Effectiveness of Home-based Educational Intervention on Community Perception of Indoor Air Pollution

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Abstract

Background: Indoor air pollution (IAP) takes 8th place in the ranking of main causes of mortality. Increasing community perception about indoor air pollution effects is one of the most pragmatic ways that might help in taking effective preventing actions. The present study aims to evaluate the effect of a home-based education program on community perception of IAP. **Subjects & Methods:** A quasi-experimental research design using pre-test and post-test was conducted among 255 household heads in a rural area of Mansoura city, Egypt through a multistage stratified cluster random sample. Data were collected using a structured interview questionnaire and observational checklist. The intervention consisted of a structured home-based educational intervention about IAP based on Healthy Housing Reference Manual published by the centers for disease control and prevention (CDC). **Results:** About 99% of the study population was exposed to at least one source of IAP and complained of at least one symptom that could be related to indoor air pollution. The pre-intervention mean score of perception of ecological/environmental and health impact of IAP was 7.2±2.6 compared with post-intervention mean scores of 9.7±0.9 with ($p \leq 0.001$). Also, the average increase in the score of perception of sources of IAP from 3.6±2.4 in the baseline to 7.4±2.8 in three months' post-intervention ($p \leq 0.001$). In addition, the average increase in the score of perception of IAP-related health problems from 3.2±1.9 in the baseline to 5.7±2.1 in three months' post-intervention ($p \leq 0.001$). furthermore, a statistically significant improvement was found in the mean score of perception of IAP-related mitigation strategies from 6.9±2.5 to 9.7±0.9 with ($p \leq 0.001$). **Conclusion:** Home-based IAP educational intervention is effective in significantly improving perception regarding all aspects of IAP including impact, sources, the intensity of risk, health problems, and mitigation strategies. **Recommendation:** Further studies are needed to expand and refine the home-based IAP education program by offering it to a larger sample in a controlled trial design with an extended follow-up period.

Keywords: Indoor air pollution; Air quality; Risk perception; Risk communication.

1. INTRODUCTION

Air pollution is defined by the World Health Organization (WHO) as "any chemical, physical, or biological agent that modifies the normal features of the atmosphere." **(Kantipudi et al., 2016; Naqvi1 & Devi, 2019; WHO, 2021).** Air pollution is recognized as a pressing sustainability concern and is specifically classified into two Sustainable Development Goals (SDG) targets SDG 11.6 (reduction of adverse impacts of cities on people) and SDG 3.9 (substantial reduction of health impacts from hazardous substances) **(Rafaj et al., 2018).**

Many parts of the world continue to have dangerously high levels of air pollution. According to new WHO data, 9 out of 10 people breathe air that contains high levels of pollutants. The WHO estimates that air pollution kills approximately 7 million people each year, with the greatest impact in developing countries. In 2016, ambient air pollution alone was responsible for approximately 4.2 million deaths, while household air pollution from cooking with polluting fuels and technologies was responsible for approximately 3.8 million deaths during the same period **(Swapna, 2019).**

Indoor air pollution (IAP) refers to air pollutants found inside our homes, schools, and other structures. Because the level of visible pollution indoors is relatively low, indoor air quality has received significant attention in recent years. In total, IAP is estimated to be responsible for about 2.7% of the global disease burden, and 1.6 million deaths occur each year for the same reason **(Tariq et al., 2018; Wong-Parodi, et al., 2018).**

Residents in both developed and developing countries spend a long time indoors. However, as pollution levels rise, the quality of air in indoor spaces is not always beneficial to human health. Indoor air pollutants are primarily released in developing countries during the combustion of solid fuels used for heating and cooking. Households that use such fuels are typically found in urban slums with poorly ventilated houses and poor rural areas (**Viegi et al., 2019).** Indoor air pollutants can have a wide range of negative health effects, including respiratory, neurological, reproductive, endocrine, cardiovascular systems and dermatologic (**Azuma, et al., 2020).** Furthermore, air pollution complications can include bad mood, depression, anger, anxiety, stress, and memory loss **(Ahmadfazeli, et al., 2019; Tran, et al., 2020).**

Improved indoor air quality has several benefits including improved health of the population, reduced environmental degradation, socio-economic development, and climate change mitigation. Improving public health and increasing their participation in initiatives necessitates community and individual-level interventions aimed at reducing IAP exposure. However, the success of these initiatives is heavily dependent on how people perceive risk and exposure **(Dettori et al., 2020; Riley et al., 2021).**

