ATTACHMENT 8

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COMMENTS TO PROPOSED RULE ON APPROVAL TESTS AND STANDARDS FOR CLOSED-CIRCUIT ESCAPE RESPIRATORS

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The Human Energy Cost of Fire Fighting

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This study assesses the energy costs of four selected isolated fire fighting tasks. The four most strenuous fire fighting tasks as judged by the men and their administrators were selected for the study. Twenty male professional fire fighters, ages 23 to 43 years, served as subjects. After the men participated in a series of laboratory evaluation for % body fat, muscular strength and functional capacity (aerobic and anaerobic capacities), they participated in the four specified work tasks (aerial ladder climb, rescue of a "victim," hose drag, and ladder raise). All tasks were performed at constant predetermined work rates.

The results indicate that fire fighting consists of heavy physical work (≃ 60-80% $M\dot{V}O_2$) even when the obvious external stresses present at an actual fire are eliminated (i.e., heat, humidity, decreased O_2, increased CO_2, as well as emotional stress). With the possible exception of $M\dot{V}O_2$, there appears to be little or no relationship between a number of the physical capacities of the fire fighters and the individual physiological adaptations employed to meet the energy requirements of the tasks. Although $M\dot{V}O_2$ values were not significant ($P < 0.10 > 0.05$), there was an indication that those fire fighters with $M\dot{V}O_2$'s >40 ml.Kg^{-1}.min.$^{-1}$ might be able to supply a greater percentage of the total O_2 cost aerobically when compared to those men with $M\dot{V}O_2$'s < 40 ml.Kg^{-1}.min.$^{-1}$.

It was concluded that the level of physiologic work, alone, is not of sufficient stress to contribute significantly to the development of ischemic heart disease in fire fighters.

Ischemic heart disease (IHD) has become a major health problem throughout the world. In the so-called "developed" or "industrialized" countries IHD is the number one cause of nonaccidental deaths among the middle and older age groups. It alone is responsible for 39% of all deaths in the United States, claiming over 700,000 lives annually.[1] This fact, coupled with various other reports, has suggested that professional fire fighters experience a higher than normal incidence and mortality rate from IHD than the general population.[2 3 4] Initially, this was thought to be the result of a higher than average proportion of the so-called risk factors associated with the development of IHD (blood lipid levels, hypertension, obesity, smoking, inactivity, etc.) in the fire fighting population. It was discovered, however, that the number of IHD risk factors in fire fighters is unusually low.[2 5 6 7] As an alternative explanation, it has been suggested that the higher incidence and mortality rate from IHD in fire fighters might be accounted for by the nature of their work.[5 6 8] This cannot as yet be substantiated, however, since the energy cost of fire fighting has not been reported as it has with numerous other occupational tasks.[9] If there is a relationship between the physiological demands of fire fighting tasks and IHD, a thorough investigation of the energy cost of individual fire fighting tasks may provide some physiological basis for the positive relationship.[5 6 8]

The purpose of the present study was to evaluate the energy cost of selected fire fighting tasks in terms of total net oxygen cost (aerobic component and anaerobic component), kilocalorie equivalents, $\dot{V}O_2$ (aerobic component), recovery O_2 uptake (anaerobic component), respiratory exchange ratio (RE), heart rate (HR) and the length of the work periods.

Methods

Twenty healthy male professional fire fighters ages 23 to 43 years employed by the City of Windsor, Ontario Fire Department acted as subjects and were separated into two groups on the basis of maximum oxygen uptake ($M\dot{V}O_2$) Group 1 $<$ 40 ml.Kg^{-1}.min^{-1} and Group 2 $>$ 40 ml.Kg^{-1}.min^{-1}. Anthropometric, functional capacity, and strength data of these fire fighters are presented in Table 1. These parameters were determined as reported previously.[10] Ten fire fighters selected randomly (five of each group) participated in each of four routine work tasks (Fig 1).

HR determinations and expired gas volumes were collected during the work tasks, and separately for six minutes of recovery employing radiotelemetry and portable equipment respectively (Fig 1). These gas volumes were then thoroughly mixed and 50 ml aliquots were drawn into well-lubricated matched glass syringes. Subsequently, these samples were analyzed chemically, in duplicate, employing a Gallenkamp-Lloyd Gas analyzer.[11] After the gas volumes were corrected for the difference between inspired and expired volumes and converted to STPD, VO_2 was calculated. RE and caloric cost were also calculated for each task (1 litre O_2 = 5.0 kcal). In order to determine the net O_2 debt six minutes pre-exercise $\dot{V}O_2$ collected.

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