Waging the Low Wage War: Differential Work Experiences of Low Wage Workers

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Background

- Almost half the US working population (around 44%; roughly 53 million) between the ages of 18-64 work in a low wage job (Ross & Bateman, 2019).
- Such low wage workers (LWWs) usually represent a vulnerable population given their working conditions and compensation; they are negatively stereotyped as being low skill and/or competence as well (Fiske et al., 2002; Maxwell, 2008).
- Despite forming an integral part of the workforce and being considered an essential job, LWWs have long been an understudied occupational group (Cubrich, 2020).
- Customer facing LWWs additionally face uniquely added burdens associated with their daily job demands.
- Work schedules and job demands experienced might be different across customer facing LWWs like fast food workers, grocery store workers, and retail stores workers; hence, making it essential to explore the differences between the different LWWs.

Objectives

- Examine the workplace experiences of low wage workers.
- Explore differences in customer interactions between different customer facing low wage jobs.
- Appropriately inform future interventions and positively impact workplace experiences for low wage workers.

Study Population

Around 150 LWWs working in fast food, retail, and grocery jobs in northwest Ohio will be recruited for the initial survey, up to 90 of which equally distributed along the three categories will be included for the daily diary study.

Study Design

- This study will use the daily diary method, with 1 initial baseline survey and then 2 daily online surveys every morning and evening for 14 days (28 daily surveys in total) being collected.
- Participants will be recruited through flyers, social media, and word of mouth techniques at their workplaces.
- Participants will be compensated for their time and participation – completing the initial survey will result in them being rewarded $10 each, and then $2.50 for every daily survey (along with a bonus incentive structure based on survey completion rates).
- A multi-level power analysis will be conducted (PINT; Snijders & Bosker, 1993) to test the within-person sample size.
- Data will be analyzed using hierarchical linear modeling; intraclass correlations to account for variance proportion will be run to warrant use of multilevel modeling.

Task Description

The instrument will be kept short, and the following will be recorded in addition to basic demographic information and shift timings:

Variable	Measure	Sample Item	Initial Survey	Morning Survey	Evening Survey
Work Schedule – Rigidity	3 item scale	*"Are you allowed to choose your own starting and quitting times within some range of hours?"*	X		
Work Schedule - Unpredictability	2 item scale	*"How often are you required to work paid or unpaid extra or overtime hours?"*	X		
Work Schedule – Instability	2 item scale	*"Would you prefer to have a full-time job right now?"*	X		
Emotional Labor	Emotional Labor Scale	*"I resist expressing my true feelings at work."*	X	X	X
Incivility – Customers	5 item scale	*"Customers make insulting comments to me."*	X	X	X
Incivility – Coworkers	Workplace Incivility Scale	*"Put you down or was condescending to you."*	X	X	X
Social Support – Coworkers	Social Support Scale	*"My coworkers help me get my work done."*	X	X	X
Social Support – Supervisor	Supervisory Support Scale	*"My supervisor gives me helpful feedback about my performance."*	X	X	X
Psychological Well-Being	WHO-Five Well-Being Scale	*"I feel calm and relaxed."*	X	X	X
Stress Recovery	Recovery Experiences Questionnaire	*"During time after work, I kick back and relax."*	X	X	X
Burnout	Copenhagen Burnout Inventory	*"Is your work emotionally draining?"*	X	X	X
Sleep Quantity	1 item scale	*"How many hours of sleep did you get?"*	X	X	
Sleep Quality	1 item scale	*"How was the overall quality of your sleep?"*	X	X	

Limitations

- Given the frequency of surveys sent out in addition to the workload of such LWWs, potential dropouts and missing data can be a concern for the study's results.
- With recruitment relying on visiting places with LWWs in all three categories, it might be resource intensive and provide logistical challenges.
- The sample for this study will be recruited from the Northwest Ohio region for convenience but this might introduce issues of generalizability and limit diverse perspectives.

Expected Results

- This study's results will help in understanding important differences in workplace characteristics and associated outcomes for LWWs, making a significant contribution to the literature.
- Understanding the differences and interactions within each category of LWWs will also help in identifying the group most impacted by negative work experiences.
- Differences analyzed not just within different LWW categories but also based on gender and race will help in understanding differences across such groups, addressing future interventions.

Future Directions

- This study will be the first step in the direction of understanding the unique work characteristics and experiences of LWWs and can guide future research in this area focusing on this population.
- Future research can focus on examining ways of improving LWW's experiences and design effective future interventions.
- With minority populations generally employed in majority of low wage jobs, future studies can also focus on investigating these groups in specific and their differences.

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Assessment of the Ergonomic Exposures for Home Healthcare Workers in the United Kingdom.

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BACKGROUND

- Home healthcare has been identified among the most hazardous industries in healthcare[1].
- Many of the tasks being conducted by home healthcare workers are associated with significant demands (physical and psychological)[2,3].
- Homes in the United Kingdom have potentially unique exposures due to the healthcare system and design of the homes

OBJECTIVE

To investigate the ergonomic exposures for home healthcare workers in the United Kingdom.

METHODS

- A cross-sectional observational study
- 7 trained supervisors completed direct observations of the caregivers in the patient's homes
- Utilized a validated observation tool: Home Healthcare Worker Observation Tool (HHCWO)[4]
  - Patient handling tasks
  - Handling of furniture and medical equipment
  - Care tasks: changing bedding and clothes
  - Use of lifts and patient-handling devices
- Observation of nurses and nurse aides in the homes for 30 to 60 minutes
- Descriptive statistics: counts and percentages

Table 1: Number (Percentage) of Hazards Observed Ergonomic Hazards for Home Healthcare Providers during Home Visits

Tasks	Overall (N=69)	Nursing Aides (N=52)	Nurses (N=14)
Reposition in bed	24 (34.8%)	20 (38.5%)	2 (14.3%)
Transfer from chair to chair	18 (26.1%)	15 (28.9%)	3 (21.4%)
Transfer off bed/ back to bed	5 (7.25%)	4 (7.7%)	1 (7.1%)
Transfer from bed to chair	18 (26.1%)	18 (34.6%)	0 (0.0%)
Transfer chair to bed	11 (15.9%)	10 (19.2%)	0 (0.0%)
Transfer bed to a wheelchair	12 (17.4%)	10 (19.2%)	2 (14.3%)
Transfer wheelchair to bed	6 (8.7%)	4 (7.7%)	2 (14.3%)
Transfer bed to the bathroom	3 (4.4%)	2 (3.9%)	0 (0.0%)
Lift from floor to bed	2 (2.9%)	2 (3.9%)	0 (0.0%)
Transfer to/from the toilet	3 (4.4%)	3 (5.8%)	0 (0.0%)
Change bedding	17 (24.6%)	12 (23.1%)	2 (14;3%)
Change clothes	10 (14.5%)	9 (17.3%)	1 (7.1%)
Move furniture	6 (8.7%)	5 (9.6%)	0 (0.0%)
Move medical equipment	10 (14.5%)	4 (7.7%)	6 (42.9%)
Use of lift hoist	13 (18.8%)	12 (23.2%)	1 (7.1%)
Use of a slip sheet or slide board	7 (10.1%)	7 (13.5%)	0 (0.0%)

Results

- United Kingdom home healthcare workers appear to unique exposures
- Nursing aides completed the most patient-handling activities
- Repositioning and transferring patient from bed to chair
- Very limited use of patent lift equipment.

LIMITATIONS

- Observations were completed by multiple supervisors
- Number of observations completed was relatively small
- Observations were limited to adult care

CONCLUSIONS

- Observations confirmed ergonomic exposures in the U.K. are similar to in the U.S.
- HHCWs work alone, handle patients alone
- Nurse aides completed the most patient handling
- Nurse aides were more exposed to physical tasks

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OHIO FARMWORKERS AND HEAT-RELATED ILLNESS PREVENTION: A FOCUSED ETHNOGRAPHY

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Background

- When compared to all occupations, farmworkers have a 35% increased risk of death from heat[1].
- Farmwork is physically demanding and requires workers to work during the hottest months of the year.
- Ohio recorded among the highest frequency of heat-related deaths in a 1999 heatwave[2].
- In Ohio, farmworkers account for more workers' compensation claims for HRI than any other occupation[3].

Project Aims

- Understand farmworkers' knowledge of heat-related illness prevention and behavioral and cultural factors related to HRI prevention.

Methods
- Ethnography

Study Design
- The P.I. worked alongside farmworkers
- Semi-structured interviews with 14 participants

Analysis
- Braun and Clarke's thematic analysis5

Results

- Four themes emerged (See Table):
- No workers reported on-the-job training.
- All participants had some knowledge of heat-related illness signs and prevention.
- No participants had a plan or reported receiving education or training about acclimatization.
- Twelve participants reported an experience with heat-related illness.

Themes	Sub-Themes
Acquisition and Interpretation	a. Education and Training b. Beliefs c. Personal Experience
Interoception	a. Listening to your Body b. The Limit c. Acclimatization
Perception	a. Attitudes Towards Prevention b. Work Norms c. Control
Action	a. Personal Protective Equipment (PPE) b. Shade c. Breaks d. Decrease Body Temperature e. Hydration f. Anti-Prevention g. Lifestyle Behaviors and Home Remedies

Discussion & Implications

- It is necessary to understand HRI and prevention from the perspective of farmworkers.
- Cultural aspects that are not always visible from an outside perspective.
- Ohio farmworkers need more protection, education, and training.
- Workers may be gaining relevant knowledge through on-the-job experience.
- Workers use prevention based on how they feel, possibly explaining high rates of symptoms.
- Participants listen to their bodies rather than following policies or guidelines.
- Negative attitudes toward prevention measures were likely related to machoism.
- Positive norms can help create a culture of safety at work.
- Feelings of control impact behaviors.

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References

Evaluating the Role of Human Sweat in the Dermal Absorption of Inorganic Pb

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INTRODUCTION

- Inorganic Pb is associated with a range of adverse health effects including central nervous system injury, impaired renal function, hematological dysfunction, cardiovascular effects, etc. (ATSDR, 2023).
- Exposure to inorganic lead is a health concern for workers in industries such as battery manufacturing, ammunition manufacturing, mining, etc., where there is frequent exposure to Pb dust either through inhalation, ingestion, or dermal absorption.
- Pb exposure studies have focused more on inhalation, and ingestion, and less on dermal absorption (Niemeier et.al, 2022). As a result, dermal absorption of Pb remains poorly characterized and is typically not factored into aggregate risk assessments. A robust occupational health risk assessment should consider all exposure pathways.
- Workers in above stated industries are typically engaged in manual labor which result in the expenditure of a significant amount of energy, so they are likely to sweat. Human sweat acts as a solvent for inorganic Pb dust deposited on the skin. (Niemeier et.al., 2021).
- Understanding the kinetics of iPb dermal absorption in the presence of sweat is crucial for estimating the risks associated with dermal exposures.

OBJECTIVES

This study aims to investigate the effect of human sweat on dermal absorption of soluble inorganic Pb and quantify dermal absorption as a step towards defining the dermal component of the aggregate risk for occupational Pb exposures.

RESEARCH APPROACH / METHODOLOGY

Artificial sweat solution will be formulated at University of Cincinnati Laboratories with its constituent and concentration close to what is reported in published human sweat data. (Harvey et.al 2010).

Aim 1 : Characterize the dissolution of inorganic Pb salts in synthetic human sweat**.**

- A dissolution assay will be conducted with lead nitrate in deionized water and later in synthetic sweat solution making use of the VK 7000 dissolution apparatus (Figure 1). Samples will be collected at five different time points over a 10-hour period with the pH of sweat maintained at 5.3 and the water bath maintained at 36.3^{o}C.
- Analysis of samples will make use of Inductively Coupled Plasma Mass Spectroscopy (ICP-MS).
- Results from both assays will be compared and a temporal dissolution model will be developed based on the data generated.

***Figure 1.** VK 7000 Dissolution Apparatus*

Aim 2: Determine the effect of pH on the dissolution of iPb ions in synthetic human sweat.

- A dissolution assay will be used to evaluate the effect of pH on the interaction between lead nitrate and synthetic human sweat.
- Synthetic sweat solutions will be prepared same as in Phase I at three different pHs (5, 6 and 7) and samples would also be collected at five tie points.
- Sweat samples will be analyzed using Inductively Coupled Plasma Spectroscopy (ICP-MS) and results from the sweat solutions with different pHs will be compared.

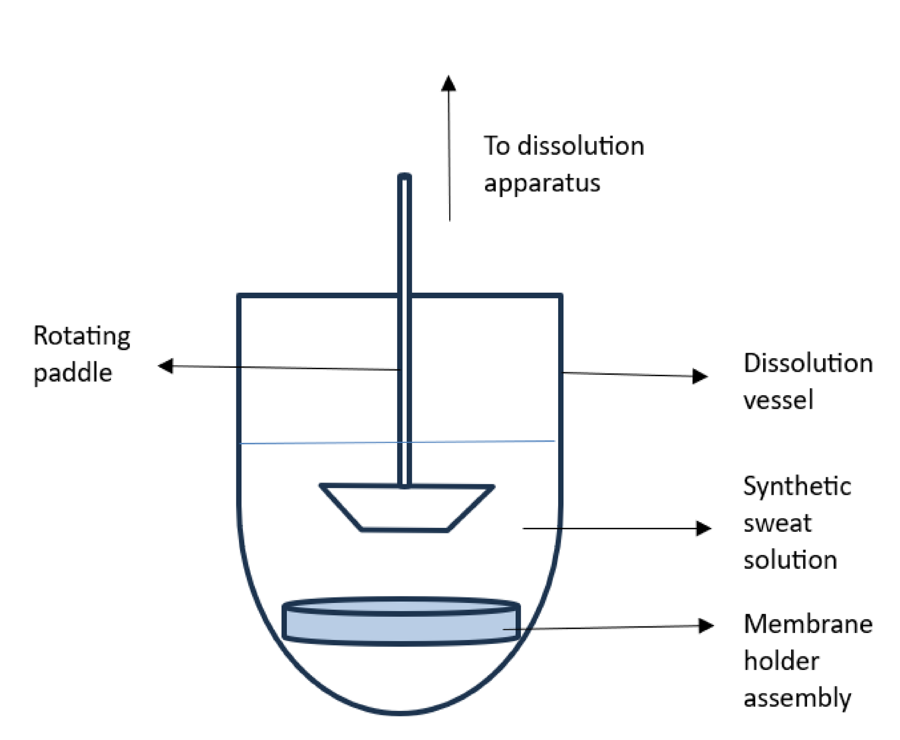

***Figure 2**: Dissolution vessel with paddle and membrane holder assembly.*

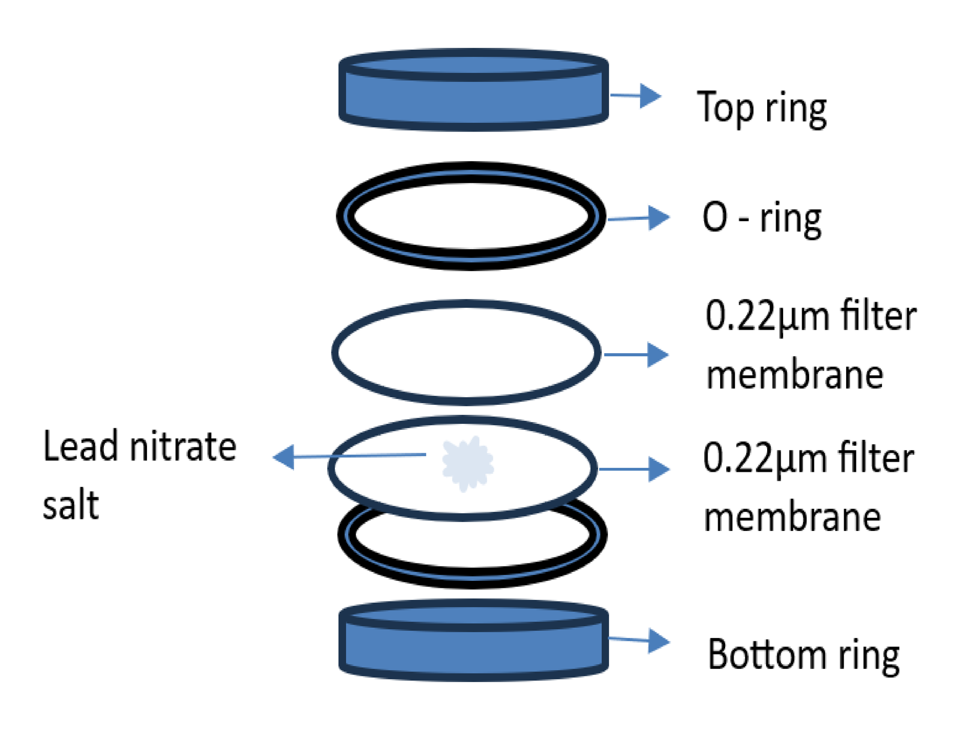

***Figure 3.** Membrane holder assembly.*

Aim 3 : Quantify dermal penetration of iPb ions through human skin**.**

- The Franz Diffusion cell will be employed to measure the diffusion of iPb across the skin. Human skin cadaver will be employed as the surrogate for human skin (occupying the position of the membrane in Figure 4).
- Franz cell is dosed with homogenized equimolar solution of lead nitrate in deionized water in the first instance and lead nitrate in synthetic sweat solution in the second instance. Set up is allowed to stand for a period so that the sample solution can permeate the skin cadaver and move from the donor chamber to the receptor chamber.
- Samples will be taken from the receptor solution at five-time points over 24 hours and treated with nitric acid to stabilize it before analysis using ICP-MS. Skin samples will be separated into parts, epidermis, and dermis, and analyzed separately.

