

Original research

Assessment of CO₂ Levels in Some Kindergartens and Nurseries in the Cities of Fier and Vlora

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Abstract

The issue of air quality in schools, kindergartens, and nurseries is a growing concern with direct implications for children's health and development. According to global directives, including those of the World Health Organization [16] polluted indoor air in educational settings can cause respiratory diseases, allergies, and breathing difficulties, and may adversely affect children's learning abilities. Monitoring carbon dioxide (CO₂) levels in nurseries and kindergartens represents an important step toward ensuring a healthy environment for children—particularly in cities such as Vlora and Fier, which may face air pollution challenges due to urban transport activities [10]. This study aims to evaluate the air quality in educational environments of nurseries, kindergartens, and preschools in the cities of Fier and Vlora by continuously monitoring carbon dioxide concentrations and ecological factors that directly influence CO₂ levels. In total, 16 institutions (10 public and 6 private) were monitored in both cities

between May and October 2025. For each institution, measurements were conducted in a single classroom, with children aged from 8 months to 6 years. CO₂, temperature, and relative humidity values were recorded using a drager instrument (gas detector). Analysis of air quality monitoring results indicated overall good air quality, as CO₂ concentrations in all public and private institutions remained within the normal range (400–800 ppm). Statistical tests (One-Way ANOVA) conducted using SPSS software revealed significant differences between the cities of Fier and Vlora, as well as between public and private institutions, regarding the average CO₂ concentrations measured in the monitored nurseries, kindergartens, and preschools.

Keywords: CO₂, temperature, humidity, air quality, kindergarten, nursery

Original research

Introduction

The issue of air quality in schools, kindergartens, and nurseries is a matter of increasing concern, with direct implications for children's health and development. According to global guidelines, including those of the World Health Organization [16], polluted indoor air within educational settings can cause respiratory diseases, allergies, and breathing difficulties, and may negatively affect children's learning abilities. The harmful effects of air pollutants—such as dust, nitrogen oxides, carbon dioxide, and other chemical substances—are particularly pronounced in enclosed environments where ventilation is insufficient and children spend most of their time.

Monitoring CO₂ levels in nurseries and kindergartens is an essential step toward ensuring a healthy environment for children. Elevated indoor CO₂ levels can adversely affect children's health, leading to fatigue, poor concentration, and breathing difficulties. Children are especially vulnerable to air pollution due to their ongoing physiological development, which may contribute to the spread and exacerbation of respiratory diseases [6], [19]. Consequently, air pollution in schools and nurseries may pose an increased risk of developing long-term health problems.

Furthermore, air pollution impacts children's neurological development and cognitive performance and has been linked to cardiovascular diseases and even cancer [6]. Therefore, continuous monitoring of CO₂ levels can help prevent the deterioration of indoor air quality and ensure that oxygen levels remain suitable for children's daily activities. Based on numerous studies, one of the key indicators of indoor air quality in kindergartens and nurseries is the concentration of carbon dioxide (CO₂), whose value reflects the effectiveness of indoor ventilation [17]. The most commonly recommended and simplest ventilation method is natural ventilation [14], in which indoor air with a higher concentration of carbon dioxide is exchanged with outdoor air containing lower CO₂

levels. However, this may not always be effective in cities such as Fier and Vlora, which are characterized by significant levels of urban pollution (as reported by the National Environmental Agency).

It is also important to emphasize that with natural ventilation through window openings, it is not possible to precisely control the rate of air exchange according to the current indoor conditions. In such cases, the frequency and duration of ventilation depend entirely on individuals who may adapt quickly to the surrounding environment [14]. Therefore, ensuring adequate ventilation through windows becomes problematic if the space is not equipped with sensors to measure indoor environmental quality.

According to many international best practices, if a room is designed to be ventilated naturally through windows, it should be equipped with sensors to assess the safety and quality of indoor air—namely, sensors for CO₂ concentration or for other pollutants such as volatile organic compounds (VOCs). Temperature and relative humidity sensors are also suitable for monitoring thermal comfort.

By installing air quality monitoring systems in schools and kindergartens, immediate measures can be taken whenever CO₂ levels become elevated [14]. Moreover, improving ventilation and implementing air filtration systems in these institutions can help reduce concentrations of pollutants and CO₂ [2]. Another essential step is the promotion of public transportation and the establishment of green spaces to enhance air quality in the mentioned cities [16].

