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Healthcare Professionals' Perception of the Link Between Climate Variability and Respiratory Diseases in Northern and Southern Togo: A Case Study of Asthma in Savanah Region and Grand-Lome

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Abstract The impact of climate change and air pollution on respiratory diseases has garnered significant attention over the past decades. Despite this heightened interest, it remains the case that key stakeholders in the healthcare domain still lack comprehensive understanding of the potential existential links between climate, pollution, and health. This article aims to elucidate the level of comprehension regarding the relationship between climatic variables and atmospheric pollutants on the severity of asthma crises in Togo. Within the framework of this study, a survey was conducted in healthcare centers in the Savanah and Grand-Lomé regions, involving 338 healthcare professionals, comprising 65.4% males and 34.6% females, with surveyed profiles predominantly distributed as follows: 23% physicians, 49.6% nurses, and 27.4% medical assistants from various medical departments including pulmonology, pediatrics, and internal medicine services. The findings revealed that approximately 39.2% of participants had undergone training in climate change, indicating a growing awareness of the significance of this subject. However, the majority (46.6%) considered themselves to be beginners in the field of climate change. Regarding air pollution, 83.4% of participants exhibited some level of knowledge, indicating encouraging awareness. Most participants believed that climate contributes to asthma crises (75%) and acknowledged that air quality influences lung function (100%). Periods conducive to asthma crises included the harmattan season (56.7%), dry season (41.8%), with triggering factors including dust (100%) and smoke (59.1%). The integration of climate counseling in asthma treatment was reported by 90.3% of participants, highlighting significant awareness among healthcare professionals. However, the study revealed that the majority (82.8%) were unaware of the existence of national asthma surveillance and management documents. Furthermore, 95% of those aware of such documents were uncertain whether these documents consider climatic and environmental aspects. In conclusion, the study underscores the necessity for climate-proofing national strategic health documents, increased awareness, ongoing training, and integration of modules on the climate-health nexus into medical curricula

Keywords: *Climate variability, respiratory diseases, perception, asthma, healthcare professionals, Togo*

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1. Introduction

The climate change and atmospheric pollution constitute one of the paramount threats to global health in our era, with their impacts on human health and well-being being considerable and worsening (https://www.cdc.gov/climateandhealth/). They affect ecosystems, resulting in direct and indirect impacts on patients suffering from allergic and respiratory diseases [1]. According to [2], the impact of climate change on health is considered the most significant global public health issue and the threat to humanity of this century. Its magnitude and severity on health vary depending on the locations, primarily due to the state of preparedness, vulnerability levels, and adaptability of populations. [3,4] further argue that, besides the current warming and evolving climate-related hazards, existing societal challenges such as social inequalities, progressive urbanization, aging populations, will exacerbate the health burden attributed to climate change. For instance, climate

change disproportionately affects and will continue to affect vulnerable and already marginalized populations, including impoverished and undernourished communities.

Moreover, climate change escalates levels of atmospheric pollution, a significant environmental factor responsible for approximately 11.8% of all global deaths, equating to 6.7 million premature deaths annually [5]. Indeed, global climate change is largely attributable to anthropogenic activities that generate pollution from atmospheric particles, tropospheric ozone, and vehicular emissions [5].

This air pollution is convincingly associated with many signs of exacerbation of asthma (increased bronchial hyper-reactivity, emergency department visits, hospitalizations, increased medication consumption, etc.) [6]. Furthermore, several atmospheric pollutants such as carbon dioxide (CO2) and ozone (O3) are among the greenhouse gases involved in climate warming [7]. There exists a close link between atmospheric pollution and climate change [8]. According to [4], a 10 µg/m3 increase in O3 would result in a 0.55% increase in mortality associated with respiratory diseases in China. [9] highlight that levels of atmospheric pollution can be amplified by heatwaves, storms, and forest fires induced by climate change, thereby increasing the risk of complications and hospitalizations due to respiratory diseases.

ealth professionals, being the primary custodians of population health, find themselves somewhat powerless in the face of this public health emergency, which often hinders patient treatments. Understanding and addressing these issues are therefore a major challenge that healthcare professionals must necessarily address. Thus, this article proposes to study their perceptions of the existential links between climate change and the growing presence of respiratory diseases (especially asthma) and allergies in Togo. The main objective is to provide information on concrete measures to mitigate these impacts and promote sustainable respiratory health for asthmatics.