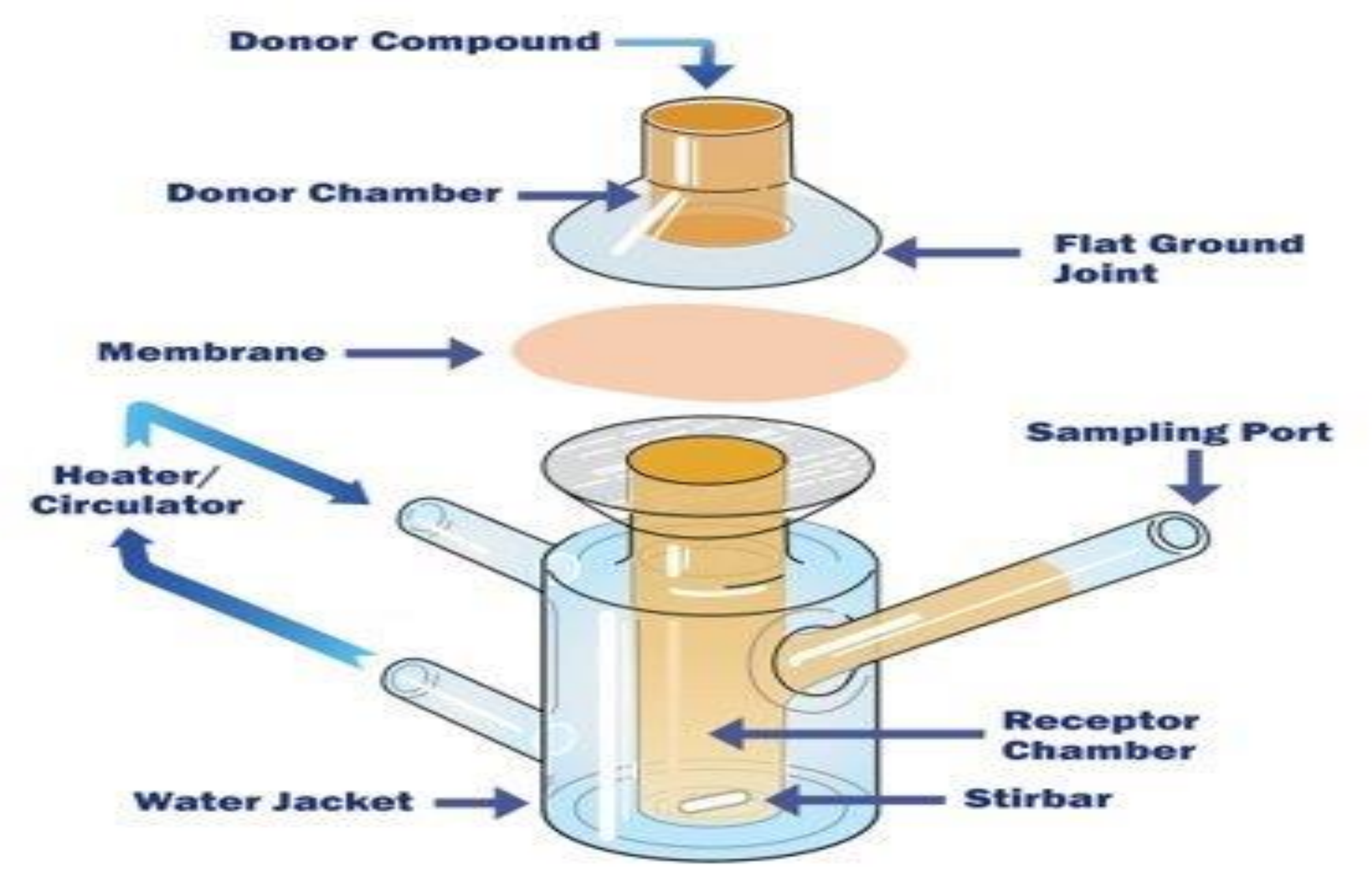

***Figure 4:** Franz Diffusion Cell. Source: PermeGear, 2023.*

EXPECTED RESULTS

- A single-phase linear dissolution. Precipitate formation in the dissolution assay with Pb salts and human sweat and little or no precipitation in the dissolution assay using distilled water as solvent. Higher detection of Pb ions in the samples taken from the Pb salt - deionized water dissolution assay compared to samples taken from Pb salt - synthetic sweat dissolution assay.
- A single-phase linear dissolution with higher dissolution rates at lower pH with a gradual decline in dissolution rate as pH increases from 5 to 7.. Results will enable us define the relationship between pH and the dissolution of iPb in a synthetic sweat solution.
- Diffusion across the Franz cell will be dependent on concentration. More Pb ions would be detected in the receptor solution consisting of the iPb salt and deionized water. Pb nitrate should readily go into solution with deionized water making Pb ions freely available to cross the skin barrier.
- For samples taken from the synthetic sweat solution, we expect to detect fewer Pb ions if any in the receptor solution because of the possible precipitation resulting from the reaction between components of the sweat solution and the Pb salt which takes Pb ions out of the solution thus inhibiting dermal penetration.

LIMITATIONS

- Most artificial sweat formulations used for in-vitro assessment of chemical dissolution have little biological relevance to human sweat (Harvey et al., 2010). The study design addresses this drawback by ensuring synthetic sweat is formulated according to published human sweat data.

FUTURE DIRECTIONS

- Future research could go a step further and consider how other factors, such as gender differences, humidity, temperature, etc., affect dermal absorption of inorganic Pb.
- The dissolution and dermal absorption models developed upon completion of the proposed research study could be applied to other heavy metal dissolution estimations involving human sweat.

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PREDICTING SAFE FIREFIGHTING DURATION USING MACHINE LEARNING

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BACKGROUND

- ***500,000***[1] people die annually due to ***heat-related illnesses***
- Firefighters are more vulnerable to heat-related illnesses due to the nature of their job[2]
- Each firefighter has a unique ***safe firefighting duration*** influenced by their physiological and environmental factors
- A personalized algorithm is needed to alert firefighters before their core bodies reach unsafe temperatures

OBJECTIVE

- Improve prediction of *safe firefighting duration* for firefighters based on acceptable limits of ***core body temperature***

HYPOTHESIS

- A machine learning algorithm that combines individual physiological data with environmental factors can improve prediction of safe firefighting durations and reduce the risk of heat-related illnesses

SPECIFIC AIM

- Develop a Physics-Informed Neural Network (PINN) trained on CFD-simulated data to predict *safe firefighting duration* – defined using a maximum core body temperature limit of 40°C

NOVELTY

- This work uses a validated CFD model to generate a large and diverse dataset, avoiding the limitations and costs of small human trials
- It uses physics information from the governing equations to optimize the neural network and reduce computational cost

METHODS

CFD model

- The whole body model comprises of two components: ***the Pennes bioheat*** equation and an ***energy balance equation***
- ***Pennes equation*** is used to simulate the tissue temperature distribution in the body (T_t) and is defined as:

$$\rho c \frac{dT_t}{dt} = k_t \nabla^2 T_t + q_m + (\rho c)_{blood}\,\omega (T_{blood} - T_t)$$

- The ***Energy Balance equation***[3] is used to determine the change in blood temperature (T_{blood}) during a process and is given as:

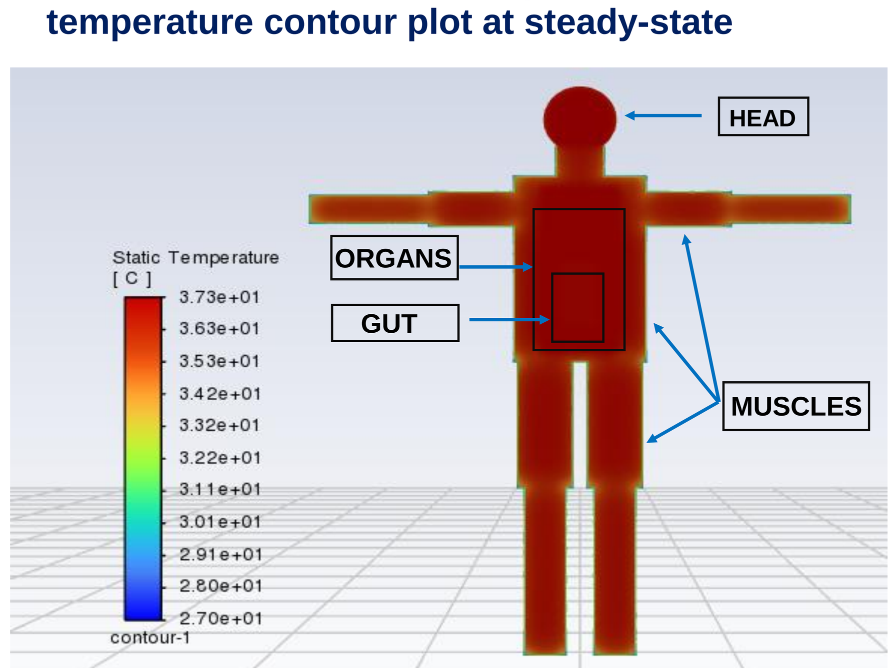
$$(\rho c V)_{blood}\frac{dT_{blood}}{dt} = -(\rho c \omega_{avg})_{tissue} V_{body} (T_{blood} - T_{wt})$$

$$\omega_{avg} = \frac{1}{V_{body}}$$

$$T_{wt} = \frac{1}{\omega_{avg} V_{body}} \iiint_{V_{body}} \omega T \, dV_{body}$$

- T_{blood} will increase if the RHS of the energy balance equation becomes positive
- During exercise, the increase in weighted average tissue temperature (T_{wt}) leads to ***heat gain*** by the blood during its circulation
- The heat gained by blood would be then used to compute the new ***temperature distribution*** in the human body using the Pennes equation
- Since both equations are coupled, they are solved simultaneously, updating both T_{blood} and T_{wt} during the simulation process

Schematic of the whole-body model with a temperature contour plot at steady-state

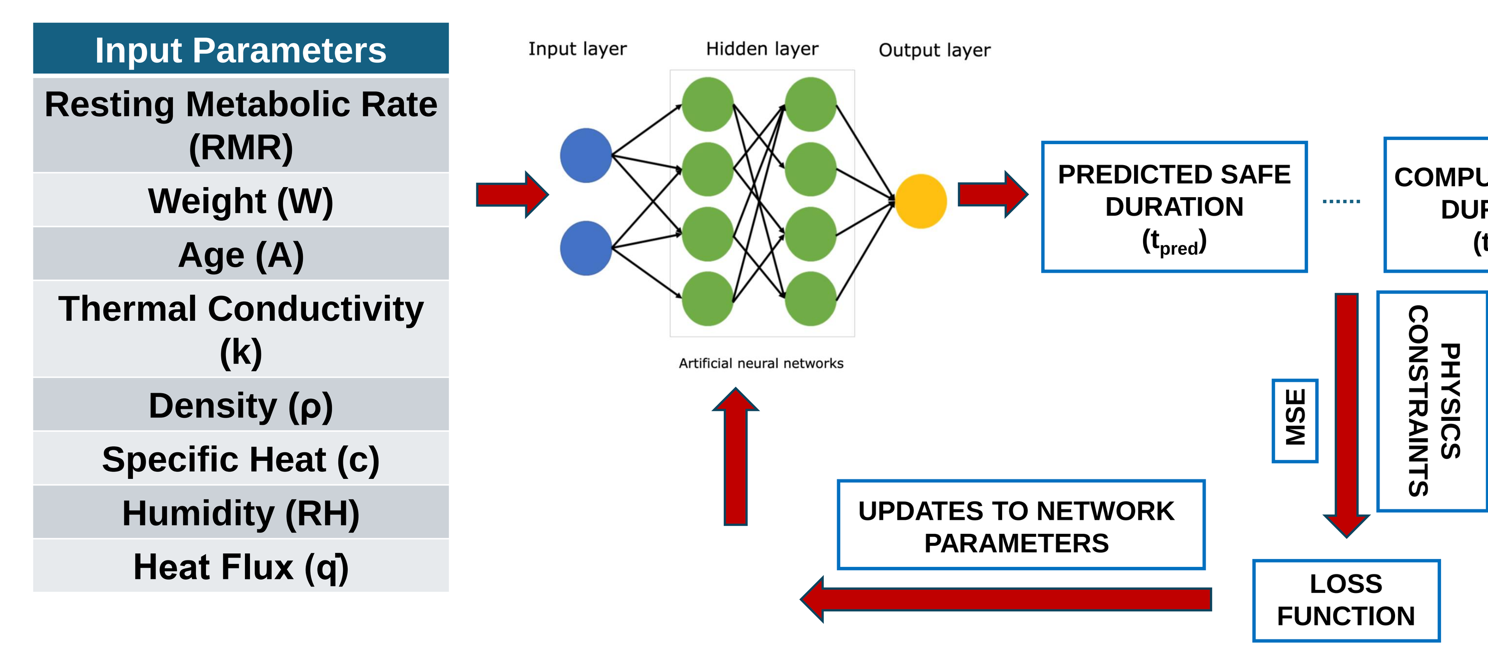


Material properties for the whole body

Physical Property (Whole Body)	Units	Range of Values
Thermal Conductivity (k)	(W/m °C)	0.40 - 0.45
Density (ρ)	(kg/ m3)	1009 - 1100
Specific Heat (c)	(J/kg °C)	2885 - 3293

Domain	Metabolic Rate, $\dot{q}$ (W/ m^3)
Head	5051 - 7330
Muscle	306 - 444
Organ	2215 – 3214
Gut	3581 – 5196