According to reports from the National Environmental Agency, the Institute of Public Health, and the Environmental Inspectorate, cities such as Vlora and Fier face air pollution challenges primarily due to urban transport activities. Addressing the issue of air quality in such contexts requires an integrated approach. This can be achieved through the installation of air quality monitoring systems in schools and kindergartens, which would allow for immediate corrective actions when CO₂ levels rise.

Original research

Additionally, improving ventilation and adopting air filtration technologies in these institutions can effectively lower pollutant and CO₂ concentrations. Further more, promoting public transportation and developing urban green spaces contribute to improving air quality in these cities. The collaboration between local authorities and educational institutions is crucial for ensuring a safer and healthier environment for children.

Materials and methods

This article is a product of the project (PKZHUV, 2025) at the Department of Biology, UV, on the topic: Monitoring CO₂ levels in kindergartens and nurseries in the cities of Fier and Vlora [4]. The objective of this study is to evaluate air quality in the learning environments of nurseries, kindergartens, and preschools in the cities of Fier and Vlora through continuous monitoring of carbon dioxide (CO₂) concentrations. To achieve this objective, a total of 16 institutions (10 public and 6 private) were monitored across both cities during the period from May to October 2025. For each institution, monitoring was conducted in one classroom, with children aged from 8 months to 6 years.

In the nursery institutions, the monitored classrooms included an average of 8 children aged between 8 months and 3 years. In kindergartens and preschools, the monitored classrooms included an average of 20 children aged between 3 and 6 years. These classrooms had wall heights exceeding 3 meters and windows oriented toward the south or southeast. The available floor area per child in these institutions averaged approximately 2.5 m². Measurements of CO₂ concentration, temperature, and relative humidity were carried out using a Dräger instrument at three different positions within each classroom: near the window, near the door, and at the center of the room. Data were collected during the morning hours as well as at midday, prior to the children's departure. According to the user manual, the Dräger instrument employed in this study is

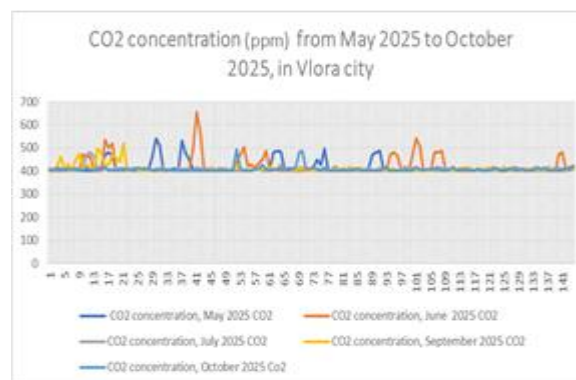
standardized in accordance with international standards. The device is equipped with an alarm system that activates whenever CO₂ levels indicate that the environment has reached a high pollution threshold. For this reason, all potential alarm events were carefully recorded during the monitoring process.

CO₂ measurements were conducted in each classroom at regular intervals, five days per week, for a period of one week each month, capturing potential variations throughout the day. The measurements were performed during children's active hours (08:00–13:00), as this period has the greatest influence on CO₂ levels. Data on CO₂ monitoring parameters and ecological factors in the classrooms included in this project were summarized in the corresponding tables and processed using SPSS and Microsoft Excel software.

Results

Based on the monitoring process carried out in public and non-public schools in the cities of Fier and Vlora, within the framework of the project: "Monitoring the level of CO₂ in kindergartens and nurseries in the cities of Fier and Vlora", the data obtained were processed through statistical programs (Excel and SPSS) presented in Figure 1-6.

