Title: Reduction of exposure to simulated respiratory aerosols using ventilation, physical distancing, and universal masking_dataset

Dataset Number:

Introduction

The association between human respiratory disease transmission by respiratory droplets and aerosols is well established for several known pathogens.1 Given that the average individual spends > 90% of their day indoors, there has been intense focus on factors associated with indoor transmission. To minimize exposure risks, the Centers for Disease Control and Prevention (CDC) recommends behavioral and personal protective equipment mitigation strategies to limit COVID-19 transmission, including wearing masks, maintaining physical distances of $\geq$ 1.8 m, and avoiding crowded indoor and outdoor spaces. As such, the current investigation examines the combined effect of physical distancing, universal masking, and ventilation on exposure to airborne particles generated during breathing and coughing within a controlled indoor environment. The results of this investigation quantitatively examine the contribution of the matrix of controls employed and provides guidance on respiratory disease mitigation strategies within the indoor environment.

Methods

1. **Environmental Chamber and Ventilation**
    a. The testing environment consisted of an environment chamber measuring 3.15 m x 3.15 m x 2.26 m (gross internal volume of 23.8 m^3). An internal re-circulating HEPA filtration system was used for ventilation.
    b. Six Grimm 1.108 optical particle counters (OPCs) were positioned at height of 152 cm throughout the chamber to measure salt aerosols.

2. **Aerosol Source and Simulators**
    a. The source simulator had a head form with pliable skin coughed and exhaled aerosols produced from a 14% w/v KCl solution nebulized by a single jet Collison atomizer.
    b. To simulate a recipient, a breathing simulator with a pliable skin head form breathed while an OPC was affixed next to the mouth to measure aerosols as a proxy of exposure.

3. **Experimental Procedure**
    a. For experimental trials with masking conditions, a three-ply cotton mask was fitted to the respective simulator and fit measured using the PortaCount Pro+ in the N95 mode.
    b. For masking, the combinations of no masking (neither simulator wore a mask) and universal masking (both simulators wore a three-ply cotton mask) were examined.
    c. For physical distancing, 0.9 m and 1.8 distances were examined.
    d. For ventilation, four ACH rates were selected: 0, 4, 6, and 12.

e. After the ventilation stabilized, the source simulator was initiated to cough or exhale. Aerosol concentrations were measured for 15 minutes using the OPCs.

4. **Data Processing and Statistical Analysis**
    a. The mean mass concentration was calculated as the average mass concentration over the test duration and served as the exposure metric in these simulations.
    b. Regression modeling was performed in R using the base linear model (*lm*) function using a logarithmic transformation of the mean mass concentration at the mouth of the breathing recipient against three predictor variables
        i. Masking (Unmasked = 0 and Masked = 1; categorical)
        ii. Distance (0.9 m = 0 and 1.8 m = 1; categorical)
        iii. Theoretical ACH (0, 4, 6, and 12; continuous)
    c. All point estimates are presented as the arithmetic mean ± 1 standard deviation of the measured mean mass concentration.
    d. All statistical analysis were conducted using the R statistical environment v. 4.0.2.

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