Machine learning model



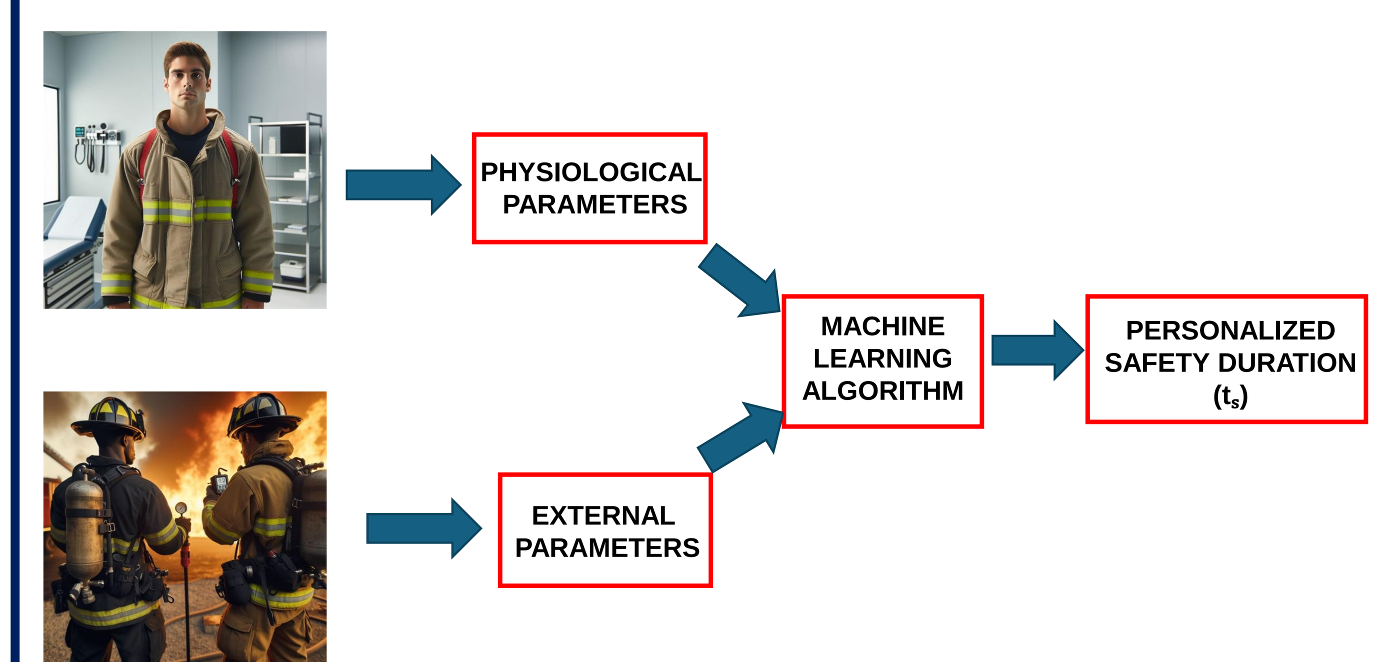
Flow Diagram of the Neural Network Training

- ***Multi-Layer Perceptron*** (MLP) with fully connected layers
- Mean Squared Error (MSE) used to ***minimize*** the difference between predicted and actual safe durations

EXPECTED RESULT

- ***Trained neural network*** optimized using physic information that can accurately predict personalized ***safe firefighting duration*** for firefighters

REAL-WORLD APPLICATION



- New firefighters undergo a simple test to estimate key ***physiological parameters*** like weight, density, specific heat, and thermal conductivity
- ***External parameters*** like heat flux and humidity are recorded in the field right before firefighting
- Both physical and environmental data are ***input*** into the algorithm to predict safe operational duration

LIMITATIONS

- Accuracy of the neural network predictions is reliant on the accuracy and validity of the CFD model used for data generation
- Training data for the neural network does not consider rest periods for firefighters

FUTURE

- The algorithm can be ***embedded*** in a *wearable device* that uses haptic feedback to alert firefighters of unsafe firefighting durations
- Can be adapted for other workers in ***high-risk jobs*** like construction, mining, military, etc.
- By changing the training dataset, the algorithm can also be used to prevent hypothermia

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Comparison of particulate matter (PM) 2.5 concentrations using a low-cost sensor with United States Environment Protection Agency (EPA) measurements

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Introduction

- **PM2.5 (particles < 2.5 μm):** Linked to health risks, environmental harm, reduced visibility, and material damage[1-3]
- **Purple Air sensors:** Low-cost, community-based PM2.5 monitoring tools
- **Sensor correction:** Required for accuracy compared to EPA regulatory monitors[4]
- **Goals:**
  - Calibration and data analysis of Purple Air sensors in Gary, Indiana (industrial pollution zone)
  - Compare Purple Air sensor data vs. nearest EPA regulatory station

Purple Air monitor

EPA regulatory station (IDEM)

Methods

- **Purple Air Data:** Every 2 minutes in 2023 from two Purple Air monitors
- **EPA data:** 24-hour averages, collected every 3-6 days from a central monitor
- **Purple Air calibration:** Using published equations; 24-hour averages calculated
- **Correction equation:** Based on temperature (T) and relative humidity (RH) inside the monitor[6]

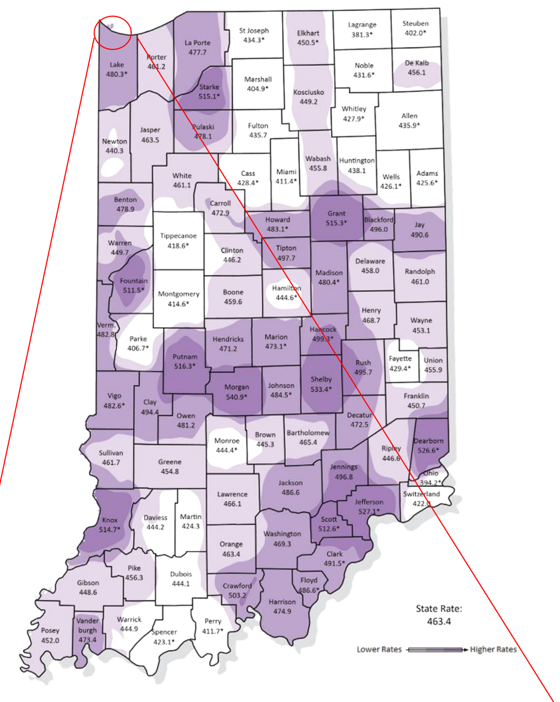
$$CF_u = \frac{PM_{CF=atm}}{0.00025599 \times RH^2 - 0.002648 \times RH + 0.88732}$$

$$PM_{2.5,u} = \frac{CF_u}{0.0020883 \times T^2 - 0.012708 \times T + 1.1235}$$

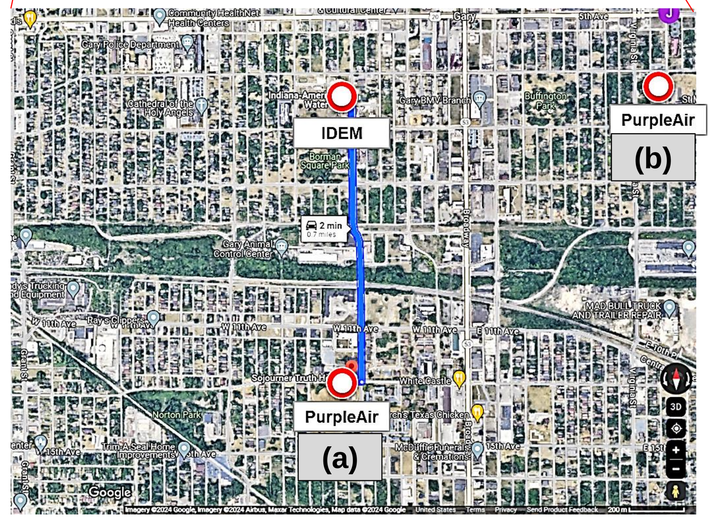
$$PM_{2.5,Gary} = a_0 + a_1 \times PM_{2.5,u} + a_2 \times RH + a_3 \times T + a_4 \times weekend + a_5 \times daytime$$

- **Analysis:** Correlation between adjusted Purple Air data and EPA data using descriptive statistics and linear regression

Results

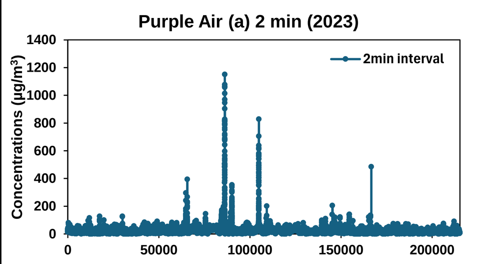
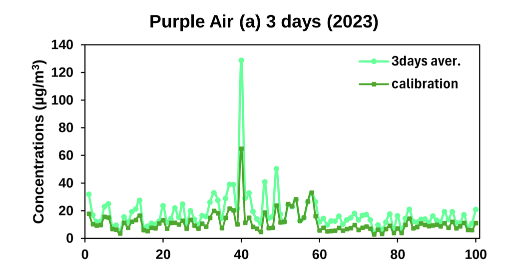
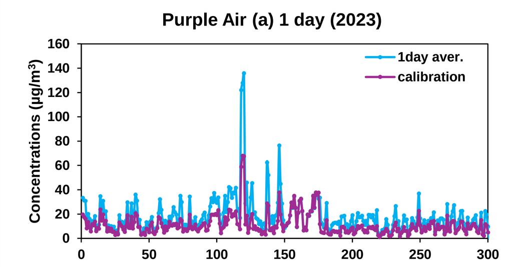
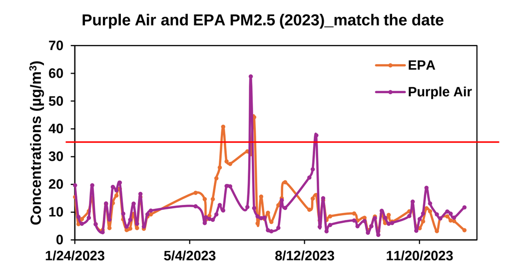
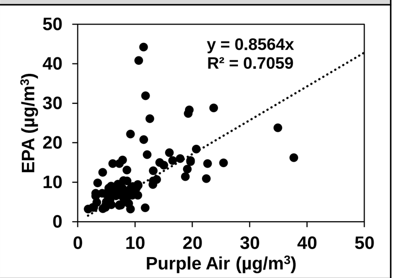
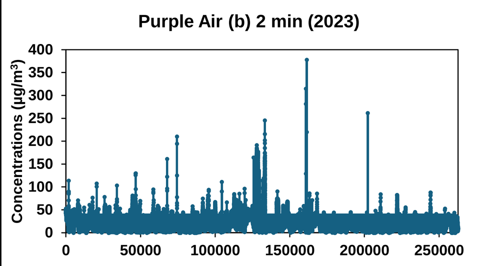
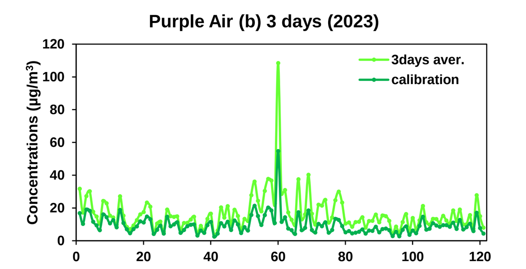
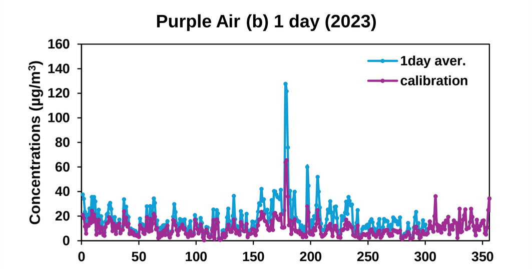
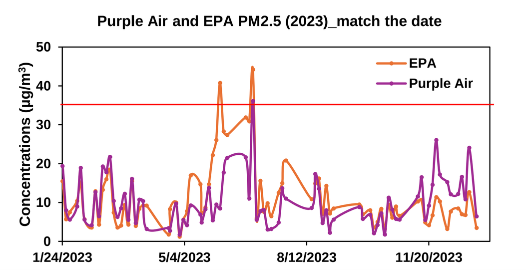
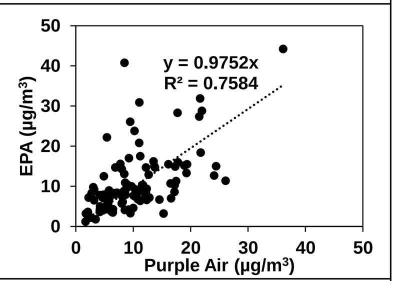


Indiana cancer incidence rate (2021)[5]



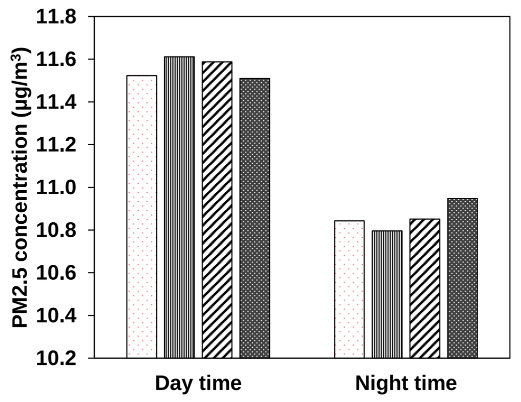
Measurement locations

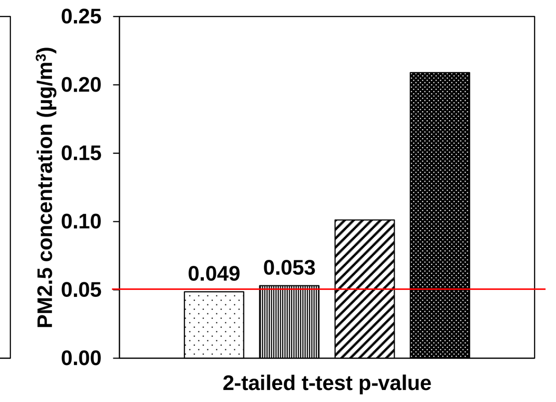
< Calibration and comparison of Purple Air and EPA monitors >

	Raw	3 days average	1 day (24 hours average)	Matched date with 1 day data	Regression analysis
(a)					
PM2.5	< 1200 μg/m³	< 70 μg/m³	< 70 μg/m³	< 60 μg/m³ Correlated r = 0.54, p < 0.05	y = 0.8564x R^2 = 0.7059
(b)					
PM2.5	< 400 μg/m³	< 60 μg/m³	< 70 μg/m³	< 40 μg/m³ Correlated r = 0.57, p < 0.05	y = 0.9752x R^2 = 0.7584

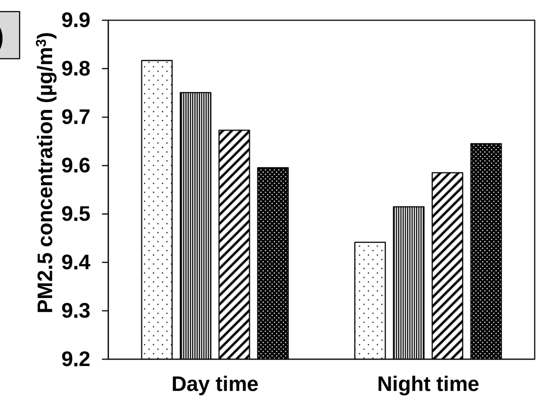
< Day and night-time difference (1 year average) >

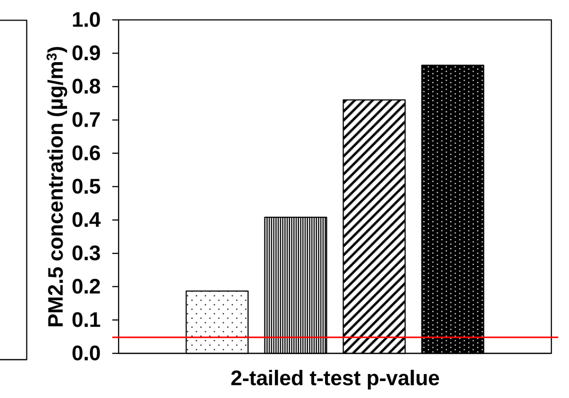
(a)





(b)





	Day time	Night time
(dotted)	6AM-6PM	6PM-6AM
(grey)	7AM-7PM	7PM-7AM
(hatched)	8AM-8PM	8PM-8AM
(black)	9AM-9PM	9PM-9AM

<Comparison of Purple Air and EPA monitors >

	Purple Air (a)	Purple Air (b)	EPA monitor
Date-matched data	N=85	N=104	-
Average 24-hour concentrations	11.23 μg/m³ (SD: 8.52)	-	11.71 μg/m³ (SD: 8.32)
	-	10.36 μg/m³ (SD: 6.16)	11.01 μg/m³ (SD: 7.81)
Days of 24-hour standard (35 μg/m³) <	2 days (2%, 2/85)	1 day (1%, 1/104)	2 days (2%, 2/85)
Linear regression	β: 0.86; 95% confidence interval (CI): [-2.07, 9.94]; R^2: 0.71	β: 0.98; 95% CI: [-1.260, 9.516]; R^2: 0.76	-
Pearson's correlation coefficient	r: 0.54 (p-value < 0.05)	r: 0.57 (p-value < 0.05)	-

Conclusions

- **Purple Air sensors:** Track air quality trends but may have limitations in predicting EPA data under certain conditions
- **Diurnal variations:** Statistically significant differences in PM2.5 between daytime (6 AM – 6 PM) and nighttime (6 PM – 6 AM)
- **Exposure analysis:** Focus on 12-hour intervals, particularly from 9 AM – 6 PM, aligning with active human hours
- **Calibration improvement:** Refinement needed to enhance predictive accuracy
- **Future research:** Investigate optical properties and calculate correction factors by including particle specifics and size distributions, particle shape, and particle composition in Gary, Indiana

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Acknowledgements

This study was supported by NIH/NIEHS (ES032463), Showalter Trust, and the Institute for a Sustainable Future (Purdue University). We thank Abe Orozco-Munoz, Julie Peller, Kenneth Brown, Graham Peaslee, Jodi Allen, and Jon-Paul McCool for their contributions. Special thanks to Sojourner Truth House, Faith Farms, and the Northern Lake County Environmental Partnership for their collaboration.

