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Development of an integrated wearable-mobile platform for continuous monitoring of tobacco smoke exposure in controlled and real-world environments

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Background. Assessment of active and passive tobacco smoke exposure is still largely based on self-reported information or single-point environmental measurements, which provide limited temporal resolution and may underestimate individual exposure. Wearable technologies offer the opportunity to continuously monitor environmental pollutants under real-life conditions, providing objective exposure assessment for epidemiological research and preventive interventions.

Materials And Methods. An integrated monitoring platform was developed combining the Atmotube Pro wearable sensor, the AirAware mobile application, and a cloud-based infrastructure. The system continuously acquires particulate matter (PM_1, $PM_{2.5}$, PM_{10}), volatile organic compounds (VOCs), and Air Quality Score (AQS) data while implementing algorithms for automated data processing, event detection, and exposure alerts. Validation was performed in two sequential phases: controlled indoor experiments and real-world monitoring involving three exposure profiles (smoker, non-smoker, and non-smoker living with a smoker).

Results. The platform achieved stable continuous monitoring with reliable background acquisition, Bluetooth connectivity, and cloud synchronization. In the controlled experiment, smoking a single cigarette produced an immediate increase in particulate matter and VOC concentrations, accompanied by a persistent reduction in air quality. During real-world monitoring, the system identified a clear exposure gradient, with the lowest pollutant levels observed in the non-smoker, intermediate levels in the participant exposed to passive smoke, and the highest levels in the smoker. The platform consistently captured exposure patterns associated with participants' daily activities, demonstrating robustness under both experimental and real-life conditions.

Conclusions. The proposed wearable-mobile platform enables continuous and objective assessment of tobacco smoke exposure, overcoming important limitations of conventional exposure assessment methods. The integrated sensor–mobile–cloud architecture represents a promising tool for epidemiological studies, exposure characterization, and evaluation of public health interventions, with potential applications in vulnerable populations, including pregnant women.

References. World Health Organization. WHO report on the global tobacco epidemic 2023: protect people from tobacco smoke. Geneva: World Health Organization; 2023. Imtiaz MH, Ramos-Garcia RI, Wattal S, Tiffany S, Sazonov E. Wearable sensors for monitoring of cigarette smoking in free-living: a systematic review. Sensors (Basel). 2019;19(21):4678. Mu G, Zhang Y, Yan Z, Yu Q, Wang Q. Recent advancements in wearable sensors: integration with machine learning for human-machine interaction. RSC Adv. 2025;15(10):7844-54.