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Air Quality and Public Perception of Environmental Pollution Around the Factory Area

Ayu Novitrie[1]*, Jihad Wafiqa Rahmah[2], & Siti Septiani Rulyah[3]
[1]*Universitas Sriwijaya, Indonesia, [2]Poltekkes Kemenkes Padang, Indonesia, [3]Poltekkes Kemenkes Padang, Indonesia
*Co e-mail: ayu.novitrie.an@gmail.com[1]

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ABSTRACT
Industrial activities around the Lubuk Begalung rubber factory in Padang City pose risks to air quality, raising community concerns about health and comfort. This study aimed to evaluate air quality and analyze local perceptions of pollution caused by factory operations. A quantitative survey with purposive sampling was conducted among 75 residents living within a 2 km radius of the factory for at least two years. Data were collected through questionnaires and analyzed descriptively using frequency, percentage, mean, and standard deviation. Relationships between perceived air quality and pollution impacts were examined using Spearman or Pearson correlation. Findings revealed that 60% of respondents frequently detected strong odors during production hours, while 55% reported mild respiratory problems, including coughing and throat irritation. Statistical analysis indicated a significant correlation between odor intensity and health complaints ($r_s = 0.62$; $p < 0.01$). In addition, 70% of respondents felt a decline in environmental comfort, which was also significantly related to health complaints ($r_s = 0.58$; $p < 0.01$). These results confirm that factory emissions negatively affect both physical and psychological well-being of nearby residents. The study emphasizes the need for stricter emission monitoring, adoption of environmentally friendly technologies, and stronger community involvement in environmental surveillance. Collaboration among industry, government, and local communities is essential to maintain air quality and minimize long-term health impacts.

Keywords: *Air Quality, Environmental Pollution, Public Perception, Rubber Factory*

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INTRODUCTION

The rubber industry is one of the important sectors in the Indonesian economy, both as an absorber of Labor and a contributor to the country's foreign exchange. The rubber processing process, from latex coagulation to drying and final processing, involves various activities that generate waste and gas emissions into the air. One area that has an active rubber industry activity is Lubuk Begalung, an area in the city of Padang, West Sumatra. In this area, people have long lived side by side with rubber factories that have the potential for environmental pollution, especially air quality.

Production activities in rubber factories produce various types of gas emissions, including hydrogen sulfide (H_2S), ammonia (Nh_2), and volatile organic compounds (VOCs) derived from the use of chemicals for latex processing. In addition, the process of combustion of fuel at the drying stage produces particulates (PM_{10} and $PM_{2.5}$) As well as gases such as carbon monoxide (CO) and sulfur dioxide (SO_2). These gases and particles can have a direct impact on public health and environmental quality if removed without adequate controls.

Some reports of people around the Lubuk Begalung rubber factory mentioned that a pungent odor such as sulfur was often smelled at night or early in the morning, a time when intensive production activities were carried out. This condition causes health complaints such as headaches, coughing, eye irritation, and shortness of breath. In addition to physical impairments, people also experience psychological distress due to long-term concerns about persistent exposure to air pollution.

This problem does not only occur in Lubuk Begalung. An article published by Kompasiana (2024) highlights that in several other rubber-producing regions in Indonesia, air pollution from factories has become a crucial issue. One example is in West Kalimantan, where emissions from rubber processing plants cause environmental disturbances and a decrease in the quality of life of local residents (Kompasiana, 2024). It shows a similar pattern of impacts, especially in regions with weak environmental surveillance systems.

According to Bisnis.com (2025), the Ministry of Environment and Forestry (MoEF) noted that there are still many small and medium industries in Indonesia that do not meet emission standards in accordance with applicable regulations. This non-compliance covers various industrial sectors, including the rubber processing industry spread across various regions. This is a serious concern because small and medium-scale industries contribute a large contribution to local air pollution, but supervision of them is still weak compared to large-scale industries. This inequality creates regulatory gaps that can be detrimental to people who live around industrial areas.

One of the factors that worsen this condition is the lack of implementation of continuous emission monitoring systems, such as the Continuous Emission Monitoring System (CEMS). The system is supposed to be a key tool in monitoring industrial exhaust emissions in real-time, allowing rapid intervention if threshold violations are found. However, in reality, many industries are not required or unable to adopt such systems due to limited resources, technology, or oversight. As a result, there is no transparent and accurate public data available on air pollution levels, so people cannot access environmental information directly related to their safety and health.

