

## Research Article

# Knowledge, Attitudes, and Perceptions of Air Pollution in Accra, Ghana: A Critical Survey

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Air pollution has been a major challenge worldwide particularly in the developing world. It has dire implications for human health. Understanding the knowledge and behaviour of the populace is key to the development and implementation of necessary intervention programmes. The aim of this study was to assess the knowledge, attitudes, and perceptions of air pollution in the Accra, Ghana. The study employed a cross-sectional design to obtain quantitative data from 1404 respondents, and the results were analysed with SPSS version 23. There were more (54.1%) female respondents than males (45.9%) in the study. The majority (70.5%) of the respondents were aware of the haze (air pollution) and its adverse effects on health. There was however a significant relationship between the sociodemographics and air pollution awareness ( $P = 0.01$ ). There was also a correlation between residents' age, educational level, length of stay, marital status, and knowledge/awareness rate of air pollution ( $P < 0.05$ ). Although the majority of the respondents are aware of air pollution and its relationship to their health, rates of awareness were low in some demographic groups like the elderly and the less educated. Therefore, nondiscriminatory policies should be formed toward the education and guidance of people to become knowledgeable about air pollution and related health challenges. Most of the residents admitted improving air quality is the responsibility of every citizen. The government should utilize this to form collaborative measure with the citizens for a more effective control of air pollution.

## 1. Introduction

Breathing in good quality air daily is important for healthy living [1]. As a result, exposure to polluted air is now recognized as a vital risk factor for noncommunicable human disease conditions [2]. Air pollution has long-term health effects on people [3]. The World Health Organisation (WHO) in 2016 stated an estimated 7 million people died globally that year because of household and ambient air pollution with 90% of such deaths reported in middle- to low-income countries in Asia and Africa.

A wide range of pollutants are associated with air pollution. Particulate matter (PM) presents as a very dangerous and commonly occurring pollutant amongst them. Particulate matter has been implicated with several cardiovascular and respiratory complications [4]. Ultrafine particulates of

2.5 or less in diameter ( $PM_{2.5}$ ) can cause respiratory disorders in certain concentrations [5]. Several activities such as electronic waste recycling, heavy car traffic, and industrial processes are linked with the emission of diverse air pollutants including dust of heavy metals, persistent organic pollutants, dioxins, carbon dioxide, and carbon monoxide into the outdoor atmosphere; all of which are linked with respiratory health problems [6]. Majority of these activities associated with emission of air pollutants are within urban communities.

Ghana is notably one of the fast-developing countries on the African continent [7]. However, this rapid economic growth appears to have influenced gradual increases in air pollution in the country. More than 28,000 deaths were attributed to air pollution in Ghana as of September 2018 [8]. The WHO further reports that the annual mean level of

PM<sub>2.5</sub> in Ghana as of 2016 was 31.1  $\mu\text{g}/\text{m}^3$  which far exceeds the recommended annual guideline of 10  $\mu\text{g}/\text{m}^3$  [8]. This gives an indication of the growing poor air quality in Ghana and its repercussions on human health. A study by [6] on the health of women trading at Agbobbloshie market (near a large e-waste recycling site at Accra, Ghana) found that majority of female traders showed symptoms of sore throats, cough, colds, and persistent sneezing among other respiratory health-related problems. Apart from these market women, street hawkers and vendors who trade along major traffic-prone roads throughout Accra are equally exposed to air pollution from heavy car traffic as well as the drivers themselves.

In a comparative study by [9], results showed the average PM<sub>2.5</sub> exposure of 99 personnel who were either street vendors, hawkers, taxi drivers, or minibus drivers in Accra to be 56.4  $\mu\text{g}/\text{m}^3$ . This far exceeds the recommended annual level of exposure, thereby posing a high risk to respiratory diseases. Additionally, pregnant women could lose their foetus prematurely, when they are frequently exposed to air pollution from vehicular traffic [10]. It is worth noting that industries such as oil refineries are also capable of emitting air pollutants to unhealthy levels [11]. Several studies have revealed that the Tema Oil Refinery in Ghana constantly emits PM<sub>2.5</sub> and greenhouse gases above acceptable limits [7].

The above submissions illustrate air pollution being a significant health problem in Ghana and will continue to pose threats to the health of people, if mitigative measures are not put in place. Yet we do not know the knowledge of the populace who are affected by these emissions. However, this is critical for the development of appropriate health interventions to mitigate the problems associated with these emissions. Furthermore, assessing the knowledge of people as well as educating them about air pollution is a significant step towards combating or minimizing air pollution [1, 12]. The objective of this paper is to assess people's knowledge, attitudes, and practices to air pollution in Accra, aiming at obtaining information to aid stakeholders and government alike to develop and implement effective policies towards the management of air pollution and to ensure improvement in air quality.

