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Risk of developing respiratory symptoms in populations living near artisan brick kilns, El Salvador, 2021-2022

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ABSTRACT

Introduction: There are many artisans brick kilns near the communities in Nejapa city. The reported prevalence of respiratory diseases or symptoms in this city is 7.2%. This study aims to determine the relationship between exposure to smoke generated by artisan brick kilns and the presence of respiratory symptoms in residents ≥18 years of age in a gated community in the Nejapa city.

Materials and methods: This is an analytical cross-sectional study that included 46 individuals. Data were collected through an interview form and an observation form. Frequency analysis, association measures, and prevalence ratios were calculated. This study received ethical approval.

Results: Twenty-nine individuals reported respiratory symptoms such as sneezing, itching, and nasal congestion. Twenty-eight people reported experiencing respiratory symptoms. The most frequently reported symptoms were sneezing, nasal itching, nasal congestion, and cough. Daily exposure to smoke from the brick kilns doubled the risk of nasal congestion. Living at 61 m or more from the brick kilns increased the risk of nasal congestion by 3.22 times. Living at a distance between 46 and 60 m from the kilns doubled the risk of coughing.

Conclusion: There is a relationship between the development of respiratory symptoms and daily exposure to smoke generated by artisan brick kilns. The risk of developing symptoms varies depending on the distance between the individual's residence and the brick kilns.

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Introduction

Air pollution is an unavoidable threat to public health [1, 2]. Exposure to air pollution can cause a range of adverse health effects, such as respiratory diseases, cardiovascular diseases, and lung cancer [3, 4]. It is estimated that in 2019, air pollution was responsible for 6.7 million (CI 5.90–7.49 million) deaths worldwide [5].

Exposure to atmospheric pollutants, such as particulate matter, ozone, nitrogen dioxide, and sulfur dioxide, is linked to public health issues and daily mortality across the globe [1]. One of the occupational activities that produces a significant amount of these pollutants is artisan brick production [6]. In Latin America, it is estimated that 40–50% of brick production is carried out in artisanal brick kilns [7].

A study conducted in Nepal showed the presence of respiratory symptoms such as cough (14.3%), phlegm (16.6%), and bronchitis (19.0%) in people occupationally exposed for one year to smoke from brick kilns [8]. Another study conducted on brick kiln workers in Bengal, India, showed a prevalence of 46.8% for dyspnea, 39.2% for phlegm, 27.6% for chest tightness, 25.2% for chronic cough, 28.8% for sneezing, and 14.4% for wheezing [9]. Additionally, there is evidence supporting the relationship between air pollution and chronic respiratory diseases such as asthma and Chronic Obstructive Pulmonary Disease (COPD) [10].

In El Salvador, the artisanal production of bricks is a very common activity [11]. These brick kilns are located near communities, exposing all inhabitants to the pollutants emitted by these kilns. There are approximately 70 brick kilns in Nejapa city [12].

In the department of San Salvador, a prevalence of 17.6% for acute respiratory infections was reported in 2020 [12], and specifically in the municipality of Nejapa, a prevalence of 7.2% was reported [13]. This prevalence may be influenced by the presence of pollutants emitted by artisanal brick kilns, most of which operate without any authorization or environmental control.

This is the first study conducted in El Salvador as an initial approach to understanding the relationship between exposure to brick kiln smoke and the presence of respiratory symptoms. Therefore, this study aimed to determine the relationship between exposure to smoke generated by artisanal brick kilns and the presence of respiratory symptoms in individuals ≥18 years of age living in a gated community in Nejapa city.

Materials and methods

This study employed an analytical cross-sectional design, conducted with individuals≥18 years of age residing in a gated community in the Nejapa city. This is a residential area near the artisan brick kilns of Nejapa. The perimeter wall of the community directly borders the artisan brick kilns and has a total of 200 residents ≥18 years of age. The study sample was calculated based on this population using the StatCalc function of EpiInfo version 7. A respiratory symptom prevalence of 7.2% and a 95% confidence interval were considered for the sample calculation. The final sample consisted of 134 individuals.

