The Association Between Occupational Smoke Exposures and the Prevalence of Eye and Respiratory Health Conditions Among Commercial Fish Smokers in Abuesi, Ghana: A Cross-Sectional Self-Reported Study

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ABSTRACT: Biomass smoke exposure represents a critical health concern, especially for those in occupational settings such as fish smoking. While substantial research has addressed indoor air pollution from domestic cooking, the specific risks faced by fish smokers have received insufficient attention. This study sheds light on the alarming relationship between smoke exposure and health issues among commercial fish smokers in Abuesi, Ghana. Through a comprehensive cross-sectional analysis involving 302 participants, we utilized structured questionnaires and expert eye assessments to gather vital data. Our statistical evaluation, including descriptive statistics, ANOVA, and chi-square tests, revealed a troubling prevalence of respiratory symptoms such as cough, asthma, and breathlessness, all significantly linked to prolonged smoke exposure. Eye health findings were equally concerning, with distant vision impairment affecting 26.37%, eye discomfort reported at 53.02%, and notable rates of cataracts (28.6%) and refractive errors (17.9%). For those suffering from breathlessness, asthma, and pneumonia, the data indicated that longer exposure durations correlated with more severe health outcomes. Specifically, subjects without breathlessness had an average smoking duration of 14.84 years (SD = 12.29) compared to just 10.26 years (SD = 11.15) for those with the symptom—a statistically significant *P*-value of .014. Asthma and pneumonia exhibited similar trends, highlighting a distressing reality: shorter smoking histories align with more severe health conditions, suggesting that such symptoms might drive smokers to abandon their practices prematurely. Given the serious health risks tied to traditional fish smoking practices, this study strongly advocates for the implementation of improved smoking technologies, better ventilation systems, and comprehensive health education initiatives. These measures are essential to safeguard the health of those involved in this vital industry and reduce exposure to hazardous smoke.

KEYWORDS: Respiratory and eye conditions, fish smoking, biomass fuel, self-reported, Abuesi, Ghana

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Introduction

Fish smoking is a prevalent method for preserving and enhancing fish flavor, especially in coastal communities worldwide. The process typically involves the use of biomass fuels such as firewood. The combustion of these fuels releases harmful pollutants, including polycyclic aromatic hydrocarbons (PAHs) and particulate matter (PM), which pose significant health risks, particularly affecting the respiratory system and eye health. While much research has focused on domestic exposure to biomass smoke from cooking, less attention has been given to occupational exposure in settings such as fish smoking.[1,2]

The combustion of biomass fuels generates smoke that contains a complex mixture of gases and fine particles. These pollutants cause respiratory issues such as chronic obstructive pulmonary disease (COPD), asthma, and pneumonia. Moreover, prolonged exposure to biomass smoke has been linked to eye conditions like cataracts, conjunctivitis, and other visual impairments.[1,2] The eyes are particularly vulnerable because they are directly exposed to the smoke during the fish-smoking process.

In Ghana, fish smoking is not only a traditional practice but also a significant economic activity, particularly for women who dominate this sector.[3] However, traditional fish smoking methods typically involve using biomass fuels, such as firewood, in poorly ventilated enclosed spaces. This practice exposes fish smokers to harmful substances, including polycyclic aromatic hydrocarbons (PAHs) and particulate matter (PM), which can have profound health implications.[2,4]

In the fishing community of Abuesi, located in the Western Region of Ghana, fish smoking is a primary occupation for many households. The traditional fish smoking methods employed here involve long hours of exposure to biomass

smoke, significantly increasing the risk of developing both respiratory and ocular diseases.[5] Despite the known health risks, the adoption of protective measures and modern smoking technologies remains limited.[6,7]

The release of pollutants during fish smoking is known to cause a range of health problems, including respiratory issues like chronic obstructive pulmonary disease (COPD), asthma, and pneumonia, as well as ocular conditions such as cataracts, conjunctivitis, and glaucoma.[2,4,8-13]

The exposure levels in fish-smoking environments can be intense, as the process often occurs in poorly ventilated, enclosed spaces, leading to higher concentrations of harmful particles. This occupational hazard is compounded by fish smokers, particularly in rural Ghana, who often work for extended hours under these conditions. Given the continuous and prolonged exposure to biomass smoke, fish smokers are at a heightened risk of developing chronic health conditions, both respiratory and ocular.[2,14,15]

Women dominate the fish-smoking industry in many fishing communities, including Abuesi in the Western Region of Ghana. They are responsible for processing the fish their male counterparts catch, which is a primary source of income for many households.[3] However, the health risks associated with this occupation disproportionately affect women, as they are exposed to smoke for more extended periods. Studies have shown that women involved in fish smoking face higher risks of respiratory diseases and eye conditions due to their prolonged exposure to biomass smoke.[5]

The lack of awareness and safety measures among these women exacerbates the health risks. While some fish smokers are aware that exposure to smoke can cause health issues, the adoption of protective measures, such as wearing masks or ensuring proper ventilation, remains low.[13] This gap between awareness and action highlights the need for targeted interventions to mitigate the health risks faced by commercial fish smokers, particularly women.