## 2. Materials and Methods

**2.1. Study Design and Sample Size.** The study employed a cross-sectional design to obtain quantitative data using questionnaires. The questionnaires were self-administered and were paraphrased into the local language for respondents who, for literacy reasons, could not answer in English. Content and face validity of the questionnaire were determined by a panel of experts before and after pretesting.

**2.2. Sampling Technique.** The study utilized multiple sampling techniques. Thus, a multistage sampling technique comprising a cluster and simple random sampling was employed. The district under study was thus divided into six subdistricts called clusters. Two hundred and fifty (250) respondents were then selected from each of the six

subdistricts for the study. A total of 1600 respondents were approached with the questionnaires. However, 1404 completely filled and returned the questionnaire which gave a response rate of 93.6%.

**2.3. Data Collection and Analysis.** This study took place between 1 December 2018 and 28 February 2019. A standardized structured questionnaire designed to meet the objectives of this research was used for data collection. Field inspection of questionnaire data was carried out daily after the interview was conducted, and any errors were immediately verified and corrected. The final survey instrument comprised of 30 questions in five major areas: demographic information (10 items); general environment (6 items); and air pollution (14 items). Final instrument was administered to the subjects via the self-administered questionnaire method. It took approximately 25–35 minutes to complete the instrument.

Five experts in waste management measurement and evaluation assisted with the determination of face validity of the instrument. The average overall face validity was equal to 95%. Reliability for internal consistency was done by Cronbach's alpha test and it was equal to the reliability coefficient of 0.87, which is adjudged high reliability.

**2.4. Survey Instrument Development and Pilot Testing.** Face validity of the instrument was established by basing the content of the survey on a comprehensive review of the published research literature regarding air pollution, sociodemographics of the area under study, among others. Face validity was further established by using validated and reliable items and subscales from previously published research. Content validity of the survey instrument was developed by seeking feedback from an expert panel of health and safety professionals with many years of experience. Recommended edits from this expert panel were incorporated into the survey prior to pilot testing. The average overall face validity was equal to 95%. Reliability for internal consistency was done by Cronbach's alpha test and it was equal to the reliability coefficient of 0.87, which is adjudged high reliability.

**2.5. Respondents' Consent.** Prior to data collection, respondents' verbal and written consent was sought. They were informed about the purpose of the study and were made to understand that participation was voluntary and refusal to participate in the study attracted no penalty and would not impact their work. The study respondents were assured of confidentiality. Personal identifiers were removed after data collection in the summary data to ensure confidentiality. Ethical clearance was obtained from the Ethics Review Committee (ERC) of the GIMPA School of Public Service and Governance.

**2.6. Data Analysis.** The data from the completed surveys were analysed using SPSS for Windows version 22.0. Our analysis involved 3 steps: (1) Descriptive statistics (e.g.,

frequencies, mean, and standard deviation) were used to describe the respondents and their responses on various survey items. (2) We conducted a bivariate analysis to establish relationships between the outcome variable of pollution awareness and the independent variables.

The chi-squared test was used to assess the bivariate relationship between these variables. Fisher's exact test was used when the minimum expected frequencies were less than five in a  $2 \times 2$  table. All statistical tests were two-tailed and  $\alpha = 0.05$  or less was considered statistically significant. (3) We developed a multiple logistic model with the outcome variable of air pollution awareness (yes = 1; no = 0) and to identify factors associated with air pollution awareness while controlling for all independent variables which attained a level of significance at the bivariate level.

### 3. Results

**3.1. Demographic Characteristics of Respondents.** Table 1 shows the demographic characteristics of respondents. The age group ranged from  $\leq 29$  to  $\geq 61$ , with the majority (45.4%) in the  $\leq 29$  age group. Female respondents were more than males in all the age groups. Majority (81.3%) of the respondents were Christians, with the least (2.9%) being traditionalists (2.9%). Most (44.6%) of the respondents belong to the Akan tribe (44.6%). It was observed that 87.0% of the respondents had a tertiary education, followed by JHS/SHS level (10.5%) and the least having no form of formal education (2.5%). Most of these respondents belonged to the middle class (70.5%) and were living mostly in urban residence (92.7%). Most of these residents have lived over 10 years (46.3%) in their residents, followed by those who have lived 3 years and below (26.9%).

**3.2. Respondents' Awareness of the Haze/Air Pollution and Its Adverse Effects on Health.** Respondents' awareness of the haze (air pollution) and its adverse effects on health are presented in Table 2. More than 50% of the respondents were aware of the haze in their community. We observed that most females (37.7%) were aware of the haze than the males (32.8%). Most of the middle-class groups (48.4%) were aware of the haze and its adverse effects on the health. On the other hand, lower-class group reported the least awareness of the haze (2.1%).

