WORKING FOR A HEALTHY FUTURE

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Fitness for Work: Estimate of the deterioration of the aerobic fitness of firefighters with age

Dr Richard Graveling FIEHF
Principal Ergonomist Consultant
Head of Human Sciences

RESEARCH **CONSULTING** SERVICES
Multi-disciplinary specialists in Occupational and Environmental Health and Hygiene

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SUMMARY

Various aspects of physical work capacity have been shown to deteriorate with age, including the general capability to perform physical work (cardio-respiratory fitness) as quantified by aerobic capacity (usually measured as a volume of oxygen per minute, standardised to body weight – "ml kg^{-1} min^{-1}").

Although there have been very few studies of any size of UK firefighters in recent years, there is evidence from other countries that firefighters are no different in this respect. There is also evidence, both from the UK and overseas, that firefighters do not differ in average fitness from the general adult population.

A UK report, prepared on behalf of the Firefit Steering Group (Stevenson et al, 2009), recommends a UK National standard of cardio-respiratory fitness of 42 ml kg^{-1} min^{-1} with withdrawal from operational duties below 35 ml kg^{-1} min^{-1}. It should be noted that the proposed standard is very similar to the best current estimate of the average level of fitness within the UK Fire Service (43 ml kg^{-1} min^{-1}). As such, it implies that almost 50% of serving firefighters have fitness levels below that value.

This short report takes the relationship between age and aerobic capacity from one study, which appears to reflect similar levels of fitness to UK firefighters, and uses this to predict the proportion of firefighters in the UK who would fail to meet either of those two values. The results are summarised in Table 1.

Age	40	45	50	55	60
% below 42 ml kg^{-1} min^{-1}.	64	77	86	92	95
% below 35 ml kg^{-1} min^{-1}.	19	31	47	61	74

These figures should not be relied on to provide categorical values. Nevertheless, in the absence of any recent UK data, they serve to indicate the potential proportion of serving firefighters who, according to these criteria, would either fail to meet the proposed National standard or, importantly, fail to meet the minimum level below which they should be withdrawn from operational duties.

1 INTRODUCTION

1.1 It is well established that physiological work capacity deteriorates with age. For example, Hossack and Bruce (1982) reported regression lines showing declines with age for various cardio-respiratory parameters, in adult males and females aged from 20-75 years, with similar (more recent) findings from Babcock *et al* (1992) amongst many other authors.

1.2 Although it might be thought that firefighters maintain a level of fitness, similar studies have shown age-related deteriorations in firefighters, with studies in the USA (Saupe *et al,* 1991) and Canada (Horowitz and Montgomery, 1993) showing a consistent pattern. In fact the latter paper suggests that Canadian firefighters at least might show a more rapid decline than the general Canadian population.

1.3 The actual fitness levels of UK firefighters is not known (ODPM, 2004), with the last study of any significant size being almost 25 years old (Scott *et al,* 1988). This major review concluded that firefighters seemed to be no fitter than their sedentary non-service peers (and were fatter than recommended), conclusions which mirror those of their American and Canadian counterparts.

1.4 This ODPM review stopped short of prescribing a required level of fitness for firefighters. However, a more recent report (Stevenson *et al,* 2009) recommended a National standard of 42ml kg^{-1} min^{-1} with firefighters being withdrawn at a capacity of less than 35ml kg^{-1} min^{-1}. This recommendation is of some concern, as the same report earlier reported the ODPM conclusion that the average aerobic capacity (maximum oxygen uptake) of firefighters was 43ml kg^{-1} min^{-1}. Recommending a minimum standard little different to the estimated mean suggests that almost 50% of currently operational firefighters therefore fall below that standard.

1.5 This brief report presents some estimates of the impact of the decline in aerobic with age amongst the UK firefighter population.

2 CHANGES IN AEROBIC CAPACITY

2.1 Although a number of papers have presented statistical regressions of age and aerobic capacity, one problem in applying these to the UK firefighter population is to identify an appropriate data set on which to base any prediction. Thus, in the data reported by Hossack and Bruce (1982), it can be calculated that those in the 20-50 years age range (which might best represent current firefighters) have an average aerobic capacity of 39.3ml kg^{-1} min^{-1}, somewhat less that the value of 43ml kg^{-1} min^{-1} cited above (although within the range quoted in the ODPM report of 32-57ml kg min^{-1}). Similarly, the firefighters in the American study have a comparable mean aerobic capacity of 39.0ml kg^{-1} min^{-1} (20-45 years) whilst the first two groups in the Canadian population reported by Babcock *et al* (1992), with an age range of 30-49 years, have a lower mean capacity of 35.1ml kg^{-1} min^{-1} presumably reflecting the absence of younger (20-29 years) adults.

2.2 However, once converted into a regression equation, the data from Hossack and Bruce (1982) yield what seems to be an appropriate comparator. Taking the regression mean for individuals aged 20, 30, 40 and 50 years of age (and assuming equal weighting for each age band) thus yields an average aerobic capacity of 42.3ml min^{-1} kg^{-1}. In the absence of any substantive UK dataset, the values presented by Hossack and Bruce were therefore utilised to provide estimates of the influence of age and fitness.