Exposure to biomass smoke has been linked to various respiratory and ocular health issues. Respiratory conditions such as asthma, chronic bronchitis, and pneumonia are common among individuals exposed to high levels of smoke over long periods. These conditions are caused by the delicate particulate matter in biomass smoke, which can penetrate deep into the lungs, causing inflammation and long-term damage.[7,8,16,17] Additionally, carcinogenic PAHs further contribute to the development of respiratory diseases and increase the risk of lung cancer.[2]

Ocular conditions are also prevalent among fish smokers due to the constant exposure to smoke. The irritants in biomass smoke can cause conjunctivitis, cataracts, and other visual impairments. In particular, cataracts are one of the leading causes of blindness in individuals exposed to biomass smoke, as the pollutants cause clouding of the eye's lens.[18] Studies have also shown a strong association between biomass smoke exposure and the development of glaucoma, further underscoring the severe health risks faced by fish smokers.[2,9,11,12,18]

The present study addresses a critical public health issue that has received limited attention in Ghana. By focusing on the occupational health risks commercial fish smokers face, the study will provide valuable insights into the prevalence of respiratory and ocular conditions in this population. The findings will also contribute to the growing body of literature on the health impacts of biomass smoke exposure and inform the development of targeted interventions to reduce these risks.

Moreover, the study will have practical implications for public health initiatives in coastal communities. Understanding the specific health challenges faced by commercial fish smokers can also guide the design of effective interventions, including promoting improved fish smoking technologies that reduce smoke emissions and implementing health education programs that encourage safer practices. Given the gendered nature of the fish-smoking industry, these interventions must be gender-sensitive, addressing the unique health needs of women who dominate this sector. This present study aims to address this gap by examining the health impacts of occupational smoke exposure on commercial fish smokers.

While there is substantial evidence documenting the adverse health effects of biomass smoke exposure, most studies have focused on indoor cooking environments rather than occupational settings like fish smoking. For example, research by Gordon et al[8] highlighted the high prevalence of respiratory conditions among women using biomass fuels for cooking. Similarly, Kyei et al[9] found significant ocular health issues among individuals exposed to biomass smoke in various occupational settings. However, there is a paucity of studies explicitly examining the health risks faced by commercial fish smokers in Ghana. This is a critical gap, as fish-smoking environments expose workers to high levels of smoke for extended periods, increasing their risk of developing severe respiratory and ocular health issues.

Moreover, existing studies often emphasize respiratory health, with less attention given to the ocular impacts of biomass smoke exposure. Since fish smokers are directly exposed to smoke that affects their lungs and eyes, it is essential to study the dual implications of biomass smoke on respiratory and ocular health. This study aims to fill this gap by examining respiratory and eye conditions among commercial fish smokers in Abuesi, Ghana.

The primary objective of this cross-sectional study is to assess the association between occupational smoke exposure and the prevalence of respiratory and eye health conditions among commercial fish smokers in Abuesi, Ghana. The study aims to investigate the prevalence of self-reported respiratory conditions (eg, cough, phlegm, breathlessness, asthma, and pneumonia) and eye conditions (eg, cataracts, conjunctivitis, and refractive errors) among fish smokers. The study also examines the relationship between the duration of smoke exposure and the prevalence of these health conditions.

