads to headache | 131 | 87.30 | 14 | 9.30 | 05 | 3.30 | 2.84 |
| Causes fatigue | 100 | 66.70 | 36 | 24.00 | 14 | 9.30 | 2.57 |
| Sleep quality is not affected | 91 | 60.70 | 26 | 17.30 | 33 | 22.00 | 1.61 |
| Causes cold and cough | 114 | 76.00 | 31 | 20.70 | 05 | 3.30 | 2.73 |
| Impacts mental well-being | 83 | 55.30 | 19 | 12.70 | 48 | 32.00 | 2.23 |
| Reduces oxygen intake | 106 | 70.70 | 12 | 8.00 | 32 | 21.30 | 2.49 |
| Increases allergic reactions | 86 | 57.30 | 28 | 18.70 | 36 | 24.00 | 2.33 |
| Increases the risk of lung problems | 90 | 60.00 | 17 | 11.30 | 43 | 28.70 | 2.31 |

*Note: f= Frequency, %= Percentage, WMS- Weighted Mean Score*

***Table 3: Knowledge on practice of preventive measures to combat indoor air pollution*** ***n=150***

| Statement | Always | | Sometimes | | Never | | WMS |
|---|---|---|---|---|---|---|---|
| | f | % | f | % | f | % | |
| Use of eco-friendly cooking fuels | 68 | 45.30 | 26 | 17.30 | 56 | 37.30 | 2.08 |
| Use of indoor plants | 49 | 32.70 | 12 | 8.00 | 89 | 59.30 | 2.14 |
| Avoid smoking indoors | 143 | 95.30 | 03 | 2.00 | 04 | 2.70 | 2.93 |
| Improve cross ventilation | 95 | 63.30 | 23 | 15.30 | 32 | 21.30 | 2.42 |
| Use of air purifiers | 20 | 13.33 | 10 | 6.67 | 120 | 80.00 | 1.33 |
| Regular cleaning of the house | 138 | 92.00 | 12 | 8.00 | 00 | 0.00 | 2.92 |
| Keep windows open | 130 | 86.70 | 20 | 13.30 | 00 | 0.00 | 2.87 |
| Minimise the use of chemical cleaners | 69 | 46.00 | 10 | 6.70 | 71 | 47.30 | 1.99 |
| Use non-toxic paints | 120 | 80.00 | 30 | 20.00 | 00 | 0.00 | 2.80 |
| Reduce the use of air fresheners | 54 | 36.00 | 77 | 51.30 | 19 | 12.70 | 2.23 |
| Maintain HVAC systems | 58 | 38.70 | 72 | 48.00 | 20 | 13.30 | 2.25 |
| Minimise the use of synthetic fragrances | 72 | 48.00 | 31 | 20.70 | 47 | 31.30 | 2.17 |
| Use eco-friendly cleaning products | 71 | 47.30 | 09 | 6.00 | 70 | 46.70 | 2.01 |
| Ensure proper ventilation during household activities | 117 | 78.00 | 10 | 6.70 | 23 | 15.30 | 2.63 |
| Limit the use of candles or incense indoors | 66 | 44.00 | 45 | 30.00 | 39 | 26.00 | 2.18 |

*Note: f= Frequency, %= Percentage, WMS- Weighted Mean Score*

*Table 4: Association between demographic profile and knowledge of respondents about health effects of indoor air pollution n=150*

| Variables | Awareness on health effects | | Awareness on preventive measures | |
|---|---|---|---|---|
| | $\chi^2$ | F-value | $\chi^2$ | F-value |
| Age | 4.12$^{NS}$ | 0.92$^{NS}$ | 1.35$^{NS}$ | 0.78$^{NS}$ |
| Family type | 1.76$^{NS}$ | 0.17$^{NS}$ | 0.63$^{NS}$ | 0.70$^{NS}$ |
| Education | 25.21$^{*}$ | 3.11$^{*}$ | 53.61$^{**}$ | 9.40$^{**}$ |
| Occupation | 8.50$^{NS}$ | 4.93$^{*}$ | 16.45$^{*}$ | 9.68$^{**}$ |
| Annual Income (₹) | 16.61$^{*}$ | 10.99$^{**}$ | 10.28$^{*}$ | 4.67$^{*}$ |
| Socio economic class | 16.76$^{*}$ | 5.44$^{*}$ | 32.02$^{**}$ | 14.74$^{**}$ |

*NS- Non Significant, * indicates significant at 5% level, ** indicates significant at 1% level,*

*Table 5: Relationship between demographic profile of the respondents and knowledge on indoor air pollution n=150*

| | Health effects | Preventive measures |
|---|---|---|
| **Age** | 0.099 | 0.071 |
| **Family type** | 0.053 | 0.007 |
| **Education** | 0.296$^{**}$ | 0.446$^{**}$ |
| **Occupation** | 0.194$^{*}$ | 0.307$^{**}$ |
| **Income** | 0.321$^{**}$ | 0.247$^{**}$ |
| **SES** | 0.262$^{**}$ | 0.442$^{**}$ |

*** Correlation is significant at the 1% level*

## CONCLUSION

The study revealed that while most respondents were aware of the immediate health effects of indoor air pollution (IAP), such as asthma, eye irritation, coughing and headaches, awareness of long-term impacts like cardiovascular diseases, lung problems and cognitive decline was limited. Preventive practices largely focused on low-cost, visible measures such as cleanliness and ventilation, while adoption of eco-friendly products, indoor plants and air purifiers remained low. Education, occupation, income and socio-economic status significantly influenced awareness and practices, whereas age and family type had little impact. These findings highlight the need for targeted awareness programs and affordable interventions to bridge knowledge gaps and encourage broader adoption of effective preventive measures against IAP.

### Future scope of the study

Future research may incorporate longitudinal designs to assess changes in awareness and practices over time and include objective measurements of indoor air quality parameters. Intervention-based studies evaluating the effectiveness of educational programmes and low-cost technological solutions could further strengthen policy and community-level recommendations. Expanding the study to rural and peri-urban settings would also provide comparative insights.

### Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

### Acknowledgements

The authors express their sincere gratitude to all the respondents who participated in the study and to the institutions that provided support and facilities for conducting this research.

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