**3.3. Respondents' Attitudes towards Air Quality and Related Health Risk.** Table 3 shows attitudes of air quality and related health risk among respondents. More than 50% of the respondents were satisfied with air quality in their community. About 70% of the respondents had paid attention to air pollution in their community whilst 29.9% did not. More than 50% respondents knew the source of air pollution in their community as against 35.2%, who did not.

Over 50% of the respondents strongly agree that improving the environment is the responsibility of every citizen, whilst 1.5% strongly disagree. About 50% of the respondents stated that it will take within 3–5 years for air

quality to improve, whilst 24.7% were of the view it will take at least 10 years for air quality to improve.

Television and Internet (69.4%) were the medium mostly used to access information regarding the air pollution and related protective measures. Most (63.8%) of the respondents used handkerchiefs to cover their nostril to protect themselves against the air pollution. Others wear face masks (13.8%), whilst the rest do nothing (22.3%). Most of the respondents proposed the use of television and Internet (57.5%) to receive information about environmental issues and adaptation methods. Others proposed the social media (20.7%) and national radio (14.4%). Very few respondents proposed the Municipal Assembly (0.3%) as a means for receiving information.

Figure 1 shows the levels of air pollution in the communities as indicated by the respondents. From the figure, it can be observed that majority (47.7%) of the respondents rated the air pollution in their environment to be moderate. However, 38.6% of the respondents were of the view that rates of air pollution within their community were low, while 13.6% of respondents indicated it was high.

Figure 2 shows the sources of air pollution as identified by the respondents in their communities. Exhausts from vehicles (33.1%) were reported as the major source of air pollution whilst pollution from fume chambers was the least (7.1%) reported. Quite a number (20.6%) of the respondents indicate that smoke from dump sites was the main source of air pollution in their community.

**3.4. Relationship between Air Pollution Awareness and Selected Variables.** Table 4 shows the relationship between air pollution awareness and the following variables: gender, age, educational qualification, social status, length of stay, marital status, and residence. Significant difference ( $P < 0.05$ ) existed between age and marital status (0.054), and social status and residence (0.039).

**3.5. Association of Sociodemographic Characteristics on Air Pollution Awareness.** Table 5 shows the results of multiple logistic regression model for the association of socio-demographic characteristics on air pollution awareness. Respondents between the ages of  $\geq 61$  were more likely to be aware of air pollution (3.45) than those in the other age groups. Middle-class respondents were 2.26 times more likely to be aware of the air pollution. Regarding educational qualification, results indicate that air pollution awareness increases with level of education and that tertiary respondents are 2.30 times more likely to be aware of the air pollution.

### 4. Discussion

The effects of air pollution on human health cannot be overemphasised. Currently, air pollution is a major threat globally, including Ghana. Particularly in urban cities like Accra, Ghana's capital, the quest for infrastructural development and high standards of living have led to uncontrolled or unlimited exploitations of the environment

TABLE 1: Demographic characteristics of respondents.