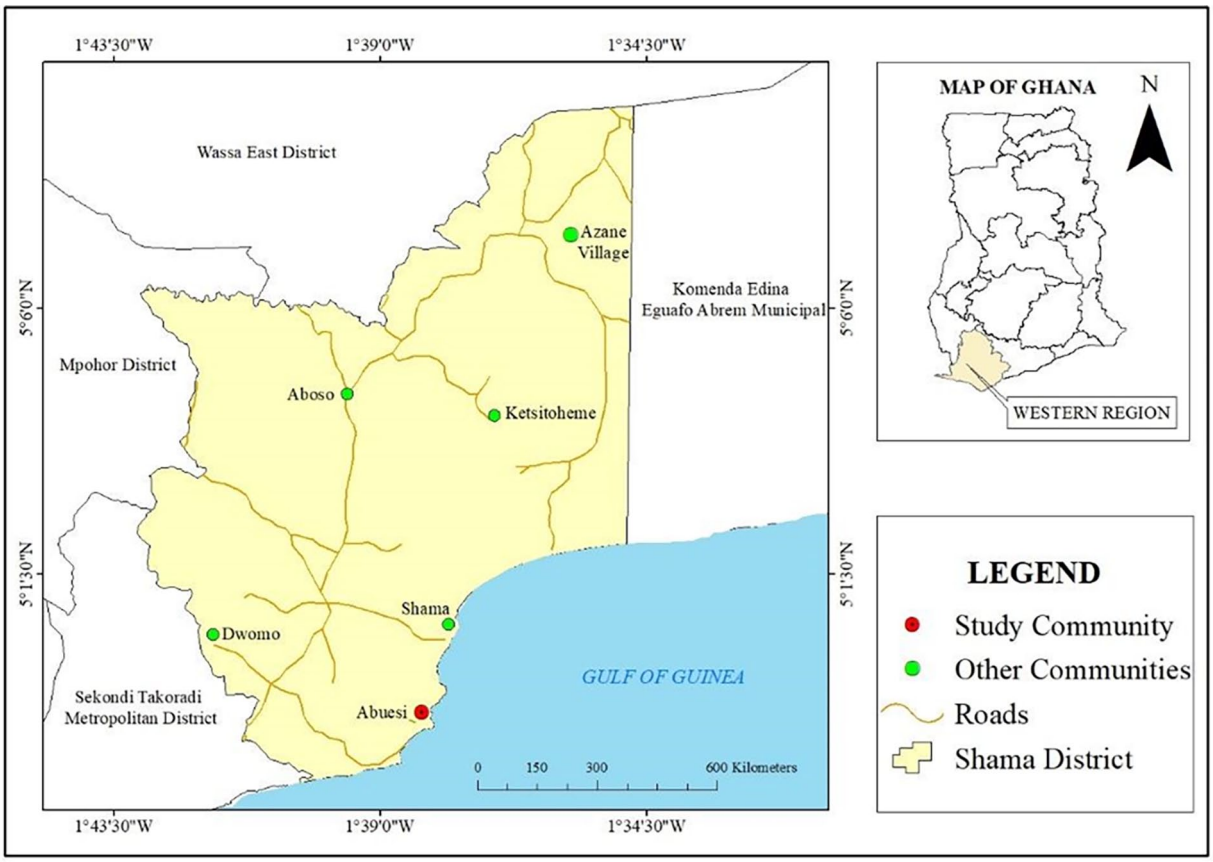

Figure 1. Map of Abuesi, showing the study site.

Materials and Methods

Study design, setting, and population

This cross-sectional study was conducted in Abuesi, a fishing community in the Western Region of Ghana, known for its fish-smoking activities, Figure 1. Abuesi spans approximately 3190 km^2 in the Sharma District, 20 km from Takoradi, the regional capital. The town is bordered by Shama to the east, Injreisia to the west, Inchaban to the north, and the Atlantic Ocean to the south, located at 4.98333°N, 1.63333°W, and experiences a tropical climate with two rainy seasons.

Abuesi features four first-cycle schools (two private, two public) and six religious centers. Abuesi is a populated area with a population of about 3190, with about 70% being females and married as well as.[19] Out of the female population, 70% of the females engage in fish smoking, while the males primarily work as fishermen. Most fish smokers are between the ages bracket of 23-48 years. Women usually start learning the trade from their parents around ten, using old mud stoves in enclosed smokehouses or open areas. Commonly smoked fish include herrings, mackerel, and red grouper, with widely used firewood types like mangrove, esa, cocoa, bolambo, and rubber.

The study focused on fish smokers using various biomass fuels, predominantly firewood, in enclosed smokehouses and was conducted over 6 months.

Sample size

Using Cochran's[20] formula for a single population proportion, with a 95% confidence level, a 0.05 margin of error, and a 27% prevalence of wheezing among farmers, the calculated sample size was 320. The prevalence was used because wheezing is documented as a critical respiratory symptom in similar occupational groups.[21,22]

Sampling

Permission was obtained from the Chief of Abuesi. A meeting was held with the fish smokers in the community to explain the procedure to them. Those who agreed to participate were given a questionnaire to fill out after their consent. Participation in the study was entirely voluntary, with no coercion or financial incentives offered. Participants had the freedom to decide whether or not to take part. They were informed that their contributions would enhance the overall understanding of the study and that their information would be kept confidential. Fish smokers were selected via simple random sampling. A structured questionnaire assessed knowledge of health risks, safety measures practiced, and the relationship between years spent smoking and health effects like headaches, cough, phlegm/wheezing, breathlessness, respiratory issues, eye disease (redness), asthma, and pneumonia.

Data collection

Data were collected through face-to-face interviews using a structured questionnaire covering demographic data, smoking years, self-reported health symptoms, and eye health. Approximately 302 fish smokers were interviewed. Eye examination was followed up with the help of optometry doctors, of which 77 out of the 302 respondents participated, among those willing to undergo the screening. A smaller proportion of men engaged in fish smoking, often assisting in or managing aspects of the trade. While this study emphasizes the health risks faced by women—who dominate the industry and usually experience prolonged exposure to biomass smoke—it also considers the experiences of male fish smokers, offering a comprehensive view of occupational health risks in this population.

Measurement of variables

Exposure duration to smoke was measured by years spent smoking. Health outcomes were self-reported, including headaches, cough, phlegm/wheezing, breathlessness, and eye diseases. Visual impairment was measured using self-reported visual health status.

Eye examination

The self-reported health symptoms are the data obtained from the questionnaire. After that, an eye examination was done by optometry doctors from the University of Cape Coast Eye Clinic. Eye assessments were conducted using LogMAR visual acuity charts, ophthalmoscopes, retinoscopes, and handheld slit lamp biomicroscopes. Seventy-seven participants were screened. The examination included visual acuity, anterior segment examination with a portable slit lamp, posterior segment examination through funduscopy, objective refraction with a handheld retinoscope, and subjective refraction.

Ethical considerations

Ethical clearance was obtained from the University of Michigan Health Sciences and Behavioral Sciences Institutional Review Board (HUM00138934). The study's purpose was explained, and informed consent was obtained from participants before data collection.

Data analysis

Descriptive statistics summarized demographic characteristics. Means and standard deviations were computed for continuous variables, while frequencies and percentages were used for categorical variables. Chi-square tests were employed to investigate associations between categorical variables, with a *P*-value of less than .05 considered statistically significant. All analyses were performed using SPSS.

Results and Discussion

Results

Table 1 shows the socio-demographic characteristics of the fish smokers. The study population primarily comprised female fish smokers (94.7%), with a small percentage of males (5.3%) indicating a predominantly female-dominated activity. The majority of fish smokers (67.2%) were aged between 30 and 65 years, with fewer under 30 years (26.8%) and over 65 years (6.0%), suggesting middle-aged individuals primarily perform fish smoking.