Perception is defined as a subjective assessment of an environmental hazard's level of exposure and concern about the consequences of that exposure. It is the identification, organization, and interpretation of sensory information in order to represent and understand the environment. An individual's perception determines one's knowledge gained about any ideas as well as their acceptance, adoption, continuation, and rejection. **(Jaishi et al., 2018).** It is a mental process that is constantly influenced by media, peer pressure, and other forms of communication, as well as internalized through social and cultural education. It is an important public health concept because it influences the hazards that are concerned about and how those hazards are dealt with by people **(Shin, et al., 2019).**

Effective risk communication interventions, such as household interventions, can be beneficial in promoting risk perception and consequently mitigating the negative effects of air pollution exposure **(Ammons et al., 2021).**

Significance of the study:

Globally, air pollution is the most serious environmental threat to human health. Air pollution exposure is caused by outdoor and indoor air pollutants. The health risks of indoor air pollution (IAP) are greater than those of outdoor air pollution **(Moreno-Rangel et al., 2020).** Approximately 3.8 million people prematurely die from IAP illnesses annually according to the WHO. Pneumonia is responsible for 27% of these deaths, stroke is responsible for 18%, ischemic heart disease is responsible for 27%, chronic obstructive pulmonary disease (COPD) is responsible for 20%, and lung cancer is responsible for 8% **(Avis, Mariga& Singh, 2018).**

Perception is a necessary component of behavior modification and has a significant impact on how people react to risk exposures **(Cori et al., 2020; Noel, Vanroelen, &Gadeyne, 2021).** Proper risk perception interventions can increase community participation in IAP risk reduction programs, reduce climate change-related damages, and reinforce preventive behaviors at the community level **(Schneiderbauer et al., 2021).** Home-based environmental teaching programs increased people's perception of environmental exposures while decreasing the presence of home hazards **(Paudel et al., 2021).** However, there are few studies in the literature that report on indoor air pollution risk perception in relation to home-based health education interventions. Therefore, this study is conducted to evaluate the effect of implementing home-based educational intervention on community perception of indoor air pollution.

Aim of the Study:

The study's main aim was to evaluate the effect of a home-based educational intervention on community perception of indoor air pollution.

The specific objectives were to:

(i) Describe the housing condition and household air pollution emission sources.
(ii) Describe the IAP-related symptoms.
(iii) Measure the effect of home-based educational intervention on IAP risk

perception among the household head in the rural area.

Study hypothesis:

There will be a difference in the mean score of indoor air pollution risk perception among the participants between the pre and three months after the home-based educational intervention.

2. MATERIALS AND METHODS

2.1 Study Design

A quasi-experimental study design was conducted throughout the study.

2.2 Study Area

Salamon Al-Qomash village is one of the villages in the Mansoura district in the Dakahlia Governorate in the Arab Republic of Egypt. According to the statistics for the year 2021, the total population of Salamon Al-Qomash was 32000 people, of whom 6153 housing units and 5625 families. This village was selected to implement the intervention because it is a densely populated region with diverse demographic and socioeconomic indicators. In addition, it is easily accessible and more cooperative, therefore was appropriate for the study.

2.3 Study Subjects

The study units were households in the village, while respondents were household heads either male or female from various ages, family size, educational qualifications, and communication exposure. In this study, a household was defined as one or more persons residing under one roof and using the same kitchen. All empty buildings were excluded and substituted by the buildings close to them. Household heads were involved in the study because it was anticipated that they knew more about their respective households concerning issues of indoor air pollution than other members. In the absence of a household head, another responsible member such as the spouse served as the respondent in the study. The respondent should have been living in their household for more than one year to be eligible to take part in the study.

2.4 Sample Size Estimation

The sample size was calculated online to estimate the approximate number of eligible households using Medcalc 15.8 (https://www.medcalc.org/). The primary outcome of interest is the total score of perception of health problems and diseases related to air pollution. A pilot study on 30 houses revealed that the mean (SD) pre- and post-intervention scores were 3.5(1.5) and 5.3(2.1); respectively. With alpha error of 1%, study power of 99%, and design effect of 5 due to the cluster sampling method, then the sample size is 255 at least.