| Variable ( <i>n</i> = 1404)                | Male <i>N</i> (%) | Female <i>N</i> (%) | Total <i>N</i> (%) | Significance level |
|--|-------------------|---------------------|--------------------|--------------------|
| <b>Age (years)</b>                         |                   |                     |                    |                    |
| ≤29  | 260 (18.5)        | 378 (26.9)          | 638 (45.4)         | $X^2 = 18.501$     |
| 30–40                                      | 206 (14.7)        | 172 (12.3)          | 378 (26.9)         | $P \leq 0.001$     |
| 41–50                                      | 113 (8.0)         | 140 (10.0)          | 253 (18.0)         | $df = 4$           |
| 51–60                                      | 45 (3.2)          | 49 (3.5)            | 94 (6.7)           |                    |
| ≥61  | 20 (1.4)          | 21 (1.5)            | 41 (2.9)           |                    |
| Total                                      | 644 (45.9)        | 760 (54.1)          | 1404 (100)         |                    |
| <b>Religion</b>                            |                   |                     |                    |                    |
| Christian                                  | 509 (36.3)        | 633 (45.1)          | 1142 (81.3)        | $X^2 = 20.875$     |
| Islam                                      | 115 (8.2)         | 93 (6.6)            | 208 (14.8)         | $P \leq 0.001$     |
| Traditionalist                             | 10 (0.7)          | 31 (2.2)            | 41 (2.9)           | $df = 3$           |
| Total                                      | 644 (45.9)        | 760 (54.1)          | 1404 (100)         |                    |
| <b>Ethnicity</b>                           |                   |                     |                    |                    |
| Akan                                       | 264 (18.8)        | 362 (25.8)          | 626 (44.6)         | $X^2 = 39.272$     |
| Ga-Adangbe                                 | 114 (8.1)         | 184 (13.1)          | 298 (21.2)         | $P \leq 0.001$     |
| Mole-Dagbon                                | 7 (0.5)           | 10 (0.7)            | 17 (1.2)           | $df = 4$           |
| Ewe  | 73 (5.2)          | 86 (6.1)            | 159 (11.3)         |                    |
| Others                                     | 186 (13.2)        | 118 (8.4)           | 304 (21.7)         |                    |
| Total                                      | 664 (45.9)        | 760 (54.1)          | 1404 (100)         |                    |
| <b>Marital status</b>                      |                   |                     |                    |                    |
| Single                                     | 321 (22.9)        | 429 (30.6)          | 750 (53.4)         | $X^2 = 11.807$     |
| Married                                    | 296 (21.1)        | 286 (20.4)          | 582 (41.5)         | $P = 0.008$        |
| Divorced                                   | 20 (1.4)          | 38 (2.7)            | 58 (4.1)           | $df = 3$           |
| Widow/widower                              | 7 (0.5)           | 7 (0.5)             | 14 (1.0)           |                    |
| Total                                      | 644 (45.9)        | 760 (54.1)          | 1404 (100)         |                    |
| <b>Education</b>                           |                   |                     |                    |                    |
| No formal                                  | 7 (0.5)           | 28 (2.0)            | 35 (2.5)           | $X^2 = 9.675$      |
| JHS/SHS                                    | 69 (4.9)          | 79 (5.6)            | 148 (10.5)         | $P = 0.008$        |
| Tertiary                                   | 568 (40.5)        | 653 (46.5)          | 1221 (87.0)        | $df = 2$           |
| Total                                      | 644 (45.9)        | 760 (54.1)          | 1404 (100)         |                    |
| <b>Social status</b>                       |                   |                     |                    |                    |
| Upper class                                | 135 (9.6)         | 199 (14.2)          | 334 (23.8)         | $X^2 = 7.951$      |
| Middle class                               | 478 (34.0)        | 512 (36.5)          | 990 (70.5)         | $P = 0.019$        |
| Lower class                                | 31 (2.2)          | 49 (3.5)            | 80 (5.7)           | $df = 2$           |
| Total                                      | 644 (45.9)        | 760 (54.1)          | 1404 (100)         |                    |
| <b>Residence</b>                           |                   |                     |                    |                    |
| Rural                                      | 67 (4.8)          | 36 (2.6)            | 103 (7.3)          | $X^2 = 16.468$     |
| Urban                                      | 577 (41.1)        | 724 (51.6)          | 1301 (92.7)        | $P \leq 0.001$     |
| Total                                      | 644 (45.9)        | 760 (54.1)          | 1404 (100)         | $df = 1$           |
| <b>Length of stay in residence (years)</b> |                   |                     |                    |                    |
| ≤3   | 172 (12.3)        | 206 (14.7)          | 378 (26.9)         | $X^2 = 13.314$     |
| 4–6  | 114 (8.1)         | 126 (9.0)           | 240 (17.1)         | $P = 0.004$        |
| 7–9  | 81 (5.8)          | 55 (3.9)            | 136 (9.7)          | $df = 3$           |
| ≥10  | 277 (19.7)        | 373 (26.6)          | 650 (46.3)         |                    |
| Total                                      | 644 (45.9)        | 760 (54.1)          | 1404 (100)         |                    |

resulting in serious outcomes. One of those outcomes is the pollution of the air space in communities and towns. In view of this, our study aimed at investigating the KAPs of air pollution by residents of Accra in relation to their health.

Results from the study showed majority (70.5%) of the respondents were aware of the haze (air pollution) and its adverse effects on health. It is worth noting that residents in Accra are increasingly becoming aware of air pollution and the threats it poses to their health. Similarly, in their study on KAP of the relationship between air pollution and respiratory health in Shanghai, China, Wang et al. [1] identified that majority (about 80%) had high level of knowledge on air

pollution and its health effects. Awareness creation is very critical in addressing measures that could aid in minimizing air pollution [13]. Among the majority of residents who were knowledgeable about air pollution and its effects, it was promising to have identified that many (51.7%) of the respondents were young (40 years or less). Getting to know about air pollution in an environment at a young age could be a crucial step towards minimizing prolonged exposure to its adverse effects extending to old age. Additionally, youths possess the exuberance and energy needed to protect the environment against pollution [14]. Majority (63.7%) of the respondents whom were aware of the haze have been