Educational attainment among fish smokers was generally low: 32.0% had no formal education, 29.3% completed primary education, and 29.9% finished Junior High School. Only a tiny fraction reached Senior High School (5.4%), Vocational/Technical School (1.4%), or Tertiary education (2.0%), highlighting the industry's lower educational levels.

Regarding marital status, most fish smokers were married (54.6%), followed by unmarried (17.7%), and divorced (13.7%). Smaller percentages were cohabitating (4.1%) and widowed (9.9%). The majority identified as Christians (83.3%), with Muslims (13.3%) and followers of traditional religions (3.4%) forming more minor groups.

Figure 2 presents the duration of fish smoking. The males have been smoking fish for an average of 17.4 years, while females have a slightly lower mean duration of 13.8 years. The higher standard deviation for males (17.7) than females (11.9) indicates more significant variability in smoking duration among male participants. The overall mean duration of fish smoking is 14.0 years, with a standard deviation of 12.2, suggesting moderate variability across the sample.

The mean age of male fish smokers is 45.2 years (SD 18.0), indicating significant age variability, while female fish smokers have a mean age of 40.4 years (SD 14.6), showing less variability. The overall mean age of participants is 40.7 years (SD 14.8), indicating a predominantly middle-aged demographic.

These data suggest that male and female fish smokers in Abuesi have substantial experience, with males generally having a longer average duration. The wider age range and smoking duration among males might result from fewer male participants or a more diverse age range. Fish smoking, mainly using traditional methods like firewood, is a long-term occupation that poses significant health risks. Prolonged exposure to smoke can lead to respiratory and other health issues. Fish smokers must be aware of these risks and adopt protective measures such as improving ventilation, using cleaner fuels, or wearing masks to mitigate health hazards.

Most fish smokers are female (94.7%), with males making up only 5.3%. This indicates that fish smoking is predominantly a female-dominated activity. The majority (67.2%) of fish smokers are between 30 and 65 years old, with a smaller portion (26.8%) under 30 years old and an even smaller group (6.0%) over 65 years old. Most fish smokers have low levels of

Table 1. Socio-demographic characteristics of fish smoker.

DEMOGRAPHICS	GENDER				χ^2/*P*-VALUE
		MALE	FEMALE	TOTAL	
		N (%)	N (%)	N (%)	
Age	Less than 30	4 (1.3)	77 (25.5)	81 (26.8)	2.492/.646
	30-65	10 (3.3)	193 (63.9)	203 (67.2)	
	>65	2 (0.7)	16 (5.3)	18 (6.0)	
	Total	16 (5.3)	286 (94.7)	302 (100.0)	
Highest level of education	Non-formal	7 (2.4)	87 (29.6)	94 (32.0)	
	Primary	4 (1.4)	82 (27.9)	86 (29.3)	6.423/.779
	Junior high	2 (0.7)	86 (29.3)	88 (29.9)	
	Senior high	1 (0.3)	15 (5.1)	16 (5.4)	
	Vocational/technical	0 (0.0)	4 (1.4)	4 (1.4)	
	Tertiary	0 (0.0)	6 (2.0)	6 (2.0)	
	Total	14 (4.8)	280 (95.2)	294 (100.0)	
Marital status	Unmarried	1 (0.3)	51 (17.4)	52 (17.7)	3.552/.895
	Married	8 (2.7)	152 (51.9)	160 (54.6)	
	Divorced	3 (1.0)	37 (12.6)	40 (13.7)	
	Cohabitation	1 (0.3)	11 (3.8)	12 (4.1)	
	Widow	1 (0.3)	28 (9.6)	29 (9.9)	
	Total	14 (4.8)	279 (95.2)	293 (100.0)	
Religion	Christian	14 (4.8)	230 (78.5)	244 ()	3.588/.892
	Muslim	0 (0.0)	39 (13.3)	39 (13.3)	
	Traditional	0 (0.0)	10 (3.4)	10 (3.4)	
	Total	14 (4.8)	279 (95.2)	293 (100.0)	

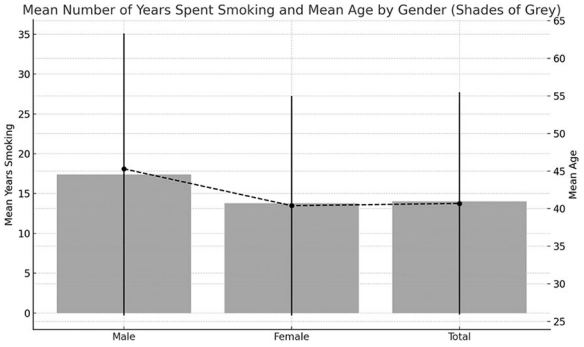

Figure 2. Mean number of years spent smoking.

formal education, with 32.0% having no formal education, 29.3% having primary education, and 29.9% having finished Junior High School. Higher education levels are rare.

Over half of the fish smokers are married (54.6%), followed by unmarried (17.7%), divorced (13.7%), cohabitating (4.1%), and widowed (9.9%). The majority of fish smokers are Christians (83.3%), with Muslims (13.3%) and followers of traditional religions (3.4%) forming more minor groups.

ANOVA (analysis of variance) for commercial fish smoking duration and the prevalence of respiratory and eye conditions among smokers. We performed the ANOVA test to compare the means of smoking durations to the health conditions to determine if there are statistically significant differences between them. The *F*-value represents the test statistic from the ANOVA; a higher *F*-value indicates a more tremendous difference between group means. A *P*-value below .05 was considered a statistically significant difference between the means.

