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A Mobile App to Measure Facial Dimensions and Predict Respirator Size

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ABSTRACT

The current workflow for sizing military respirators is time consuming, manually intensive, and tedious, but is necessary due to the critical need for respirators to fit properly, especially in operating environments when Warfighters may be exposed to chemical, biological, radiological, and nuclear threats. To reduce the time and resource cost of the fitting process, Technology Solutions Experts, Inc. developed a software application to rapidly generate a 3D model of a user's face, accurately compute anthropometric measurements, and estimate the appropriate size of a respiratory protective mask. In this paper, we discuss implementing our 3D model generation and size prediction methodology in a mobile app, and collecting and analyzing data to measure the methodology's predictive capability. Our verification and validation results show that our current method for fit prediction is insufficient to replace traditional fit tests. However, there is evidence to suggest that face measurements obtained from 3D models can produce fit predictions as accurate as hand measurements but in a fraction of the time, and without subject matter expertise.

Keywords: Respirator, mask, fit, 3D, model, prediction, face, images, measurements, anthropometry

The Effect of Particle Size, Membrane Type, and Face Velocity on TiO_2-Containing Paint Dust Filtration

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ABSTRACT

The U.S. Centers of Diseases Control suggests the use filtering facepiece respirators (FFRs) for painters and related construction occupations. Engineered titanium dioxide (TiO_2) nanoparticles, shown to be more tumorigenic than bulk TiO_2, are prevalent in paint formulations. Specific occupational protection protocols are developed to manage tasks associated with TiO_2-containing paints and dust. In this study, the efficacy of different types of filtration membranes, namely, packed polypropylene (used in N95 FFRs), cellulose acetate, polycarbonate and polytetrafluoroethylene to remove paint dust containing TiO_2 nanoparticles was examined at various conditions. The particle mass size distribution of paint dust was measured using real-time 10-stage Quartz Crystal Microbalance (QCM) cascade impactor. Particles above 300 nm were more efficiently removed by cellulose acetate and polytetrafluoroethylene membranes. The filtration efficiency dropped rapidly for smaller particles in the 100-300 nm range. The results showed that the filtration efficiency of packed polypropylene membrane increased as particle size decreased with the highest computed for particles below 100 nm. This may be due diffusion by Brownian motion and electrostatic attraction. The low collection efficiency of cellulose acetate for the most penetrating and harmful particles below 100 nm was improved by increasing the face velocity. These results can be used by manufacturers to select materials for their respirators. The results can also facilitate future studies on the design and optimization of respirators using polypropylene or cellulose acetate membranes to remove the most potent TiO_2-containing ultrafine paint dust particles.

Keywords: Engineered TiO_2 nanoparticles, paint dust, ultrafine particles, N95 membrane, cellulose acetate