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Investigation of the Relationship between Environmental Conditions and Public Health in Developing Countries from a Psychological Perspective

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The surrounding landscapes and environmental conditions significantly influence humans psychologically, physically, and in quality of life. By examining both environmental conditions and overall human health, it is possible to enhance health support and implement more effective policies. Landscape affects human beings significantly in various aspects, including political, aesthetic, health, and well-being. Although the previous studies focus on developed countries,

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fewer studies have been conducted in third-world countries. This paper aims to investigate the impact of everyday environmental conditions on health in third-world countries, specifically through the lens of environmental psychology. Data were collected through field research in Guatemala. Generally, suburban and rural areas with suitable environmental conditions have a positive health effect compared to urban areas with poor environmental conditions. Our results suggested that these effects include mental health improvements, physical illness recovery, and overall well-being. Our study advocates for stronger governmental support and increased public awareness regarding the influence of environmental conditions on overall health to reduce emissions and improve both environmental quality and health outcomes.

Keywords: Carbon monoxide perturbation; environmental conditions; psychological relation; urbanization.

1. INTRODUCTION

Urbanization, a pressing global issue, refers to the mass movement of populations from rural to urban settings and the consequent physical changes to urban settings [1,2]. In 2019, the United Nations estimated that more than half the world's population, 4.2 billion people, now lives in urban areas, and by 2041, this figure will increase to 6 billion people [3]. This rapid urbanization poses significant challenges to public health, particularly in developing countries.

As cities continue to grow, they play multifaceted roles in all societies. They are the heart of technological development and economic growth of many nations, but they also serve as a breeding ground for poverty, inequality, environmental hazards, and infectious diseases. However, with the right interventions, these issues can be addressed. The urgency of this issue is underscored by the fact that many rural migrants who settle in urban slum areas bring their families and domesticated animals— pets and livestock—with them. This influx of humans and animals leads to the vulnerability of all migrants to circulating infectious diseases and the potential to establish an urban transmission cycle [4-6].

Further, most urban poor live in unregulated slums, have congested conditions, are overcrowded, are positioned near open sewers, and are restricted to geographically dangerous areas such as hillsides, riverbanks, and water basins subject to landslides, flooding, or industrial hazards [7]. These factors spread communicable and non-communicable diseases, pollution, poor nutrition, road traffic, and so on [8,9,10]—the problems the poor face spill over to other city dwellers. As the trend of urbanization continues, this spillover effect increases and takes on a global dimension as more and more of the world's populations are affected [11].

Urbanization has led to rapid city growth, an increasing number of people, and various challenges. Since the 18th century, significant technological developments globally have contributed to limited access to nature and changes in environmental conditions [12]. Environmental factors, such as lighting, access to nature, noise, and indoor and outdoor quality, profoundly influence people's behavior, health, and well-being [13]. Extending this relationship, numerous studies have demonstrated that better environmental conditions, particularly those providing access to nature, increase physical activity levels and reduce stress and anxiety, thereby enhancing cognitive function [14]. As a result, the critical relationship between the environment and health has been recognized, becoming a significant research topic today. The relationship between human health and the environment is complex, dynamic, and multifaceted [15,16]. Although the environment supports human health, substances or environmental conditions can also increase the risk of disease, disability, and death. According to the World Health Organization, ‘Health’ is defined as “a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.” [17] This comprehensive definition emphasizes the importance of investigating the impact of environmental exposure on both individual and social, physical, and mental health. While third-world countries getting limited access to nature due to urbanization, literature on health effects related to environmental exposure has focused extensively on overcoming negative influences [18], such as hazardous chemicals, natural disturbances, and dangerous geographical regions, not on increasing access to nature to

enhance the physical, mental, and social well-being of people.

Global change is harmful for everyone, and CO levels are the main issue [19]. In addition, waste and the way we trash have a main effect on human health [20]. We must take good care of our urbanity and understand the reality as in Guatemala [21].

