Contribution ID: **71** Type: **not specified**

Indoor Particulate matter concentration in student dormitories: A case study in Ambo University, Ethiopia

Indoor environmental quality (IEQ) can directly impact the comfort, productivity, and health of occupants. Given that individuals spend approximately 90% of their time indoors, the quality of the indoor environment directly impacts human well-being. For university students, dormitories are not just places of rest but serve as essential restorative environments that support their academic journey. The IEQ of these living spaces is particularly significant, as it affects students' physical health and well-being.

This study aims to evaluate the concentration of particulate matter (PM) in university dormitories, assess the vulnerability of students to fine particle exposure based on international guidelines, and raise awareness within the academic community about the importance of IEQ. This enhanced understanding is intended to foster the development of sustainable and pleasant indoor environments. Research on IEQ in African university dormitories is limited, with most studies focusing on other regions. Specifically, there is a notable absence of research on PM concentrations in Ethiopian universities. This gap is especially apparent at Ambo University, where data on dormitory PM concentrations remain largely unexplored.

To address this, a field survey was conducted at the Hachalu Hundessa Campus of Ambo University, Ethiopia, to investigate particulate matter concentrations in the dormitories. A total of 52 dormitories (11 female and 41 male) were monitored, involving over 200 volunteer students, from which 184 valid data sets were collected (36 female and 148 male students). Measurements were taken during night-time over two phases between August 2024 and January 2025. An Aranet PM sensor was utilized to measure PM concentrations, with data remotely accessed through the Aranet cloud platform. The PM sensor transferred measurements to a base station, which then relayed the data to the cloud via an internet connection. Additionally, a questionnaire was administered to determine students' dormitory occupancy durations. The study focused on measuring PM1, PM2.5, and PM10 concentrations. To ensure reliability, the low-cost sensor was calibrated against a DustTrak reference instrument under various conditions, including background concentrations, incense burning, and post-burning phases.

The results indicated mean PM concentrations of 17.8 $\mu g/m^3$ (10.3–29.1 $\mu g/m^3$) for PM1, 18.6 $\mu g/m^3$ (10.3–29.55 $\mu g/m^3$) for PM2.5, and 24.9 $\mu g/m^3$ (16.6–34.8 $\mu g/m^3$) for PM10, with the ranges representing the 5th and 95th percentiles. This study successfully monitored PM concentrations in Ethiopian dormitories, marking a rare and possibly first-of-its-kind effort in this context. According to WHO air quality guidelines, the 24-hour average exposure should not exceed 15 $\mu g/m^3$ for PM2.5 and 45 $\mu g/m^3$ for PM10 more than 3–4 days per year. The study's findings emphasize the need for eco-feedback mechanisms to improve air quality in student dormitories.

In conclusion, this study measured PM concentrations in university dormitories and analyzed the results, laying the groundwork for future research. Further investigations could include 24-hour PM monitoring and assessing the health impacts of particle exposure on occupants to enhance indoor air quality management.

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