2.5 Sampling Technique

A multistage stratified cluster random sample was adopted for households' selection, all public structures such as schools, clinics, restaurants, police barracks, and mosques were excluded. The cluster sampling is divided into four stages as in figure (1).

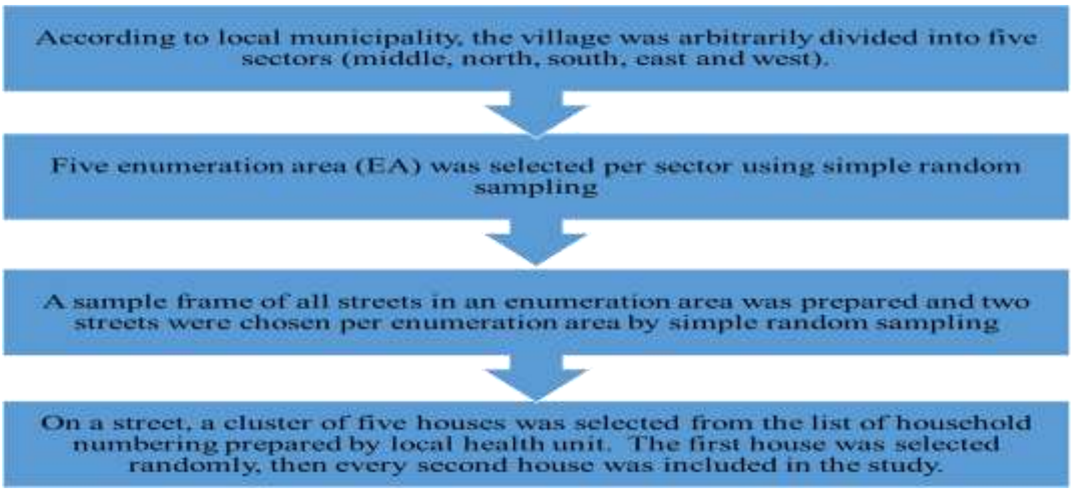

Figure 1: Sampling technique

2.6 Data Collection

Data was gathered from household heads from November 2021 to May 2022 through door-to-door visits using structured interview questionnaires, and an observational checklist to assess the demographic data, household air pollution emission sources, IAP-related symptoms, and perception regarding indoor air pollution risk. The investigators designed the data collection tools in Arabic form based on an extensive search of previous literature and experts' opinions. The survey was conducted in the form of a face-to-face interview, and it took approximately 20-25 minutes to complete.

Part I: Socio-demographics structured interview questionnaire

It consisted of eight questions that inquired about general information about age, gender, marital status, educational level, occupation, income, number of family members, as well as the duration of the homestay.

Part II: Household air pollution emission sources

It consisted of two parts. The first part was an observational checklist adapted from **(Maharana et al., 2018; Priyadarsini et al., 2022; Suzuki et al., 2021).** It consisted of 11 questions and was used to obtain general information about the housing characteristics including type of ventilation, presence of humid conditions, type, and place of the cooking place, distance from the kitchen to the living room in addition to, the presence of black smoke in the kitchen. Observations were made through home visits to know their living conditions through an observational checklist.

The second part was an interview questionnaire adapted from **(Belachew et al., 2018; Padmanabha, Rajesh, Nagarajaiah & Rajappa 2021)**. It was used to collect information about the household activities and practices that produce indoor air pollutants. These pollutants include solvents and detergents, pesticides, formaldehyde, combustion by-products, and biological pollutants.

Part III: Indoor air pollution-related symptoms

It consisted of nine self-reported IAP-related symptoms/diseases adapted from (**Egondiet al., 2014; Fauzan, Jalaludin & Chua, 2016).** It included the experience of cough, breathlessness, wheezing, and allergic rhinitis at the time of study or in the 12 months prior.