Psychosocial Factors and Worker Health Impacts in the Museum and Cultural Heritage Industry

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PURDUE UNIVERSITY

INDIANAPOLIS

Abstract

Exposure to traumatic material may result in stress for museum workers who care for items centered in trauma, interpret these difficult narratives to museum visitors or are otherwise exposed to this material. A variety of adverse health effects are associated with these exposures, including anxiety, depression, sleep disturbances, and hypertension. The goal of this study is to raise awareness and to quantify the psychosocial factors of exposure to traumatic material. A better understanding of this stress and psychological trauma will help in developing intervention strategies to improve the working conditions of museum workers.

Background

Museum professionals around the world are not only charged with caring for the tangible items that fit their institution's mission, but also the interpretation of those objects. Sometimes the stories we must tell reveal hard truths. Museum staff deal with the emotional stress of managing these collections and exhibitions. Examples of difficult stories include the casket of Emmett Till at the National Museum of African American History and Culture, items from and stories of victims at the 911 Memorial and Museum & the Holocaust Museums, Many museum professionals are also charged with caring for human remains. This study investigates how museum workers experience stress as part of their job.

Methods

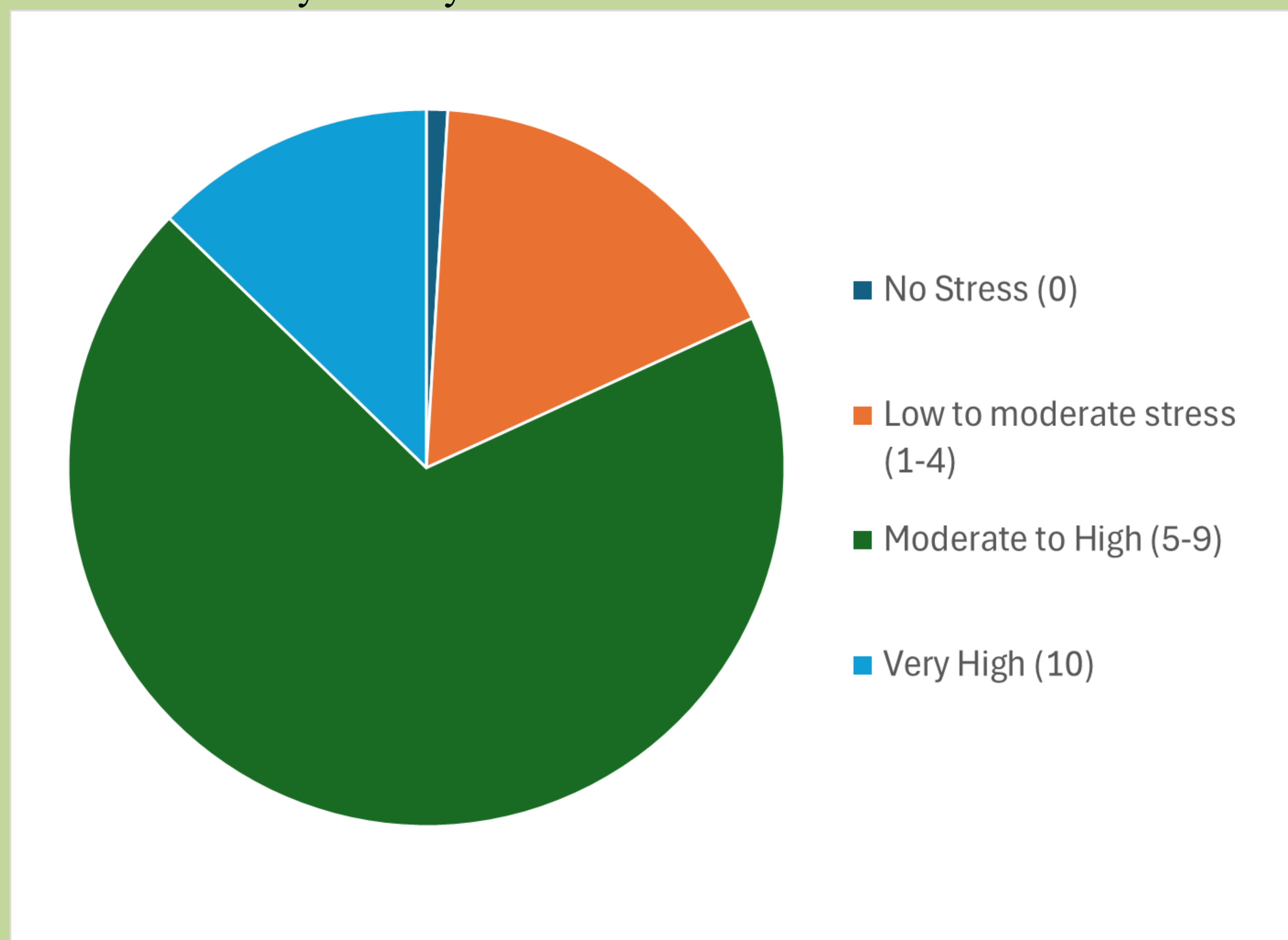
The study includes individuals who care for, curate, and interpret items that can trigger a traumatic response. The NIOSH definition of job stress was utilized in this study. Recruitment is taking place via email announcements and advertisement through museum professional organizations.

Acknowledgement

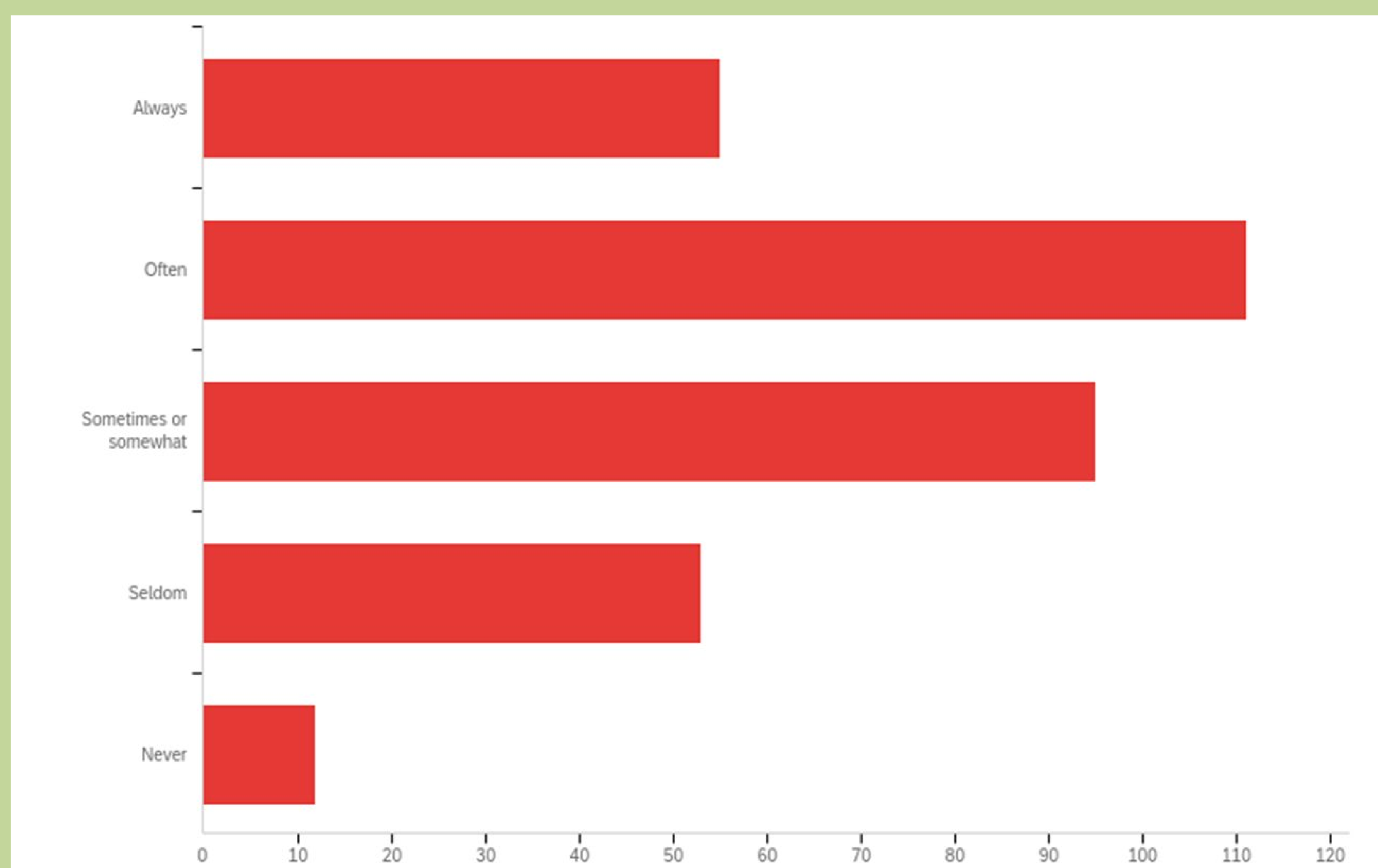
This research was supported by a grant through the University of Michigan COHSE NIOSH Pilot Project Training Grant (T42OH008455)

Results

How would you rate your level of stress on a scale from 0 = no stress



Do you feel burned out because of your work?



Results

During the past two weeks, how much have you been bothered by the following problems?

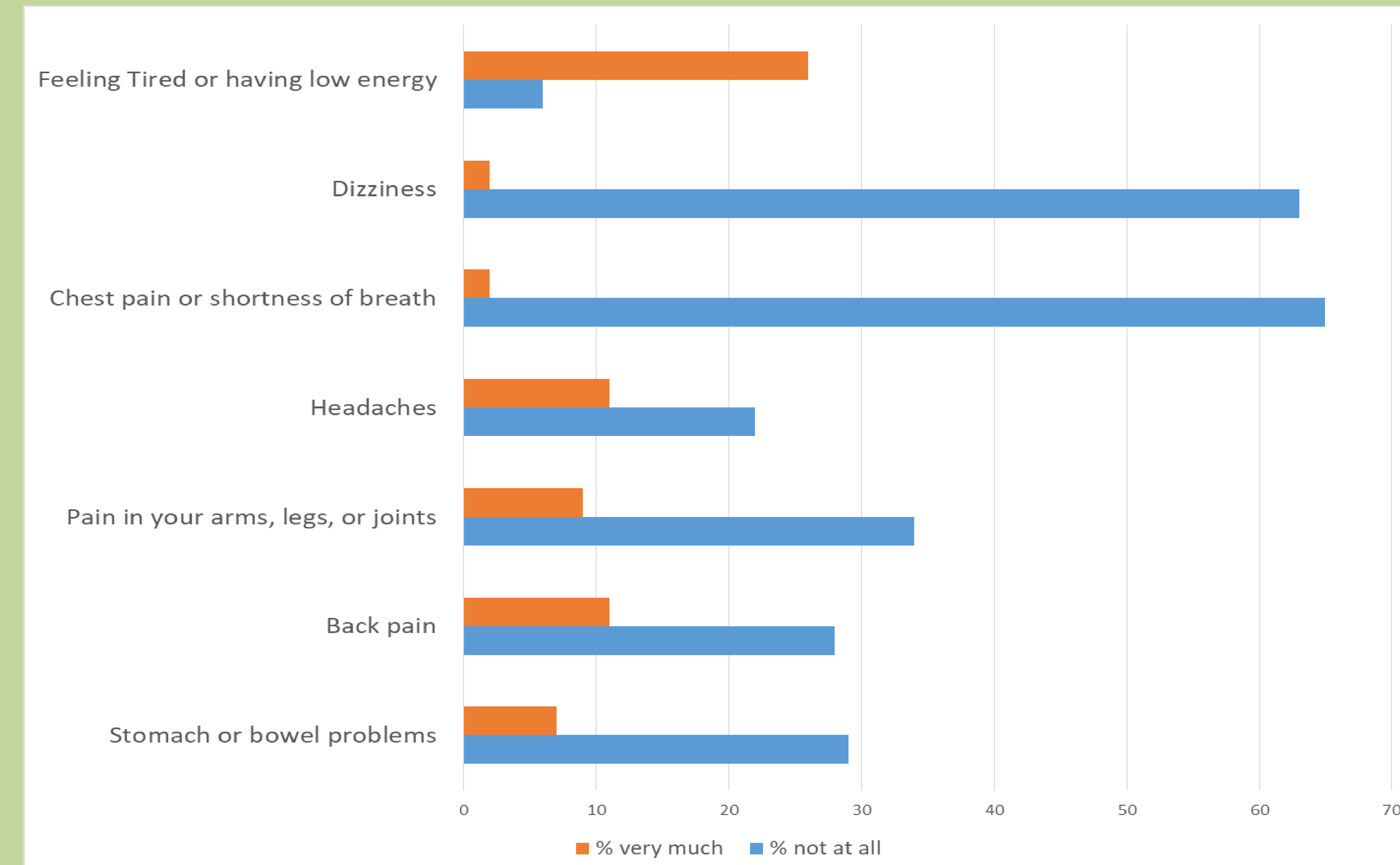


Figure 1: At the 911 Memorial Museum in New York City, Objects of trauma are carefully curated to tell difficult stories.

Discussion

- This study is the first detailed assessment of exposure to traumatic material in the museum industry.
- The majority of participants report a moderate to very high level of stress at work.
- A feeling of being tired or low energy is the symptom museum workers report being bothered by to the greatest extent.

