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Physical fitness profile of professional Italian firefighters: Differences among age groups

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ABSTRACT

Firefighters perform many tasks which require a high level of fitness and their personal safety may be compromised by the physiological aging process. The aim of the study was to evaluate strength (bench-press), power (countermovement jump), sprint (20 m) and endurance (with and without Self Contained Breathing Apparatus – S.C.B.A.) of 161 Italian firefighters recruits in relation to age groups (<25 yr; 26–30 yr; 31–35 yr; 36–40 yr; 41–42 yr). Descriptive statistics and an ANOVA were calculated to provide the physical fitness profile for each parameter and to assess differences ($p < 0.05$) among age groups. Anthropometric values showed an age-effect for height and BMI, while performances values showed statistical differences for strength, power, sprint tests and endurance test with S.C.B.A. Wearing the S.C.B.A., 14% of all recruits failed to complete the endurance test. We propose that the firefighters should participate in an assessment of work capacity and specific fitness programs aimed to maintain an optimal fitness level for all ages.

1. Introduction

Considerable information substantiates firefighting as one of the most hazardous civilian occupations, implying variable working conditions, unpredictable and heavy physical demands (Bos et al., 2004). Firefighters perform strenuous muscular work (i.e. climb stairs and ladders, carry and use heavy tools) in dangerous environments (extreme temperatures, toxic smoke) and chaotic conditions (loud noise and low visibility), under time urgency and psychological stress of knowing that civilians are in imminent danger.

To reduce the risk of injuries, firefighters wear personal protective devices, composed by layered thermal protective clothing, heavy footwear to protect against penetration and crush injuries, a helmet to protect the head and a Self-Contained Breathing Apparatus (S.C.B.A.) to protect against smoke and noxious gases. However, the use of S.C.B.A. (weighing 11–23 kg) can have negative effects on gait, metabolic and thermal efficiency, and fatigue (Perroni et al., 2008, 2009, 2010; Knapik et al., 2004; Blacker et al., 2010; Qu and Yeo, 2011).

Musculoskeletal injuries, traumas, respiratory and cardiovascular diseases are the major risks resulting from exposure to multiple physical and chemical agents, and from particularly high level of stress experienced during emergency operations (Burnett et al., 1994). Recent statistics in the United States (C2 Technologies Report, 2007) reported that 46% or 55% of deaths were classified as the result of stress or overexertion that led to heart attack or stroke. Although the majority of these deaths were in firefighters over 45 years old, there were still 19 deaths due to heart attack for those under 45 years old. A study by Szubert and Sobala (2002) showed an analysis of the injury ratio (annual number of injuries per 1000 workers) by injury circumstances (Emergency operation, Physical training, Equipment maintenance and repair, Routine service, Commuting to/from work) and victim's age among firefighters. The ratio was the lowest (67.9) among firefighters aged 30–39 and the highest (76.1) among those aged more than 50 years. During compulsory physical training, accidents were less frequent (24.6) in the 40–49 firefighters age group than in 20–29 (30.8) and 50–59 (30.4) age groups.

High levels of fitness have been correlated with improved job performance during real firefighting activities (Elsner and Kolkhorst, 2008; Michaelides et al., 2008; Rhea et al., 2004) and a decreased risk of injury (Knapik et al., 2001; Mattila et al., 2007).

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Unlike some sports or occupations that focus on a single training goal (e.g., power, strength, or endurance), firefighters are required to optimize multiple training goals simultaneously. For instance, they must possess power to perform forcible entry maneuvers, strength to advance hose lines and perform salvage and overhaul tasks, and aerobic and muscular endurance to carry equipment up flights of stairs.

Given the limited availability of firefighters to take part in experimental settings during real emergencies, the physical demands and psychological distress of firefighters have been investigated mainly in laboratory (Bruce-Low et al., 2007; Dreger et al., 2006) and in simulated firefighting activities (Eglin and Tipton, 2005; Harvey et al., 2008; Holmer and Gavhed, 2007; Perroni et al., 2010, 2009). Despite some authors (Bos et al., 2002; Kales et al., 2007; Rhea et al., 2004) indicated a minimum level of 45 mL kg^{-1} min^{-1} VO_{2max} to successfully complete intense firefighting tasks, few indications are available regarding the minimum standards of muscle strength (Gledhill and Jamnik, 1992; Garver et al., 2005; Henderson et al., 2007; Perroni et al., 2008).

