Effectiveness of Filtering Facepiece Respirators and Elastomeric Half-mask Respirators against Nanoparticles

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ABSTRACT

Objective: Filtering facepiece respirators (FFRs) and elastomeric half-mask respirators (EHRs) are commonly used by workers for protection against potentially hazardous particles, including engineered nanoparticles. The purpose of this study was to evaluate the effectiveness of these types of respirators against nanoparticles using a salt aerosol generated in an exposure chamber.

Methods: Simulated workplace protection factors (SWPFs) were measured for 8 respirator models (two series N95 and P100 for each FFR and EHR type) worn by 25 healthy test subjects (12 males and 13 females) with varying face sizes. Before performing an SWPF test**,** each subject passed a quantitative fit test. Each SWPF test was performed using six exercises for three minutes each: 1) normal breathing, 2) deep breathing, 3) moving head side to side, 4) moving head up and down, 5) bending at the waist, and 6) cleaning exercise. Two scanning mobility particle sizers (SMPSs) were used to measure air samples outside and inside the respirator simultaneously, and the SWPF was calculated as a ratio of the outside to inside particle concentrations across the size range measured (20-400 nm).

Results: Geometric mean SWPF (GM-SWPF) was the highest for the P100 EHRs, followed by P100 FFRs, N95 EHRs, and N95 FFRs. This trend holds true for nanoparticles, larger size particles (>100 nm) or all size range. All respirators provide better or similar protection levels for nanoparticles as compared to larger particles in the 100-400 nm size range. This study found that the P100 respirators provided higher SWPFs compared to the N95 respirators ($p < 0.05$) for both EHRs and FFRs and that the P100 and N95 EHRs provided better performance than the P100 and N95 FFRs ($p < 0.05$), respectively.

Conclusions: All respirators tested provided effective protection (5^{th} percentile SWPF > 10) against nanoparticles. This finding supports the current respirator selection logic.