Part IV: Perception of indoor air pollutants

This measure was IAP risk perception self-rating scale contained five categories. It was adapted from **(Gamachu & Jegora, 2019; Goin, 2021; Mahami, 2020; Nwanakwere, & Oyedokun 2020; Odonkor & Reta & Girum, 2019).** The first category contained five items that assessed participants' perceptions of the negative impact of IAP. It was measured on a 3-point Likert scale ranging from 0 = disagree to 2 = agree, giving an overall row score ranging from 0 to 10. The second category contained ten items that assessed participants' perceptions of sources of IAP. It was measured on a 2-point ranging from 0 = disagree to 1 = agree, giving an overall row score ranging from 0 to 10. The third category contained11 items that assessed participants' perceptions of the extent of risks resulting from IAP. It was measured on a 5-point Likert scale ranging from 0 = no risk to 4 = very high, giving an overall row score ranging from 0 to 44. The fourth category contained seven items that assessed participants' concern for diseases and health problems resulting from IAP. It was measured on a 2-point ranging from 0 = disagree to 1 = agree, giving an overall row score ranging from 0 to 7. The last category contained five items that assessed the participant's perception of the action needed for controlling and mitigating IAP, it was measured on a 3-point Likert scale ranging from 0 = disagree to 2 = agree, giving an overall row score ranging from 0 to 10. Higher scores indicate higher risk perception.

2.7 Survey Instrument validation and Pilot Testing.

The instrument's face validity was established by basing the survey's content on a thorough review of the published research literature on indoor air pollution and risk perception. The survey instrument's content validity was determined by soliciting feedback from five expert panels with extensive experience in community and environmental health (3 in nursing & 2 in medical faculties). Prior to pilot testing, the expert panel's suggested edits were incorporated into the survey. Cronbach's alpha was used to assess reliability for internal consistency, and the reliability coefficient ranged from 0.75-0.87, indicating high reliability.

A pilot study of 30 household heads was conducted one month before the main project to test the applicability and relevance of the study tools, as well as the clarity of the designed questionnaire, and to calculate the sample size. The necessary changes were made, and these households were removed from the study sample.

2.8 Intervention

2.8.1 Pre-intervention phase

The pre-intervention phase included advocacy visits to the head of the local health units and the local municipality of the village to seek permission and cooperation when conducting the study and facilitate sampling of the households. Initially, the household heads who accepted to participate in the study were visited and the purpose of the study was explained to them. The interview was then conducted with the prepared questionnaires serving as a pre-test. An appointment was scheduled for each household head to meet at their home for implementing a health education program. Then, an analysis of the obtained pre-test data was done. After that the researchers designed the home-based health education intervention program based on the result of preliminary assessment, which was conducted for a period of ten weeks.

2.8.2 Intervention phase

Researchers carried out the health education by visiting each respondent's house with the nurse in the local healthcare unit of the village. This home visit consumed about 60–90minutes. The home-based indoor air pollution educational intervention was based on Healthy Housing Reference Manual published by the centers for disease control and prevention (CDC), (2006). The home-intervention program aimed to teach families information on measures to reduce hazardous exposure to IAP in the household. It included the following components: indoor air pollution, toxic materials in the home, their sources, health effects and methods for controlling these hazards, and methods to create a healthier home environment **(U.S. Department of Health and Human Services, 2006).**

The researchers provided education on ways to prevent and control indoor air pollution, through the use of an educational booklet. This booklet presents an overview of the definition, types, sources, and negative health effects of IAPs in addition to the mitigation strategies to prevent and control them. The educational booklet is available in Arabic form and all materials are tailored to families with limited literacy skills. The researchers met with the study group twice every week for a 60–90minutes health education intervention session in Arabic for a period of ten weeks. The health education included a clear message, as well as simple brochures, PowerPoint presentations, and posters to explain all of the items concerning indoor air pollution prevention. Individuals were taught face-to-face in their homes through lectures, group discussions, and question & answer sessions. Brochures were distributed to households' heads to remind them about health messages regarding steps they could take to reduce hazardous exposure in the home. A poster displaying a health message about air pollution-related symptoms was also displayed in the local health unit of the village.

2.8.3. Post-intervention phase

The same households' heads were then subjected to a post-test three months later, using the same pre-test interview form, to assess the changes in their perceptions following the intervention.

2.9 Ethical Consideration

Ethical approval to conduct this study was obtained from the Research Ethics Committee of the Faculty of Nursing, Mansoura University (Ref. No. P.0246). Approvals were also obtained from the head of the local municipality and the local health unit of the village. The households' heads provided verbal informed consent. They were informed about the study's purpose and were made aware that participation was entirely voluntary, with no consequences for refusing to participate. They were assured of their privacy and confidentiality.