Given the nature of their employment, a physiological age-related decline could be expected during the occupational period of firefighters. Although in the literature there are numerous studies about the relationship between physical activity and aging, there are only few surveys about firefighters (Rhea et al., 2004; Sluiter and Frings-Dresen, 2007; Davis et al., 2002; Saupe et al., 1991).

The purpose of this study was to compare the fitness status (i.e., muscle strength, power, sprint and endurance) of Italian firefighters recruits in relation to the age. It was hypothesized that the younger age of firefighters might result in a higher fitness performances and that wearing protective clothing and S.C.B.A. might reduce the performances.

2. Methods

2.1. Participants

All the male Italian firefighters recruits ($N = 161$), who finished the residential Italian Fire Fighter Corp training course, had at least 3 years of previous firefighting experience and were not engaged in structured physical training programs. The subject had the following general baseline characteristics, as mean ± SD: chronological age 33 ± 7 yr, height 1.76 ± 0.06 cm, weight 75.8 ± 8.4 kg, BMI 24.4 ± 2.3 kg m^{-2}. All subjects were divided into five different age groups, under 25-year-old (<25 yr), 26- to 30-year-old (26–30 yr), 31- to 35-year-old (31–35 yr), 36- to 40-year-old (36–40 yr) and 41- to 42-year-old (41–42 yr).

2.2. Procedures

The local Institutional Review Board approved the study designed to investigate the differences of fitness level (i.e. aerobic, strength, and anaerobic evaluations) in firefighters. Fitness evaluations were administered during two experimental sessions with a gap of a week. The first session included anthropometric (i.e., weight, height and body mass), strength, anaerobic test and the aerobic power test which was performed without protective garments and S.C.B.A. The second session aimed to evaluate the aerobic power with protective garments and S.C.B.A.

Prior to the evaluation, each individual signed a consent form and answered to the AAHPERD exercise/medical history questionnaire to ascertain his activity level, educational background, dietary habits, tobacco smoking and alcohol consumption, and medication and history of physical activity. Then, firefighters underwent a 15-minute standardized warm-up period, which consisted of jogging (40–60% of maximal heart rate), strolling locomotion, stretching of the chest muscles and limb (upper and lower). To eliminate circadian rhythms, nutrition and climate-related factor, all the experimental evaluations were performed in the morning (from 9.30 to 11.00 am), in similar conditions (temperature: 22–24 °C; humidity: 50–60%).

2.2.1. Strength evaluations

Strength evaluations included a bench-press test performed on a bench press station using a standard Olympic weightlifting bar and free weights. Firefighters were free to choose the weight to perform a maximum of ten lifts at a 30 beat min^{-1} frequency dictated by a metronome. The subject's 1 repetition maximum (1RM) was estimated using the equations of Wathan (1994) who showed an intraclass correlation coefficients ranging from 0.96 to 0.99:

$$m_{1RM} = m_n/(0.985 - 0.025n) \text{for } 2 \leq n \leq 10$$

where m_{1RM} is the 1RM-mass and m_n is the maximum mass that can be lifted in n times.

2.2.2. Anaerobic evaluations

Measurements of anaerobic performance included countermovement jump (CMJ) (Fig. 1) and 20 m sprint (20 m) tests.

High test-retest stability coefficients have been found for CMJ (range 0.80–0.98) and 20 mt (0.96) performances (Slinde et al., 2008; Gabbett et al., 2008).

The CMJ performances were evaluated using an optical acquisition system (Optojump, Microgate, Udine, Italy), developed to measure with 10^{-3} s precision all flying and ground contact times.

Fig. 1. Countermovement jump (CMJ): starting position (a), stretch-shortening cycle (b), flight (c), arrive (d).