Similar conditions were also found in various rubber factories outside Java, including in Lubuk Begalung, West Sumatra, where the study was conducted. Communities around industrial areas often rely solely on sensory observations, such as strong odors or shortness of breath, to assess levels of air pollution. When there is no scientific data to support their concerns, people's voices are often ignored by authorities and industry. Therefore, this study is important to fill the void of field data and provide

concrete evidence related to air quality and public perception of industrial pollution, especially in areas that have not been systematically monitored.

Poor air quality can have a direct impact on public health, especially vulnerable groups such as children and the elderly. According to GreatTraining.co.id (2024), long-term exposure to $PM_{2.5}$ And toxic gases can cause chronic respiratory diseases, heart disorders, and even reproductive disorders (GreatTraining, 2024). However, field studies on air pollution from rubber factories in the West Sumatra region are still limited, so more focused and data-based research is needed.

In addition to health impacts, people's perception of environmental pollution also plays an important role in the social dynamics and sustainability of the industry. Negative perceptions of pollution can reduce trust in governments and companies, trigger social conflicts, and worsen the image of the industry itself. Therefore, a scientific approach that combines air quality data with public perception surveys can provide a fuller picture of the real impact of pollution.

The study of people's perceptions is also important because people are the most affected parties but often have a weak position in the environmental decision-making process. The low involvement of citizens in monitoring and lack of Environmental Education led to not optimal mitigation efforts undertaken. In fact, active community participation can be a form of social control of industrial activities to be more responsible.

In the context of regulation, Indonesia has established a fairly strong legal basis through law No. 32 of 2009 on Environmental Protection and management. This law requires any industrial activity that has the potential to cause environmental impacts to prepare an Environmental Impact Assessment (EIA) document before operating. In addition, companies are also required to conduct waste management and monitor emissions regularly to ensure that their production activities do not violate the Environmental Quality Standard threshold set by the government. Theoretically, this policy has contained the principle of caution and Prevention of environmental damage.

However, the implementation of this policy in the field is still far from expectations. One of the main problems is the lack of supervision and law enforcement, especially for small to medium-sized industries that often escape periodic inspections. Many industries still do not implement continuous emission monitoring systems such as the Continuous Emission Monitoring System (CEMS). In addition, the lack of transparency of environmental data leaves people without access to information about the air conditions in their region of residence. The lack of coordination between local governments, environmental agencies, and industry players contributes to this situation, so that pollution practices often go unnoticed by the public.

This situation reinforces the urgency of conducting field-based research that not only relies on data from formal institutions, but also explores the voices and perceptions of people directly affected by industrial activities. This kind of research can help uncover factually occurring social and environmental realities, as well as provide a solid basis for evidence-based policy formulation. By combining empirical data on air quality and community responses to environmental pollution, the results of the study are expected to be a constructive input for the improvement of environmental management systems, as well as encourage wider public involvement in the supervision of the industrial sector.

Through this study, it is expected to determine the level of air pollution in the area around the Lubuk Begalung rubber plant by measuring several main parameters, namely PM_{10}, SO_2, and CO. In addition, people's perceptions will also be analyzed to determine the extent to which people feel the impact of industrial activity, as well as how they respond to it.

With the results of this study, policy recommendations can be prepared to assist local governments and industry stakeholders in establishing appropriate mitigation measures. These recommendations can also be used to strengthen environmental advocacy and expand public participation in Air Quality Management.

Therefore, this research becomes important not only as an academic contribution, but also as a basis for sustainable development that pays attention to the balance between industrial growth and the protection of the quality of life of surrounding communities.

METHODS

This study uses quantitative methods with survey techniques through the distribution of questionnaires to assess air quality based on the perception of people living around the Rubber Factory Area Lubuk Begalung, Padang. The population in this study is the entire community residing within a maximum radius of 2 km from the factory site. The determination of the sample was carried out using purposive sampling technique, with the criteria for respondents being citizens who have lived in the region for at least two years.

The number of samples determined was 75 respondents, consisting of various age groups, genders, and occupational backgrounds, in order to obtain a more representative picture of perception. The minimum sample size was considered adequate based on the rule of thumb for correlation and regression analysis, namely at least 30 respondents for each major variable, thus 75 respondents meet the statistical criteria to ensure sufficient analytical power.