The study included individuals ≥18 years of age with respiratory symptoms and apparently healthy individuals. It excluded people who only used the residence on weekends, active and passive smokers, individuals with high occupational risks due to inhalation of chemicals (smoke, silica, asbestos, cotton, sawdust, coal, etc.), and those with pre-existing pulmonary diseases or diagnosed respiratory conditions (chronic bronchitis, bronchial asthma, emphysema, bronchiectasis, pneumonia, chronic obstructive pulmonary disease, asbestosis, silicosis).

When administering the data collection tool, only 104 individuals responded, but only 47 met the established criteria to ensure the quality of the information required for the study and to avoid

biases in the results. Therefore, this study was based on 47 residents of the gated community. The study sample was selected using non-probabilistic random sampling.

The study variables included age, gender, education level, occupation, duration of residence in the area, distance from the residence to the brick kilns, perception of smoke in the residence, time of day when smoke was perceived, frequency of smoke presence, presence of particles in the residence, location in the home where particles were most noticeable, presence of smoke particles outside the residence, outdoor location where particles accumulated, presence of smoke from other sources, other sources of smoke emissions in the area, predominant direction of the smoke plume, respiratory symptoms, frequency of respiratory symptoms, duration of respiratory symptoms, geographic location where the person experienced the most intense symptoms, and time of day when respiratory symptoms occurred.

Based on the study variables, two data collection instruments were created (an interview tool and an observation tool). The interview tool was structured into three sections (sociodemographic data, assessment of exposure to brick kiln smoke, and presence of respiratory symptoms). The interview tool consisted mainly of structured, closed-ended questions. The observation tool contained only one section, focused on assessing exposure to smoke from the brick kilns. Both instruments were digitized using the KoboToolBox platform.

For data collection, the link to the tool was shared via a WhatsApp group that included all residents of the gated community. This WhatsApp group was managed by community leaders who added the researchers during the data collection period to actively promote the completion of the survey. In addition, house-to-house visits were conducted to encourage the completion of the interview tool, covering all the residences.

The study area was visited to observe all aspects indicating population exposure to smoke from the brick kilns. Authorization was requested from the owners of two homes near the kilns to conduct an observational evaluation of smoke residue in the homes. Subsequently, access was requested to a home located at a medium distance from the kilns, and finally, a residence at the furthest point from the kilns was visited to compare the exposure marks generated by the smoke from the kilns. Google Maps was used to measure the distance between the residences and the brick kilns.

First, the interview and observation databases were exported from KoboToolbox to an Excel sheet. Second, a quality control process was performed to identify typing errors, missing data, and inconsistencies between variables. The databases were then merged into a single file, which was migrated to Epi Info version 7.2.5.0 for analysis, using frequencies and percentages to describe the findings. Finally, the risk of developing respiratory symptoms due to exposure to brick kiln smoke was calculated using the Prevalence Odds Ratio (POR), with a 95% confidence interval and statistical significance set at $p<0.05$.

Results and discussion

A total of 47 residents of the gated community were interviewed. The average age of the respondents was 40.8 years (SD 14.5). The majority (29) were women. The predominant age group was 30 to 39 years (16 people) (Table 1). More than three-quarters of the population (37 people) had a professional or higher education level, followed by eight people with secondary education. The most common occupation was housewife (8 people), followed by five entrepreneurs and five physicians (Table 1).

Table 1. Sociodemographic characteristics of the population ≥18 years of age residing in a gate community (n = 47)

Variables	N	%
Age group		
≥18 to 29 years	11	23
30 to 39 years	16	34
40 to 49 years	7	15
50 to 59 years	7	15
Over 60 years	6	13
Sex		
Male	18	38
Female	29	62
Educational level		
Basic education	2	4
Secondary education	8	17
Professional	31	66
Specialist	2	4
Master's degree	4	9
Occupation		
University student	2	4
Lawyer	1	2
Physician	5	11
Teacher	2	4
Housewife	8	17
Entrepreneur	5	11
Businessperson	3	6
Nurse	1	2
Others	20	43
Distance between homes and artisan brick kilns		
15 m or less	9	20
16 to 30 m	12	26
31 to 45 m	5	11
46 to 60 m	2	4
61 m or more	19	39

