TECHNICAL MODIFICATION OF THE METAMAX II METABOLIC ANALYZER FOR MEASUREMENTS ON FIREFIGHTERS IN THE HEAT

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Background

Fire-fighting is physically very demanding. Testing of firefighters' physical ability is needed, but there is no close agreement between performance on standard laboratory tests and results of simulated rescue operations [1]. This suggests that tests should be carried out on fire-fighting-related activities, which may include tasks in the heat. The Metamax II (Mmx) is a portable metabolic analyzer that allows field testing [2]. This instrument like all electronic instruments does not tolerate heat. Moreover, the Mmx' software requires that both inspired and expired air is passed thru its triple V flow transducer to work properly. When firefighters work at the scene of fire, they are dressed up for smoke diving, inspiring from bottles with pressurised air led to the face mask thru a solid tube. Expired air is released to the surroundings. Consequently, during smoke diving only expired air is available for analysis by the Mmx. Therefore, to measure the oxygen uptake of firefighters during smoke diving by the Mmx, we had to modify the instrument. We here describe our approach.

Principle of operation

The Triple V flow transducer is a turbine-type flow-meter a light-weight fan rotates in proportion to the flow. Two sets of diodes and photocells (flow 1 and flow 2) record each rotation, and the sequence 1–2 or 2–1 distinguishes between inspiration and expiration. Only data for expirations are used for further calculations, but the software requires an inspiration signal between two expirations to work properly.

Methods: An extension to the cable connecting the Triple V to the main unit was cut. The individual wires of the cut ends were mounted on a small circuit board with a Pic 16F 628/20 microprocessor, programmed to pass all signals thru during expiration. After a complete expiration the microprocessor produced an artificial inspiration signal. Noise was removed. The signal in each wire during use was read on an oscilloscope.

Connections to fit the Triple V to the outlet of the Interspiro face mask were made, thus allowing expired air to pass from the mask thru the Triple V. The Mmx II was placed in a dedicated heat-protected box mounted out the subject's back, and tubes as well as the Triple V were heat protected by isolating materials.

Results: With no inspiration signal the software did not work properly, reporting a lung ventilation at least 30% too low. The microprocessor reproduced the square-wave signals even during maximal expirations. During exercise lasting up to 8 min in a heat chamber (t > 120 °C) the temperature in the heat protecting box stayed below 30 °C.

Conclusions

By proper modifications the Mmx II may be used to measure the oxygen uptake of firefighters dressed up for smoke diving even in hot and polluted environments.

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EFFECTS OF LOAD CARRIAGE AND POLES USE ON WALKING VELOCITY AT FIELD TRACKS

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INTRODUCTION: The use of the walking poles has increased, however de literature still does not a consensus about their benefits. It as also been reported that the load carriage with poles use, spite of reducing the mechanical load of the lower limb may cause higher fatigue. The purpose of this study was to determine the effects of poles and load carriage on the walking velocity and on rate of perceived exertion (RPE). The velocity was examined for four walking condition: non-poles and non-load (W), with poles and non-load (WP), non-poles and with load (WL), with poles and with load (WLP).

METHODS

Twenty six healthy masculine volunteers walked at a self-selected pace during a pedestrian field track with 821 m long on level terrain (mean±SD, age 23,30 ± 2,69 years; body weight 76,96 ± 12,19 Kg; height 176,25 ± 5,70 cm; body fat percentage 14,69 ± 5,89%). The subjects completed each trail in a randomized order after return to the metabolic rest values between trails. The rest heart rate (HR) and oxygen consumption (VO2) were recorded by a portable telemetric system. Rating of perceived exertion (RPE) was measured at the end of each trial by the modified Borg scale (1-10)[1]. The weight carriage was 25% of the subject's body mass, in a backpack with internal frame, sternum strap, hip belt and load lifters adjusted for each subject as well the telemetric poles.

RESULTS: Significantly differences were not found in RPE for comparisons M vs MP and ML vs MLP. Walking speed shows a significantly decrease (= 0,05, IC 95% 0,01 to 0,1, P 0,05) between M vs MP.

CONCLUSIONS

The results indicate that the use of poles doesn't increase the perceptive demands (RPE). The use of poles at load carriage didn't alter RPE and the walking speed. These results indicate that the use of poles may point as a strategy to reduce perceptions of physical exertion associated to the load carriage.

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