Validation of the firefighter WFI treadmill protocol for predicting VO₂ max

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Background The Wellness-Fitness Initiative submaximal treadmill exercise test (WFI-TM) is recommended by the US National Fire Protection Agency to assess aerobic capacity (VO₂ max) in firefighters. However, predicting VO₂ max from submaximal tests can result in errors leading to erroneous conclusions about fitness.

Aims To investigate the level of agreement between VO₂ max predicted from the WFI-TM against its direct measurement using exhaled gas analysis.

Methods The WFI-TM was performed to volitional fatigue. Differences between estimated VO₂ max (derived from the WFI-TM equation) and direct measurement (exhaled gas analysis) were compared by paired t-test and agreement was determined using Pearson Product-Moment correlation and Bland–Altman analysis. Statistical significance was set at P < 0.05.

Results Fifty-nine men performed the WFI-TM. Mean (standard deviation) values for estimated and measured VO₂ max were 44.6 (3.4) and 43.6 (7.9) ml/kg/min, respectively (P < 0.01). The mean bias by which WFI-TM overestimated VO₂ max was 0.9 ml/kg/min with a 95% prediction interval of ±13.1. Prediction errors for 22% of subjects were within ±5%; 36% had errors greater than or equal to ±15% and 7% had greater than ±30% errors. The correlation between predicted and measured VO₂ max was r = 0.55 (standard error of the estimate = 2.8 ml/kg/min).

Conclusions WFI-TM predicts VO₂ max with 11% error. There is a tendency to overestimate aerobic capacity in less fit individuals and to underestimate it in more fit individuals leading to a clustering of values around 42 ml/kg/min, a criterion used by some fire departments to assess fitness for duty.

Key words Firefighters; fitness tests; physical fitness.

Introduction

Firefighting requires strenuous lifting and meticulous manoeuvring while wearing cumbersome personal protective equipment (often weighing >25 kg) in high ambient temperatures (100°C is considered routine) under stressful conditions [1]. These physical and psychological factors probably contribute to high rates of injury and cardiovascular events [2–4]. Furthermore, lack of physical fitness and deconditioning that may lead to overexertion, coupled with unrecognized cardiovascular disease risk factors, greatly increase the risk of on-duty injuries or death amongst firefighters [2,5,6]. In fact, sudden cardiac events account for the largest proportion of firefighter deaths on duty [7].

In view of this, a joint task force of the International Association of Firefighters and International Association of Fire Chiefs developed the Fire Service Joint Labor Management Wellness-Fitness Initiative (WFI) [8]. The WFI, most recently revised in 2008, aims to improve the quality of life for safety personnel and to produce a working environment conducive to remaining safe, healthy and physically fit. Inherent in this programme is the need for an accurate assessment of a firefighter’s cardiovascular fitness.

Aerobic capacity (VO₂ max) is a measure that defines the limits of cardiovascular function. Research data