2.10. Data Analysis

Data were analyzed using Statistical Package for Social Sciences for Windows, version 21.0 (Chicago, Illinois, USA). Statistical analysis included (1) Descriptive statistics (e.g., frequencies, mean, and standard deviation) were used to describe the study participants and their responses to various survey items. (2) The dependent sample t-test analysis was used to compare mean differences between pre- and post-IAP-risk perception. Results were considered statistically significant at conventional $P \leq 0.05$ level.

3. RESULTS

Table 1 reveals that 51% of the respondents were less than 50 years old with an average age of 49 years and standard deviation 12.3. There were more female participants in this study than males expressed as 75.3% to 24.7% respectively. 79.6% of the participants were married. It was observed that 51.8% of the respondents were housewives or not working, followed by 29.4% as farmers or manual workers and the least 18.8% were employees. From the total respondents 60% had attained less than secondary of education and 40% of household heads respondents had attained a secondary or a higher education level. Moreover, 52.2% of respondents had not enough family income. Total family size was about five persons or more in 62.4% of the studied households.

Table 2 shows that 93.7% of the studied household heads had an appropriate cooking area with 90.2% cooked in a sanitary kitchen. It was found that 28.2% and 16.1% of them complained of black smoke in the kitchen or corridors respectively. In addition, 94.1%, 93.3%, and 63.5% of the study participants had an adequate number of fans, windows, and hoods. 98.8%, of them live lived in houses with adequate ventilation. In addition, around 53.3% of the household heads lived in their households for more than 20 years old with an average duration of 21.4 years and standard deviation 13.7.

Table 3 shows that various sources of indoor air pollution were identified within the house. Regarding the pesticide sources, 86.7% and 60% of the respondents had disinfectants and insecticides in their houses respectively. Using gas stoves 92.5%, candles 62.4%, and smoking 46.7% were found to be the major sources of combustion by-products inside the houses. Concerning Volatile Organic Compounds (VOCs) and formaldehyde emission sources, 39.2% and 32.5% of the respondents had new carpets and textiles respectively. Moreover, 85.1%, 75.7%, 74.9%, and 61.2% of the respondents relied on plastics, incense, air fresheners, and cleansing agents respectively. Among the sources reported for biological hazards were the presence of humid conditions in the form of dampness and leaky roof were prevalent in 54.9% and 52.9% of households respectively.

Figure 2 demonstrates that among the surveyed households, the highest prevalence of general symptoms was headache 43.1%. Among the irritable respiratory mucosa and skin symptoms were dyspnea 33.3%, cough, allergic rhinitis 24.3% and eye irritation with (29.8%), which were more common than other symptoms.

Table 4 shows that the average score of the respondents perceived that mismanagement of indoor air pollution had a negative economic, ecological/environmental, and health impact with 7.2±2.6 before the home-based intervention compared to 9.7±0.9 three months after implementing the home-based intervention. The mean scores of perceived impacts significantly improved after the intervention ($t = 14.8$, $p \leq 0.001$). Moreover, the average score of the respondent's perception of main sources of IAP was 3.6±2.4 before the home-based intervention compared to 7.4±2.8 three months after implementing the home-based intervention. The mean scores of perceived sources improved significantly after the intervention ($t=22.0$, $p \leq 0.001$). Additionally, the average score of the respondent's perception of extent of pollution and risks from indoor air pollutants was 14.3±8.0before the home-based intervention compared to 27.4±10.8three months after implementing the home-based intervention. The mean scores of perceived sources significantly improved after the intervention ($t=22.0$, $p \leq 0.001$). Also, the average score of the respondent's perceived health problems was 3.2±1.9 before the home-based intervention compared to 5.7±2.1 three months after implementing the home-based intervention. The mean scores of perceived health problems improved significantly after the intervention ($t=19.0$, $p \leq 0.001$). Lastly, the average score of perceived mitigation strategies for controlling indoor air pollution was 6.9±2.5 before the home-based intervention compared to 9.7±0.9 three months after implementing the home-based intervention. The mean scores of perceived effects improved significantly after the intervention (t = 17.2, p≤0.001).