Table 2 shows the association between the duration of exposure to smoke and self-reported health outcomes. Those without headaches have a slightly higher mean smoking duration (14.6 years) compared to those with headaches (13.7 years).

Table 2. Association between duration of exposure to smoke and self-reported health outcomes.

		MEAN SMOKING DURATION (SD)	*F*	*P*-VALUE
Headache	No	14.56 (11.32)	0.361	.548
	Yes	13.72 (12.67)		
Cough	No	14.76 (12.38)	1.279	.259
	Yes	13.08 (11.95)		
Phlegm/wheezing	No	14.66 (11.91)	2.417	.121
	Yes	12.32 (12.85)		
Breathlessness	No	14.84 (12.29)	6.099	.014
	Yes	10.26 (11.15)		
Respiratory (chest cold, chest illness)	No	14.61 (11.98)	0.829	.363
	Yes	13.38 (12.44)		
Eye disease (redness)	No	17.02 (14.41)	3.868	.050
	Yes	13.38 (11.62)		
Asthma	No	15.13 (12.23)	18.595	.000
	Yes	6.00 (8.50)		
Pneumonia	No	15.08 (12.24)	17.297	.000
	Yes	6.14 (8.59)		
Others	No	14.13 (12.23)	2.082	.150
	Yes	5.25 (3.59)		

The difference is minimal, and the *P*-value of .5 indicates no significant difference between the two groups. In contrast, the mean smoking duration for individuals without a cough is 14.8 years, slightly higher than those with a cough (13.1 years) (*P*-value of .3). Phlegm/Wheezing was reported with a higher mean smoking duration (14.7 years) compared to those with the symptom (12.3 years) (*P*-value of .1). In addition, a significant difference is observed (*P*-value of .0), with those not experiencing breathlessness having a mean smoking duration of 14.8 years, compared to 10.3 years for those with breathlessness. Chest illness and respiratory issues reported had a mean smoking duration of 14.6 years, slightly higher than those with these issues (13.4 years) (*P*-value of .4).

Eye redness was observed to be higher with shorter smoking duration; a mean smoking duration of (17.0 years) for those not having the condition compared to those with the symptom (13.4 years), a *P*-value of .1). Asthma prevalence was significantly higher with shorter smoking duration (*P*-value of .0). It was reported that those not experiencing asthma had a mean smoking duration of 15.1 years, compared to 6.0 years for those with asthma (Table 2).

Pneumonia prevalence also followed the same trend: a significantly lower (*P*-value of .0) for those with a mean smoking duration of 15.1 years, compared to 6.1 years for those with pneumonia.

Breathlessness, asthma, and pneumonia show significant associations with shorter smoking durations, suggesting that these severe symptoms prompt individuals to quit fish smoking earlier. However, symptoms like headache, cough, phlegm/wheezing, respiratory issues, eye disease (redness), and other health issues do not show significant differences, indicating that these may not strongly influence the decision to stop smoking.

In brief, the *P*-values for breathlessness (*P* = .014; significant), eye disease (*P* = .050; significant at the .05 threshold), asthma (*P* = .000; highly substantial), and pneumonia (*P* = .000; highly significant) are all below .05, indicating that for these health outcomes, the duration of exposure to smoke significantly affects the health outcome (based on the self-reported data). Specifically:

For the other health outcomes (headache, cough, phlegm/wheezing, respiratory issues, and others), the *P*-values are more excellent than .05, indicating no statistically significant association with the duration of exposure to smoke.

Number of children below 5 years who come to the smokehouse. The number of children below 5 years who come to the smokehouse is presented in Figure 3. The mean number of children below 5 years accompanying male fish smokers to the smokehouse is 2.3 ± 1.7, indicating some variability in the number of children. The mean number of children below 5 years accompanying

female fish smokers to the smokehouse is 2.8 ± 2.2, and males 2.7 ± 2.2. The presence of young children in smokehouses exposes them to harmful smoke and pollutants, which can adversely affect their health and development. This highlights the need for interventions to reduce children's exposure, such as improving childcare options or creating safer smokehouse environments.

Choice of firewood and health risk. Figure 4 outlines the type and choice of firewood and material used for stove construction by fish smokers. The type of firewood used by fish smokers displays the count of different types of firewood used, while the preferred kind shows the preferences of fish smokers. The materials used for stove construction illustrate the materials used in constructing stoves.

Fish smokers use various firewood types and significantly prefer unspecified types. Preferred firewood characteristics are hardness, smoke production, and drying efficiency. The majority of fish smokers (61.2%) use types of firewood classified as "others," indicating a preference for less common or unspecified types of firewood other than Cocoa (15.3%), Acacia (10.2%) and Sugarcane (9.5%) and Palm Kernel (3.4%). When the smokers have options, most fish smokers (79.6%) prefer using firewood types classified as "others," reflecting the same trend observed in the types of firewood used. Cocoa (8.5%) and Acacia (7.1%) are also preferred but far less than the "others" category. Meanwhile, sugarcane (2.7%) and palm kernel (0.7%) are the least preferred firewood types, mirroring their lower usage rates.

Considering the materials used for stove construction, Mud (83.7%) is the most common material for constructing stoves, suggesting its availability, cost-effectiveness, or suitability. Second to mud is Cement (8.2%), which is the second most used material, though it is significantly less common than mud, while much lower proportions; wood (4.1%), Stone (1.4%), and Others (2.4%) are used much less frequently, indicating they are not the preferred choices for stove construction among fish smokers. The most commonly used firewood is unspecified ("others") at 61.2%, followed by cocoa (15.3%), acacia (10.2%), sugarcane (9.5%), and palm kernel (3.4%). Despite this, 79.6% prefer unspecified firewood, with the rest favoring cocoa, acacia, sugarcane, and palm kernel in smaller percentages.