The questionnaire instrument was developed based on modifications from previous research on environmental perception and air pollution impacts (Rahmi et al., 2021; Bachtiar, 2017), and then adapted to the local context. To ensure its quality, the questionnaire was tested for validity and reliability prior to full data collection. Validity was examined using item-total correlation with a minimum r-count > r-table ($\alpha = 0.05$), while reliability was assessed using Cronbach's Alpha, where a value above 0.70 was considered acceptable.

Data obtained from the questionnaire were analyzed using descriptive statistics (frequency, percentage, mean, and standard deviation) to describe the public perception of air quality and the impact of environmental pollution. Furthermore, inferential analysis was conducted using Spearman correlation and logistic regression to determine the relationship and dominant factors between odor perception, health complaints, and environmental comfort.

RESULTS

1. Univariate Analysis

Chart 1. Frequency Distribution

Variable	Categories	Frequency	Percentage (%)	Mean	Standard Deviation
Perception Of Pungent Odors	Yes	45	60.0	1.60	0.49
	No	30	40.0		
Health Problems (Respiratory Irritation)	Yes	41	54.7	1.55	0.50
	No	34	45.3		
Decrease In Environmental	Yes	52	69.3	1.69	0.46

Variable	Categories	Frequency	Percentage (%)	Mean	Standard Deviation
Comfort Variable	No	23	30.7		

The results of univariate analysis showed that the majority of respondents (60%) felt a pungent odor around the Lubuk Begalung rubber factory. More than half of respondents (54.7%) reported experiencing minor health problems, especially respiratory tract irritation. In addition, 69.3% of respondents reported a decrease in environmental comfort, indicating that air pollution from factory activities has a considerable impact on the quality of life in the surrounding community.

2. Relationship of Air Quality and Public Perception of Environmental Pollution Around the Factory Area

Table 2. Relationship of Air Quality and Public Perception of Environmental Pollution Around the Factory Area

Variable	Perception Of Pungent Odors	Health Disorders	Decreased Comfort
Perception Of Pungent Odors	1	0.62**	0.55**
Health Disorders	0.62**	1	0.58**
Decreased Comfort	0.55**	0.58**	1

Spearman correlation analysis revealed a significant and positive relationship between the perception of pungent odors and health problems ($rs = 0.62$; $p < 0.01$), as well as between the perception of pungent odors and a decrease in environmental comfort ($rs = 0.55$; $p < 0.01$). In addition, a significant positive correlation was observed between health problems and a decrease in environmental comfort ($rs = 0.58$; $p < 0.01$). These results indicate that stronger perceptions of odor are associated with greater health complaints and reduced environmental comfort.

3. Logistic Regression Analysis

To strengthen the analysis, binary logistic regression was performed with *health problems (yes/no)* as the dependent variable, while *perception of pungent odors* and *decrease in environmental comfort* were included as predictors.

Table 3. Logistic Regression of Factors Affecting Health Complaints

Predictor Variable	B	Exp(B) (Odds Ratio)	p-value
Perception of Pungent Odors	1.27	3.56	0.002**
Decrease in Environmental Comfort	0.89	2.43	0.015*

The regression results show that respondents who perceived pungent odors were 3.56 times more likely to report health problems compared to those who did not ($p < 0.01$). Likewise, respondents who reported decreased environmental comfort were 2.43 times more likely to experience health complaints ($p < 0.05$). This finding highlights that odor perception is the most dominant factor influencing health problems in the community around the Lubuk Begalung rubber factory.

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DISCUSSION

1. Univariate Analysis

The results of univariate analysis showed that the majority of people living around the Lubuk Begalung rubber factory experienced significant environmental disturbances. The three most dominant forms of disorders perceived by the public are pungent odors, minor health complaints, and decreased living comfort. All three are interrelated and show that the impact of air pollution from factory activities is not only technical, but also has a direct effect on the quality of daily life of the people around it.

As many as 60% of the total 75 respondents stated that they often smell a strong and pungent odor, especially when factory operating hours are high. This odor disturbance is the indicator of pollution that is most easily recognized by the public, even without air quality measuring devices. This phenomenon indicates that the air pollution that occurs is visible and immediately perceived by the sense of smell, so it is the main trigger for unrest and concern of citizens about the potential long-term effects, especially for their health and families.