2. Methodology

2.1. Study Area

The "Grand-Lome" region and the Savanah region were the geographical focus of this study. The Grand-Lome region is situated in the extreme southwest of the country, along the Gulf of Guinea coastline, and encompasses the capital city (Figure 1a). With an estimated population of 2,188,376 inhabitants in 2022 [10], Grand-Lome experiences a Guinean climate and has two rainy seasons. The primary rainy season spans from April to July, followed by a less significant second season starting in September and ending in late November. The average maximum temperature under shelter is 30°C in the afternoon, and the average minimum temperature is 23°C in the morning. From December to February or March, the Harmattan, a dry wind from the Sahara, occasionally blows, lowering the morning temperature to 19°C. The region receives approximately 900 mm of rainfall annually.

The Savanah Region (Figure 1b), located between 0°10 and 1°00 East longitude and 9°55 and 11°05 North latitude, with an estimated population of 1,143,520 inhabitants in 2022 [10], is the northernmost region of Togo and covers an area of 8,533 km², accounting for 15% of the national territory. It experiences a Sudanian climate characterized by a rainy season from June to September and a dry season from October to May. The average annual rainfall is approximately 1050.0 mm, and the annual average maximum temperature is around 34°C. The annual average minimum temperature hovers around 23°C. The average relative humidity ranges from 50 to 70%. The average wind speed is about 2 m/s, and the average daily duration of sunshine is approximately 7 hours.

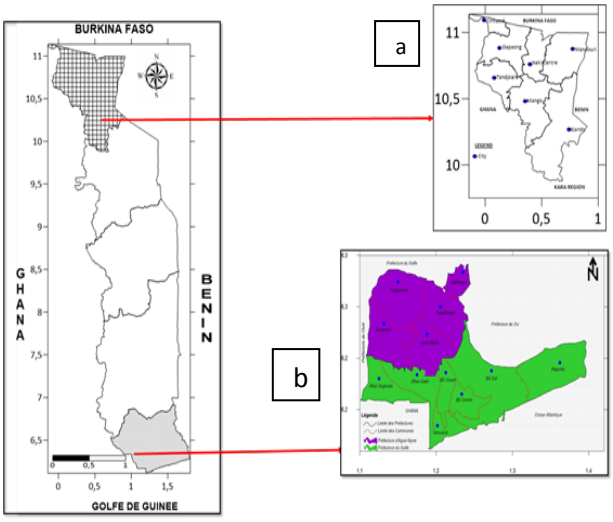

Figure 1. Study area

2.2. Studied Population

The target population of this study consists of healthcare professionals treating asthma patients in healthcare centers within both the Savanah region and Grand-Lomé. Determining the sample size followed statistical principles to ensure that the collected data were reliable and reflective of the broader community. Survey participants include all doctors, medical assistants, and nurses working in the pulmonology, pediatrics, ainternal medicine departments of hospitals equipped to treat asthma patients. This selection helped minimize biases and improve result generalization.

2.3. Estimation of Sample Size

To determine the number of individuals to survey, we used the following SCHWARTZ formula (Equation 1):

$$n = \frac{Z^2 * p(1-p) * N}{Z^2 * p(1-p) + (N-1)e^2}$$

Where:

- n is the minimum sample size to survey for obtaining significant results;
- z is the confidence level, i.e., the 95th percentile of the normal distribution (z=1.96);
- N: size of the target population (N=1141)
- p = Initial level of proportion for a population characteristic (p =0.5);
- e = the margin of error, typically set at 5%.

Thus, by substituting the values into the formula, we find n=287.58, which rounds up to 288 individuals to survey. Due to non-responses, we increase this number to a total of 350 individuals.

2.4. Ethical Considerations

Increasingly, surveys raise a number of ethical issues. These issues relate to individuals' right to privacy, the necessity of obtaining informed consent, and the responsibilities involved in disclosing potential health problems during a survey. It was therefore important to consider these principles from the outset of the survey.

Thus, confidentiality was maintained throughout the survey. Recordings were securely stored and did not contain any names. Respondents were informed of the interview contents and the measures taken. They understood the procedures and gave their full approval. Informed consent was sought from each respondent, and interviews were conducted in private. To obtain respondents' consent, a consent form was read and explained to them before we started.

2.5. Statistical Analysis

In this study, the online tool Google Forms via tablets was used for data collection. Data collected in the field were exported to Excel software for cleaning and processing. Data cleaning is the first fundamental step in the data preparation process. It involved identifying errors, missing values, outliers, syntax errors, irregularities, etc., in a dataset and correcting them to ensure that only high-quality and clean data are used for analysis.