Spatial and temporal assessment of secondhand cigarette smoke exposure to home healthcare workers

Sripriya Nannu Shankar

Department of Environmental & Public Health Sciences, University of Cincinnati

Collaborators: Jun Wang, Kermit Davis, Yevgen Nazarenko, Elizabeth Bien

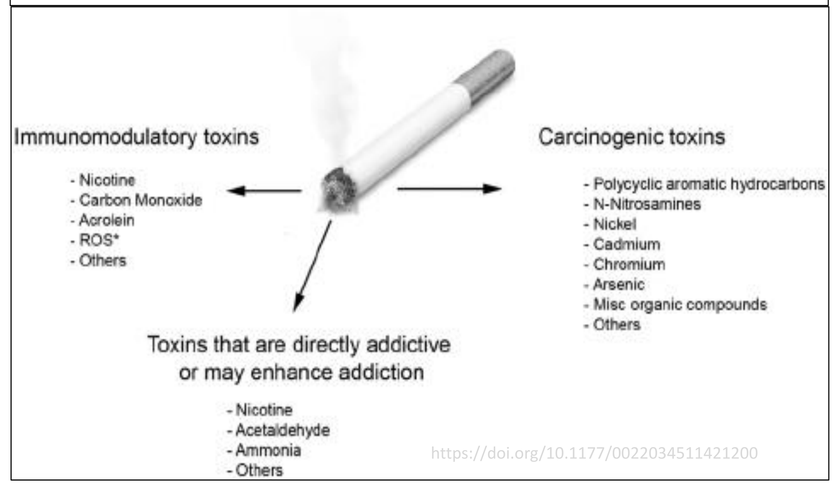
University of Cincinnati Education and Research Center

Introduction

- Home health care and personal care are among the fastest-growing occupations in the USA[1], with a projected growth rate of 22% from 2022 to 2032[2].
- Home healthcare workers (HHCWs) are skilled workers providing medical or nursing care (such as nurses, therapists, home health aides, and medication aides)[3].
- When HHCWs care for patients at the patients' residences, the chances of being exposed to secondhand smoke (SHS) are higher.
- Over 7,000 chemicals have been identified in SHS, of which at least 69 are carcinogens[4].

SHS = Mainstream smoke + Side stream smoke

Cigarette smoke is a mixture of thousands of chemicals generated from the burning or heating of tobacco

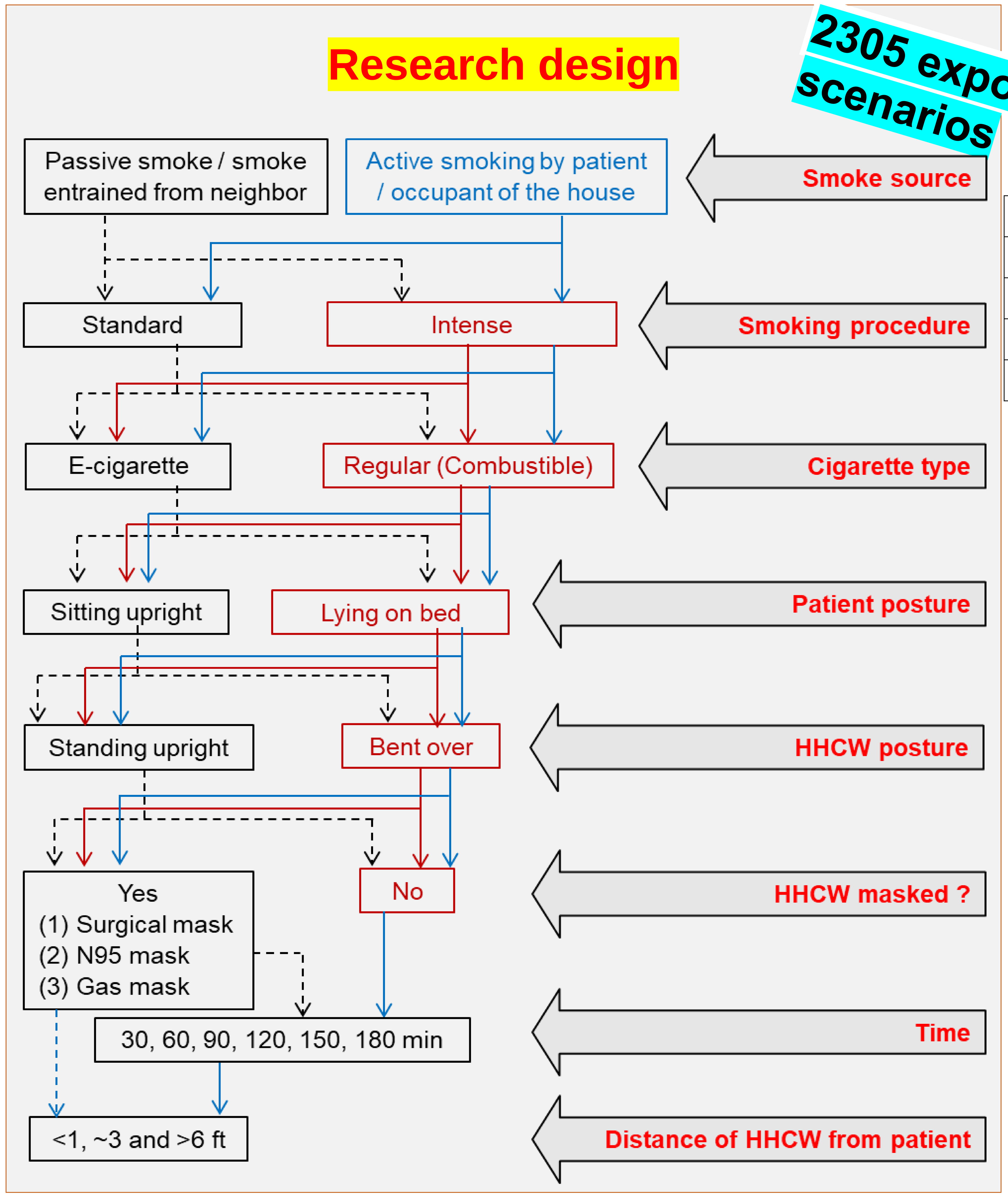


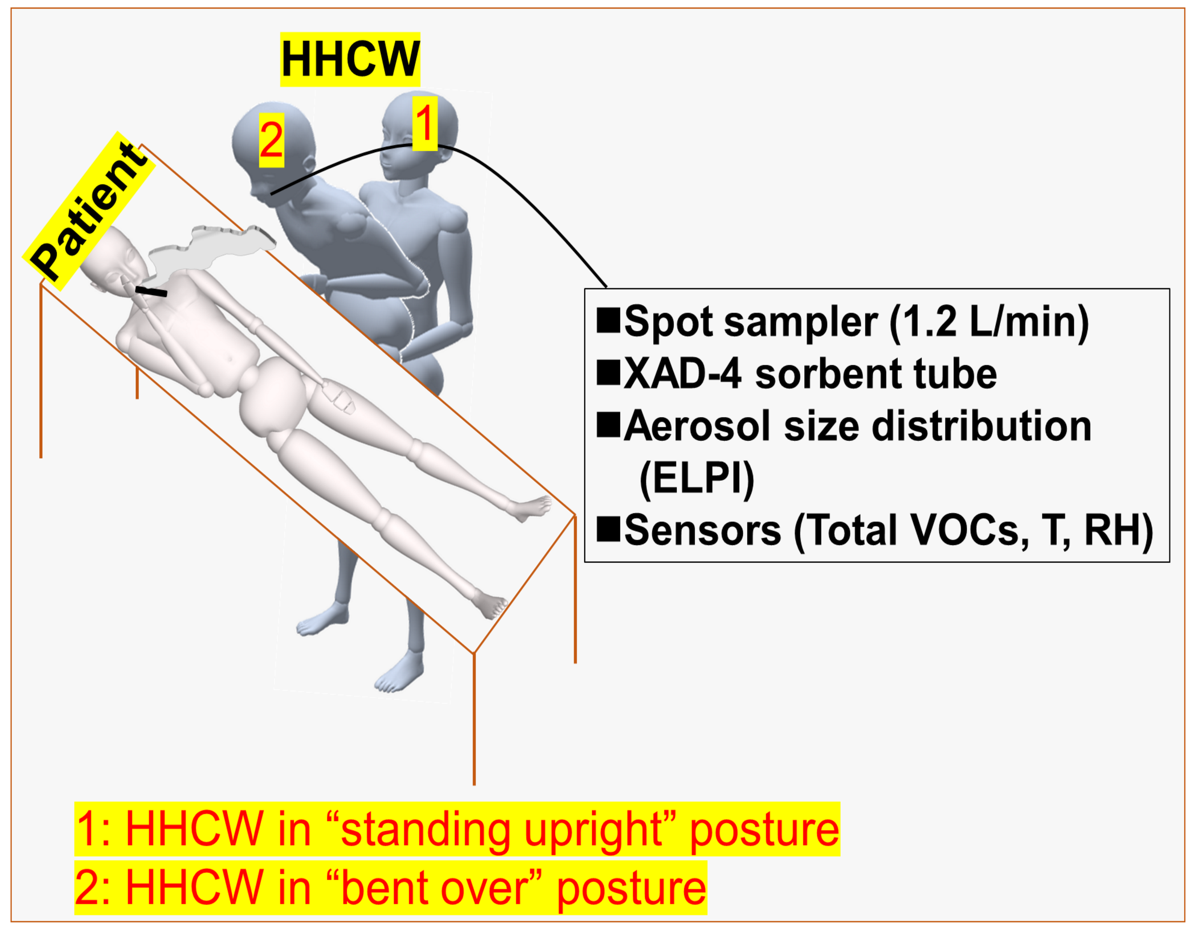
- There are **no studies that provide quantification of SHS** compounds that HHCWs are exposed to[5].

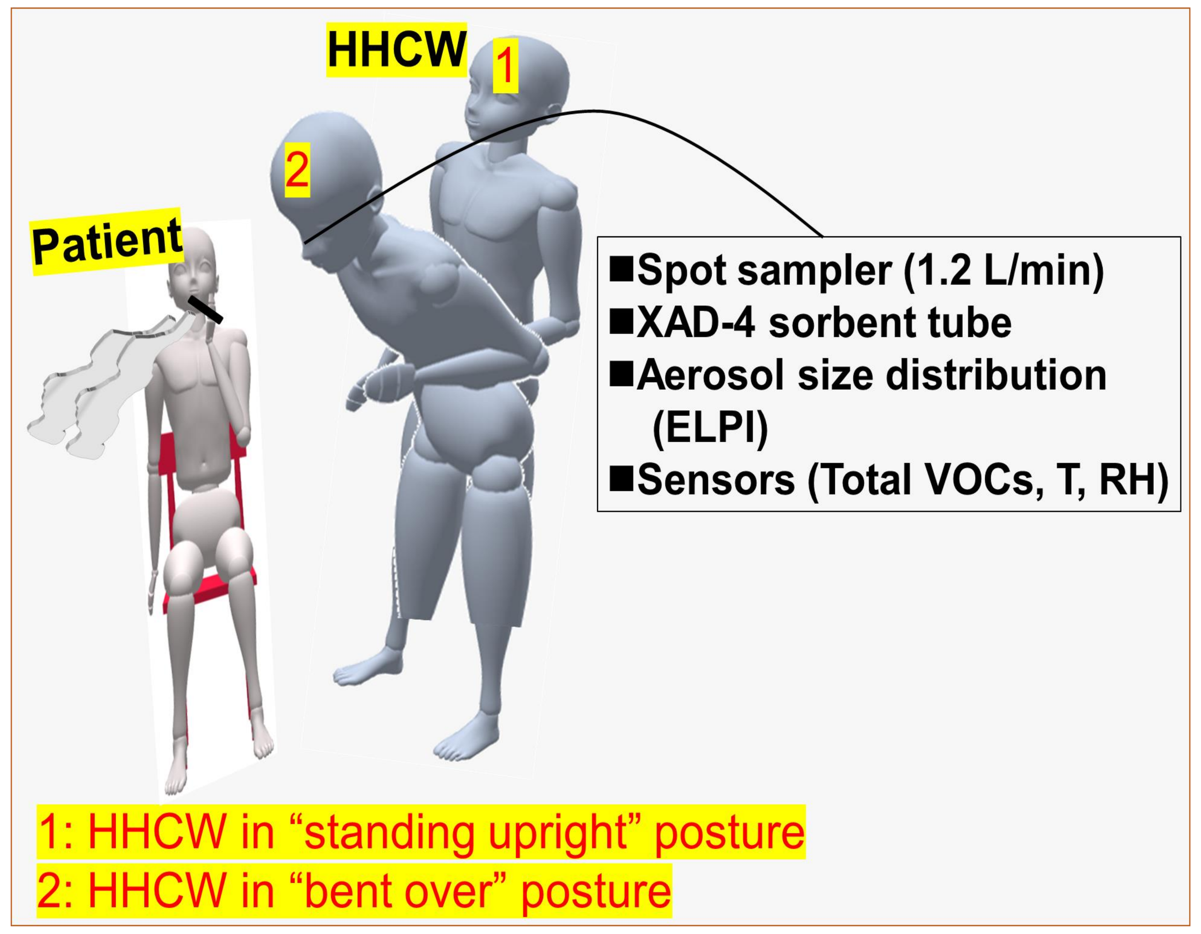
Aims

- Determine the temporal and spatial distribution of SHS compounds collected in scenarios that mimic exposures to HHCWs in real life (Manikin based studies).
- Determine the oxidative potential and inflammatory action of smoke compounds using acellular assays.

Research design







Manikin images produced using https://setpose.com/

There is NO safe level of exposure to SHS !!

ISO recommended regimes[6-8]

	Standard	Intense
Puff volume	35 mL	55 mL
Puff duration	2 s	2 s
Puff frequency	60 s	30 s

Significance

- Particulate vs. Gas phase compounds – Inflammatory action / Oxidative potential
- Effectiveness of PPE
- Interdisciplinary focus (Exposure assessment of aerosols, Ergonomics, Nursing)

Relevance to NORA

(1) Objective 5.2.1 (Investigate how cigarette smoking interacts with occupational exposures to adversely impact respiratory health) of cross-sector NORA for Respiratory Health; and
(2) Objective 16 (Explore the impact of emerging and existing work organization factors and nontraditional systems on worker health and safety, with emphasis on low-wage occupations).

Acknowledgements

This research study is supported by the National Institute for Occupational Safety and Health through the Pilot Research Project Training Program of the University of Cincinnati Education and Research Center Grant #T42OH008432.

Contact

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nannussa@ucmail.uc.edu

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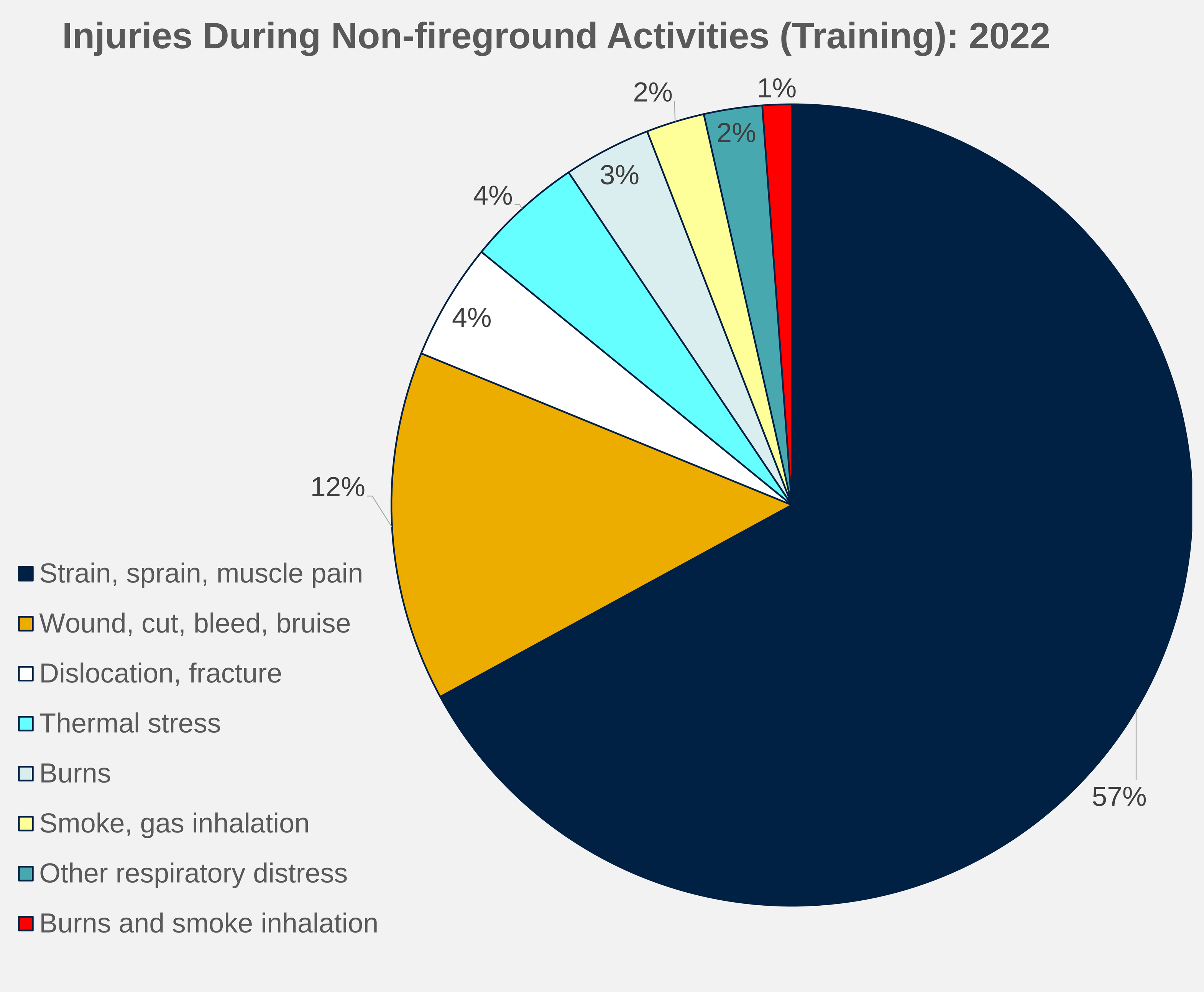
Utilizing Artificial Intelligence with Digital Human Modeling to Assess Risk of Musculoskeletal Disorders in Non-fireground Firefighter Activities

MURRAY STATE UNIVERSITY

Susan Miller, PhD and Julie Boyd, PhD
Murray State University, Department of Occupational Safety and Health

Background



Campbell, R.; Hall, S. United States Firefighter Injuries in 2022; National Fire Protection Association: Quincy, MA, 2023.