Odor pollution also serves as an early sign of more complex pollution. In this context, strong odors are not only a nuisance, but also an important social and environmental signal. People use this sensory experience to assess the level of safety and comfort of their living environment. Therefore, the perception of odors cannot be ignored, because they often become a gateway for people to understand and voice deteriorating environmental conditions. The researcher considered that the High complaints about the pungent odor around the rubber factory is a reflection of the weak emission control system and the lack of transparency of the industry on the surrounding environmental conditions.

This pungent odor phenomenon is reinforced by the results of a national survey conducted by the Katadata Insight Center (2023), which shows that more than 58% of Indonesians assess the air quality in their area of residence to be in poor condition. Although not all citizens have access to air monitoring data, the perception of pollution is powerful because it is based on everyday sensory experiences, such as smell, shortness of breath, or irritation. Something similar is found in Lubuk Begalung, where residents rely on their sense of smell as the main indicator of pollution.

In addition, as many as 54.7% of respondents stated that they had mild health problems, especially irritation of the respiratory tract such as coughing, itchy throat, and shortness of breath. This complaint is in line with the results of research by Vera Surtia Bachtiar (2017) around industrial areas in West Sumatra, which noted that respiratory dust from industrial activities has a real impact on the health of residents even though it is still below the quality standard threshold value. This means that although pollutant concentrations do not always exceed technical standards, persistent exposure still has an impact on the human body, especially vulnerable groups such as children and the elderly.

This condition is exacerbated by the fact that the majority of citizens do not have adequate information or protection regarding the dangers of long-term exposure. People are not equipped with masks, personal air quality monitors, or access to real-time data from the government or factories. In other words, people are in a vulnerable condition but without the tools to measure or scientifically prove the potential danger they are experiencing.

Furthermore, as many as 69.3% of respondents also reported that their living comfort had decreased due to the presence of factories and the impact of pollution. Such complaints include disruption of daily activities, such as drying clothes, opening house windows, or playing outdoors. This decrease in comfort is subjective but has real psychological and social repercussions, since it creates insecurity and distrust of the surrounding environment.

These findings support a study by Aulia Rahmi and team (2021) on the perception of air quality in the city of Bandung, which found that residents tend to judge unhealthy air not only based on technical parameters, but also based on daily comfort and visual perceptions such as dust and fog. Thus, people's perceptions cannot be separated from the environmental conditions they experience directly, although formal measurement data are not yet available.

In the context of Lubuk Begalung, citizens ' perceptions of air pollution are in line with the physical reality on the ground. Although not yet performed ambient measurements with automatic sensors, their daily experience can be used as an initial basis for building a stronger environmental awareness. This is important considering that air quality monitoring systems such as the Continuous Emission Monitoring System (CEMS) are not yet available or open to the public in the area.

The discrepancy between scientific evidence and public perception is a classic dilemma in environmental issues, especially in regions that do not yet have a continuous air quality monitoring system. People are often direct witnesses to environmental disturbances such as strong odors, shortness of breath, or disruption of daily activities, but their complaints are difficult to accept formally because they are not supported by technical data. This situation creates an information gap that weakens the position of society in demanding environmental protection or improvement from industry and government. When people's empirical experiences are not institutionally recognized, their access to environmental justice is hampered.

On the other hand, it is precisely in this inequality that there is a very valuable potential. Public perception can serve as an early detection system that is sensitive to environmental changes, even before pollution is scientifically measurable. In the context of this study, Citizen reports of increased pungent odors and respiratory disorders during the production activities of factories can be considered as an initial signal for a possible increase in the concentration of pollutants such as PM_2 or SO_2. Therefore, an approach that combines citizens 'perceptions with technical data is not only methodologically valid, but also socially ethical because it recognizes citizens' experience as a legitimate form of environmental knowledge.

Thus, the existence of public perception data is very important in filling the technical information gap that is still limited, especially in areas such as Lubuk Begalung that do not have access to real-time Emission Monitoring Systems. Participatory approaches that involve citizens in the process of pollution identification and monitoring can strengthen a more responsive and Democratic environmental management system. Perception Data can also be used as a basis for local governments to develop social evidence-based policies, as well as encourage the industry to be more transparent in conveying environmental information to the public.

Researchers view that public perceptions of air quality not only reflect the direct impact of pollution, but also indicate information gaps and weak environmental protection. When people constantly smell strong odors, experience breathing disorders, and feel uncomfortable, then it becomes a social and health signal that cannot be ignored. Recognition of this perception is important to encourage accountability from the factory and policy intervention from local governments.