Thirteen individuals had lived in the community for two years or less, and three had lived there for between two and four years. Twenty-three individuals lived in the community for between four and six years, while eight people lived there for more than six years. These results are like a study conducted in Bengal, India, where individuals exposed to smoke from artisanal brick kilns, especially workers who had been employed for over 20 years, had a higher prevalence of respiratory symptoms [9]. Various studies have demonstrated that chronic exposure to different atmospheric pollutants increases the incidence of respiratory diseases, so it is expected that individuals who have lived longer in the community, and are exposed to prolonged smoke from the kilns, would present with a higher number of respiratory symptoms [14-16]. In El Salvador, artisanal brick kilns use firewood as fuel for brick firing, as it is a cheap and easily accessible material [17]. Valdés et al. reported that the fuel used in artisanal brick kilns includes firewood, bagasse, rice husks, and coal. In Latin America, fuel primarily comes from biomass [7], due to its low cost compared to alternative fuels.

Regarding the distance between their homes and the artisan brick kilns, most participants (19) lived more than 60 m away, followed by those whose homes were between 16 and 30 m away (12 participants) (Table 1).

Most of the residents (42 people) reported perceiving smoke inside their homes. Most participants indicated that the times of day when smoke is perceived in the home are during the afternoon and evening, with the latter receiving 31 affirmative responses (Table 2). Regarding the frequency with which smoke is perceived, 30 residents said they noticed it more than three times per week (Table 2). When asked if they perceived smoke from other sources, only 10 participants responded affirmatively, with nine of them identifying sugarcane fields as an alternative source of smoke emissions (Table 2). The presence of smoke outside the homes increases exposure to this pollutant. It has been shown that exposure and proximity to pollution sources outside the home increase the concentration of pollutants inside [18]. External pollutants infiltrate homes through open windows or doors, and due to pressure and temperature differences, air is transported in and out of homes [18].

In El Salvador, the gate community are becoming increasingly popular due to various factors, including socio-economic reasons and population growth [19]. The high demand for housing in the metropolitan area of San Salvador, or nearby, has led construction companies to acquire land near pollution sources, such as artisanal brick kilns, large-scale fields irrigated with pesticides [20], and sugarcane fields that are burned before harvest, among others, for the construction of high-end private residential projects. However, construction companies often do not consider the environmental aspects of these areas, putting the health of people who move to these places at risk [21-23].

Table 2. Exposure to smoke from brick kilns and other sources among residents ≥18 years of age in a gate community located in Nejapa city (n = 42)

Variable	N	%
Time of day when smoke is perceived in the house		
Morning	13	31
Afternoon	21	50
Evening	31	74
Frequency of smoke presence in the house		
Three times per week or less	12	29
More than three times per week	30	71
Other sources of smoke emissions[b]		
Factories	1	2
Sugarcane fields	9	21
Burning trash	2	5

[a]*Percentages do not add up to 100% since not all participants reported perceiving smoke from other sources. Calculated with n = 42 for each category, which are not mutually exclusive.*

[b]*Not mutually exclusive. Percentages were calculated for each category with n = 42.*

Twenty-eight people reported experiencing respiratory symptoms, this contrasts with a study conducted in Nepal, where brick kiln workers mainly presented lower respiratory tract symptoms such as chronic cough and phlegm, bronchitis, dyspnea, and asthma [8]. This could be because brick kiln workers are directly exposed to more concentrated pollutants emitted from the kilns for longer periods, compared to cluster residents who are exposed to lower amounts and concentrations. Eleven participants were between 30 and 39 years old. The most frequently reported symptoms were sneezing (18), nasal itching (16), nasal congestion (13), and cough (11). Other studies support the decline in lung function with age [24, 25]. A study conducted in Sudan found that as age increased, the risk of developing chronic respiratory diseases also increased [26].