Therefore, our study was designed to examine the effect of contaminated air on health and human behavior. This paper might identify the environmental factors affecting human health and well-being and enhance the understanding of environmental psychology knowledge in a third-world country, Guatemala, by evaluating its practical environmental condition and individual health status.

2. STUDY METHODOLOGY

To evaluate environmental conditions across various locations in Guatemala, the research team utilized an EZ Log USB that was Lascar Electronics EL-USB-CO300 Carbon Monoxide Data Logger, 0 to 300 ppm, 32,000+ Readings were used. This device was inserted into any of these compact, 4.5" (11.4 cm) L loggers into your computer USB port to name it, choose the user's required sampling rate, select high and low alarms if needed, and set the logger start time. Once configured, the logger could be removed from the computer to log independently. Data is downloaded back onto the PC, where it can be analyzed and viewed as a graph using the manufacturer's software. Model 23039-58 was used for a 0 to 1000 ppm range, and model 23039-68 for a 0 to 300 ppm measurement range; both stored more than 32,000 readings. A bright red LED was flashed, and an audible alarm sounded when the user-determined level was exceeded. This device was employed to measure Carbon Monoxide (CO) levels while the research team was in transit and during other forms of mobility. Data was systematically collected every 30 seconds from 8:00 AM to 10:00 PM over five days. The recorded factors included location, the number of people present, the quantity of vehicles, the presence of trees, building ventilation, and the average carbon monoxide levels.

To compare the environmental parameters, questionnaires were created and administered to assess the Guatemalan population's practical awareness of mental and general well-being. This questionnaire contained five questions to measure essential knowledge and understanding of psychological issues. Thirty participants, drawn from various villages and locations throughout Guatemala, completed the survey. Surveying the volunteer site enabled a concurrent evaluation of both environmental conditions and the participants' mental well-being.

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Furthermore, a literature review was performed to investigate the impact of environmental conditions on human behavior and health. Key search terms included "environmental psychology,' 'third-world countries,' and 'psychological effects.' This review incorporated studies from various regions within the country to provide a comprehensive understanding and analysis of the environmental condition in third-world countries. This comprehensive approach facilitates a detailed examination of the interdisciplinary between ecological psychology and human health.

3. RESULTS

3.1 The environmental Condition of Guatemala

The graph illustrates the concentration of carbon monoxide (CO) over the first and second days of the study, with the y-axis indicating CO levels in parts per million (ppm), a unit of CO level [22], and the x-axis representing the measurement times. Due to the data collection being started in the late afternoon of the first day, the day 2 data collection continued from the day before. Notably, the CO levels showed a significant spike around 9:44 AM on the second day, reaching a peak of 21 ppm. This data was collected from a rural area in Chimaltenango, Guatemala, specifically from a waste landfill where urban waste is incinerated.

3.2 Miserable View of Garbage Piles

The impact of urbanization has led to the generation of substantial quantities of waste, which are transported to the rural landfill for burning. Despite the rural setting, which is supposed to have better environmental conditions, the area is plagued by poor air quality, making it difficult to find clear skies and breathe. People in this region suffer from various symptoms attributed to the elevated CO levels, including frequent headaches, stomach upsets, and chest pain along with confusion. The

environmental conditions in this rural area are far from good for enhancing physical and mental well-being, highlighting a stark contrast to the typically healthier natural environments expected in rural locales.

3.3 CO Level Fluctuation on Day 3

On the third day of the study, the most significant increase in carbon monoxide (CO) levels was observed at 5:33 PM, with a recorded concentration of 17.5 parts per million (ppm). This measurement coincided with the research team's presence in a restaurant close to an active volcano. It is well-documented that active volcanic activity can significantly elevate atmospheric carbon monoxide levels. Over the period from 2018 to 2023, multiple volcanic eruptions in the region necessitated the evacuation of over 1,000 individuals, exposed approximately 130,000 people to hazardous volcanic ash, and resulted in the deaths of 215 people, causing profound loss and suffering for their families [23].