2.3 The regression equation provides the average aerobic capacity at any age. However, in order to estimate the proportion of firefighters (or others) at that age with a capacity above or below a given level it is necessary to know the variation around that value (usually stated as the standard deviation). One difficulty is that the variation recorded is partly a function of the natural variability between individuals but, in part, is also influenced by the variability in the technique used. Thus, studies which predict maximum ability from submaximal tests tend to yield larger variances compared to those where the maximum capability is measured directly. This paper utilised on maximum test and therefore the variances recorded tend to be relatively small. However, it is noted that the variance does tend to increase amongst the older

age groups, presumably reflecting a naturally greater variability amongst adults of that age.

2.4 To facilitate the estimates presented below, the variance of the age bands given were taken as representative of each of the ages within the band. To smooth out the transitions between bands, specific ages ±2 years of the extremes of a band had a synthesised standard deviation applied of the mean of those for the two adjacent bands. Thus, those aged 48, 49, 50 and 51 years would have a standard deviation of ± 5.85 applied where the values for the adjacent deciles were 5.6 and 6.1. In carrying out calculations based on these values the assumption has been made that the data are normally distribution. As continuous biological parameters invariably have such a distribution this is believed to be valid.

3 PREDICTIONS OF PROPORTIONS OF FIREFIGHTERS AFFECTED

3.1 As stated above, Stevenson *et al* (2009) recommended a National fitness standard of 42ml kg^{-1} min^{-1} with withdrawal from operational duties at a value of 35ml kg^{-1} min^{-1}.

3.2 Figure 1 shows the estimated percentages of firefighters who would have a fitness level below either of these values, based on the data of Hossack and Bruce as discussed above.

3.3 From this it can be seen that, by the age of 40 years, approximately 65% of firefighters would be estimated as having a predicted maximum oxygen uptake (aerobic capacity) of 42ml kg^{-1} min^{-1}, with approximately 20% already failing to attain the lower criterion of 35ml kg^{-1} min^{-1}. By the age of 50 years, those values have risen to 86% failing to attain the higher criterion, with almost half (47%) not reaching the lower value.

3.4 It is possible that this is a slight over-estimate of the percentages involved. Thus, for comparison, the UK firefighters in the study by Love *et al* (1996) had a mean aerobic capacity of 46.4ml kg^{-1} min^{-1} at an average age of 31 years. Applying the regression equation above would predict a capacity of 44.2ml kg min^{-1} for the same age. However, Love and coworkers commented that the value obtained in their study was slightly greater than the average for serving

firefighters of 43.7ml kg min^{-1}, drawn from a much larger sample. On this basis it is believed that any overestimate would not be large, possibly of the order of 5% overall.

Dr Richard Graveling FIEHF
Principal Ergonomics Consultant

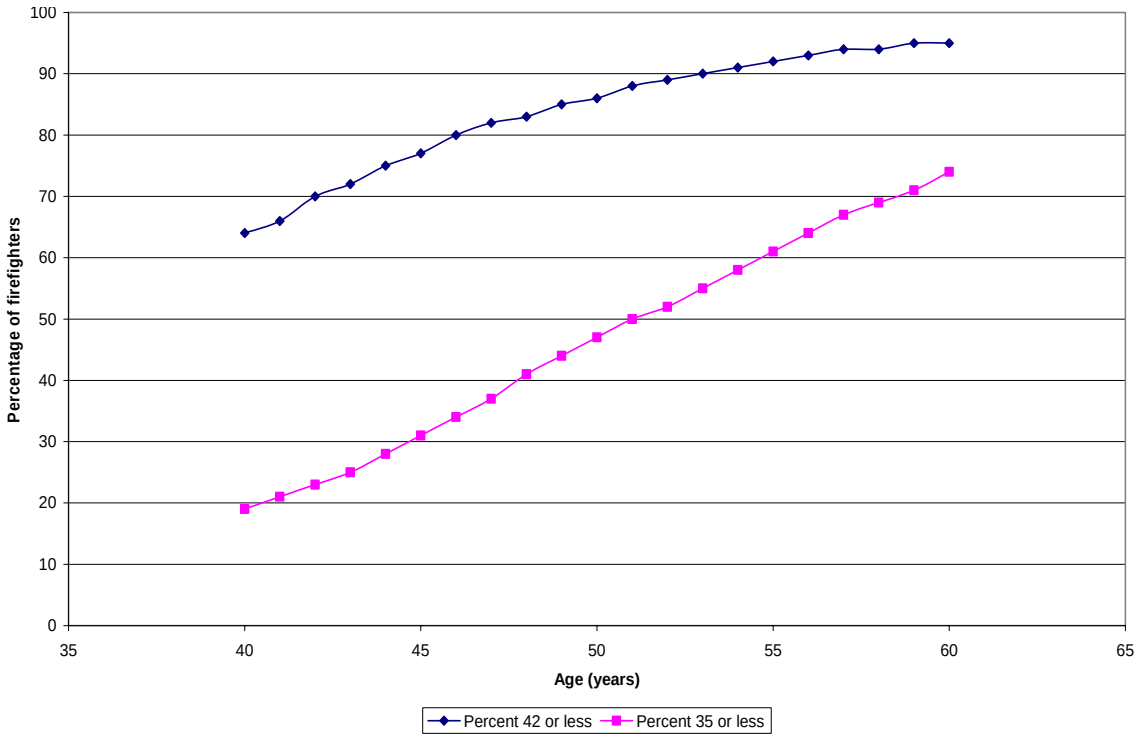

Figure 1: Predictions of percentage of firefighters with aerobic capacities below 42 or 35ml kg^{-1} min^{-1}

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