Monitoring Environmental Exposures and Behavioral Change

Clinical Trial NCT05338242

July 9, 2025

Study Protocol/Methods

Recruitment

A Community Advisory Board (CAB) of tribal leaders, elders, and concerned community members was created to provide guidance and direction on best practices in this community, assist with participant recruitment, and provide feedback on all aspects of the study.

The study population consisted of adult members of the Northern Arapaho tribe who lived in the area of the Wind River Reservation. Participants were given a kit of indoor air quality measurement tools for particulate matter (PM) and radon. They were also asked to fill out several questionnaires regarding their perceptions and behaviors concerning related environmental exposures (e.g., indoor dust).

Recruitment occurred primarily through word of mouth, posted flyers, booths at local events, and social media announcements. Consent was obtained either electronically through RedCap or on paper, depending on whether that individual had access to email and/or the internet. Only one adult member of the household was required to give consent to conduct sampling in their residence. There were no exclusion criteria other than being an adult member of the Northern Arapaho Tribe.

After consent was given by the primary participant, a demographic form including information on who lived in the house and an initial Environmental Health Perception and Behavior (EHPB) questionnaire was filled out. Further details about the EHPB questionnaire are provided below. Once these were completed, arrangements were made to install the PM monitors and radon test kits in the home. Compensation was provided separately for allowing environmental monitoring and for filling out each questionnaire.

Monitoring Equipment

Kits containing low-cost particulate matter (PM) monitors and radon tests were either self-installed or installed into the home by trained technicians. These trained technicians also filled out a dwelling unit assessment along with the participant, which identified relevant characteristics of the home, including the type of stove, presence of a clothes dryer, style of home foundation, etc. The PM monitors consisted of a Plantower PMS3003 Laser PM2.5 sensor, an Arduino board, a battery-run clock, a photodiode (to increase or decrease display lighting according to ambient light), light emitting diode (LED), and digital display (see Figure 1). These were designed specifically for this research project, including a 3D-printed housing. The Plantower PMS3003 PM2.5 sensor (Plantower, Nanchang City, Jiangxi Province) uses a laser to measure particles ranging from 0.3 to 10 μm. Sensors were calibrated according to prior published methods (Sayahi et al, 2019) before and after deployment.

Separate monitors were installed in (1) the most used space (not a bedroom), (2) a bedroom, and (3) outside the home of each participant. One group of participants received

monitors that displayed date, time, relative humidity, concentration levels of PM2.5, temperature, and a short text description of the air quality (e.g., “good”, “moderate”, etc). The LED light displayed a range of colors gradually changing from green to red depending on the PM2.5 concentration. The color of the LED corresponded with the EPA Air Quality Index (AQI) levels (EPA, 2025). The other group of participants received monitors that only showed the date and time, with the LED light always remaining green. Households were randomized by computer into these groups when initial consent was received. Monitors were in the homes for 1-3 months, which varied depending on participant availability for deployment and collection.

Questionnaire

An EHPB questionnaire was given to the primary participant multiple times throughout the study. Each time, the participant was asked how concerned they were with various environmental exposures, how often they think about exposures, and what activities they might be doing to limit these exposures. Environmental exposures of interest in the questionnaire included indoor dust, wood-burning smoke, cigarette smoke, indoor radon, outdoor air pollution, lead paint, soil contamination, water contamination, and contamination of locally-grown plants. For this clinical trial, the primary concern was the change in frequency of participant behavior of activities associated with reducing exposure to PM/indoor dust (e.g., cleaning, opening windows, etc). These responses were captured on a Likert scale for frequency. The participants were also able to specify other behaviors or actions they performed that were related to exposure reduction as an open-ended response.

The questionnaire was given multiple times: (1) before PM monitors were installed into the home, (2) when equipment was removed from the home, (3) 3 months after removal, and (4) 6 months after removal. Most of the questionnaires were completed by the participants in RedCap (a secure web platform for managing online database questionnaires). Those who could not fill out the questionnaire electronically filled it out on paper and their responses were input into RedCap by a researcher.

Data Analysis for Primary Outcomes

Individual responses from the initial, pre-sampling Environmental Health Perception & Behavior (EHPB) questionnaire were compared to the three (3) subsequent post-sampling questionnaires (immediate, 3 months, and 6 months post-sampling). The primary analysis was for changes in the frequency of behaviors associated with exposure reduction to “indoor dust.” This included the following activities: (1) cleaning (e.g., dust, vacuum), (2) opening windows, (3) using an electric air cleaner (e.g., ionizer), and (4) changing house air filters. The frequency of each activity was given a numerical value as follows: (1) daily, (2) weekly, (3) monthly, (4) yearly, (5) never, (0) not applicable. An overall exposure reduction behavior score was calculated based on the sum of these frequencies, with a lower score

indicating more frequent behaviors. For example, if a respondent answered “weekly” to all four activity questions, their score would be 8. If a participant didn’t answer a particular question or answered “not applicable” in any of the questionnaires, that question was not included in that individuals score calculation. The pre- and post-scores were then compared using a paired t-test to evaluate if there was a significant change in their responses as a result of being in the study. This was done separately for the “feedback” and “non-feedback” groups to evaluate the potential effect of real-time feedback on participant behavior.

References

Environmental Protection Agency (EPA). (2025). AQI Breakpoints. [Accessed: July 8, 2025]. https://aqs.epa.gov/aqsweb/documents/codetables/aqi_breakpoints.html

Sayahi, T et al. (2019) “Development of a calibration chamber to evaluate the performance of low-cost particulate matter sensors.” Environmental Pollution, vol. 255, Pt 1, 2019: 113131. doi:10.1016/j.envpol.2019.113131