Introduction

Household exposure to cookstove smoke causes indoor air pollution (IAP), leading to over 3.8 million deaths annually, primarily in low- and middle-income countries. This pollution consists of particulate matter, carbon monoxide, and other harmful substances, which are associated with a range of health issues, including lung cancer, chronic respiratory diseases, cardiovascular problems, and fetal and child health risks.

Objectives and Methodology

This study aimed to compare the emission mitigation abilities of porous media combustion (PMC)-based cookstoves to conventional free flame combustion (FFC)-based cookstoves. The study measured PM 2.5, PM 10, and CO emissions from methanol, ethanol, kerosene, and LPG fuels burned in FFC and PMC cookstoves in a representative kitchen environment. Temporal variation of pollutant concentrations was monitored for 2 hours (morning meal duration), and 24-hour average concentrations were compared to WHO guidelines for domestic settings.

Key Findings and Data

- PMC-based cookstoves showed significantly lower emissions ($p < 0.05$) compared to FFC-based cookstoves for all pollutants and fuels tested.
- For 2-hour duration measurements, the methanol PMC cookstove reduced PM 2.5, PM 10, and CO concentrations by 7.7%, 8.1%, and 17.2%, respectively, compared to the FFC cookstove.
- Similarly, PMC-based LPG, kerosene, and methanol cookstoves achieved emission reductions of:
    - LPG PMC: 11.7% PM 2.5, 20.4% PM 10, 41.6% CO
    - Kerosene PMC: 55.3% PM 2.5, 62.6% PM 10, 66.6% CO
- Among all tested cookstoves, the LPG PMC achieved the lowest emission values (PM 2.5: 20.6 $\mu g/m$ 3 ; PM 10: 31.3 $\mu g/m$ 3 ; CO: 1 ppm), which are lower than the prescribed WHO values (PM 2.5: 25 $\mu g/m$ 3 ; PM 10: 50 $\mu g/m$ 3 ; CO: 6 ppm).
- The 24-hour average concentration of PM 2.5 and PM 10 from conventional kerosene cookstoves was higher than the WHO guidelines by 32.4% and 27%, respectively.

- The PMC-based kerosene cookstove reduced these emissions by 4% and 10.8%, respectively, compared to WHO guidelines.

Impact and Implications

The study demonstrates that PMC-based cookstoves can significantly reduce IAP, improving the health and well-being of households that rely on traditional cookstoves. The findings support the promotion of PMC cookstoves as a cleaner and healthier alternative to conventional FFC cookstoves, particularly in rural and underserved areas where access to clean cooking fuels is limited.

Future Research Directions

Future research could explore the long-term health impacts of using PMC-based cookstoves, investigate the potential for further emission reductions through design optimizations, and assess the cost-effectiveness and scalability of PMC cookstove interventions in real-world settings.

References and Sources

The study cites several peer-reviewed journal articles and reports on indoor air pollution, household cooking fuels, and porous media combustion technology. The WHO guidelines for indoor air quality are also referenced as a benchmark for emission levels.