Table 1: Sociodemographic characteristics of study population (n=255)

Variables	N (%)
Age:	
<50	130(51)
≥50	125(49)
Mean ± SD	49.0±12.3
Sex:	
Male	63(24.7)
Female	192(75.3)
Married:	
No*	52(20.4)
Yes	203(79.6)
Occupation:	
Housewife/not working	132(51.8)
Farmers/manual workers	75(29.4)
Employees	48(18.8)
Education:	
<2ry	153(60.0)
≥2ry	102(40.0)
Family income:	
Not enough	133(52.2)
Enough**	122(47.8))
Family size:	
<5 persons	96(37.6)
≥5 persons	159(62.4)
Mean ± SD	5.0±2.0

*11single, 7 divorced & 34 widows **7 able to save

Table (2): Distribution of the study population according to housing conditions (n=255)

Variables	N (%)
Duration of accommodation:	
<20 years	119(46.7)
≥20 years	136(53.3)
Mean ± SD	21.4±13.7
Housing conditions:	
Appropriate cooking area	239 (93.7)
Sanitary kitchen	230 (90.2)
Appropriate site of kitchen	117 (45.9)
Black smoke in kitchen	72 (28.2)
Adequate ventilation	252 (98.8)
Black smoke in corridors	41(16.1)
Adequate number of windows	238 (93.3)
Presence of air conditioner	42 (16.5)
Presence of fans	240 (94.1)
Presence of hoods	162 (63.5)
Signs of mold growth	36 (14.1)

Table 3: Potential Sources of indoor air pollution among the surveyed population

Variables	N (%)
Pesticides:	
Disinfectants	221(86.7)
Insecticides	153(60.0)
Pesticides	86(33.7)
Herbicides	47(18.4)
Volatile organic compounds & Formaldehyde:	
Plastics	217(85.1)
Incense	193(75.7)
Air fresheners	191(74.9)
Cleaning agents	156(61.2)
Personal care products	146(57.3)
Varnishes	129(50.6)
Fuels	116(45.5)
Paints	107(42)
New carpets	100(39.2)
Textiles	83(32.5)
Glues and solvents	72(28.2)
Furnishings	36(14.1)
Polishes	32(12.5)
Dyes	32(12.5)
Lubricants	18(7.1)
Printers	7(2.7)
Combustion by products:	
Gas stove	236(92.5)
Candles	159(62.4)
Smoking	119(46.7)
Water heater	90(35.3)
Vehicular exhaust garage	70(27.5)
Biological allergens:	
Damp wall	140(54.9)
Leaky roof & pipes	135(52.9)
Dirt & Dust	103(40.4)
Furry pets	44(17.3)

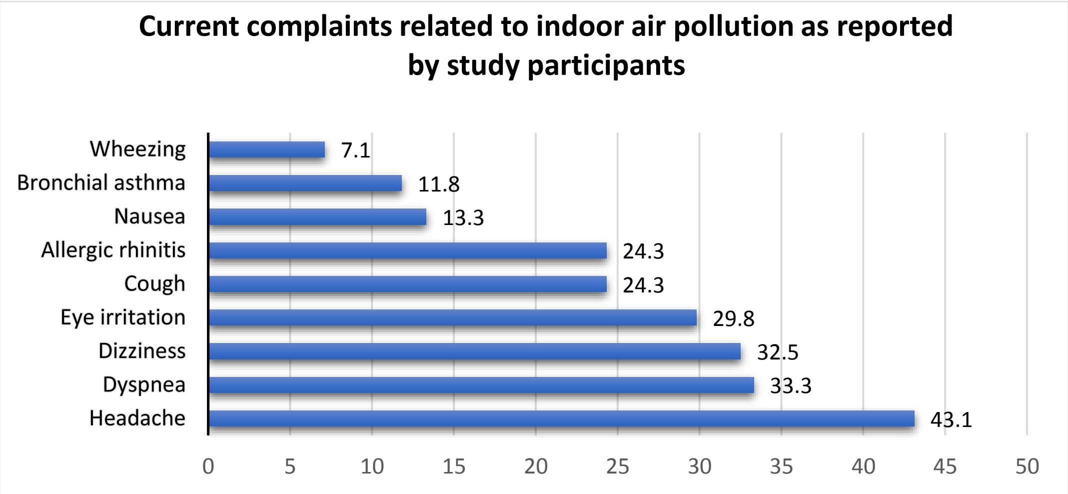

Figure 2: Horizontal bar diagram showing the distribution of study population according to perceived symptoms (n = 255)*

Table 4: Comparisons between mean scores of indoor air pollution perception at the baseline and three months after the intervention among the studied group