A bivariate analysis revealed a statistically significant association between the frequency of smoke perception and the presence of respiratory symptoms (POR 8.43; 95% CI 2.1–33.77; p = 0.000). Participants who reported perceiving smoke in their homes more than three times per week were eight times more likely to experience respiratory symptoms compared to those who perceived smoke less frequently. This finding highlights the potential role of cumulative exposure over time, even in non-occupational settings.

No statistically significant associations were found between other factors, such as age, gender, or distance from the kilns, and the presence of respiratory symptoms. The lack of significance for distance may reflect the dispersion of pollutants beyond the immediate vicinity of the kilns or the influence of indoor air pollution, which can dilute the effect of proximity [18].

Regarding gender, while women reported more symptoms than men, this was not statistically significant. Similar observations have been documented in other studies, where gender differences in respiratory health were linked to variations in household exposure levels, particularly in settings with greater indoor pollution [17, 18]. Although these findings were not statistically significant, they do not exclude the possibility of underlying associations, which may require larger sample sizes or more controlled conditions to detect. These results suggest that other environmental and behavioral factors may contribute to respiratory health outcomes in populations living near artisan brick kilns (Table 3).

Table 3. Risk factors associated with the presence of respiratory symptoms in the gate community residents

Risk factor	Association with respiratory symptoms		
	POR	95% CI	*p*
Age group			
≥18 to 29 years	0.65	0.16 - 2.60	0.7
30 to 39 years	1.55	0.43 - 5.64	0.5
40 to 49 years	0.39	0.07 - 2.01	0.3
50 to 59 years	2.66	0.27 - 26.09	0.6
60 to 69 years	1.92	0.18 - 20.10	1.0
70 years or older	0.59	0.03 - 10.14	1.0
Sex			
Female	3.57	1.0 - 12.67	0.0
Male	0.28	0.07 - 0.99	0.0
Length of residence in the community			
2 years or less	0.39	0.10 - 1.46	0.2
>2 to 4 years	1.23	0.10 - 14.69	1.0
>4 to 6 years	0.97	0.29 - 3.26	1.0
>6 to 8 years	5.33	0.59 - 47.84	0.1
Frequency of smoke perception			
Three times per week or less	0.11	0.02 - 0.47	0.0
More than three times per week	8.43	2.1 - 33.77	0.0
Season when smoke is perceived			
Dry season (May to October)	1.84	0.39 - 8.62	0.4
Rainy season (November to April)	-	-	-
Time of day when smoke is perceived			
Morning	2.22	0.63 - 7.80	0.3
Afternoon	1.64	0.48 - 5.57	0.5
Evening	1.63	0.44 - 6.07	0.6
Distance between the nearest brick kiln and home			
15 m or less	0.40	0.09 - 1.76	0.2
16 to 30 m	4.16	0.78 - 22.03	0.0
31 to 45 m	0.90	0.13 - 6.01	1.0
46 to 60 m	0.59	0.03 - 10.14	1.0
More than 60 m	0.79	0.23 - 2.73	0.9

This study has several limitations that should be acknowledged to interpret the findings better. The small sample size reduces the statistical power of the analysis and limits the generalizability of the results beyond the studied population. The initially calculated sample size was three times larger; however, the application of strict exclusion criteria, including the removal of individuals with pre-existing pulmonary conditions, smokers, and those with occupational exposure to harmful chemicals, significantly reduced the final sample. Additionally, the cross-sectional design of this study prevents establishing causality between exposure to smoke from artisan brick kilns and the presence of respiratory symptoms. The absence of data on important potential confounders, such as socioeconomic status, access to healthcare, and other environmental factors, may have influenced both exposure and the development of respiratory symptoms. Furthermore, reliance on self-reported data introduces the possibility of recall bias or subjective variability in responses. The lack of direct measurement of pollutant concentrations from the brick kilns also limits the ability to accurately quantify exposure levels. Despite these limitations, this study provides valuable insights into the relationship between environmental exposure to brick kiln emissions and respiratory health, serving as a foundation for future research and public health interventions.