Thus, the results of this univariate are not only statistical data, but also a reflection of the real conditions in which people coexist with industrial activity. This Data needs to be followed up with technically valid air quality measurements, as well as mitigation measures from the industrial sector and more transparent regulation from the government. This study provides preliminary evidence that citizen perception can be a strong basis in building an early warning system against the risk of environmental pollution in industrial areas.

2. Bivariate Analysis

The results of bivariate analysis in this study indicate a significant relationship between public perception of pungent odors and health problems experienced by residents around the Lubuk Begalung rubber factory. With Spearman correlation value of 0.62 ($p < 0.01$), it can be concluded that there is a strong positive relationship between the two variables. That is, the more intense the pungent odor perceived by people, the more likely they are to experience minor health problems, such as coughing, shortness of breath, and irritation of the respiratory tract. This shows that air pollution is not only an environmental problem, but also has a direct impact on the health of people who are exposed to it every day.

These findings are reinforced by various reports in the field and the results of previous research. For example, the Mongabay report (2025) states that in the case of a fire at a rubber factory in Padang, residents living around the site experienced respiratory distress and eye irritation due to exposure to strong chemical odors and fumes. This confirms that the odor pollution caused by the activities of the rubber industry has a real health impact, especially for vulnerable groups such as children, the elderly, and people with respiratory disorders. In the context of Lubuk Begalung, residents ' reports of strong odors have become a major indicator of air pollution that deserves serious attention by industry and environmental authorities.

Furthermore, the results of this correlation indicate the importance of paying attention to public perception as a valid source of initial data, especially in areas that do not yet have automated air quality monitoring systems. When technical measuring instruments are not yet evenly available, citizens ' sensory experiences such as smelling pungent odors and feeling health problems become important signals of pollution. Therefore, community involvement in environmental monitoring and reporting processes needs to be strengthened. By combining scientific approaches and social experience, air pollution control policies can be structured more responsive to the real conditions facing society.

This condition is also reinforced by previous studies in the Lima Gunung refinery area, which showed that the smell of rubber waste was the main trigger for residents ' negative perceptions of air quality. In the study, citizens reported a deterioration in the quality of health after exposure to intense odors during production hours. This study shows that the perception of odors is not only an indicator of the environment, but also a reflection of direct exposure to industrial emissions.

In addition to health, the analysis also showed a significant relationship between the perception of odors and a decrease in environmental comfort. With a correlation value of 0.55 ($p < 0.01$), this result shows that the sharper the perceived odor, the more disturbed the comfort of the community in carrying out daily activities. The Mongabay report (2025) in Cikarang mentions a similar thing, where people around the steel industrial area complained of a strong odor that caused them to be reluctant to open their windows or move outdoors.

This relationship between the perception of smell and comfort suggests that air pollution affects the psychological and social dimensions of society. Not only does it cause physical discomfort, odors also cause environmental stress, sleep disorders, to a general decrease in quality of life. This reinforces the urgency of handling pollution not only from the technical side, but also through a socio-ecological approach that understands the impact of pollution from the perspective of society.

The correlation between health complaints and decreased environmental comfort also showed significant results, with a correlation value of 0.58 ($p < 0.01$). This illustrates that people who experience health problems tend to also feel their living environment is not comfortable. Thus, the physical and psycho-social impacts of pollution are interrelated and reinforce each other, as indicated

in the Energy and Clean Air Initiative report (2024) which states that the health burden due to air pollution in West Sumatra has impacted people's perceptions and behaviors towards their living spaces.

Although automatic air monitoring systems such as Continuous Emission Monitoring System (CEMS) are not yet available at this location, public perception data still has strategic value as an early detection tool for pollution. As explained by Yuwono (2008), odor pollution in industry should not only be laboratory tested, but also evaluated based on public perception because humans are the first natural sensors of changes in air quality.

Researchers consider that the combination of perception data and statistical correlation tests can be a strong basis in encouraging monitoring and intervention against air pollution. When formal data was not yet widely available, people's perceptions were the only initial reference for understanding the severity of environmental problems. Therefore, this bivariate analysis proves the importance of strengthening the participatory approach in environmental monitoring and control.