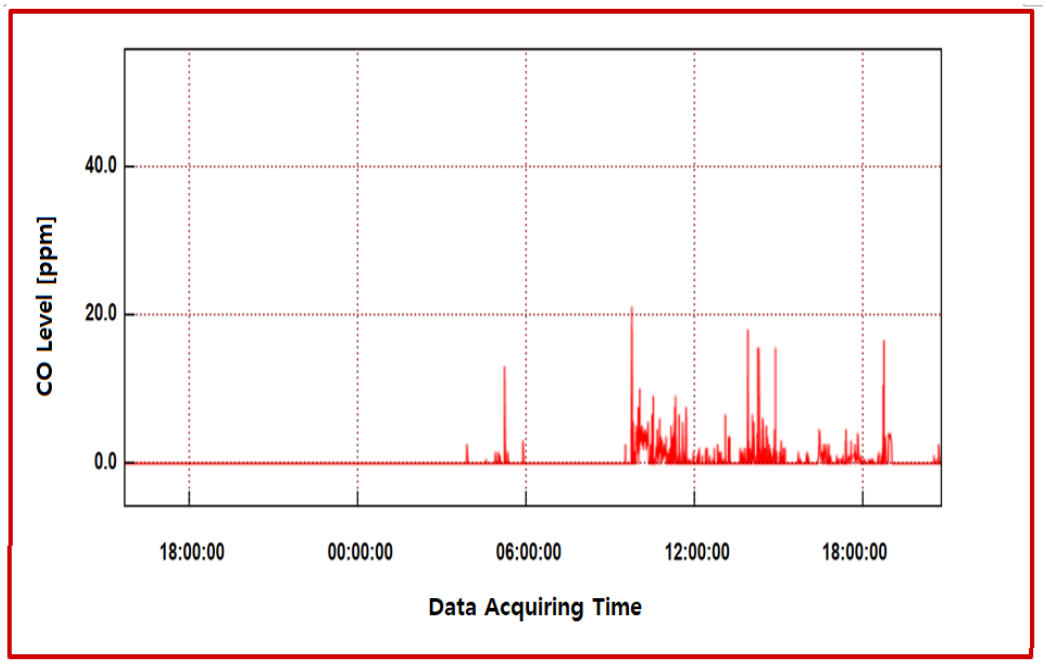

Fig. 1. Presents the air quality data on days 1 and 2

Fig. 2. Presents the pictorial views of the waste landfills in a rural area

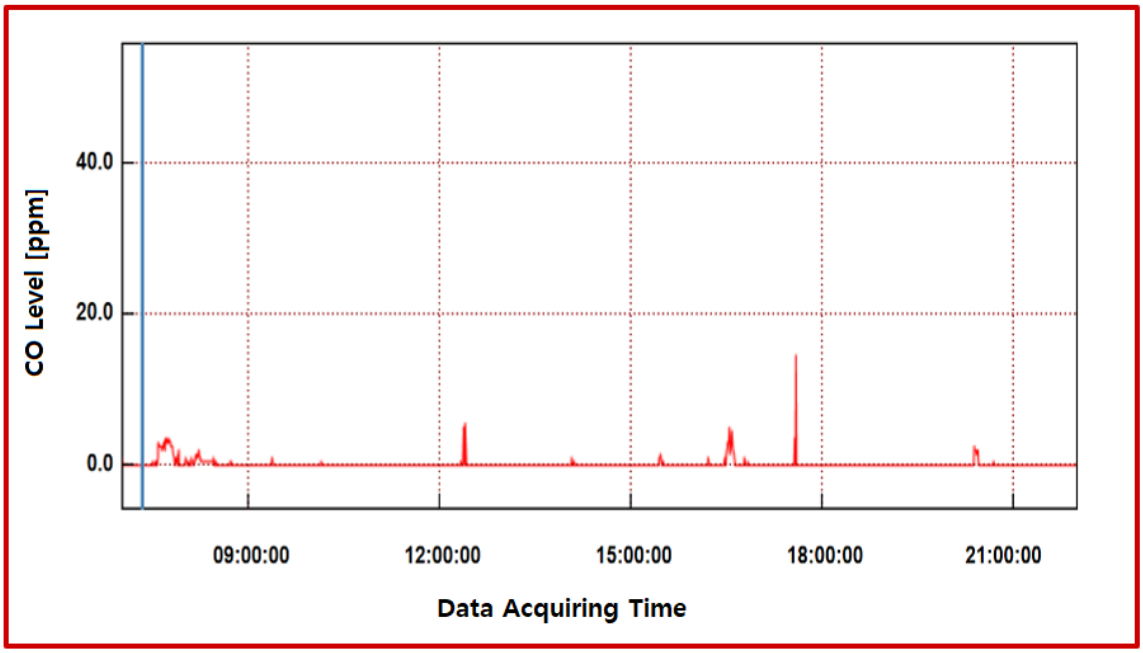

Fig. 3. shows the perturbation of CO on day 3

This series of catastrophic events has led to widespread respiratory issues and an increase in Post-Traumatic Stress Disorder (PTSD) among the affected populations. Researchers postulate that the aftermath of these eruptions, which has severely limited access to natural and green spaces, further exacerbates the difficulties faced by individuals with existing physical and mental health conditions. Unlike the data collected on the previous day, which primarily reflected the impact of urbanization, the data from the third day suggests a complex interplay of natural disaster effects and population density, contributing to heightened air pollution levels and adversely affecting the overall well-being of the area's residents.

3.4 CO Level Fluctuation on the Fourth Day of Data Acquisition

During the data collection process, a significant spike was observed at approximately 4:00 AM on the fourth day. This particular spike, standing out due to its substantial deviation from the other recorded data points, is a matter of immediate concern. The research team hypothesizes that this anomaly may be attributed to a mechanical error, potentially caused by an accidental drop or mishandling of the equipment, underscoring the need for careful handling and monitoring of the data collection process.

In contrast to this unusual spike, the subsequent highest levels of carbon monoxide were recorded around 7:00 PM and 11:00 AM, each reaching approximately 17 parts per million (ppm). Until 11:00 AM, the device had been exposed to environments such as airports and transit areas, where the high vehicular traffic density likely contributed to elevated carbon monoxide concentrations.

However, from 11:00 AM to 7:00 PM, carbon monoxide levels markedly decreased. The research team was located in Tikal's rural and forested areas during this period. The air quality in Tikal is considerably better than in other regions of the country, likely due to its status as a protected area where urbanization is restricted and natural environments are preserved.

The researchers posited that residents of Tikal, benefiting from this superior air quality and abundant natural surroundings, are likely to experience fewer physical and psychological health issues. This assumption is supported by previous studies indicating that increased access to nature is associated with a reduced likelihood of mental illness and more positive outcomes in the recovery from physical ailments. These findings underscore the potential health benefits of living in or near natural environments, emphasizing the critical role of urban planning that prioritizes green spaces in promoting public health and the urgency of its implementation.