Items	Before intervention Mean ± SD	Three months after intervention Mean ± SD	Paired t-test
Perceived impact	7.2±2.6	9.7±0.9	t=14.8, P≤0.001
Perceives sources	3.6±2.4	7.4±2.8	t=22.0, P≤0.001
Perceived intensity of risks	14.3±8.0	27.4±10.8	t=22.0, P≤0.001
Perceived health problems& disease	3.2±1.9	5.7±2.1	t=19.0, P≤0.001
Perceived mitigation strategies	6.9±2.5	9.7±0.9	t=17.2, P≤0.001

4. DISCUSSION

Air pollution is currently a major global threat. The advantages of reducing air pollution exposure have been well documented in both epidemiological studies and natural experiments. One of the most practical ways to aid in the efficient implementation of preventive measures is to increase public awareness about the effects of indoor air pollution exposure **(Carlsten, Salvi, Wong & Chung, 2020).** Accordingly, the current study was conducted in rural residential buildings where residents used several household products containing synthetic chemicals and activities that generate various physical, chemical, and biological pollutants, indicating that may lead to chronic effects in human health.

In general, Low socioeconomic status is typically linked to poor health, leaving people more vulnerable to the air pollution harmful effects. According to the study's findings, the majority of household participants were females. The mean age of the respondents was 49.0 with standard deviation of 12.3 years old. More than half of them were relatively poor and had little formal education without work or employment who were housewives or with an Agro-based livelihood. These findings are in agreement with a study on ill effects of indoor air pollution in Mangalore showed that the majority of the study participants had a primary school, were not working or employed, and were in the lower middle class **(Alex, Baisil & Badiger 2018).**

In this study, a higher proportion of the houses 53.3% were old built (more than 20 years). The majority 93.7% of these households contained a kitchen as a cooking area whereas some form of the smoke outlet (either exhaust fan or window) was observed in more than 90% of the houses. However, more than half of the kitchens did not locate at an appropriate site of the house. These findings agree with a study on determinants of indoor air pollution which reported that most of the houses 98.8% had adequate ventilation, indoor cooking practices were followed by 97.5% of households and 61.4% of the houses have windows in the kitchen **(Priyadarsini et al., 2022).**

According to the current study, 98.4% of study households had at least one source of IAP. The main pesticide contaminant sources in the houses were 86.7% and 60% from disinfectants and insecticides respectively. Main VOCs and formaldehyde contaminant sources were more than 50% from varnish, personal care products, cleansing agents, aerosol spray and air refreshers, incense, and plastics followed by 45.5% and 42% from fuel and paints respectively. If these contaminants are used in poorly ventilated homes or in the presence of susceptible individuals, they pose a number of health risks. Burning incense sticks produces air pollutants, primarily CO, and may cause lung tissue inflammation; it also increases the risk of respiratory complications as lung cancer. There was a higher prevalence of asthma and chronic obstructive pulmonary disease (COPD) in families who used incense sticks on a regular basis. Our study findings are in agreement with a study conducted by **Belachew et al., 2018** which reported that 40.4% of study subjects had recently used pesticides, paints, or solvents and the use incense and joss stick were a common practice in the homes of participants**.** It was also found that 60% of the households used insecticides. A similar study done by **Maharana et al., 2018** showed that 62.5% used insecticide repellents. However, our findings were greater than those of another study to evaluate the effects of IAP on the women health, which found that 45.4% of households used insecticide repellents **(Padmanabha, Rajesh, Nagarajaiah & Rajappa 2021).**

Carbon dioxide (CO2), several gases, and Particulate matter (PM) emissions during cooking activities and combustion sources into indoor air environments **(Tran et al., 2020).** The percentages of indoor air pollutants from combustion by-products in this study indicate that the maximum sources of were 92.5% and 62.4% from gas stoves and candles respectively, followed by about 50% from smoking. This was greater than the findings in a study on the perceived impact of indoor air pollution in a slum area of Kolkata, West Bengal which was 21.8% **(Dutta et al., 2022).**

The damp wall is usually ignored feature, but it contributes to acute respiratory infections, especially in young children who are more susceptible. Biological contaminant sources were among the contributing factors for indoor air pollution, with 54.9% of households in the current study having dampness, 52.9% having a leaky roof, and 40.4% having dust and dirt in their homes. A similar study was done by **Sarkar et al., 2014** to identify the IAP health manifestations who showed that about 40% of households may include bio-aerosols such fungi and microbial spores due to wet walls and dust.