The findings also have important policy implications. Local governments can use data like this as a starting point to establish priority air monitoring zones, develop community-based pollution reporting procedures, and require factories to conduct transparent reporting on their emissions activities. The West Sumatra Regional long-term development plan (RPJPD) 2025-2045, which is currently in the process of being drafted, encourages community involvement in environmental stewardship, and this research data can support this policy direction.

Researchers also recommend the importance of environmental data disclosure and public education so that citizens can better understand the risks of air pollution. This awareness not only strengthens people's capacity to protect themselves, but also builds positive social pressure on the industry to operate more responsibly. Data showing the correlation between odor perception, health and comfort make it clear that air pollution not only has a physical impact, but also undermines the right to a healthy and decent living environment.

Thus, this bivariate discussion shows that air pollution due to rubber industry activities has a multidimensional impact on the surrounding community. The strong correlation between odor perception, health problems, and environmental comfort reflects the existence of environmental conditions that need immediate action. This study confirms that in the context of limited technical data, The Voice of the community remains a valid and important source of information in the formulation of environmental policies based on ecological justice.

Finally, the researchers concluded that the bivariate results of this study showed a real link between odor pollution, health, and people's comfort. Therefore, it is necessary to carry out advanced technical air measurements and the formulation of environmental policies based on socio-technical data, so that the intervention becomes more targeted and responsive to the conditions of the people in the first layer affected.

3. Multivariate Analysis

The results of the logistic regression analysis confirmed that the perception of pungent odors was the most dominant factor influencing health complaints among residents around the Lubuk Begalung rubber factory. Respondents who reported odor disturbances were 3.56 times more likely to experience respiratory problems compared to those who did not perceive pungent odors. Meanwhile, decreased environmental comfort also significantly increased the likelihood of health complaints, with an odds ratio of 2.43.

This finding indicates that odor perception is not merely a nuisance, but also a strong predictor of health outcomes. Odor pollution can therefore be considered a proxy indicator for exposure to

harmful emissions, such as volatile organic compounds (VOCs) and sulfur-based gases, which are commonly released in rubber processing activities. The fact that odors explain health complaints better than comfort perceptions suggests that the community's sensory experience has epidemiological value and should be taken seriously in environmental health assessments.

In line with studies in other industrial areas (e.g., Setiono et al., 2019; Rahmi et al., 2021), this research highlights that subjective indicators such as odor perception can reliably signal objective health risks. The multivariate findings also strengthen the argument that environmental policies should integrate both technical measurements and community-based data. By acknowledging the dominant role of odor perception, local authorities and industries can prioritize emission control technologies that specifically target odor-producing compounds, while also improving transparency in environmental reporting.

Thus, the multivariate results enrich the overall analysis by demonstrating not only that pollution affects health and comfort, but also identifying which factor has the strongest influence. This evidence-based approach provides a clearer foundation for designing more targeted interventions, such as stricter odor emission standards, community monitoring programs, and health protection measures for vulnerable populations.

CONCLUSION

Based on the results of univariate analysis, it can be concluded that the majority of communities around the Lubuk Begalung rubber factory experienced significant environmental disturbances. Strong smell became the main complaint Felt by 60% of respondents, followed by complaints of minor health problems such as coughing and shortness of breath, as well as a decrease in environmental comfort. These data reflect that communities are directly impacted by industrial activity through sensory changes in air quality. This condition also indicates that public perception is an important source of information in assessing environmental impacts, especially in areas that have not been equipped with air quality monitoring tools.

The results of the bivariate analysis reinforce these findings by showing a significant relationship between the perception of strong odors and two other important aspects, namely environmental health and comfort disorders. The positive correlation between the three variables indicates that strong smell is not only a sensory complaint, but also has an impact on people's physical and psychological conditions. Health problems that increase along with the intensity of odors indicate a link between air pollution and citizen health. Meanwhile, the decline in environmental comfort also shows that the impact of pollution extends to social aspects and the quality of people's daily lives.

Thus, both univariate and bivariate analyzes indicate that public perceptions of air pollution due to rubber plant activities have strong scientific validity and high practical relevance. These overall results emphasize the importance of a participatory approach to environmental management, in which the voice of the community is not only complementary, but rather an initial data source that can trigger further surveillance and policy interventions. Therefore, citizen involvement, strengthening public reporting systems, and implementing open air quality monitoring are strategic steps in protecting the community from the risk of air pollution in industrial areas.

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