Figure 1. CO₂ concentration(ppm) from May 2025 to October 2025, in Vlora city



Original research

Figure 2. CO₂ concentration(ppm) from May 2025 to October 2025, in Fier city

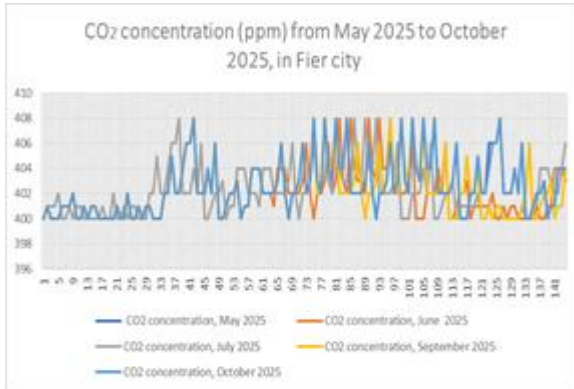


Figure 3. Humidity values (%) from May 2025 to October 2025, in Vlora city

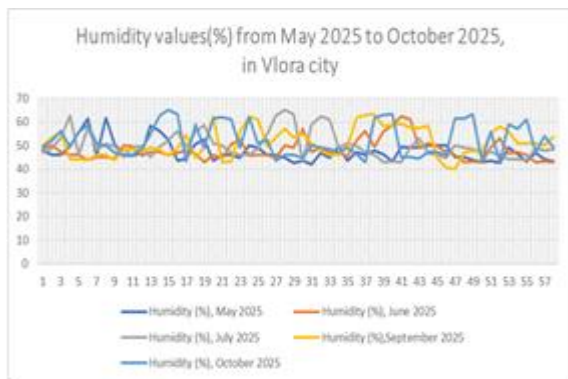


Figure 4. Humidity values (%) from May 2025 to October 2025, in Fier city

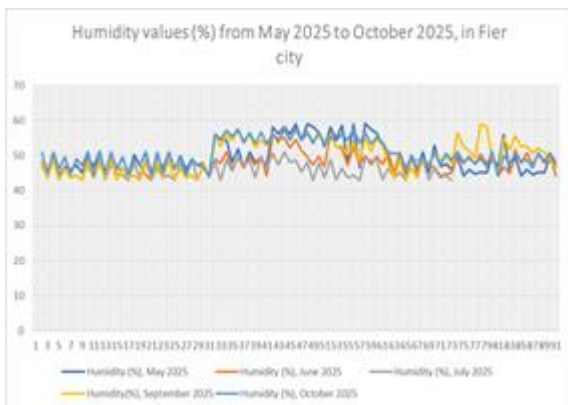


Figure 5. Temperature values (°C) from May 2025 to October 2025, in Vlora city

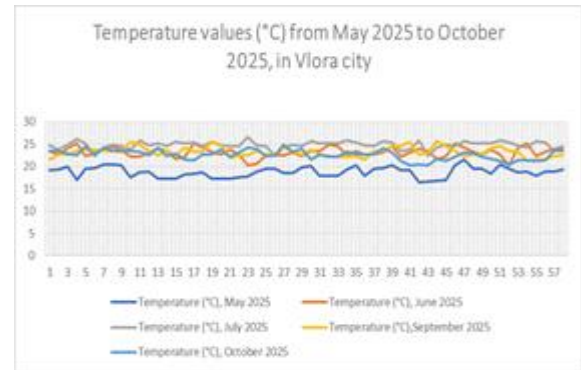
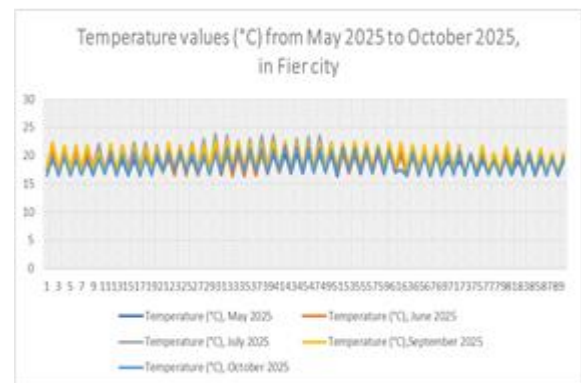


Figure 6. Temperature values (°C) from May 2025 to October 2025, in Fier city



Based on these results, during the five-month monitoring period (May 2025–October 2025), the minimum recorded CO₂ concentration was 400 ppm, while the maximum recorded value was 656 ppm. These values fall within the normal range for indoor CO₂ concentrations in kindergartens and nurseries. The minimum recorded temperature was 16.5°C, and the maximum temperature reached 30°C. These values show slight fluctuations outside the typical range for indoor temperature in kindergartens and nurseries (16°C–22°C). The minimum recorded relative humidity was 40%, and the maximum recorded value was 66%, indicating small deviations from the normal range of relative humidity in indoor kindergarten and nursery environments (40%–60%).