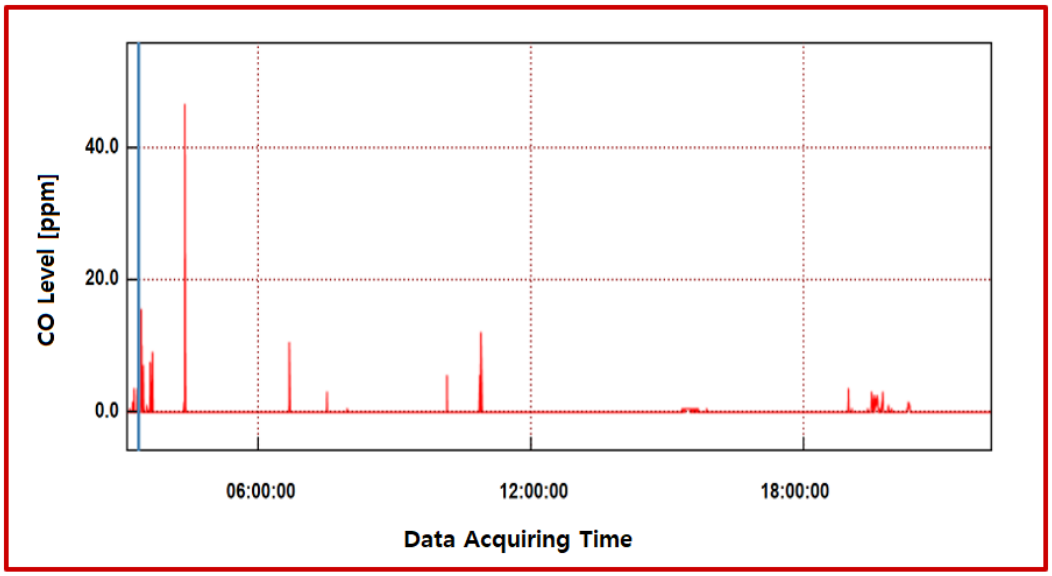

Fig. 4. Presents the changes in CO levels over time on day 4.

3.5 CO Level Fluctuation on Day 5

On the fifth day of the study, two notable spikes in carbon monoxide (CO) levels were observed. The first significant spike occurred at 9:46 AM at a church in El Tejar, Guatemala, where CO levels reached 59 parts per million (ppm). This elevated CO level was primarily attributed to multiple vehicles, including cars and motorcycles. During this period, there was also a pronounced smoky odor in the air, indicating a high concentration of pollutants.

The second significant spike in CO levels was recorded around 2:00 PM as the dedicated research team was en route to Antigua, Guatemala. At this time, the CO level rose to approximately 25 ppm, a concerning increase caused by the high volume of vehicles on the road, including the emissions from the team's bus.

Antigua, a region of great historical significance in Guatemala, was devastated by an earthquake in 1773 and has since been preserved in its ruined state [24]. Despite efforts to maintain the area with minimal urbanization, the high density of people and vehicles has raised concerns about air quality and its impact on public health. The data from Antigua's CO levels showed frequent and significant spikes, indicating that CO levels were both high and variable.

Comparative analysis with other graphs from the study revealed that the graph from Antigua exhibited the second-highest frequency of spikes, suggesting a consistently high and fluctuating level of carbon monoxide. The researchers concluded that poor environmental conditions and their effects on human health are not solely due to urbanization. Other factors, such as the density of people and the number of vehicles, also significantly affect mental and physical well-being.

3.6 Psychology and Health Awareness of Guatemala People

The comprehensive survey, composed of five questions, was administered to thirty individuals randomly selected from the crowd at the designated survey location. The primary objective of this survey was to gather extensive and detailed data concerning the level of awareness and understanding of fundamental psychological knowledge and the availability of related resources among the population in Guatemala. Through this systematic approach, the study aimed to elucidate the extent to which psychological concepts and support mechanisms are recognized and utilized within this demographic, providing valuable insights for further research and potential interventions.

The first question posed to the thirty participants was, "How familiar are you with psychological disorders such as depression, anxiety, and PTSD?" Among the respondents, 73% affirmed their familiarity with these conditions, while 27% indicated a lack of understanding. This question allowed the research team to gauge the general awareness of various mental health disorders among the participants.