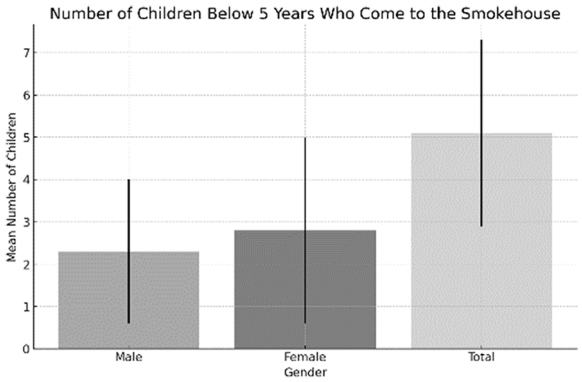

Figure 3. The mean number of children below 5 years who accompany their parents to the smokehouse, categorized by gender.

Self-reported eye discomfort. Figure 5 below presents symptoms of eye discomfort among fish smokers. Of the 302 interviewed, the prevalence of eye discomfort was 53.02%. Out of the reported discomfort cases (53.02%), the most common reported symptom was blurred vision (28.3%), followed by itching (21.7%), pain (16.7%), and tearing (6.7%). Other symptoms include foreign body sensation, photophobia, eye discharge, and burning sensation. A significant portion of fish smokers experience eye discomfort, likely due to smoke exposure. The symptoms vary in severity, indicating a range of eye health issues.

Prevalence of distance visual impairment. Table 3 below presents the distance visual impairment among the fish smokers. Of the 302 participants interviewed, the incidence of distant vision impairment was 26.37%, Table 3. Out of the 77 participants with distance visual impairment, most (81.8%) report normal or mild visual impairment, 6.5% report moderate impairment, and 11.7% report being blind. A notable portion of fish smokers

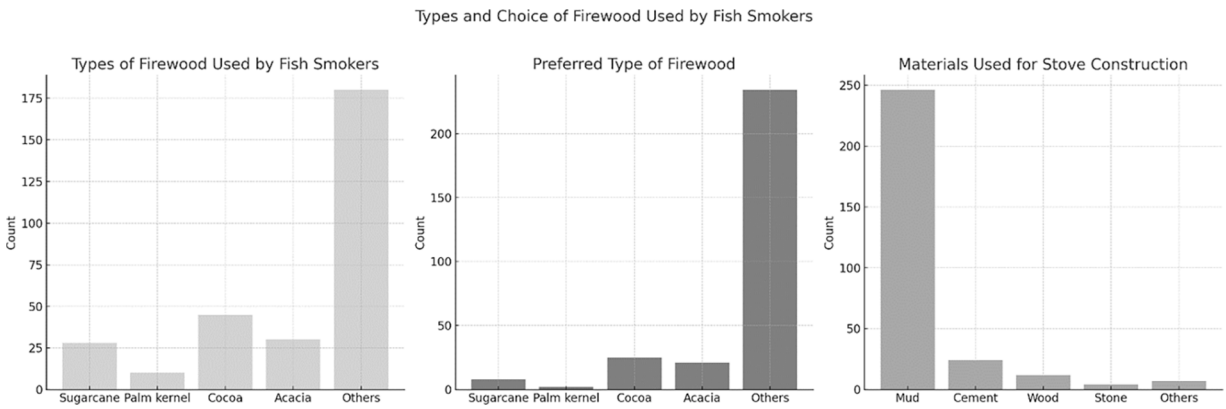

Figure 4. Types and choice of firewood and material used for stove construction by fish smokers.

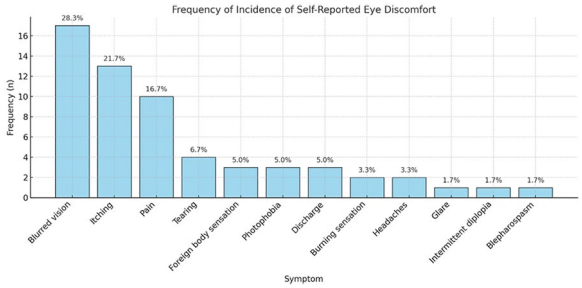

Figure 5. Self-reported eye discomfort.

Table 3. Prevalence of distance visual impairment among fish smokers.

VISUAL IMPAIRMENT CATEGORY	PERCENTAGE (%)	DESCRIPTION
Normal/mild visual impairment	81.8	The majority of the population has little to no impairment.
Moderate visual impairment	6.5	A small portion of the population experiences moderate visual issues.
Blind	11.7	A significant percentage of the population is blind.

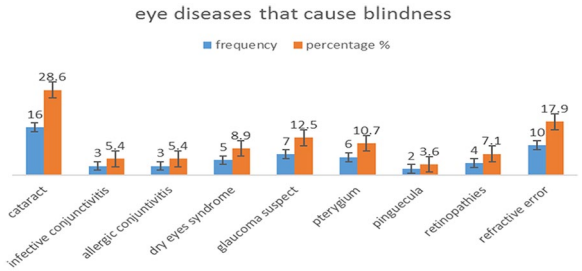

Figure 6. Eye diseases that cause blindness.

suffer from visual impairments, with some experiencing severe vision loss. Mild to severe visual impairments can significantly impact daily activities and quality of life.