Objectives

- **Specific Aim 1: To examine movements most commonly utilized in non-fireground training activities posing the greatest risk of MSDs for firefighters.**
  Utilizing AI with digital human modeling to assess and rank ergonomic risks based on a severity analysis, we hypothesize that identifying precise high-risk movements in a work cycle will more effectively show the best corrective action(s) to protect firefighters from future MSD injuries.

- **Specific Aim 2: To determine most effective corrective actions for each high-risk, non-fireground ergonomic task for firefighters.**
  We hypothesize that addressing highest-risk ergonomic tasks first will maximize the impact of reducing MSDs in firefighters during routine tasks.

Study Population

- 12-15 full-time employed local firefighters that have been professionally trained in all non-fireground activities.
- Results of the study will be shared with the individual participants as well and the leadership of the fire department to make effective changes.

Experimental Design

Qualitative	Semi-Quantitative	Quantitative
Employee Interviews	Process Observations	TuMeke® AI Digital Modeling Tool
Nordic Questionnaire	Rapid Entire Body Assessment	

Expected Results

- Multiple ergonomic issues will be identified while firefighters perform regular, daily tasks in non-fireground activities.
- Strains, sprains, and muscle pain will be the leading type of injuries reported and identified during the assessment.
- Training in techniques to reduce the mechanical load on parts of the musculoskeletal system involved in ergonomically challenging tasks, such as bending and lifting, can reduce injuries to the back and upper extremities in firefighters.
- Better aerobic fitness is associated with a lower risk of sprain and strain injuries in firefighters, underscoring a need for structured fitness programs in firefighter injury prevention.

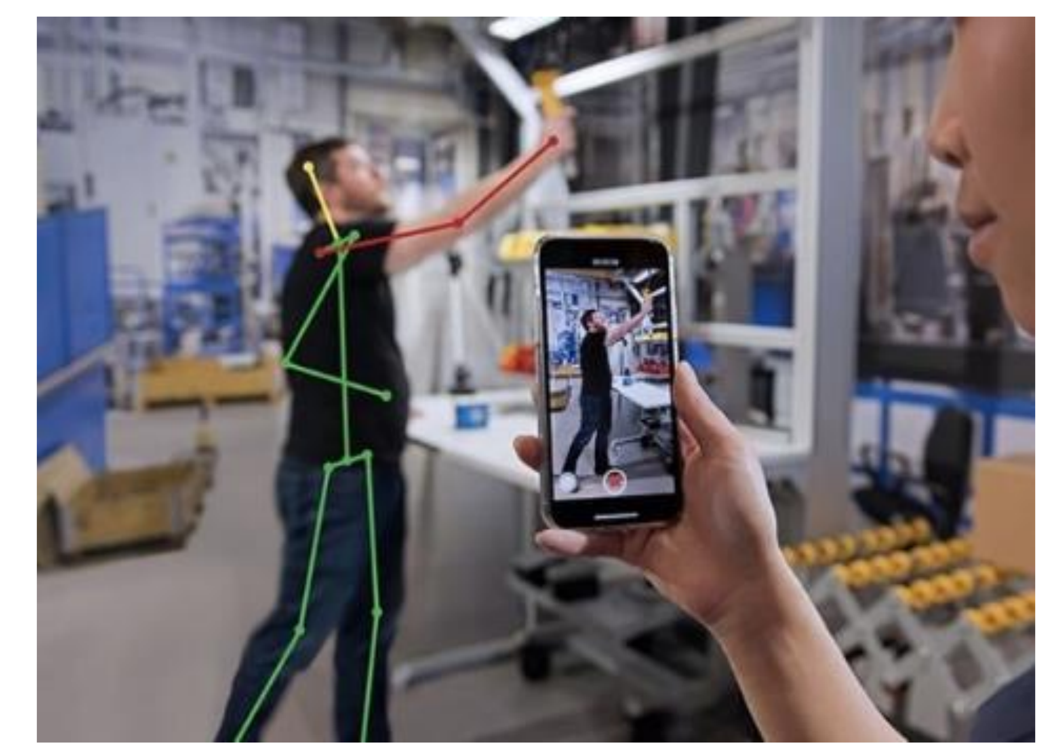
Future Direction

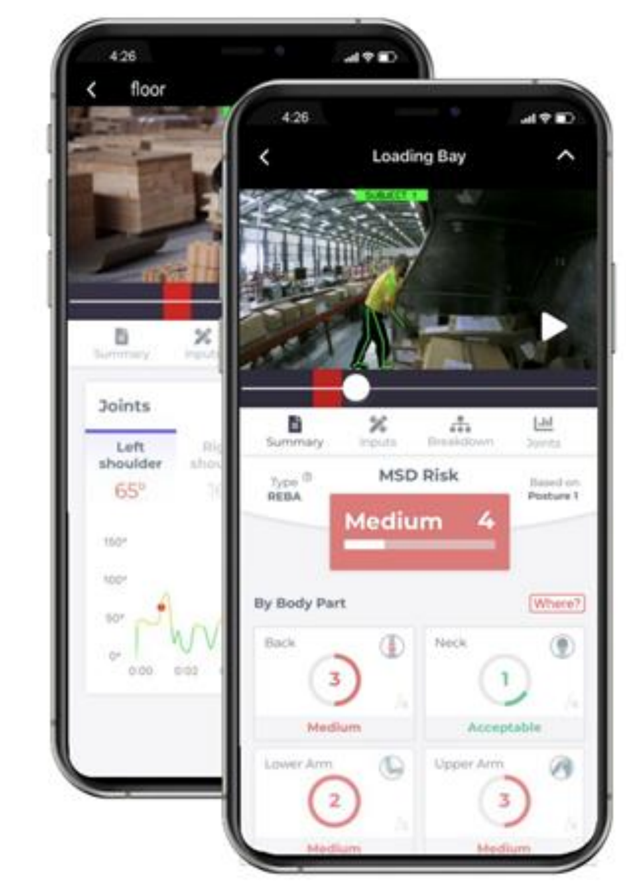
- Presently, studies employing AI technology are scarce, necessitating further investigation to establish its methodological validity conclusively.
- While some studies have validated sensor technology for assessing ergonomic risk factors, there is a notable absence of research utilizing AI tools.
- Integration of AI tools could aid in identifying ergonomic hazards and furnish objective data to bolster enhancements in processes and employee training.
- Additional investigations are slated to delve into MSD risks among firefighters, fostering an ongoing partnership dedicated to enhancing their safety and health practices.

Task Description

- **Camera-based assessments of ergonomic issues**
  Use iPad camera with TuMeke® app to videorecord firefighters as the pre-selected non-fireground tasks are performed
  - Checking equipment at beginning of shift
  - Rolling fire hoses
  - Raising ladder
  - Donning and doffing SCBA

- **Comprehensive risk analysis**
  - Summary of risk using standard MSD assessment techniques
  - High-risk postures highlighted by AI in video
  - Risk score assigned to each body region
  - Joint angles visualized in charts for deeper analysis





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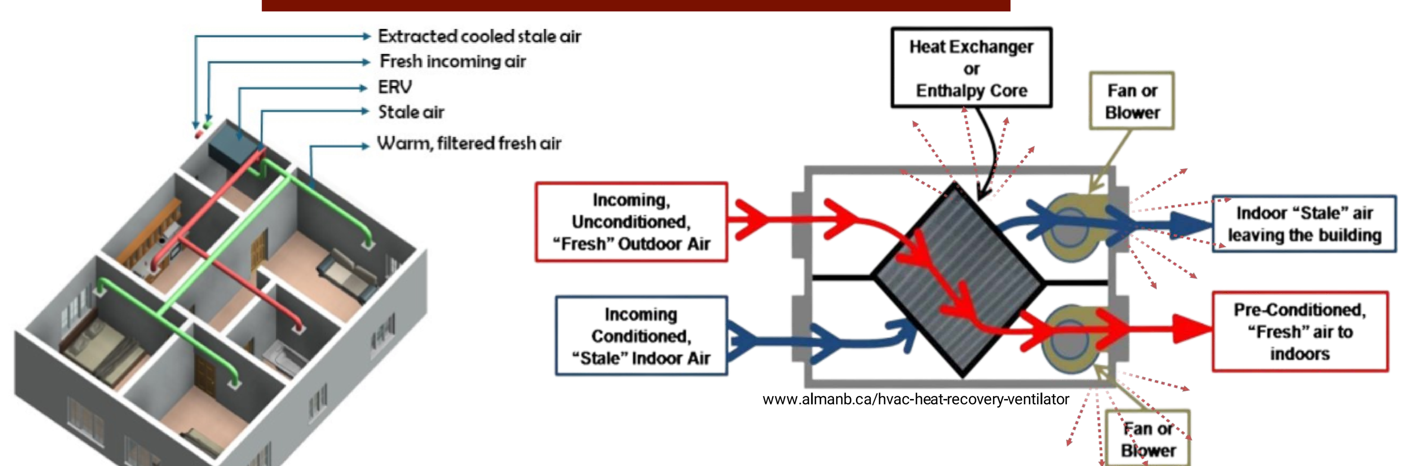
Effects of Energy Recovery Ventilation on Nanoparticulate and Gaseous Indoor Air Pollution

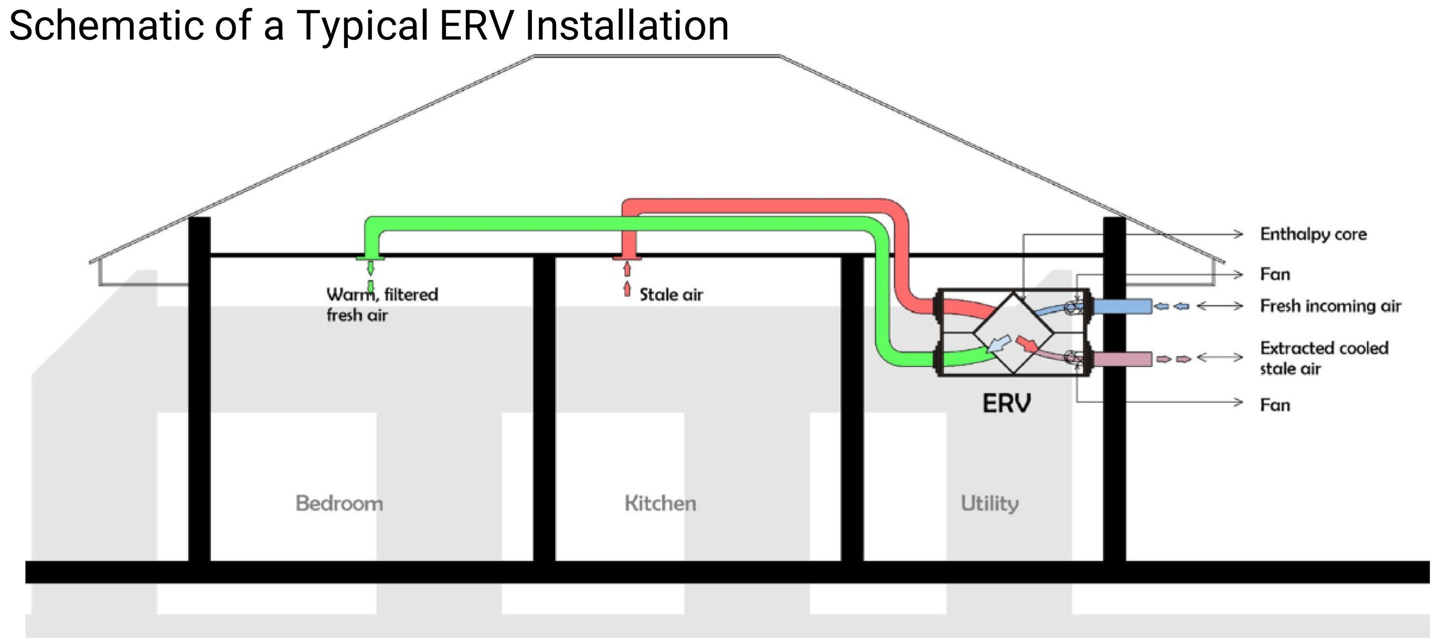
Onyinye Ezeifeka and Yevgen Nazarenko
Department of Environmental & Public Health Sciences, University of Cincinnati, Ohio, USA

BACKGROUND



Air Pollutant Circulation Indoors with an ERV Installed

Schematic of a Typical ERV Installation



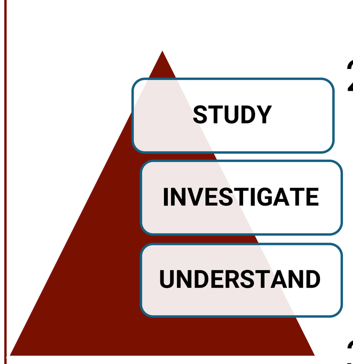
Sectional view of a building showing ERV Connection/Installation

Energy Recovery Ventilators (ERVs) improve indoor air quality (IAQ) when indoor spaces are sealed and must be heated or cooled.[2] ERVs bring in fresh outdoor air and remove stale indoor air but transfer moisture and heat between them. The energy used for heating or cooling is conserved.

We don't know enough about ERVs' effects on indoor air pollutants. There are gaps in the knowledge about the impact of ERVs on th removal, circulation, introduction, and physical and chemical transformations of indoor air pollutants. Practically nothing is known about the impact of ERVs on nanoaerosols and volatile organic compounds (VOCs).

To address this knowledge gap, we will analyze chemical identities, measure nanoaerosol size distributions, and determine cross-contamination patterns. This information will help minimize unintended air pollutant generation and spread by ERVs. The results will inform ERV design and selection and be used by engineers, policymakers, and heating, ventilation and air conditioning (HVAC) professionals to engineer healthier indoor environments using ERVs. The project supports the PRPT Program's occupational safety and health focus.