TABLE 2: Respondents' awareness of the haze and its adverse effects on health.

| Variable ( <i>n</i> = 417)          | Yes <i>N</i> (%) | No <i>N</i> (%) | Total <i>N</i> (%) | Significance level |
|-------------------------------------|------------------|-----------------|--------------------|--------------------|
| Age (years)                         |                  |                 |                    |                    |
| ≤29                                 | 426 (30.3)       | 212 (15.1)      | 638 (45.4)         | $X^2 = 22.147$     |
| 30–40                               | 300 (21.4)       | 78 (5.6)        | 378 (26.9)         | $P \leq 0.001$     |
| 41–50                               | 167 (11.9)       | 86 (6.1)        | 253 (18.0)         | $df = 4$           |
| 51–60                               | 70 (1.9)         | 24 (1.7)        | 94 (6.7)           |                    |
| ≥61                                 | 27 (1.9)         | 14 (1.0)        | 41 (2.9)           |                    |
| Total                               | 990 (70.5)       | 414 (29.5)      | 1404 (100.0)       |                    |
| Gender                              |                  |                 |                    |                    |
| Male                                | 460 (32.8)       | 184 (13.1)      | 644 (45.9)         | $X^2 = 0.480$      |
| Female                              | 530 (37.7)       | 230 (16.4)      | 760 (54.1)         | $P = 0.488$        |
| Total                               | 990 (70.5)       | 414 (29.5)      | 1404 (100.0)       | $df = 1$           |
| Marital status                      |                  |                 |                    |                    |
| Single                              | 514 (36.6)       | 236 (16.8)      | 750 (53.4)         | $X^2 = 20.861$     |
| Married                             | 439 (31.3)       | 143 (10.2)      | 582 (41.5)         | $P \leq 0.001$     |
| Divorced                            | 30 (2.1)         | 28 (2.0)        | 58 (4.1)           | $df = 3$           |
| Widow/widower                       | 7 (0.5)          | 7 (0.5)         | 14 (1.0)           |                    |
| Total                               | 990 (70.5)       | 414 (29.5)      | 1404 (100.0)       |                    |
| Education                           |                  |                 |                    |                    |
| No formal                           | 14 (1.0)         | 21 (1.5)        | 35 (2.5)           | $X^2 = 36.218$     |
| JHS/SHS                             | 82 (5.8)         | 66 (4.7)        | 148 (10.5)         | $P \leq 0.001$     |
| Tertiary                            | 894 (63.7)       | 327 (23.3)      | 1221 (87.0)        | $df = 2$           |
| Total                               | 990 (70.5)       | 414 (29.5)      | 1404 (100.0)       |                    |
| Social status                       |                  |                 |                    |                    |
| Upper class                         | 281 (20.0)       | 53 (3.8)        | 334 (23.8)         | $X^2 = 73.495$     |
| Middle class                        | 679 (48.4)       | 311 (22.2)      | 990 (70.5)         | $P \leq 0.001$     |
| Lower class                         | 30 (2.1)         | 50 (3.6)        | 80 (5.7)           | $df = 2$           |
| Total                               | 990 (70.5)       | 414 (29.5)      | 1404 (100.0)       |                    |
| Length of stay in residents (years) |                  |                 |                    |                    |
| ≤3                                  | 295 (21.0)       | 83 (5.9)        | 378 (26.9)         | $X^2 = 17.943$     |
| 4–6                                 | 174 (12.4)       | 66 (4.7)        | 240 (17.1)         | $P \leq 0.001$     |
| 7–9                                 | 87 (6.2)         | 49 (3.5)        | 136 (9.7)          | $df = 3$           |
| ≥10                                 | 434 (30.9)       | 216 (15.4)      | 650 (46.3)         |                    |
| Total                               | 990 (70.5)       | 414 (29.5)      | 1404 (100.0)       |                    |

TABLE 3: Respondents' attitudes towards air quality.

| Survey question  | Frequency<br>( <i>n</i> ) | Percentage<br>(%) |
|--|---------------------------|-------------------|
| Have you paid attention to the air pollution in the community where you live |                           |                   |
| Yes  | 990                       | 70.1              |
| No   | 414                       | 29.9              |
| Total  | 1404                      | 100.0             |
| Were you satisfied with the air quality in your community last year          |                           |                   |
| Yes  | 840                       | 59.4              |
| No   | 574                       | 40.5              |
| Total  | 1404                      | 100               |
| How do you rate the overall air quality in your community last year          |                           |                   |
| Very good  | 359                       | 25.4              |
| Good   | 366                       | 25.9              |
| Fair   | 335                       | 23.7              |
| Poor   | 154                       | 10.9              |
| Very poor  | 169                       | 12.0              |
| Don't know   | 21                        | 2.1               |
| Total  | 1404                      | 100.0             |