Prevalence of eye diseases that cause blindness. Figure 6 displays the frequency and percentage of different eye diseases among fish smokers. Of the total 302 participants interviewed, the incidence of eye impairment that causes blindness was 19.18%. Among the 56 participants with this condition, the most common disease reported was cataracts (28.6%), followed by refractive errors (17.9%), suspected glaucoma (12.5%), and pterygium (10.7%). Other conditions include dry eye syndrome (8.9%), retinopathies (7.1%), and less common conditions like conjunctivitis and pinguecula.

Cataracts are the most common eye disease, likely exacerbated by smoke exposure. Fish smokers face a variety of eye conditions, indicating the harmful effects of their work environment.

Discussion

Fish smoking, a standard method for preserving fish in coastal areas, typically involves using biomass fuels such as firewood. The combustion of these fuels releases harmful pollutants, including polycyclic aromatic hydrocarbons (PAHs) and particulate matter (PM), which pose significant health risks. The majority of fish smokers are unaware of or do not practice adequate safety measures, leading to a high prevalence of both respiratory and ocular diseases. The study conducted in Abuesi, Ghana, provides valuable insights into occupational exposure and eye health risks among commercial fish smokers, a predominantly female demographic. This study is significant as it highlights the intersection between traditional fish-smoking practices, which are deeply ingrained in the socio-economic fabric of coastal communities, and the health risks associated with prolonged exposure to biomass smoke.

Gender disparity among commercial fish smokers. The significant gender disparity among commercial fish smokers in this study, with women comprising the majority, reflects broader socio-economic trends in many developing countries. Women are often the primary actors in fish smoking due to their crucial role in household economies and food security.[3,7,10,23-25] This gender dynamic is supported by findings highlighting women's substantial contributions to local economies through fish smoking.[3,10,25] However, this predominance exposes women to higher health risks from prolonged smoke exposure, including respiratory issues and eye diseases.[2,3,10,24-26]

This pattern is not unique to Ghana. In Nigeria, a study by Gnisci[26] found that women involved in fish processing also faced significant health risks, mirroring the findings from Abuesi. However, the Nigerian study highlighted the additional burden of socio-economic constraints that limit women's access to healthcare and safety measures, a challenge that is also evident in the Abuesi context.[5,13]

Age distribution among commercial fish smokers. The study reveals that middle-aged individuals (30-65 years) are the primary labor force in fish smoking, a trend consistent with findings by N'Souvi et al.[27] This demographic involvement is driven by their physical stamina and experience, essential for the demanding tasks of fish smoking. However, this age group may experience prolonged pollutant exposure, leading to health risks.[11,28] Despite the health risks, economic necessity drives their participation, providing critical economic stability for their families.[29]

Level of education among commercial fish smokers. The low level of formal education among fish smokers restricts their ability to implement modern, safer fish-smoking techniques. A study by Armo-Annor et al[7] linked traditional smoking practices with high pollutant exposures and associated health risks. Better education correlates with higher awareness and adoption of efficient smoking methods, such as the Ahotor oven,[6] which

reduces health risks.[26] Educational initiatives to improve literacy and vocational skills can enhance economic prospects and health outcomes in the fish-smoking industry.[30]

Association between duration of exposure and respiratory and ocular health outcomes. The study finds no significant association between smoking duration and headaches, aligning with Lloyd et al,[31] which suggests that smoking may trigger headaches but not correlate with exposure duration. Chronic cough, commonly associated with long-term smoking,[32] also shows no significant duration impact in this study. However, severe conditions like breathlessness, asthma, and pneumonia are significantly associated with shorter smoking durations, indicating that these symptoms might prompt earlier cessation.[33,34]

The association between smoking duration and health outcomes in the Abuesi study provides critical insights into the chronic nature of biomass smoke exposure. The study found significant associations between longer biomass smoke durations and severe respiratory and eye conditions like breathlessness, asthma, pneumonia, and eye disease, suggesting the accumulative impact of particulate exposure.

This finding aligns with studies in other regions, such as Latin America, where prolonged exposure to biomass smoke has been linked to chronic obstructive pulmonary disease (COPD) over more extended periods.[33] The difference may be due to variations in smoking practices, the types of biomass fuels used, and the duration of exposure, highlighting the need for region-specific research and interventions.

Additionally, the presence of young children in smokehouses poses significant health risks due to their vulnerability to prolonged smoke inhalation and health risks.[16,17] Measures to reduce children's exposure are crucial. For example, providing childcare options.

Firewood type, stove type, health risk knowledge, and practice. Despite high awareness of health risks from smoke and heat exposure, measures to mitigate health risks were lacking. This observation indicates that awareness alone is insufficient. Practical interventions, such as improved ventilation and protective equipment, are necessary to minimize these risks.[35,36] Smoke emission and persistent contaminant accumulation and emission are wood-type dependents; harder woods like acacia tend to burn more efficiently and produce less smoke than sugarcane, etc.[13] This understanding enshrines the need for education in this profession and ensuring the use of clean-burning wood and sound ventilation systems to minimize health risks.

Eye health risks. The high prevalence of eye diseases among fish smokers in Abuesi, particularly cataracts and suspected glaucoma,[9,10,18,37] aligns with global research on the ocular impacts of biomass smoke. Studies in South Asia, for example, have documented similar findings, with smoke exposure being a significant risk factor for cataracts.[18] The Abuesi study adds to this body of evidence by providing specific data on a population that has been underrepresented in eye health research.