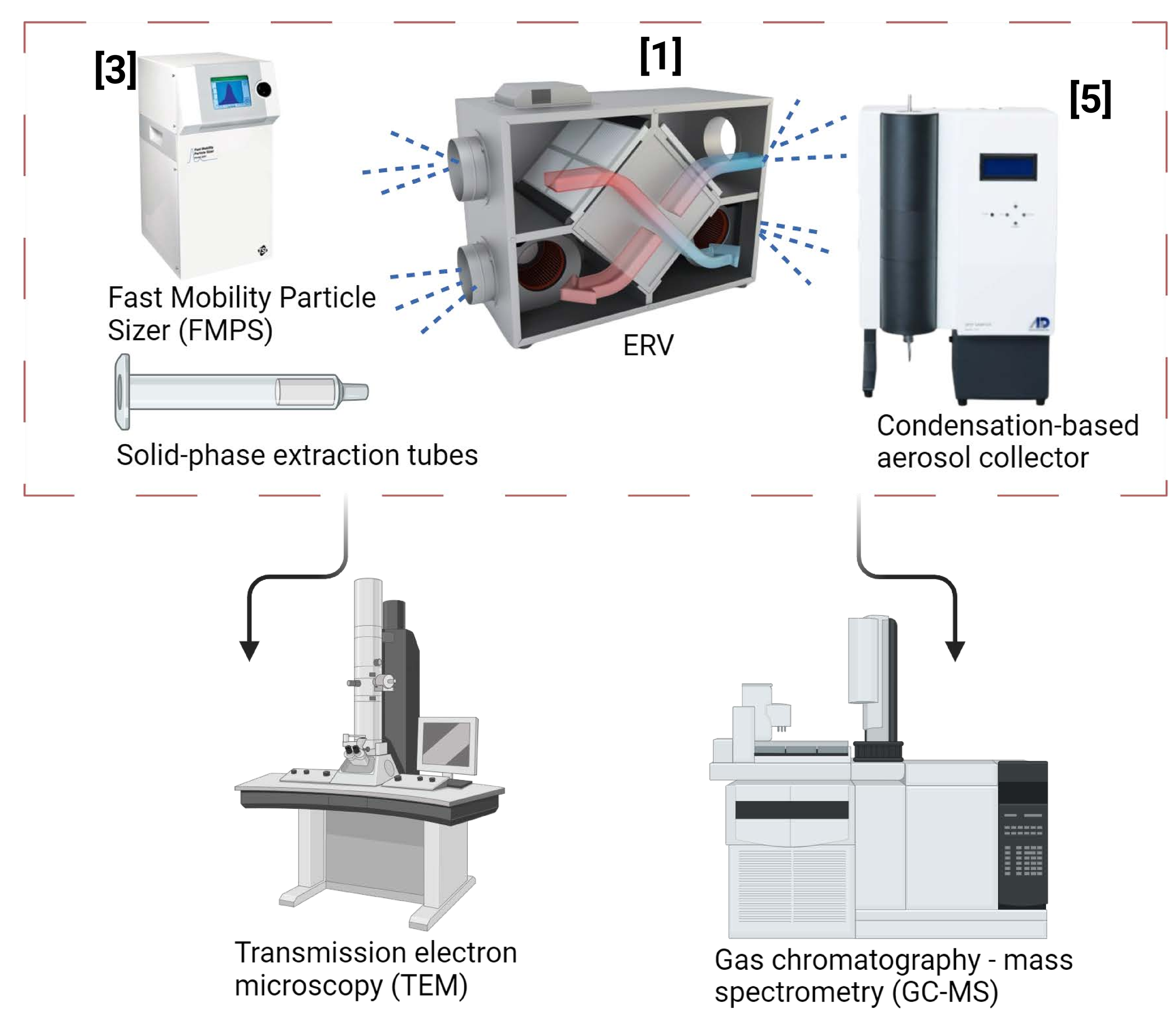
OBJECTIVES



1. Characterize the aerosols generated by ERVs, particle deposition in ERVs, and aerosol dynamics inside ERVs.
2. Investigate (a) cross-contamination and carry-over between exhaust and fresh air streams; (b) particle resuspension from surfaces inside ERVs; (c) effects of different operating regimes on nanoaerosol generation and removal with different ERVs.
3. Characterize VOC contaminants sorbed from the air during high-pollution episodes, such as indoor space cleaning and wildfires, and their subsequent slow release.

EXPERIMENTAL DESIGN

- Various ERVs will be installed in the lab, along with real-time aerosol analyzers, aerosol samplers, and VOC samplers.
- Aerosol concentrations and size distributions will be measured using a particle sizer. A condensation-based aerosol collector (Spot) will be used to collect samples for particle analysis by Transmission Electron Microscopy (TEM) with Energy Dispersive Spectroscopy (EDS).
- Samples for VOC analysis will be collected using solid-phase extraction (SPE) tubes and analyzed by GC-MS and HPLC. Relative humidity will be continuously monitored using RH probes.



TASK DESCRIPTION

- Step 1 — Acquisition and installation of equipment
- Step 2 — Testing of experimental setup
- Step 3 — Data and sample collection
- Step 4 — Data analysis and results interpretation
- Step 5 — Report writing, publication and conference presentations
- Step 6 — Extramural grant applications

LIMITATIONS

- The laboratory-based experimental setup for ERV testing facilitates good repeatability in a controlled environment but differs from a real house installation, which may limit the generalizability of the results to the broad range of real-world indoor environments.
- We may not accurately mimic real-world indoor airflow dynamics, affecting pollutant dispersion and ERV performance.
- It might be impossible to mimic seasonal variations in air quality and ERV performance.

EXPECTED RESULTS

- Determine how ERVs affect the concentration and aerosol size distribution of indoor nanoaerosols and VOCs.
- Characterize cross-mixing and carry-over of nanoaerosols and VOCs between ERV components.
- Gain insights into chemical reactions inside ERVs.

FUTURE DIRECTION

- Expand the experimental matrix and the range of investigated chemical identities to better understand how ERVs impact indoor nanoaerosols and VOCs under varying environmental conditions.
- Investigate how ERV design and operational parameters affect air contaminant retention, release and transformations.
- Probe the implementation of several novel material science and engineering approaches to enhance air purification by ERV systems and reduce pollutant accumulation and emissions.
- Work with ASHRAE to develop guidelines for ERV design and use.

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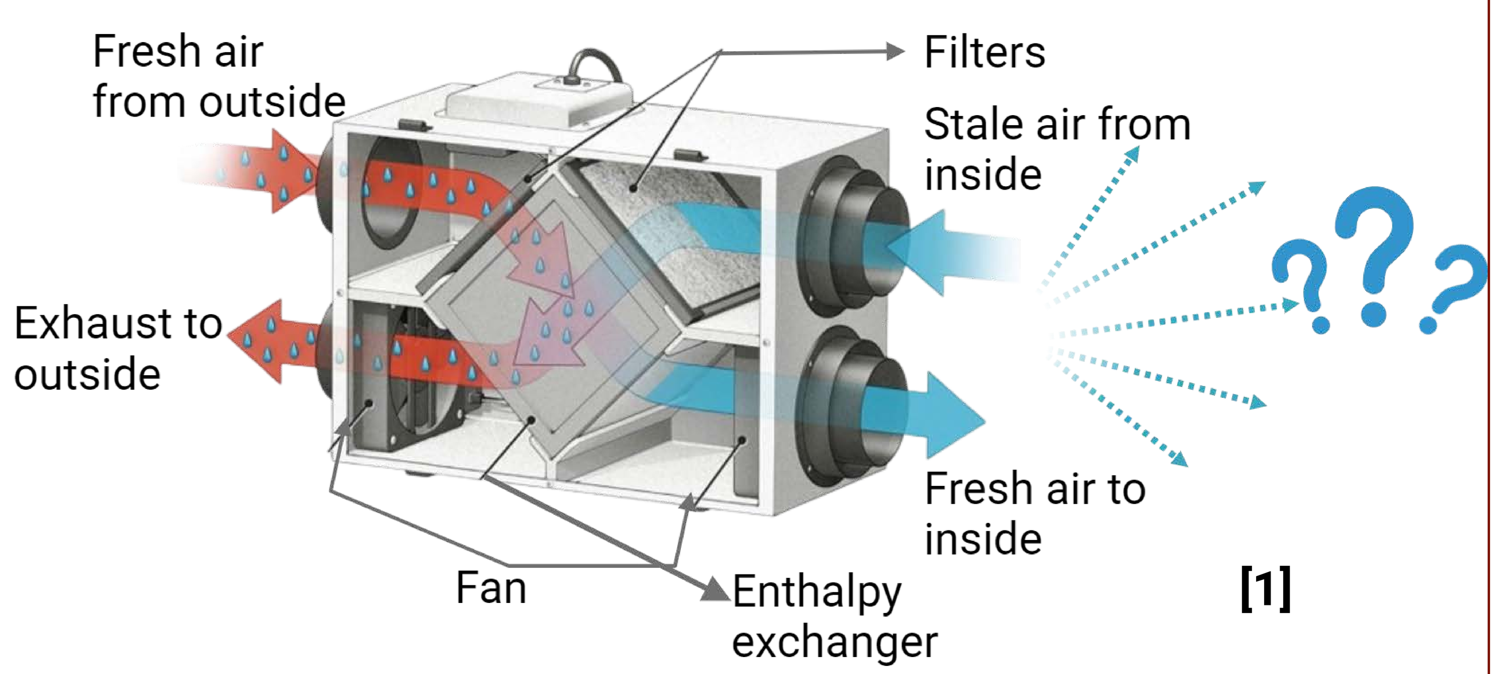
This research study was supported by the National Institute for Occupational Safety and Health through the Pilot Research Project Training Program of the University of Cincinnati Education and Research Center Grant #T42OH008432

Effects of Energy Recovery Ventilation on Nanoparticulate and Gaseous Indoor Air Pollution

Onyinye Ezeifeka and Yevgen Nazarenko
Department of Environmental & Public Health Sciences, University of Cincinnati, Ohio, USA

BACKGROUND



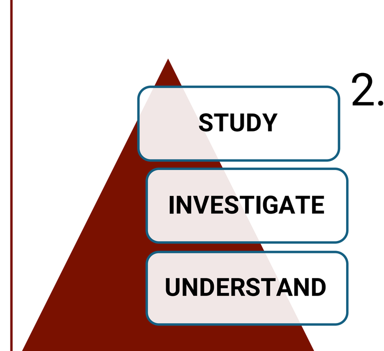
Energy Recovery Ventilators (ERVs) are an essential solution for improving indoor air quality in areas where indoor spaces must be heated or cooled.[2] ERVs enhance indoor air quality (IAQ) by bringing in fresh outdoor air and removing stale indoor air while conserving energy used to heat or cool indoor air.

Very little is known about the effects of ERVs on the removal, circulation, introduction and transformations of indoor air contaminants, including their physical and chemical transformations. Practically no research has been performed to specifically assess the impact of ERVs on nanoaerosols and volatile organic compounds (VOCs) in indoor air.

We aim to address this knowledge gap in our understanding of ERVs' impact on nanoaerosols and VOCs indoors. By analyzing chemical identities and cross-contamination patterns, we aim to generate knowledge that will help minimize unintended air pollutant generation and spread. The project will generate valuable information for engineers, policymakers, and heating, ventilation and air conditioning (HVAC) professionals to create healthier indoor environments by informing ERV design and selection.

The project supports the PRPT Program's occupational safety and health focus.

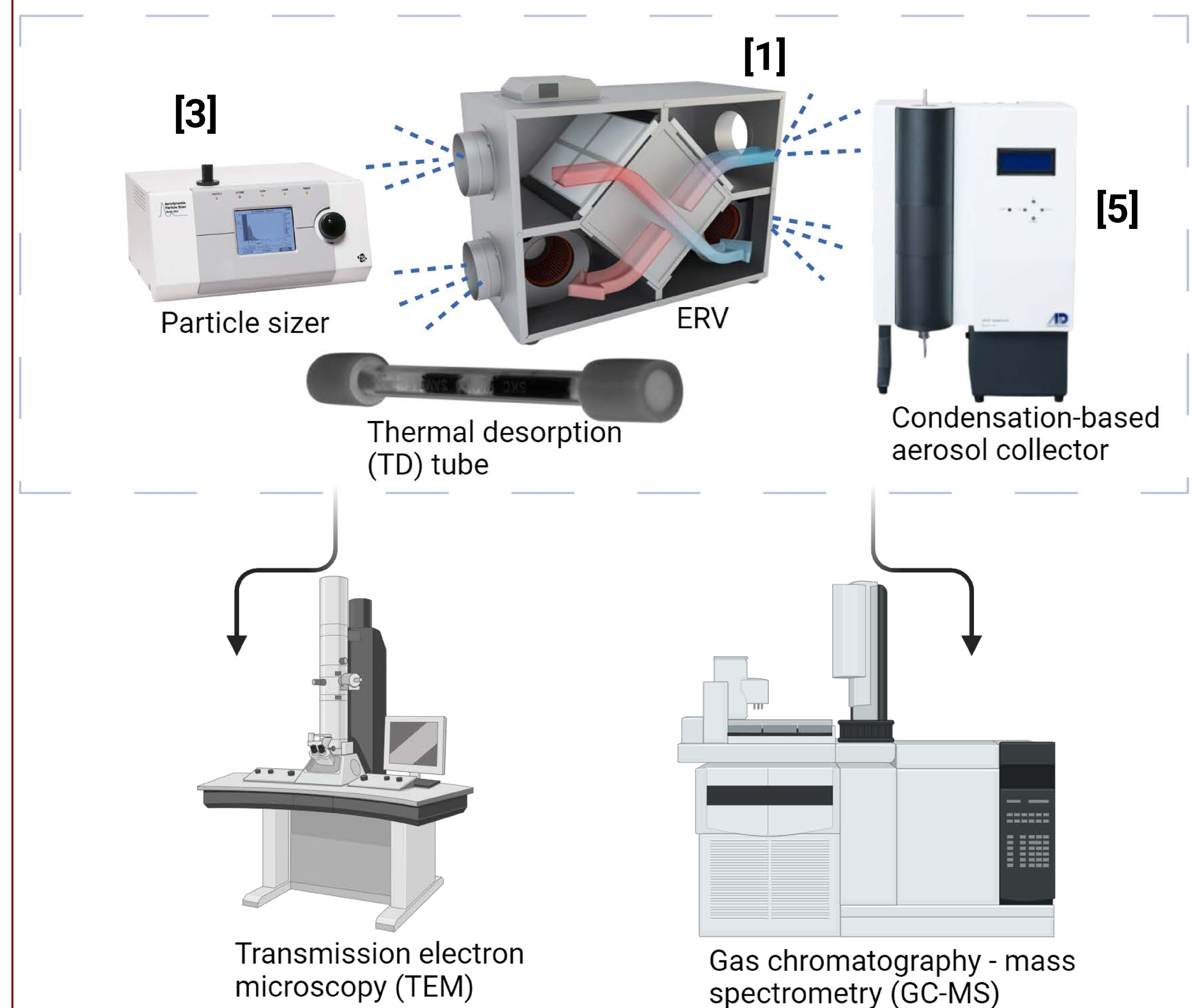
OBJECTIVES



1. Characterize the aerosols generated by ERVs, particle deposition in ERVs, and aerosol dynamics inside ERVs.
2. Investigate cross-contamination and carry-over between exhaust and fresh air streams. Investigate resuspension from surfaces inside ERVs and the effects of different operating regimes on nanoaerosol generation and removal with different ERVs.
3. Characterize contaminants retained from the air during pollution episodes such as indoor space cleaning and subsequently released, as well as other VOC emissions.

EXPERIMENTAL DESIGN

- Various Energy Recovery Ventilators (ERVs) will be installed in the lab, along with real-time aerosol analyzers, aerosol and VOC samplers.
- Aerosol concentrations and size distributions will be measured using a particle sizer, while a condensation-based aerosol collector (Spot) will be used to collect samples for particle analysis by TEM with EDS.
- Air samples for VOCs will be collected using solid-phase extraction (SPE) tubes and thermal desorption (TD) tubes and analyzed by GC-MS. Relative humidity will be continuously monitored using RH probes.



TASK DESCRIPTION

Step 1	Acquisition and installation of equipment
Step 2	Testing of experimental setup
Step 3	Data and sample collection
Step 4	Data analysis and results interpretation
Step 5	Report writing, publication and conference presentations
Step 6	Extramural grant applications

LIMITATIONS

- The laboratory-based experimental chamber may not fully replicate all real-world conditions, potentially limiting the generalizability of the findings to diverse indoor environments.
- Differences in the performance and efficiency of various ERV models and manufacturers may introduce variability in the results, making it challenging to draw definitive conclusions applicable to all ERVs.