TABLE 3: Continued.

| Survey question   | Frequency<br>(n) | Percentage<br>(%) |
|---|------------------|-------------------|
| How do you rate the air quality in your community last year compared to 5 years   |                  |                   |
| Much better   | 242              | 17.1              |
| A little better   | 395              | 28.0              |
| No difference   | 285              | 20.2              |
| A little worse  | 201              | 14.2              |
| Much worse  | 170              | 12.0              |
| Don't know  | 111              | 8.5               |
| Total   | 1404             | 100.0             |
| How severe would you say is the air pollution in the community where you live   |                  |                   |
| Low   | 546              | 38.6              |
| Moderate  | 674              | 47.7              |
| High  | 184              | 13.6              |
| Total   | 1404             | 100.0             |
| Do you agree that improving the environment is the responsibility of every citizen  |                  |                   |
| Strongly agree  | 1081             | 76.5              |
| Agree   | 228              | 16.1              |
| Disagree  | 33               | 2.3               |
| Strongly disagree   | 21               | 1.5               |
| Don't know  | 40               | 3.5               |
| Total   | 1403             | 100.0             |
| Do you think air quality will improve   |                  |                   |
| Yes   | 1115             | 78.9              |
| No  | 289              | 21.1              |
| Total   | 1404             | 100.0             |
| How long do you think it will take for air quality to improve   |                  |                   |
| In the short term   | 352              | 24.9              |
| Within 3-5 years  | 712              | 50.4              |
| At least 10 years   | 340              | 24.7              |
| Total   | 1404             | 100               |
| How do you access information with regard to the air pollution and related protective measure                             |                  |                   |
| Television and Internet   | 981              | 69.4              |
| Books and newspapers  | 109              | 7.7               |
| Expert lecture and friends  | 82               | 5.8               |
| Municipal Assembly  | 43               | 3.0               |
| Social media  | 116              | 8.2               |
| Internet  | 57               | 4.0               |
| Others  | 16               | 1.9               |
| Total   | 1404             | 100               |
| Do you have any related protective measures taken indoors   |                  |                   |
| Yes   | 814              | 57.6              |
| No  | 590              | 42.4              |
| Total   | 1404             | 100.0             |
| How do you protect yourself when there is pollution in the air  |                  |                   |
| I wear a face masks   | 195              | 13.8              |
| Cover my nostril with a handkerchief  | 902              | 63.8              |
| I do nothing  | 307              | 22.3              |
| Total   | 1404             | 100.0             |
| By which of the following methods would you like to receive information about environmental issues and adaptation methods |                  |                   |
| Television and Internet   | 812              | 57.5              |
| National radio  | 204              | 14.4              |
| Municipal Assembly  | 4                | 0.3               |
| Social media  | 293              | 20.7              |
| Internet  | 89               | 7.1               |
| Total   | 1402             | 100               |

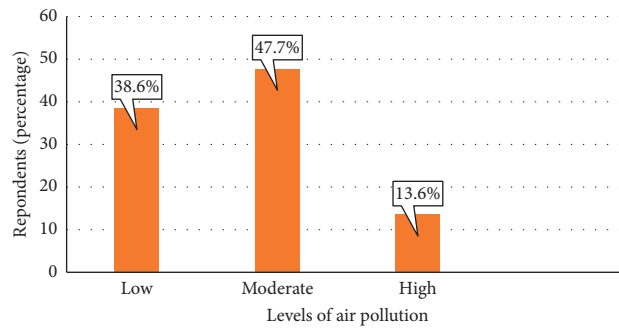


FIGURE 1: Levels of air pollution in the community.

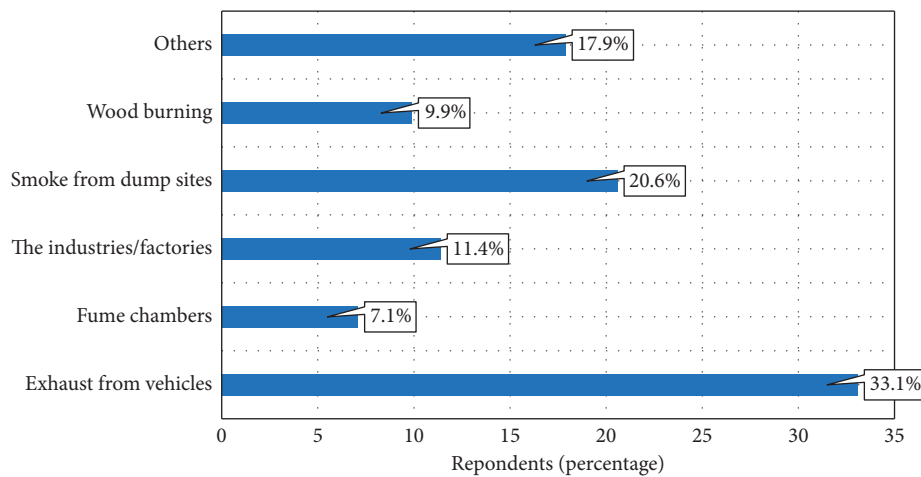


FIGURE 2: Source of air pollution.