The presence of visual impairments and self-reported eye discomfort among fish smokers in Abuesi also echoes findings from studies in rural India, where similar occupational exposures have led to high rates of blindness and visual impairment.[37] These parallels suggest that the health risks faced by fish smokers in Abuesi are part of a broader pattern of occupational hazards associated with biomass smoke.

Comparison with similar studies in Ghana. The findings of this study are consistent with previous research conducted in Ghana and other parts of the world regarding the health risks associated with biomass smoke exposure. For instance, a survey by Armah et al[1] also identified significant health risks related to indoor air pollution from biomass smoke in Ghana, linking it to respiratory diseases and visual impairments. Similarly, a study by Kyei et al[9] documented ocular disorders among individuals exposed to biomass smoke in occupational settings, aligning with the high prevalence of cataracts and refractive errors found in the Abuesi study.

In contrast to these studies, which primarily focused on general biomass exposure, the Abuesi study provides a more targeted examination of fish smokers. This group has received less attention in the literature. This focus is critical because fish smoking involves prolonged exposure to smoke in poorly ventilated environments, which may exacerbate health risks compared to other forms of biomass exposure.

Comparison with global studies. Globally, studies have consistently shown that biomass smoke exposure is a significant public health issue, particularly in low- and middle-income countries where traditional cooking and smoking methods are prevalent. A study by Gordon et al[8] highlighted the respiratory risks from household air pollution in such settings, drawing parallels to the health issues observed among fish smokers in Abuesi. The global relevance of these findings underscores the need for interventions that can be adapted to different cultural and economic contexts.

In Sri Lanka, Jinadasa et al[4] reviewed the presence of PAHs in fish and fisheries products, emphasizing the potential for these harmful compounds to enter the food chain. While the Abuesi study did not focus on the contamination of fish products, the link between PAHs in smoke and health risks remains critical. The Sri Lankan study complements the findings from Abuesi by demonstrating the broader implications of biomass smoke exposure beyond just direct health effects on smokers.[4]

Clinical implications

1. Urgent public health interventions are needed to protect fish smokers from respiratory and eye diseases. This includes promoting safety practices, improving ventilation, and providing protective equipment.
2. Educational programs should focus on the health risks of traditional fish smoking and the benefits of using improved technologies.
3. Reducing children's exposure to smoke is crucial, such as providing alternative childcare options.

Limitations

1. Reliance on self-reported health symptoms may lead to underreporting or overreporting of health issues.
2. The relatively small sample size limits the generalizability of the findings.
3. The study's cross-sectional nature limits the ability to establish causal relationships between exposure and health outcomes.

Implications of the study on policy and practice. This study emphasizes the urgent need for policies to address the health risks of fish smoking, particularly for women. National occupational health frameworks should identify fish smoking as a high-risk activity and ensure regular health screenings for respiratory and ocular conditions. Regulations should promote cleaner-burning fuels and smoke-reducing technologies, like the Ahotor oven while offering incentives for adoption.

Environmental policies must also target biomass smoke emissions to improve public health and sustainability in communities like Abuesi. Community health programs should educate fish smokers on the dangers of biomass smoke and provide solutions like masks, goggles, and better ventilation. Training on building and maintaining smoke-reducing stoves is essential. A gender-sensitive approach is necessary, given women's increased vulnerability. Collaborating with policymakers, NGOs, and community leaders can lead to practical solutions that meet local needs and protect young children from harmful smoke exposure.

Recommendations. Given the significant health risks identified in the Abuesi study, there is an urgent need for public health interventions. These should include promoting safer fish smoking technologies, such as improved stoves that reduce smoke emissions, and introducing protective measures like ventilation and personal protective equipment.

Education and awareness campaigns are also crucial, particularly in empowering women who dominate the fish-smoking industry. These campaigns should focus on the health risks of traditional smoking practices and the benefits of adopting safer methods. Additionally, interventions should address the presence of young children in smokehouses, providing alternatives to reduce their exposure to harmful pollutants.

Conclusion

This study sought to assess the health impacts of occupational biomass smoke exposure among fish smokers in Abuesi, Ghana, focusing on respiratory and ocular conditions. The findings revealed a high prevalence of self-reported respiratory symptoms, such as asthma and breathlessness, and significant ocular issues, including eye discomfort, cataracts, and refractive errors. These results highlight the dual impact of biomass smoke on respiratory and ocular health, underscoring the severe risks associated with prolonged exposure in occupational settings.

The study also examined the relationship between the duration of smoke exposure and health outcomes, finding significant associations between shorter smoking durations and severe conditions such as asthma and pneumonia. These findings suggest that severe health symptoms may prompt early cessation of fish-smoking activities. Additionally, the study identified the disproportionate exposure of women in the fish-smoking industry, emphasizing the gendered health risks in this occupation.

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Authors Contributions

Data extraction, data analysis, and writing of the first draft of the manuscript (Dr Charity Owusu). Guiding the study and commenting on the drafted manuscript (Dr. Albert Ofori) and (Dr. Frank Adusei-Mensah). Data sampling, data analysis, and commenting on the drafted manuscript (Dr. Carl Halladay Abraham) and (Prof. Samuel Kyei). Conceive and design of study methodology (Dr. Reginald Quansah) and (Prof. David Kofi Essumang). All the authors have accepted responsibility for the entire content of this submitted manuscript and approved the submission.

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