EXPECTED RESULTS

- Improved understanding of how ERVs affect the concentration and distribution of indoor nanoaerosols and VOCs.
- Identification of cross-mixing and carry-over of nanoaerosols and VOCs between ERV components
- Insight into the chemical reactions occurring inside ERV units

FUTURE DIRECTION

- Expand the experimental matrix and the range of investigated chemical identities to better understand how energy recovery ventilators (ERVs) impact indoor nanoaerosols and VOCs under varying environmental conditions.
- Investigate how ERV design and operational parameters affect air contaminant retention, release and transformations.
- Probe the implementation of several novel material science and engineering approaches to enhance air purification by ERV systems and reduce pollutant accumulation and emissions.
- Work with ASHRAE to develop guidelines for ERV design and use.

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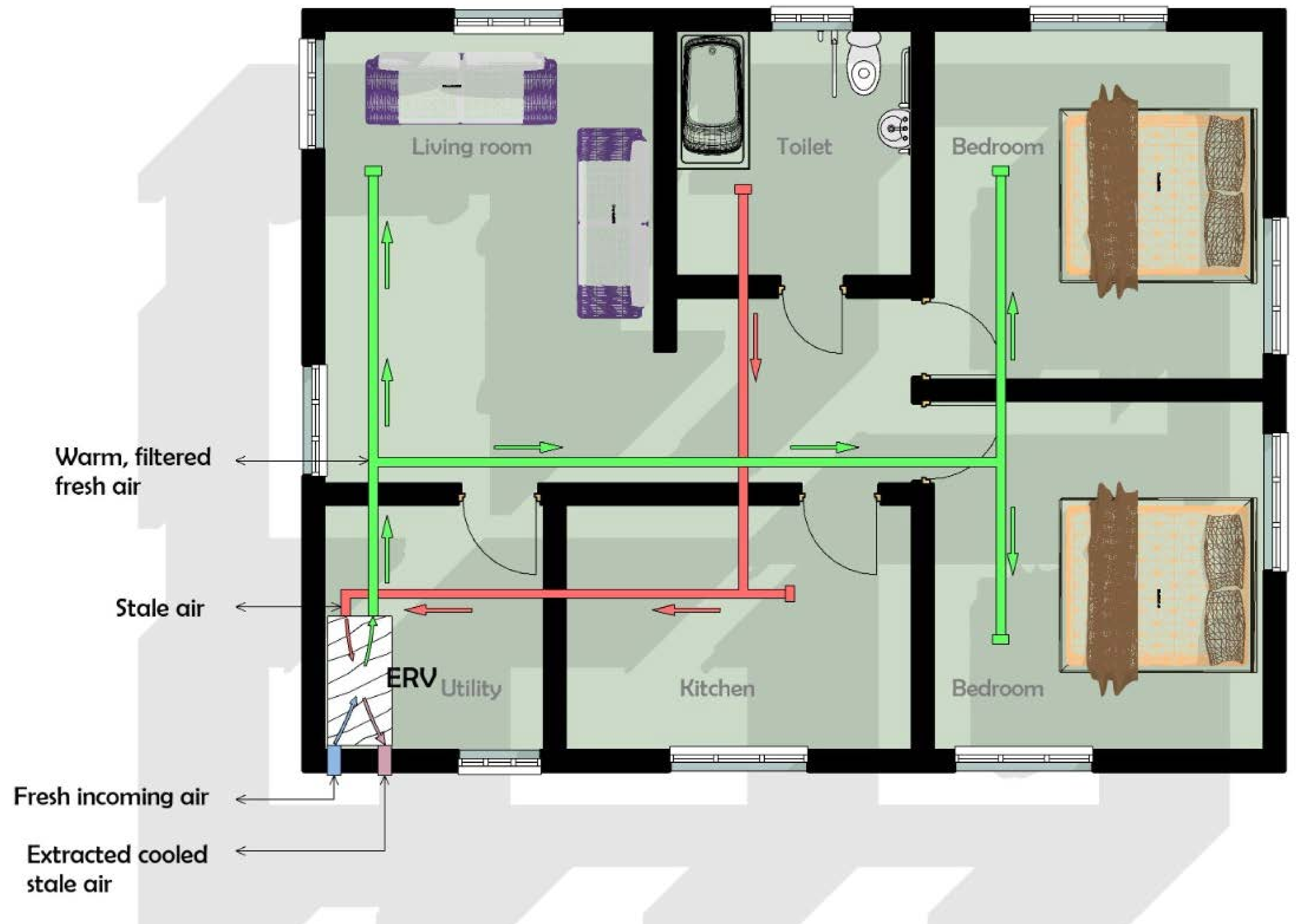
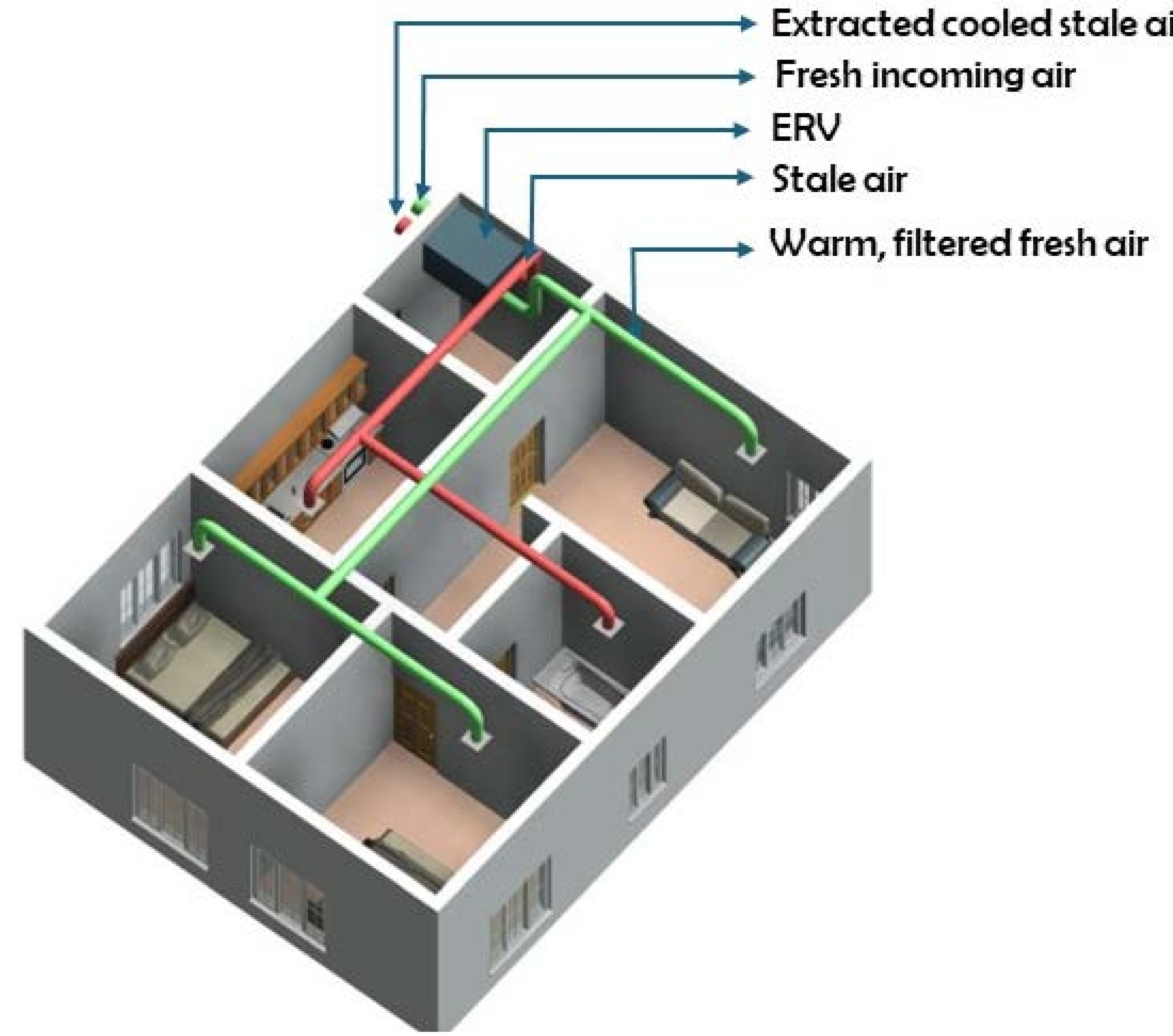
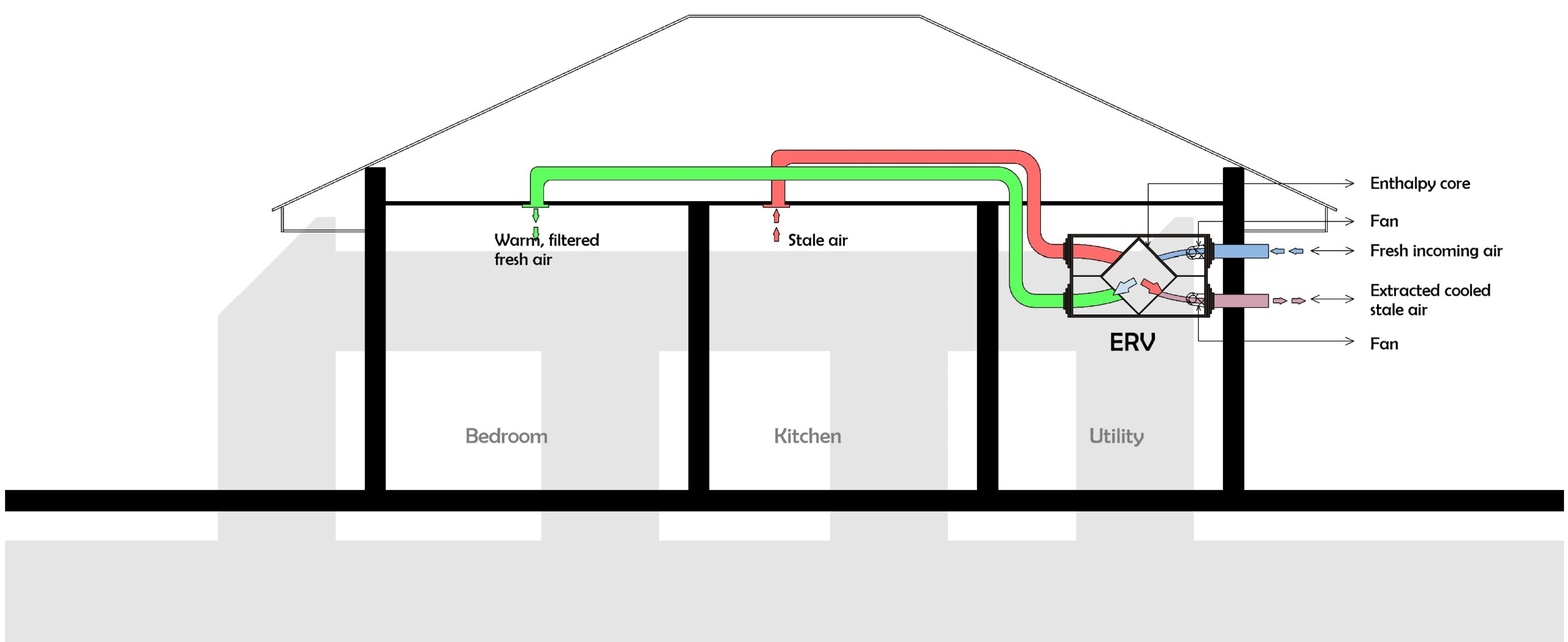
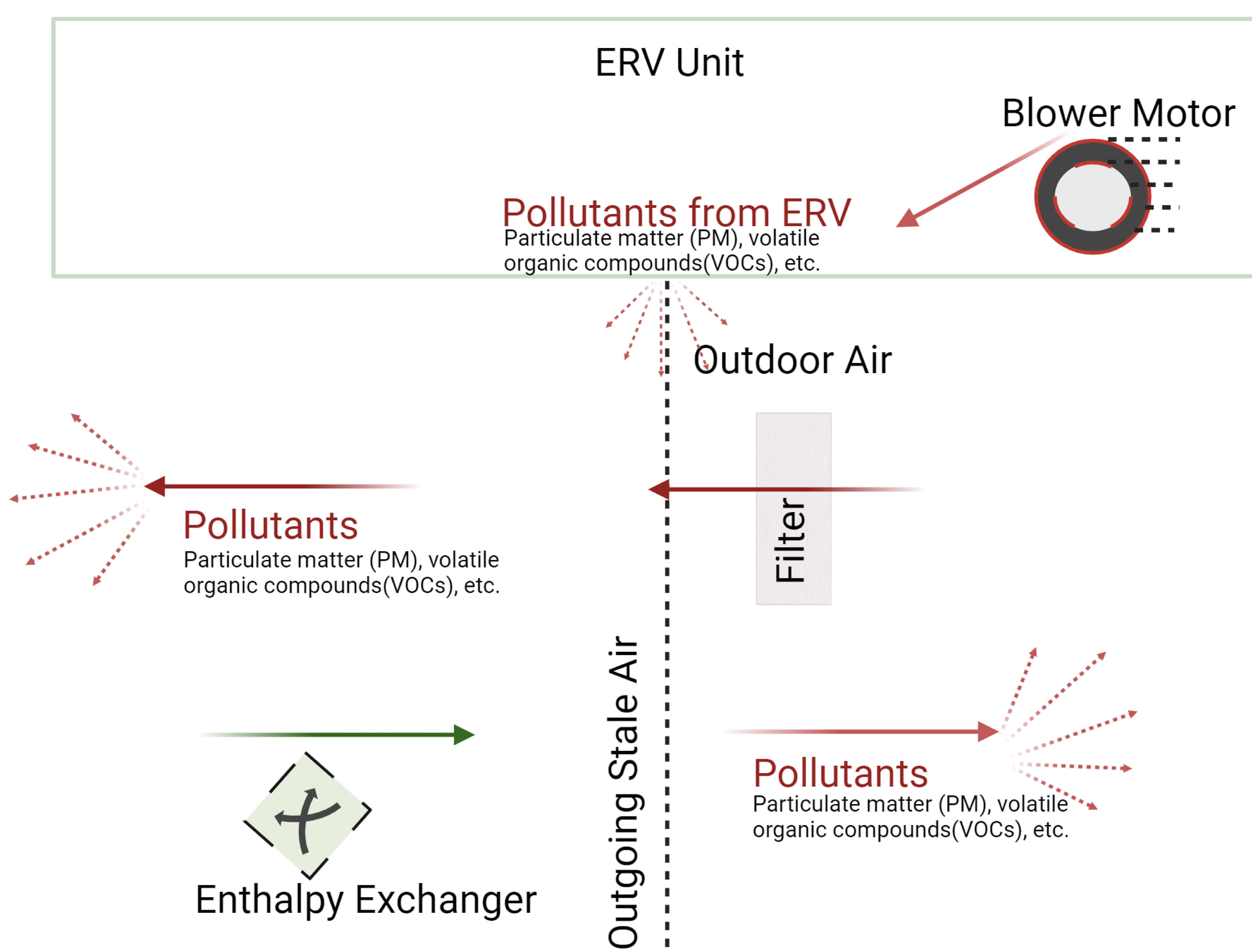

Living room
Toilet
Bedroom
Warm, filtered fresh air
Stale air
ERV
Utility
Kitchen
Bedroom
Fresh incoming air
Extracted cooled stale air


Extracted cooled stale air
Fresh incoming air
ERV
Stale air
Warm, filtered fresh air


Enthalpy core
Fan
Fresh incoming air
Extracted cooled stale air
Fan
Warm, filtered fresh air
Stale air
ERV
Bedroom
Kitchen
Utility



Winter and Summer Scenarios
https://www.swinter.com/party-walls/multifamily-passive-house-ventilation-design-part-2-hrv-or-erv/