Given the significant association between frequent exposure to brick kiln smoke and respiratory symptoms, immediate policy actions are needed to reduce exposure in residential areas near artisanal kilns. Authorities should enforce stricter environmental regulations to ensure that brick kilns implement cleaner production methods, such as transitioning from biomass fuels to less polluting alternatives or adopting more efficient kiln designs that reduce emissions. Urban planning regulations must also prioritize creating buffer zones between residential developments and industrial activities, such as brick kilns, to minimize exposure to harmful pollutants. Additionally, community-level interventions, such as awareness campaigns about the health risks associated with air pollution and measures to improve indoor air quality, including proper ventilation and air filtration systems, could further mitigate the impact of smoke exposure. Collaborative efforts between local governments, public health institutions, and the affected communities will be crucial in designing and implementing these interventions effectively.

Conclusion

Residents of the gate community who are exposed to smoke generated by artisanal brick kilns more than three times a week have a higher risk of experiencing respiratory symptoms, with sneezing being the most frequently reported symptom. While no statistically significant association was found between respiratory symptoms and factors such as distance to the kilns, sex, or age, the results highlight the critical role of cumulative exposure in residential settings.

To address these findings, it is essential to enforce environmental regulations that promote cleaner production practices in artisanal kilns. Furthermore, establishing adequate buffer zones between residential areas and industrial activities is necessary. These measures could significantly reduce the health risks associated with air pollution and improve the quality of life for affected communities. Future research should focus on quantifying pollutant levels and exploring additional confounders to strengthen the evidence base for these interventions.

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Competing interests

The authors declare that they have no conflicts of interest in the results of the study.

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Ethical considerations

"Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors."

References

1. Liu C, Chen R, Sera F, Vicedo-Cabrera AM, Guo Y, Tong S, et al. Ambient Particulate Air Pollution and Daily Mortality in 652 Cities. N. Engl. J. Med. 2019;381(8):705–715. doi:10.1056/NEJMoa1817364

2. Schraufnagel DE, Balmes JR, Cowl CT, De Matteis S, Jung S-H, Mortimer K, et al. Air Pollution and Noncommunicable Diseases. Chest. 2019;155(2):409–416. doi:10.1016/j.chest.2018.10.042

3. Landrigan PJ, Fuller R, Acosta NJR, Adeyi O, Arnold R, Basu NN, et al. The Lancet Commission on pollution and health. Lancet Lond. Engl. 2018;391(10119):462–512. doi:10.1016/S0140-6736(17)32345-0

4. U.S. Environmental Protection Agency. Integrated Science Assessment (ISA) for Particulate Matter. Washington: Environmental Protection Agency; 2019. p. 1966.

5. Fuller R, Landrigan PJ, Balakrishnan K, Bathan G, Bose-O'Reilly S, Brauer M, et al. Pollution and health: a progress update. Lancet Planet. Health. 2022;6(6):e535–e547. doi:10.1016/S2542-5196(22)00090-0

6. Pérez-Morales JG, González-Martínez KI, Negrete-Meza LA, Vázquez-Rodriguez MF, Salinas-Sanchez MA, Ortega-Castellanos M, et al. Evaluation and identification of contaminating processes, sources and routes of exposure in the brick-making areas of Guanajuato. Jovenes en Cienc. 2022;16:1–12.

7. Valdes H, Vilches J, Felmer G, Hurtado M, Figueroa J. Artisan Brick Kilns: State-of-the-Art and Future Trends. Sustainability. 2020;12(18):7724. doi:10.3390/su12187724

8. Sanjel S, Khanal SN, Thygerson SM, Carter WS, Johnston JD, et al. Respiratory symptoms and illnesses related to the concentration of airborne particulate matter among brick kiln workers in Kathmandu valley, Nepal. Ann. Occup. Environ. Med. 2017;29(1):9. doi:10.1186/s40557-017-0165-0

9. Das B. Assessment of respiratory symptoms and lung function values among the brick field workers of West Bengal, India. Arch. Environ. Occup. Health. 2016;71(4):222–230. doi:10.1080/19338244.2015.1067177

10. Annesi-Maesano I, Forastiere F, Balmes J, Garcia E, Harkema J, Holgate S, et al. The clear and persistent impact of air pollution on chronic respiratory diseases: a call for interventions. Eur. Respir. J. 2021;57(3). doi:10.1183/13993003.02981-2020

11. Municipality of Nejapa. Business Report. Transparency Portal [Internet]: Publishing; 2021.

12. Ministry of Health, Epidemiology Department. Epidemiological Bulletin. El Salvador: Ministry of Health; 2020.

13. Ministry of Health. Nejapa Intermediate Family Community Health, Unit Situation Room, 2021. 2021. Ministry of Health [Internet]: Publishing; 2021.