3. Results

3.1. Profile of Participants and Their Level of Knowledge on Climate Change and Air Pollution

This section summarizes the socio-professional characteristics of the surveyed healthcare workers as well as their level of knowledge on climate change and air pollution (Table 1).

Taking into account the participants' profile, the survey reached more nurses (49.6%) than doctors (23%), with medical assistants and other healthcare professionals representing 27.4%. The study population exhibits a clear male predominance with 170 men, accounting for 53%, and 151 women, accounting for 47%. Moreover, participants primarily come from the departments of pediatrics (22.6%), internal medicine (37.8%), pulmonology (24.9%), and maternity (14.7%).

Regarding participants' involvement in climate change training, the results revealed that 39.2% of them had undergone at least one training, while 60.8% had not had this opportunity. Thus, the relatively high percentage of beneficiaries of climate change training may indicate a growing awareness of the importance of this issue in the current context and their manifest willingness to deepen their understanding of the challenges related to climate change. This may also demonstrate their commitment to environmental protection and combating the adverse effects of climate change in general, and specifically on health. However, the knowledge acquired by this relatively high proportion of 39.2% is generally obtained through readings, personal research, or informal discussions.

Participants then assessed their level of knowledge on climate change and air pollution. Regarding climate change, the results indicate that the majority of respondents (46.6%) are beginners in this field, while 30.4% consider themselves to have an average knowledge. Only 7.7% claimed to have an advanced level of knowledge, while 15.3% have no knowledge in this field. These results are encouraging as they indicate that a large majority of respondents have at least some understanding of this crucial issue. However, efforts deserve to be made towards a better understanding of this complex issue. Conversely, regarding their knowledge levels on air pollution, the results show that the majority of participants (83.4%) have some knowledge of air pollution, while 16.6% responded negatively. Awareness of this environmental problem is encouraging, as air pollution is a major concern associated with many respiratory infections, including asthma. Knowledge of air pollution is essential for understanding its causes, its health effects, and the measures to be taken to reduce it. By being aware of the sources of air pollution and the harmful substances it contains, healthcare workers will be better prepared to take preventive and mitigative measures in caring for their patients.

Table 1. Profile of Participants and Their Level of Knowledge on Climate Change and Air Pollution

Profile of respondents				Total
Distribution by sex				
Male		Female		321
53%		47%		100%
Distribution by function				
Fonction	Nurses	Medical assistant	Doctors	321
Proportion	49.6%	27.4%	23%	100%
Medical department of surveyed				
Paediatrics				22,6%
Internal Medecine				37,8%
Pneumology				24,9%
Maternity				14.7%
Training on climate change and Health				
Beneficiaries				39,2%
Non-beneficiaries				60,8%
level of knowledge about climate change and health				
None				15,3%
Beginner				46,6%
Intermediate				30,4%
Advanced				7,7%

3.2. Link between Climate Change and Asthma

Health professionals were also questioned about their perception of the influence of climate change on asthma attacks (Table 2). In this regard, the majority of them (75%) asserted that climate change contributes to triggering asthma attacks, while 13.3% responded negatively, and 11.7% indicated they did not know.

Regarding the impact of air quality on asthma attacks, participants unanimously (100%) agreed that prolonged

exposure to poor air quality can also have adverse effects on lung function. This unanimity underscores the importance of taking measures to preserve air quality and reduce pollution levels. It is therefore important to intensify awareness campaigns about the relationship between climate change, air pollution, and asthma, as well as the need to take measures to reduce these risks and improve the respiratory health of asthmatic individuals.

Table 2. Influence of climate change and air quality on asthma attacks"

Does climate change contribute to the onset of asthma attacks?		
Yes	No	Don't know
88,2%	3,8%	8%
Does air quality contribute to the onset of Asthma attacks?		
Yes	No	Don't know
100%	0%	0%

