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Atmospheric Fine Particulate Matter (PM 2.5), Black Carbon, and Organic Carbon Levels in Oshakati, Namibia

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INTRODUCTION: Ambient air pollution, particularly fine particulate matter ($PM_{2.5}$; aerodynamic diameter ≤2.5 μm), poses a growing public health concern, contributing to cardiovascular, respiratory, and metabolic diseases. In Africa, where over 1.1 million deaths were attributed to air pollution in 2019, monitoring efforts remain limited due to the lack of ground-based data and electronic health records. Namibia does not have an air quality act, meaning there is no legal requirement to track air pollution levels, potentially exposing the population to harmful pollutant concentrations.
METHODOLOGY: This study measured ambient $PM_{2.5}$ concentrations and selected chemical components—black carbon (BC) and organic carbon (OC) at an urban background site at the University of Namibia, Oshakati Campus (-17.78664, 15.69364). $PM_{2.5}$ was sampled every sixth day from July 2021 to February 2023 using personal air samplers equipped with PTFE membrane filters, operating at a flow rate of 4.0 L/min for 24-hour collection periods. A total of 72 samples were obtained. BC and organic carbon OC levels were determined via an OT21 optical transmitter, which analyzed light absorption at 370 nm to estimate biomass-burning contributions.
RESULTS: Results showed $PM_{2.5}$ concentrations ranging from 0.5 to 47.7 μg/m³, with a mean of 10.6 μg/m³, exceeding the WHO's updated annual guideline of 5 μg/m³. The daily WHO limit of 15 μg/m³ was surpassed on 13 occasions. Average BC and OC concentrations were 0.8 μg/m³ and 0.9 μg/m³, respectively. Seasonal variations indicated the highest pollutant levels in winter, followed by spring, autumn, and summer.
CONCLUSION: This study provides the first documented assessment of $PM_{2.5}$ and its carbonaceous components in Oshakati. Elevated pollutant levels, particularly in winter, suggest potential health risks for the local population, even at concentrations below established regulatory limits. Given the absence of national air quality monitoring regulations, these findings highlight the urgent need for systematic air pollution tracking and policy development in Namibia. Further research should include source apportionment studies and health risk assessments to better understand exposure impacts and inform mitigation strategies.

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