

DETECTION THRESHOLD OF ADDED RESISTIVE LOAD TO INSPIRATION AT REST
AND DURING EXERCISE

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INTRODUCTION: Although there are many studies on respiratory protective devices (RPD), most of them are concerned with specific tests for face-mask fit, aerosol penetration and so on, we can find very few studies on the physiological aspects involved in the use of RPD in Japan. Therefore, Japanese government refers to foreign reports to make some standards for RPD without regard to the possible existence of ethnic differences in physical characteristics between Japanese and Caucasians; We have to obtain many physiological data to make original standards for Japanese workers who wearing RPD. As the first step of our purpose, we tested detection threshold of additive inspiratory resistance and examined whether small resistances at approximate detection threshold affect inspiratory pattern in breathing with mouthpiece or half facepiece mask at rest and during exercise.

METHODS: Five normal males served as subjects. Pressure-flow characteristics was nonlinear. The minimum resistance of the circuit was $0.9 \text{ cm H}_2\text{O}/40 \text{ l/min}$ and $0.8 \text{ cm H}_2\text{O}/40 \text{ l/min}$ for the use of mouthpiece and half facepiece mask, respectively. Additive resistances above the minimum value (ΔR) were tested to determine an approximate detection threshold by tracking procedure. Tracking plots generated were used to select five resistive loads which spanned the subject's approximate detection threshold. The five loads chosen were presented ten times each by randomizing five presentations of each of the five loads and reversing the order. During testing session, the load was presented every second-to-fifth breath. If the subject did not detect a load, the load was left on for two breath. The load detected with a 50% probability ($50\% \Delta R$) was calculated as a more accurate estimate of detection threshold. Exercise was performed with bicycle ergometer at a work rate of 50W or 100W. Inspiratory flow was measured using pneumotachograph (Sokken LFE-10B) and differential pressure transducer (Validyne MP-45) connected to a personal computer.

RESULTS: $50\% \Delta R$ obtained at rest was somewhat large compared with that reported by other investigators. There was a large individual difference in $50\% \Delta R$ and the difference became larger with increasing work load. Pattern of changes in $50\% \Delta R$ from rest to work at 100W was uniform between mouthpiece and half facepiece mask. Significant changes in inspiratory pattern was found after the loaded breath such as time during inspiration, peak flow rate and increasing rate of flow in both respiratory devices. These changes of pattern led to significant reduction of tidal volume, which was observed even in subject who has the smallest value of $50\% \Delta R$.

CONCLUSION: $50\% \Delta R$ obtained was somewhat large and was not affected specifically by energy expenditure. There was large individual difference in $50\% \Delta R$. Inspiratory pattern changed at approximately detection threshold in all subject, which led to significant decrease in tidal volume in both respiratory devices.