3.3. Favourable Periods for Asthma Exacerbations throughout the Year with Highest Hospitalisation Cases

Asthma is a chronic inflammatory disease of the bronchi characterized by fluctuating episodes of symptom-free periods and exacerbations. Thus, the following Table 3 highlights the periods of the year when a significant increase in asthma cases is observed in consultations, providing an insight into the impact of climate change on this respiratory condition. Consequently, the harmattan period was identified by 56.7% of healthcare professionals as a time when they receive more asthma cases in consultations and hospital admissions. This increase is often associated with plant flowering and increased pollen exposure, a common trigger for allergic asthma attacks. 41.8% and 42.8% of participants respectively reported an increase in asthma cases during the dry season and hot periods. Moreover, harmattan carries dust triggering allergic reactions in asthmatics. The increased presence of air pollutants (such as fine particles during the dry season) can also worsen asthma symptoms. Similarly, respiratory infections, more prevalent during the dry season, can trigger asthma exacerbations in asthmatic individuals. However, albeit in a smaller proportion, 22.3% of respondents claim to have received more asthma cases during the rainy season, 23.2% during cooler periods, and 14.9% during high humidity periods.

Regarding asthma triggers, several have been identified. Participants unanimously (100%) agree that dust is an asthma trigger. Other identified factors include smoke (59.1%), bushfires (43.7%), exhaust fumes (48.3%), cool temperatures (32.3%), humidity and strong winds (28.6%), and heat (45.5%).

Table 3. Favourable Periods for Asthma Exacerbations and Trigger Factors

Period within the year with most asthma hospitalisations							
Rainy season	Dry season	Harmattan	Heat period	Cold Period		High humidity	
22,3%	41,8%	56,7%	41,8%	23,2%		14,9%	
Asthma triggering factors							
Heat	Bush fire	cold	Fume	exhaust Gas	. Humidity	Low wind speed	Dust
45,5%	43,7%	32,3%	59,1%	48,3%	28,6%	39,7%	100%

3.4. Prevalence of Asthma Over the Past 5 Years

Regarding the evolution of asthma prevalence, the majority of respondents (38.2%) perceive an increase over the past 5 years, while 8.8% indicated a decrease in prevalence. Furthermore, 26.5% noted stability, and 26.5% also admitted not knowing how the trend had evolved. These latter responses reveal some variability in the perception of asthma prevalence evolution within the surveyed group. Although some have observed a decrease or stability, a significant portion of participants (38.2%) have noticed a notable increase in asthma prevalence in recent years, sounding the alarm bells.

As for the potential link between the increase in asthma prevalence and climate change, the majority of participants (84.6%) acknowledge a possible correlation between the rise in asthma prevalence and climate change, while 15.4% admitted not knowing. These results reflect a significant awareness of the potential relationship between climate change and increased asthma prevalence. Such perception underscores a growing concern regarding the impact of climate change on respiratory health, particularly concerning asthma.

Table 4. Asthma prevalence and potential link with climate change

Changes in asthma prevalence over the last 5 years			
Decrease	Constant	Increase	Don't know
8,8%	26,5%	38,2%	26,5%
Link between the increase in asthma prevalence and climate change			
Yes	No	Don't know	
84,6%	0%	15,4%	

3.5. Integration of Climate Counseling in Asthma Treatments

Regarding the integration of climate counseling in their treatment approach for asthma patients, 9 out of 10 participants (90.3%) responded positively, indicating that they effectively utilize this approach, while 9.7% do not integrate it into their practices. These results demonstrate a significant awareness and adoption of climate counseling among the surveyed healthcare professionals. The utilization of this approach reflects the recognition of the importance of climate change and its impact on respiratory health, particularly in the case of asthma.

Participants who have integrated climate counseling into asthma treatment have conveyed various messages to patients regarding the relationship between climate,

pollution, and asthma. These messages aim to inform and raise awareness among patients about preventive measures and adaptation strategies to mitigate the effects of climate change on their respiratory health.

Healthcare professionals emphasize the importance of creating a conducive indoor environment by advising patients to ventilate their rooms well and to identify and avoid allergens in their surroundings. They also recommend avoiding places exposed to dust, strong winds, and humidity. During rainy periods, limiting outdoor activities and always keeping asthma inhalers handy is recommended. Additionally, the significance of dressing appropriately in cold weather is highlighted. Patients are encouraged to avoid places with generally polluted air, as well as strong perfumes and odors. They are advised to identify their specific allergens and be mindful of dust in their environment. Avoiding crowded places and gatherings is also recommended. Guidance on the use of fans and air conditioning is provided to optimize respiratory comfort.

The importance of thorough room dusting is emphasized while educating patients about the nature of their condition. Healthcare professionals remind that air pollution and cold weather are factors that can trigger an asthma attack. Patients are encouraged to protect themselves against both internal and external environmental factors that promote asthma attacks by adopting appropriate preventive measures. It is recommended to take extra precautions during periods conducive to attacks.