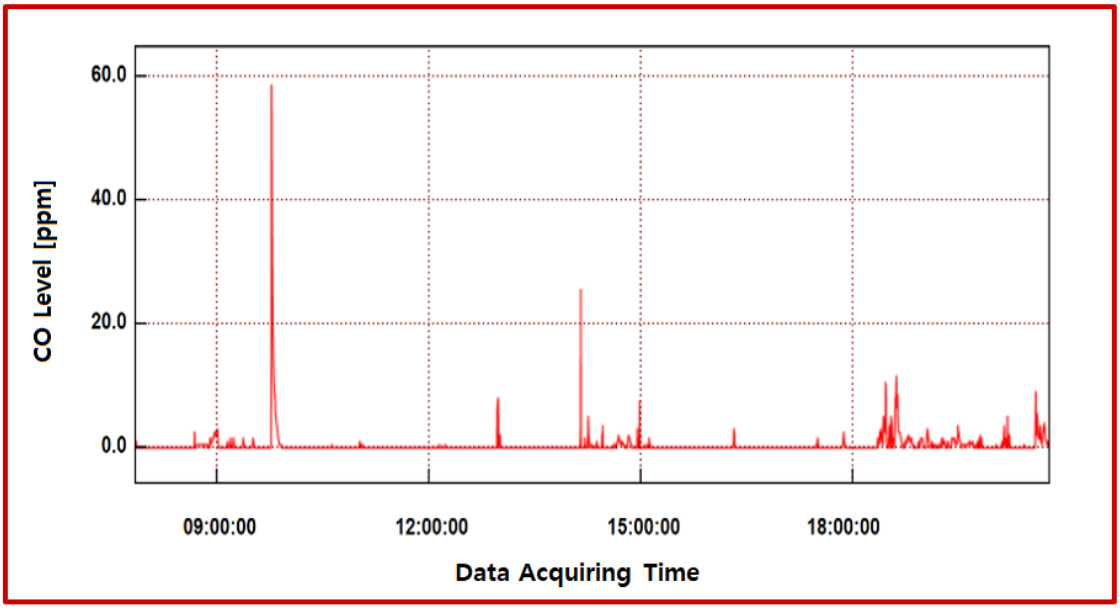

Fig. 5. illustrates the CO level of the daytime on day 5

The second question was, "Have you or someone you know ever experienced psychological challenges?" This inquiry aimed to determine the prevalence of psychological issues among the participants and their acquaintances. The responses revealed that 57% of participants had either personally experienced or knew someone who had experienced psychological challenges, indicating that more than half of the respondents had direct or indirect encounters with mental health issues. Conversely, 43% of respondents had yet to encounter such challenges.

For those who answered "yes" to the previous question, a follow-up question, "If yes, what are the main challenges faced?" was asked to identify the specific difficulties encountered by individuals with psychological issues. The responses indicated that 33% of participants cited work-related obstacles, 27% identified family problems as significant challenges, and 20% mentioned the cost of treatment and lack of resources as essential barriers.

The third question, "Are there any/enough healthcare facilities (hospitals, clinics, etc.) in your community?" aimed to assess the availability and awareness of healthcare resources in the participants' communities. The results showed that 23% of respondents believed inadequate healthcare facilities, 33% disagreed, and 44% were unsure. This question highlighted the participants' limited access to or awareness of healthcare facilities.

The fourth question asked, "Do you think the government adequately supports mental health services in your country?" The responses indicated a significant dissatisfaction with government support, with 63% of participants responding "no" and 37% saying "yes." This result suggests a prevalent belief among the participants that the Guatemalan government is not providing sufficient support for mental health services.

The final question, "What strategies do you believe could enhance mental health care access and support in your country?" sought to gather participants' opinions on potential improvements in mental health care access and support. The responses revealed that 57% of participants had no idea of effective strategies, 23% believed that increased government interest and involvement could enhance access, and 10% suggested that community discussions about mental health issues could be beneficial. These responses indicate a general indifference or lack of awareness among participants regarding their rights to adequate mental health care, which the research team attributed to insufficient support from local and national governments.

3.7 Relationship between the Environment and the Physical and Mental Health of People

The environments in which individuals spend their time, such as homes, workplaces, and community spaces, significantly impact mental

health and well-being. Given the close connection between these spaces and daily life, various conditions of these environments, including air quality and lighting, can influence physical and mental health. This field of study, "environmental psychology," examines the relationship between the environment and psychological well-being [25].