14. Hassan Bhat T, Jiawen G, Farzaneh H. Air Pollution Health Risk Assessment (AP-HRA),

Principles and Applications. Int. J. Environ. Res. Public. Health. 2021;18(4):1935. doi:10.3390/ijerph18041935

15. Fasola S, Maio S, Baldacci S, La Grutta S, Ferrante G, Forastiere F, et al. Effects of Particulate Matter on the Incidence of Respiratory Diseases in the Pisan Longitudinal Study. Int. J. Environ. Res. Public. Health. 2020;17(7):2540. doi:10.3390/ijerph17072540

16. Kim D, Chen Z, Zhou L-F, Huang S-X. Air pollutants and early origins of respiratory diseases. Chronic Dis. Transl. Med. 2018;4(2):75–94. (Special Issue: Air Pollution and Chronic Respiratory Diseases). doi:10.1016/j.cdtm.2018.03.003

17. Ascencio Miranda RM, Martínez Burgos KM del S, Serafín Olivares Y del C. Determination of the environmental contamination emanating from the brick factories and the most frequent diseases in the community of El Cedral, Municipality of Nejapa. [bachelor thesis]. University of El Salvador; 2003

18. Shrestha PM, Humphrey JL, Carlton EJ, Adgate JL, Barton KE, Root ED, et al. Impact of Outdoor Air Pollution on Indoor Air Quality in Low-Income Homes during Wildfire Seasons. Int. J. Environ. Res. Public. Health. 2019;16(19):3535. doi:10.3390/ijerph16193535

19. Zhang N, Nazroo J, Vanhoutte B. The relationship between rural to urban migration in China and risk of depression in later life: An investigation of life course effects. Soc Sci Med. 2021;270:113637. doi:10.1016/j.socscimed.2020.113637

20. Wildi Mi, Jandres Vásquez M, Santamaría N, Padilla Moreno A, Recinos Paredes G, Ramírez G, et al. Environmental and health risks of pesticides and fertilizers used in El Salvador. Case study of the sugar industry in the Brazo del Río La Paz sub-basin. San Salvador, El Salvador: Salvadoran Ecological Unity Association; 2021. p. 221.

21. Gallegos R. AS, Lang B, Fernández M, Luján M. Atmospheric pollution from brick manufacturing and its possible effects on the health of children in neighboring areas. Acta Nova. 2006;3(2):192–210.

22. León Rivas JD, Matamoro Ruiz WA. Prevalence and risk factors for developing chronic obstructive pulmonary disease (COPD) in artisanal brick makers of La Paz Centro. [Medical Thesis]. 2017.

23. Torres-Duque CA, García-Rodriguez MC, González-García M. Chronic obstructive pulmonary disease due to wood smoke: a different phenotype or a distinct entity? Arch. Bronconeumol. 2016;52(8):425–431. doi:10.1016/j.arbres.2016.04.004

24. Karaoğlanoğlu S. Chapter 6. Geriatry and Lung Health. Atakan Savrun and Şeyda Tuba Savrun Ed. Approach to the geriatric patients. 1st ed. Ankara, Turquía. Iksad Publications. 2022. 262 p.

25. Tran D, Rajwani K, Berlin DA. Pulmonary effects of aging. Curr. Opin. Anaesthesiol. 2018;31(1):19–23.

26. Ahmed R, Osman N, Noory B, Osman R, El Hassan H, Eltigani H, et al. Prevalence and determinants of chronic respiratory diseases in adults in Sudan. Int. J. Tuberc. Lung Dis. 2023;27(5):373–380. doi:10.5588/ijtld.22.0462