In summary, the messages conveyed to patients regarding the link between climate, pollution, and asthma aim to inform them about triggers, peak crisis periods, and protective measures to adopt. This educational approach contributes to strengthening asthma management by considering climate and environmental aspects, thereby enabling patients to better manage their condition and reduce the risks associated with climate change on their respiratory health.

3.6. Existence of National Asthma Surveillance and Management Documents

The results indicate that the majority of participants (82.8%) are not aware of the existence of national asthma surveillance and management documents, and 10.3% affirm the non-existence of such national documents (Table 5). This suggests a lack of information or awareness regarding the existence and accessibility of these documents at the national level. It is noteworthy that 6.9% of participants asserted the existence of national asthma management documents, namely the National Plan for Acute Respiratory Diseases and the National Operational Plan for Asthma Management.

Table 5. Existence of National Asthma Surveillance and Management Documents, and Inclusion of Climate and Environmental Aspects

Existence of national Asthma surveillance and management documents		
Yes	No	Don’t know
10,3%	6,9%	82,8%
Integration of climate and environmental aspects into national Asthma management documents		
Yes	No	Don’t know
1.2%	5.7%	95.4%

Furthermore, almost all respondents (95%) do not know if these documents take into account climate and environmental aspects, while the remaining 5% confirm the non-inclusion of climate and environmental aspects.

4. Discussion

This investigation highlights a statistical association between climate change, air pollution, and the risk of exacerbating respiratory diseases, notably asthma. The survey results potentially indicate links between meteorological events such as heatwaves, dust storms, high humidity, and air pollution on respiratory health.

[12,13] find that events and exposures related to climate change can impair lung function, increase allergic responses, and trigger the onset of asthma or lung cancer in the general population. Elevated temperatures pose increased risks of hospitalizations and mortality for respiratory illnesses. In other words, when populations are exposed to high temperatures or extreme heat, it can trigger respiratory symptoms requiring additional use of rescue medications, visits to general practitioners or emergency departments, hospitalization, or even intensive care with respiratory support (Iñiguez et al., 2021; Schinasi et al., 2022). Zuo et al. (2021) also estimate that rising temperatures combined with increased humidity constitute an additional burden, especially for asthmatic and allergic patients. The authors also find that breathing warm and humid air feels "heavy" and more difficult to breathe, leading to increased respiratory rate and ventilation frequency in healthy subjects. This also causes irritation of the airways and coughing in patients with allergic rhinitis [15] and bronchoconstriction and coughing in asthmatic patients [16].

Respondents also revealed that air pollution (both indoor and outdoor) is a major environmental concern and that exposure to polluted air can harm the health of asthmatic individuals. According to the European Environment Agency, air pollution is the most significant environmental risk factor, responsible for 6.7 million deaths worldwide in 2019 and 373,000 in Europe. There is an intrinsic link between air pollution and climate change [17]. Indeed, greenhouse gases and atmospheric pollutants share the same primary sources: the combustion of fossil fuels and biomass (burning wood and coal for energy production and heating and cooking, etc.), methane and greenhouse gases, as well as ammonia emitted by animal production, form particles and can be harmful to patients with respiratory diseases.

Furthermore, meteorological conditions can worsen air quality, already poor, by modifying its dispersion capacity, composition, and toxicity. According to [3], higher temperatures and prolonged sun exposure increase the formation of tropospheric ozone, a potent pulmonary irritant that can trigger asthma and mortality due to respiratory diseases. According to [18], the majority of the world's population lives in areas with high air pollution. This exposure to high levels of air pollution can have adverse effects on health. According to [6], fine particulate air pollutants, less than 2.5 microns, are capable of depositing in the lower respiratory tract and damaging structures such as lung alveoli. The authors

further indicate that ozone is a dangerous pollutant that damages the tissues of the airways and lungs. [19] indicate that over the next 30 to 50 years, climate change is expected to have a significant impact on respiratory health, with potential consequences such as a 15% increase in respiratory deaths due to ozone by 2100. Thus [9], in evaluating the effect of air pollution on respiratory diseases in the Casablanca region of Morocco, found that road traffic (increased O3) and urban industry (increased SO2 and MP10) are the main causes of respiratory diseases in the region. According to [20], atmospheric pollutants such as particles (PM2.5, PM10), nitrogen dioxide (NO2), nitric oxide (NO), nitrogen oxides (NOx), sulfur dioxide (SO2), ozone (O3), ammonia (NH3), and carbon dioxide (CO) can have adverse effects on respiratory health. [2] show that the significant reduction in anthropogenic activities during the COVID-19-related lockdown led to improved air quality, as indicated by lower levels of these key pollutants. This suggests that reducing anthropogenic activities, especially those related to transportation, could potentially improve air quality and, consequently, public health.