TABLE 4: Correlation between air pollution awareness and selected variables.

| Variable                       | AW      | G       | A      | EQ     | SS     | LS     | MS     | R      |
|--------------------------------|---------|---------|--------|--------|--------|--------|--------|--------|
| Air pollution awareness (AW)   | 1       | 0.582** | -0.322 | -0.764 | 0.587  | 0.873  | 0.223  | 0.439  |
| Gender (G)                     | 0.582** | 1       | 0.177  | -0.762 | 0.782  | 0.718  | 0.222  | 0.148  |
| Age (A)                        | -0.322  | 0.177   | 1      | 0.102  | 0.321  | -0.174 | *0.054 | -0.588 |
| Educational qualification (EQ) | -0.764  | -0.762  | 0.102  | 1      | -0.841 | -0.819 | -0.292 | -0.335 |
| Social status (SS)             | 0.587   | 0.782   | 0.321  | -0.841 | 1      | 0.716  | 0.358  | *0.039 |
| Length of stay (LS)            | 0.873   | 0.718   | -0.174 | -0.819 | 0.716  | 1      | 0.532  | 0.383  |
| Marital status (MS)            | 0.223   | 0.222   | 0.054  | -0.292 | 0.356  | 0.532  | 1      | 0.098  |
| Residence (R)                  | 0.439   | -0.148  | -0.588 | -0.335 | 0.039  | 0.383  | 0.098  | 1      |

\*\*Correlation is significant at  $P < 0.01$  level (2-tailed). \*Correlation is significant at  $P < 0.05$  level.

educated at least to the tertiary level. Though our study did not ascertain whether this category of respondents was exposed to information about air pollution at the tertiary level, it tends to suggest however that education has a significant influence on Accra residents’ awareness of the haze. Awareness creation of this haze should be clear and understandable to everyone irrespective of their educational background. Apart from education, awareness of the haze can also be significantly influenced by length of stay in a community as shown in Table 4.

There have been growing concerns over air quality in Ghana’s urban communities, including Accra [15]. Since people instinctively feel the change when the effects of poor

quality become obvious, it was not surprising majority of the respondents (about 70%) had paid attention to air pollution and were able to distinguish the severity of the haze. Interestingly, over 50% of the respondents were satisfied with air quality in their community and majority also admitting a little improvement in air quality over the last five years. According to Qian et al. [16], people paying serious attention to the haze and also providing such information about air quality in their environments are evident of their strong hanker for involvement and assistance in operations related to air pollution.

It is worth noting that some respondents in this present study indicated that air pollution was not bad within their

TABLE 5: Multiple logistic regression model for the association of sociodemographic characteristics on air pollution awareness.

| Variable                        | $\beta$ | OR   | OR 95% CI* | P value |
|---------------------------------|---------|------|------------|---------|
| Age group                       |         |      |            |         |
| ≥29 (reference)                 |         | 1    | 0.00–0.00  | 0.28    |
| 30–40                           | 1.26    | 1.18 | 0.88–1.76  | 0.01    |
| 41–50                           | 0.45    | 1.65 | 1.15–2.30  | 0.01    |
| 51–60                           | 1.43    | 2.56 | 2.78–4.94  | 0.01    |
| ≥61                             | 0.19    | 3.45 | 2.45–5.02  | 0.01    |
| Marital status                  |         |      |            |         |
| Single (reference)              |         |      | 0.00–0.00  |         |
| Married                         | 1.36    | 1.23 | 0.80–1.46  | 0.01    |
| Divorced                        | 0.65    | 1.81 | 1.50–2.10  | 0.01    |
| Widow/widower                   | 1.53    | 2.46 | 2.28–4.14  | 0.01    |
| Social status                   |         |      |            |         |
| Upper class (reference)         |         |      | 0.00–0.00  |         |
| Middle class                    | 0.86    | 2.26 | 1.28–4.10  | 0.01    |
| Lower class                     | 0.79    | 1.23 | 1.08–4.63  | 0.01    |
| Level of education              |         |      |            |         |
| No formal education (reference) |         | 1    | 0.00–0.00  |         |
| JHS/SHS                         | 0.77    | 1.2  | 0.53–2.16  | 0.01    |
| Tertiary                        | 0.76    | 2.3  | 0.86–5.79  | 0.01    |

\*Significant at 0.05. OR = odds ratio; 95% CI = 95% confidence interval; Ref = reference category.

communities and were satisfied with the air quality (Table 3). This observation might have been accurate based on where they live and their exposure to air pollution. This is important noting because it has implications for educational campaigns and policy directions.

