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Comparison of the Physiological Effects of Wearing a Dust Mask and a Breath–Synchronized Powered Air-Purifying Respirator – a Comparative Crossover Study

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ABSTRACT

Background: Few studies have examined the physiological effects of wearing respiratory protective equipment in Japan. The aim of this study was to evaluate the physiological effects of wearing a dust mask (replacement–type) and a breath–synchronized powered air purifying respirator (BS–PAPR).

Methods: Eight non-smoking healthy men aged 20 to 39 years participated in this study. We randomly divided the subjects into three groups and conducted a comparative crossover study with a counterbalanced design to control for experimental order effects. The participants underwent exercise tests under three conditions: not wearing a mask, wearing a dust mask and wearing a BS-PAPR. We measured several physiological indicators, including respiration rate, fractional gas concentration in the respirators (fraction of expired carbon dioxide ($FECO_2$) and fraction of inspired carbon dioxide ($FICO_2$)), blood pressure, heart rate, double products and New Borg scale score. These parameters were analyzed using a repeated analysis of variance.

Results: Comparison among the three conditions showed no significant difference in blood pressure, heart rate, double products, respiratory rate, or degree of subjective fatigue. However, the respiratory rate tended to be lower when wearing a BS–PAPR than when wearing a dust mask. Similarly, the New Borg scale score tended to be lower when wearing a BS–PAPR than when wearing a dust mask. $FECO_2$ and $FICO_2$ values were significantly lower when wearing a BS–PAPR than when wearing a dust mask before and after the exercise test, although there was no significant difference during exercise.

Conclusions: Our findings suggest that use of a BS–PAPR may reduce the burden on the respiratory system due to exercise loading, and improve subjective fatigue compared to a regular dust mask.

Keywords: Respiratory protective equipment, Breath–synchronized powered air purifying respirator, Dust mask, Physiological effects, Subjective fatigue

History of U.S. Respirator Approval (Continued) - Gas masks, Supplied-air respirators, and Chemical cartridge respirators

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ABSTRACT

This article is the third in a series of four articles on respirator history. This article continues to follow the history of respirator approval, use, and improvements in the US as discussed in our article entitled, *History of U.S. Respirator Approval*, published in the ISRP Journal, Vol. 35, No. 1, 2018 (Spelce. et. al. 2018). In addition, a 1957 respirator decision logic diagram illustrates the U.S. Bureau of Mines (USBM) rules to follow for respirator selection (USBM 1957).

Keywords: respirator approval, certification history, USBM respirator decision logic

Assessment of Two Personal Breathing Recording Devices in a Simulated Healthcare Environment

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ABSTRACT

Background: In the field of respiratory protection for healthcare workers (HCWs), few data are available on respiratory airflow rate when HCWs are performing their work activities. The objective of this study was to assess the performance of two wearable breathing recording devices in a simulated healthcare environment.

Methods: Breathing recording devices from two different manufactures "A" and "B" were assessed using 15 subjects while performing a series of simulated healthcare work activities (patient assessment; vitals; IV treatment; changing linen; carrying weight while walking; normal breathing while standing). The minute volume (MV, L/min), mean inhalation flow (MIF, L/min), peak inhalation flow (PIF, L/min), breathing frequency (f, breaths/min), and tidal volume (TV, L/min) measured by each device were analyzed. Bland-Altman method was applied to explore the variability of devices A and B. Duncan's multiple range test was used to investigate the differences among activity-specific inspiratory flow rates.

Results: The average MV, MIF and PIF reported by device A were 23, 54, and 82 L/min with 95% upper confidence intervals (CIs) of 25, 60 and 92 L/min; the mean differences of MV, MIF and PIF presented by the two units of device A were 0.9, 1.3, and 2.8 L/min, respectively. The average values and mean differences of MV, MIF and PIF found with device B were significantly higher than device A ($P<0.05$), showing a high variability. During non-speech activities, the PIF/MV and MIF/MV ratios were >3.14 and >2, while with speech, the ratios increased to >6 and >3. The f during speech (15 breaths/min) was significantly lower than non-speech activities (20-25 breaths/min). Among different simulated work activities, the PIF of "patient assessment" was the highest.

Conclusions: This study demonstrated a novel approach to characterize respiratory flow for healthcare workers using an innovative wearable flow recording device. Data from this investigation could be useful in the development of future respirator test standards.

Keywords: Healthcare worker, breathing, respiratory flow, powered air-purifying respirator, minute volume, peak inhalation flow