In their study on the effect of climate change on respiratory diseases, [21] find that atmospheric pollutants can lead to decreased lung development in individuals under 18 years of age and increase the risk of respiratory diseases in the future. The authors also show that global temperature rise leads to an increase in allergens and their potency, thus resulting in more exacerbations in individuals with extrinsic/allergic asthma. They finally demonstrated that thunderstorms generate a higher number of airborne allergens, especially in the early part of the storm. [22], in their epidemiological studies, indicate that climate change and indoor air pollution affect respiratory health, particularly by increasing the prevalence of allergic diseases and asthma. [16] find that in the world's most populous regions, the burden of outdoor and indoor pollutants as well as domestic pollutants is enormous, increasing the risk factors for allergic diseases. This is strongly linked to urbanization and a range of environmental factors. Moreover, geographical differences in exposure to air pollution and the effects of climate change play an important role in the risk of respiratory diseases. According to [23], several factors contribute to these differences, including regional climate variations, land use patterns, and local policies. Indeed, urban areas generally record higher levels of air pollution due to transportation, industries, and urbanization [17].

In a retrospective study conducted from 2011 to 2012 in China, [18] showed that early childhood allergic symptoms were mainly associated with indoor environmental exposures, and allergic diseases diagnosed by a physician later in life were linked to both ambient air pollution and indoor environmental exposures. According to [8], climatic and meteorological conditions will continue to change and could have devastating effects on our planet. According to the authors, this is the greatest global health threat of the 21st century.

5. Perspectives to Consider

Given the results of this study, several perspectives need to be considered. Thus, healthcare personnel should take into account the seasonality of asthma in healthcare service planning to provide tailored care and implement preventive measures for better asthma management according to the seasons.

Another important point to raise concerns the availability of national asthma surveillance and management documents, which are essential for ensuring effective management of this respiratory disease. These documents could provide guidelines, protocols, and specific recommendations for healthcare professionals to improve the surveillance, diagnosis, treatment, and management of asthma in a national and climatic context. It is therefore essential to implement initiatives aimed at informing and raising awareness among healthcare professionals about the existence and use of these national asthma surveillance and management documents. This could be done through continuing education programs and promoting easy access to these resources via online platforms or printed materials.

Additionally, it would be recommended, in addition to raising awareness among healthcare professionals about such documents, to proceed with the climate-proofing of the documents. Climate-proofing asthma management documents is crucial to address the impacts of climate change on this respiratory disease. This will help to adapt management strategies to minimize negative effects on asthmatic patients in a climate change context.

In light of the above, several recommendations can be made to improve asthma management and further integrate considerations related to climate change: (i) use social media platforms to raise awareness among the population about behaviors that may influence climate change; (ii) regularly organize information sessions on climate change for healthcare professionals, asthmatic patients, and the general population to better understand the links between climate change, air pollution, and asthma, as well as preventive measures to take; (iii) implement specific support projects (and create centers) for people with asthma.

6. Conclusion

The approach to climate change must be integrated and anticipatory to protect and treat patients with asthma and other climate-sensitive allergic diseases against triggers that are likely to cause this phenomenon. At the end of this analysis of the link between climate change and respiratory diseases (notably asthma) in Togo, the results show that climate change (increasing temperatures, episodes of air pollution, and extreme weather events) has adverse effects on health, particularly on the respiratory system, and can exacerbate asthma symptoms and provoke crises.

In summary, the results of this study reveal that a thorough analysis of possible interventions to mitigate the adverse effects of climate change on respiratory health is necessary. This could include evaluating innovative technologies, effective environmental policies, and adapted public health practices, focusing on practical and achievable solutions. Finally, particular attention must also be paid to public and healthcare professional education. It is crucial to raise further awareness about the links between climate

change and respiratory diseases while promoting sustainable behaviors and healthcare practices adapted to environmental challenges. This awareness can contribute to better adherence to prevention recommendations and the promotion of informed decision-making.

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