Extensive research has demonstrated that the impact of the environment on mental health extends beyond physical health considerations. The two are deeply interconnected; understanding this relationship is crucial for our well-being. For instance, a study employing the Boruta algorithm identified environmental degradation and the lack of green spaces as primary ecological risk factors and critical mediators in the relationship between environment and mental health. The findings suggest that individuals living in degraded environments or areas devoid of green spaces are at higher risk of mental health issues [26].

Moreover, the environment also affects physical health, particularly regarding recovery from illnesses. People naturally seek safe, clean, bright, and physically and psychologically comfortable environments. This innate preference is linked to an individual's physical and mental health. Cozy and clean surroundings have been shown to facilitate recovery from physical stress and mental fatigue [27].

Research consistently concludes that the environmental setting is crucial for physical and mental health outcomes. Individuals living in environments lacking healthy conditions, such as poor air quality, limited clean resources, and green spaces, are more susceptible to mental health problems. Therefore, it is essential to consider the quality of living environments when addressing overall health and well-being, as the presence of green, clean, and comfortable spaces contributes significantly to both physical recovery and psychological resilience.

4. DISCUSSION

The findings of this study underscore the significant impact of environmental conditions on mental health in developing countries, with a specific focus on Guatemala. Our results reveal a clear correlation between environmental quality and health outcomes, emphasizing the need for enhanced ecological policies and public awareness.

Data collected through our field research in Guatemala highlighted the detrimental effects of poor environmental conditions on health. Elevated carbon monoxide (CO) levels were recorded in various locations, particularly in urban areas and regions affected by industrial activities and natural disasters. For instance, high CO levels in Chimaltenango's waste landfill and near active volcanoes significantly impacted the local population's respiratory health. They contributed to an increased incidence of Post-Traumatic Stress Disorder (PTSD) due to prolonged exposure to hazardous conditions. These findings align with existing research, which indicates that environmental degradation and the lack of green spaces are major risk factors for mental health issues.

The study also demonstrated the positive effects of green spaces and natural environments on well-being. In Tikal, where air quality was notably better due to its protected status and minimal urbanization, residents experienced fewer physical and psychological health issues. This observation supports the principles of environmental psychology, which suggest that access to nature can reduce stress, enhance cognitive function, and improve overall mental health. The data collected from Tikal reinforces that natural environments are crucial in promoting mental health, highlighting the need for urban planning incorporating green spaces.

Survey results provided additional insights into psychological awareness and the availability of mental health resources among the Guatemalan population. A substantial portion of participants (73%) were familiar with psychological disorders such as depression, anxiety, and PTSD. However, there was a notable gap in the availability and awareness of healthcare facilities, with 33% of respondents indicating insufficient healthcare infrastructure in their communities. This gap underscores the critical need for increased governmental support and investment in mental health services, particularly in developing countries with limited resources.

The study also revealed a general dissatisfaction with government support for mental health services, with 63% of participants believing that the government does not provide adequate support. This perception highlights the necessity for more effective mental health policies and public health campaigns to educate the population about available resources and the importance of mental health.

While this study provides valuable insights, it has limitations. The sample size of thirty participants restricts the generalizability of the survey findings. Future research should include a more extensive and diverse sample to understand better the broader implications of environmental conditions on psychological health in developing countries. Additionally, the study focused primarily on CO levels as a measure of environmental quality. Future studies could incorporate a broader range of environmental indicators, such as particulate matter and other pollutants, for a more comprehensive analysis.

5. CONCLUSION

In conclusion, this research highlights the critical relationship between environmental conditions and public health from a psychological perspective in Guatemala. The findings reveal that poor environmental quality, marked by high carbon monoxide levels and environmental degradation, exacerbates respiratory issues and mental health disorders such as PTSD. These findings emphasize improving environmental quality and increasing access to mental health services. Conversely, improved environmental conditions in areas with better air quality and more green spaces are associated with better physical and psychological health. The study also reveals notable gaps in mental health awareness and resource availability, with many respondents reporting insufficient healthcare infrastructure and government support. Addressing these issues through enhanced environmental policies and better public health strategies can promote the overall well-being of populations in developing countries, leading to healthier and more resilient communities.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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