We found in this study that more than half of the respondents strongly agreed environmental protection was the responsibility of every citizen. Furthermore, when asked to answer questions relating to the duration needed for air quality in their respective communities to improve, close to 50% of the respondents stated 3–5 years and about 25% stated short term and at least 10 years. The duration it will take for air quality to improve will probably depend on the degree of air pollution in a community and actions taken to address it. Serious circumstances of the haze may require longer periods than the less complicated instances, depending on the effectiveness of air monitoring and control measures available. This is because, in sub-Saharan Africa, urban air quality data are scarce as a result of the use of low-cost, ineffective portable air quality monitoring systems [17]. Several studies have linked exhaust from vehicles which is one of the leading causes of air pollution in Ghana's urban communities with premature foetal loss and respiratory diseases [6, 10]. Majority of the respondents in our study confirmed vehicular exhaust as the main cause of pollution in their communities followed by smoke from dumpsites. Exhausts from vehicles contain a considerable amount of particulate matter PM<sub>2.5</sub> which is the commonest component of air pollution [9]. It will be very complicated for Ghana's government to reduce the use of vehicles in Accra, since it is her capital and a central trading hub. However, a step in the right direction is coming up with measures that will check faulty vehicles and ways to repair or getting rid of them. This is because faulty vehicles with worn out engines and poor fuel monitoring system have increasing emissions

of pollutants into the atmosphere as compared to those in good conditions [18].

The present study showed that television and Internet are gradually replacing books and local newspapers as the most popular ways of obtaining information on air pollution and protective measures. This finding is consistent with similar studies by Qian et al. [16]. Information dissemination changes in line with changes in our society and this finding is illustrative of that.

The current study showed most of the residents have indoor-related protective measures and found the use of handkerchiefs to cover their nostrils followed by putting on face masks as the most effective means of protecting themselves from the haze. Though this demonstrated the residents developing a bit of consciousness and attitude of protecting themselves against air pollution, other means such as reducing outdoor exercise as indicated by Pasqua et al. [19] could also be employed. When asked about how they will like to receive information on environmental issues and adaptation methods, majority of the respondents preferred television and Internet.

Univariate and multivariate logistic regression analysis in this study showed a correlation between residents' age, educational level, length of stay, marital status, and knowledge awareness rate of air pollution. In this study, air pollution awareness increased with increasing level of education which was consistent with studies by Wang et al. [1] and Qian et al. [16] and inconsistent with a similar study by Rotko et al. [20].

In this study, we found that awareness of air pollution among the youth was higher than that of the elderly, which is in contrast with other studies that showed youth had poor awareness than the elderly [21, 22]. This observation could be as a result of the increasing use of social and other electronic media by the youth to obtain information. However, Qian



et al. [16] explained that the varying contrast surrounding the association of age, education, and air pollution awareness could be attributed to inadequate uniform evaluation procedures for air pollution awareness and varied age control of research respondents. They further encouraged sufficient studies should be carried out to better ascertain the influence of these sociodemographic qualities on people's awareness of air pollution and other environmental problems.

**4.1. Study Limitations.** This study utilized a cross-sectional design, which may present difficulties in ascertaining the direction of causality between the variables analysed. Therefore, caution needs to be taken in the interpretation of the findings with regard to causality. The study might be vulnerable to reporting bias, response bias, and selection bias. However, we do not think that this would be a big problem in our study because we used a standardized questionnaire.

## 5. Conclusion

The study revealed that majority of residents in Accra are aware of air pollution and its relationship to their health. On the other hand, awareness was low in some demographic groups like the elderly and the less educated. Therefore, nondiscriminatory policies should be formed toward the education and guidance of people to become knowledgeable about air pollution and related health problems.

Most of the residents (over 50%) admitted improving air quality is the responsibility of every citizen. The government should utilize this to form collaborative measure with the citizens for a more effective control of air pollution in Accra.

## Data Availability

The data used to support the findings of this study are included within the article.

## Conflicts of Interest

The authors declare no conflicts of interest.

## Authors' Contributions

STO conceptualized and design the study. STO and TM contributed to the acquisition of the data. STO analysed and interpreted the data. STO and MO drafted the manuscript. All authors critically revised the manuscript and provided final approval of the version to be published. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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