Pollutants in the indoor air environment play a significant role in the development of human diseases. In respect to established health impact data in this study, 98.2% of the residents reported symptoms linked to their residential buildings' indoor environments in the previous year. In the present study, headache 43.1% and dyspnea 33.3%, and dizziness 32.5% were mostly reported among the residents, followed by eye irritation 29.8%. These findings are similar to those of a study conducted to assess the community perceptions about air pollution health risks (**Egondiet al., 2014)**. Moreover, these findings were supported also by another study done in Kuala Lumpur and Selangor to evaluate the relation between sick building syndrome and indoor air quality, where they reported that fatigue, unusual tiredness, irritated eyes, chest tightness, sneezing, shortness of breath, and cough were the significant symptoms experienced due to poor indoor air quality **(Fauzan, Jalaludin & Chua, 2016).** The current prevalence is higher than that discovered in a study conducted in three North European cities. The prevalence reported by the later study was 8% dermal symptoms, 10% general and 20% mucosal. **(Sahlberg et al., 2013).**

To the best of our knowledge, this is the first study to evaluate the effect of implementing an educational intervention for indoor air pollution risk communication on community risk perception. After implementing the home-based intervention, we found a significant difference between the pre- and post-average scores of perceptions among the respondents regarding all aspects of IAP. The respondents perceived the main air pollution sources (e.g., dust, smoke, ovens, carpets, paints, solvents, pesticides) and air pollutants (e.g., molds, Formaldehyde, VOCs, asbestos) inside their household. They realize that these pollutants contained harmful components and other chemicals.

Perceived exposure was found to influence health risk perception, which, in turn, influenced the perception of health symptoms and diseases. The respondents rated intensity of poor air quality in their houses and the extent of the risks associated with it as a serious condition. They realized possible symptoms and most common adverse health effects of exposure to indoor air pollution ranging from respiratory illness to chronic illness such as cancer. In relation to residents' perceptions about IAP mitigation interventions. They also believed that both the government and individuals share responsibility for improving air quality. This demonstrates that residents have a strong desire to engage, support, and participate in the governance of IAP.

These results were consistent with other studies which evaluated the effect of implemented home or community-based educational intervention but on different outcomes. According to the findings of a study conducted by **Koochakzai et al., 2018**, which recommended that home-based educational program is suggested for enhancing women's perceived self-efficacy in neonatal care. Another study revealed that the use of a home-based intervention was successful in improving the perception of women. (**Mohsen, El-Abbassy, & El-Abd, 2020**). An additional study conducted by **Fatugase,**

Amoran, & Fatugase, 2013 which reported that, a systematic health education program at home for caregivers should be a part of the Malaria program in Africa to improve their perception about childhood infections in Nigeria rural communities. Moreover, the effectiveness of educational interventions directed at agricultural workers' knowledge, behavior, and risk perception for lowering pesticide exposure risk was reviewed in a systematic review and meta-analysis, which found that educational interventions are a suitable way for doing so. Additionally, a study in Ghana discovered that these interventions are crucial for enhancing women's knowledge and perceptions of cervical cancer and screening as well as raising self-efficacy **(Ebu et al., 2019).**

Limitations

There were some limitations to the current study. The presence of IAP was determined using a questionnaire and a checklist, whereas PM (Particulate Matter) 2.5 concentration is the ideal measure of IAP. Second, spirometry should have been performed to evaluate respiratory issues. Third, because some of the data were self-reported, the possibility of recall bias exists. Fourth, factors other than indoor air environments were not taken into account.

5. CONCLUSION

The current study found that the majority of the households were exposed to indoor air pollutants and reported at least one symptom of indoor air pollution. Home-based IAP educational intervention improves perceptions regarding all aspects of IAP including impact, sources, the intensity of risk, health problems, and mitigation strategies.

6. RECOMMENDATIONS

The findings of this study indicate that expanding the home-based IAP education program to include low-income communities for improving their perception of the sources and hazards of indoor air pollution will be the most effective method of controlling the situation. Further studies are needed to refine the home-based IAP education program by offering it to a larger sample in a controlled trial design with an extended follow-up period.

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