Original research

The data recorded during the monitoring period were analyzed using the One-Way ANOVA statistical test, which was applied to compare the mean CO₂ concentration levels between two groups in the city of Vlora (public vs. private institutions). The results indicated a statistically significant difference [$F(1, 862) = 12.81, p < 0.001$] between public and private institutions based on the measured CO₂ levels. In contrast, for the city of Fier (public vs. private institutions), the results showed no statistically significant difference in the measured CO₂ concentrations ($F(1, 862) = 1.881, p = 0.170$). The CO₂ concentration data were also analyzed to assess potential significant differences between the two cities, Vlora and Fier. The One-Way ANOVA test revealed statistically significant differences between the two cities ($F = 160.360, df_1 = 1, df_2 = 2095, p < 0.001$) in terms of the average CO₂ concentration levels.

Discussion

The recorded data for the classrooms included in this project confirm compliance with the guidelines established under Law No. 7643, dated 02.12.1992, as amended by Law No. 99/2024, dated 12.09.2024, and updated on 03.03.2025, "On Sanitary Inspection" [1]. The study also adheres to the Hygienic-Sanitary Regulation No. 359, dated 30.05.1995, "On the construction and operation of kindergartens" [8], and Hygienic-Sanitary Regulation No. 4, dated 06.01.1995, "On the construction and operation of nurseries" [9]. The monitoring device used in this study is capable of signaling when air pollution exceeds abnormal levels. However, no such alarm signals were observed during any of the measurements conducted across all public and private institutions in the cities of Fier and Vlora. This finding indicates that these institutions ensure adequate ventilation in the classrooms where children stay, achieved through the regular opening of windows and skylights several times a day for periods of 10–15 minutes. The lowest recorded CO₂ concentration in both cities was 400 ppm, while the highest value, 656 ppm, was measured in a

public institution in the city of Vlora. In Fier city, no CO₂ concentrations exceeding 408 ppm were recorded. This may be related to the fact that relative humidity values in Fier remained within the normal range for indoor environments in kindergartens and nurseries (42.2%–59.7%), whereas in Vlora city, deviations from the normal range (40%–66%) were observed. A similar trend was observed for temperature values in both cities, with deviations from the upper limit of the normal temperature range (22°C) for indoor kindergarten and nursery environments. In Fier, the measured temperatures generally remained within the normal range, with minor variations in both public and private institutions (16.5°C–24.5°C). In contrast, Vlora city exhibited greater fluctuations (16.5°C–30°C), with the highest temperatures recorded in several public institutions—specifically those where higher relative humidity levels were also observed.

According to numerous studies, these deviations in temperature and relative humidity values may contribute to elevated CO₂ concentrations in indoor kindergarten and nursery environments, thereby explaining the maximum recorded CO₂ value of 656 ppm. The months characterized by the greatest fluctuations in temperature and relative humidity were July, September, and October, which correspond with the typically higher environmental temperatures recorded in the cities of Fier and Vlora during these months. Based on multiple studies and local climatic characteristics, the city of Vlora is considered to be warmer and more humid than Fier. This represents another factor contributing to the greater variability of these parameters observed in the kindergartens and nurseries of Vlora city.

Conclusions

Based on the main objective of this study — "*Assessment of air quality in the learning environments of nurseries, kindergartens, and preschools in the cities of Fier and Vlora through continuous monitoring of carbon dioxide (CO₂) concentrations*" — this study successfully evaluated the air quality in educational

Original research

environments of nurseries, kindergartens, and preschools in both cities by continuously monitoring carbon dioxide levels, along with key ecological parameters such as temperature and relative humidity. According to numerous studies, CO₂ concentration is a reliable indicator of indoor air quality, as it reflects the effectiveness of ventilation systems and the overall air circulation within these spaces. This study analyzed how CO₂ concentrations varied across different public and private institutions in the cities of Fier and Vlora, through systematic monitoring conducted over the period May–October 2025. The analysis of the results for the classroom parameters included in this project demonstrated compliance with the relevant guidelines established under Law No. 7643, dated 02.12.1992, as amended by Law No. 99/2024, dated 12.09.2024, and updated on 03.03.2025, “On Sanitary Inspection” [1]. The findings are also in accordance with Hygienic-Sanitary Regulation No. 359, dated 30.05.1995, “On the construction and operation of kindergartens” [8], and Hygienic-Sanitary Regulation No. 4, dated 06.01.1995, “On the construction and operation of nurseries” [9].

Recommendations

It is recommended that this type of project be continued to monitor air quality during the winter period as well. Furthermore, future studies should include a larger number of public and private institutions, particularly those attended by children in the early stages of childhood. This age group is directly affected by variations in air quality, which can significantly influence their health and overall quality of life.

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Original research

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