The BASES Expert Statement on The Importance of Young People's Aerobic Fitness for Health

Produced on behalf of the British Association of Sport and Exercise Sciences by Dr Keith Tolfrey FBASES, Dr Mark De Ste Croix, Prof Gareth Stratton FBASES and Assoc Prof Craig Williams FBASES

Introduction

Preventive exercise-related strategies targeting the health of children and adolescents (young people <18 years) are required to complement attempts to reduce and prevent disease or ill-health in adults. Aerobic (cardiorespiratory) fitness[1] is regarded as an important marker of young people's health because of its effect on or association with obesity, cardio-metabolic risk factors, diabetes, certain cancers and mental health (Ortega *et al*., 2008). However, approximately 25 years ago there was a shift in emphasis from fitness towards identifying the most valid ways to objectively quantify physical activity and increase daily habitual activity levels. Technological advancements led to more objective quantification of physical activity and how this might relate to obesity and other lifestyle health problems. Moreover, a tide of opinion suggested that indiscriminate fitness testing and a misguided focus on population level improvement in fitness were dominating school physical education to the detriment of other important curriculum areas. Subsequently, interest in fitness related to health fell out of favour. Without dismissing the importance of obesity and the role of physical activity *per se* in paediatric exercise science, we will highlight the critical role of fitness when considering the health of young people. Moreover, we support evidenced-based, minimum cut-off values to identify young people with low fitness and increased chance of clustered cardiovascular risk factors. The statement draws on studies that have measured peak oxygen consumption (peak $\dot{V}O_2$) directly and also indirect assessment where young people completed the 20 metre shuttle run test (20-mSRT). While we recognise the distinction between the physiological (peak $\dot{V}O_2$) and performance (20-mSRT) measures (see Tomkinson & Olds, 2007), we believe the combined evidence supports the importance of fitness, particularly for young people with low fitness levels.

Background and evidence

Several European population-based studies with young people have shown that a lower level of fitness is associated with various indicators of current or future ill health (see Ruiz *et al*., 2011), whereas higher levels of fitness confer a lower cardio-metabolic risk factor profile. Health has been defined in various ways using numerous outcome measures including: body composition (obesity); plasma insulin; glucose and lipid concentrations; acute lymphoblastic leukaemia; depression; anxiety; and self-esteem. The relationship between fitness and cardiovascular risk factors during the years of growth is strongest in longer-term, prospective studies (Tomkinson & Olds, 2007). There is evidence of an independent effect of fitness once chronological age, body size and composition, biological maturation and sex have been accounted for (Andersen *et al*., 2008); however, further support for this is required from well-controlled, longitudinal population studies. The interplay between fitness and body mass index (BMI) has been examined and it was estimated that BMI accounted for 15 to 45% of the variability of performance tests of fitness (Tomkinson & Olds, 2007). Recently, however, it has been shown that changes in fitness over six years were independent of body weight status (Stratton *et al*., 2007).

Cut-off values for fitness

Age, sex and body mass-specific minimum cut-off values for fitness, from a population-based sample of young people, have been proposed recently (Adegboye *et al*., 2011). These values can be used to identify children and adolescents of low fitness with a higher propensity for clustering of risk factors for cardiovascular disease. From a sample of 4,500, 8 to 17 year old boys and girls, peak $\dot{V}O_2$ and standardised components of metabolic syndrome were measured. Receiver operating characteristic (ROC) analysis cut-off values that discriminated between low and high cardio-metabolic risk are shown in Table 1.

Table 1. Cut-off values for aerobic fitness

Age	Girls	Boys
8 to 11	37.4	43.6
14 to 17	33.0	46.0

Cut-off values are $\dot{V}O_2$ in mL kg^{-1} min^{-1}

Although this is not the first time that cut-values have been proposed (see Table 3 in Adegboye *et al*., 2011), this study has avoided normative standards based on percentiles and the values are derived from current health markers in a large sample. However, prospective longitudinal studies are needed to examine whether young people below these cut-off values have a greater incidence of cardio-metabolic diseases when they become adults compared with those above the cut-values.

Renewed interest in fitness is a consequence of the global trends that have demonstrated a sustained and significant decline in fitness assessed by 20-mSRT (Tomkinson & Olds, 2007). Comparative data on English children's fitness, also from 20-mSRT performance, are available from two recent studies. First, fitness was measured annually between 1998 and 2004 and comprised a total sample size of 15621, 9 to 10 year old children from the North West (Stratton *et al*., 2007). Second, 303 children aged 10 to 11 years from the South East were measured in 1998 and compared with 315 measured in 2008 (Sandercock *et al*., 2010). Both studies reported an identical 0.8% annual decrease in fitness, which was double the decline reported in global data albeit over 45 years (Tomkinson & Olds, 2007). These studies did not measure 2 directly so it is not possible to determine what proportion of the samples fell below the cut-off values proposed by Adegboye *et al*. (2011). Nevertheless, the findings suggest that fitness monitoring and enhancement of some young people is advised and the identification of 20-mSRT cut-off values would be useful for practical reasons.

Relationship of body size and fitness

Part of the impact on fitness scores is the effect of increasing body (fat) mass in children over the last 15 years. It is well recognised that body size and fitness share a strong association particularly in weight bearing modes of exercise (i.e., walking or running). Stratton *et al*. (2007) divided their sample by sex and BMI and found that fitness declined year on year regardless of low, average or high BMI category. Sandercock *et al*. (2010) concluded that the decrease in fitness was largely independent of changes in BMI after finding that girls' BMI did not change over the 10 year observation period and only a small change existed for boys' BMI. Collectively, these studies show that changes in fitness do not merely reflect an increase in body size but also that lean and overweight children have experienced reductions in fitness. Moreover, there is evidence of a divergence between the least and most fit.

In adults, exercise training results in enhanced fitness – particularly in low fit individuals. The commonly reported blunted trainability of young people's peak $\dot{V}O_2$ likely reflects sub-optimal exercise programmes that are too short and lack adequate intensity (Tolfrey, 2007). Those with the lowest pre-intervention fitness demonstrate the greatest gains (Tolfrey, 2007). However, a self-selection bias pervades the literature with low fit children and adolescents avoiding studies aimed at enhancing fitness. Therefore, exercise programmes designed to increase fitness should be targeted at low fit, young people, below the cut-off values, rather than used universally (see Table 1).

Recent fitness debates

The UK Chief Medical Officer suggested recently (Department of Health, 2010) that comprehensive physical fitness testing should be piloted in secondary schools. We share some of the concerns about indiscriminate measurement of all young people and support a more targeted approach. An all-inclusive approach may be possible, but only if the primary objective is an educational experience. Although schools may act in a capacity to provide the fundamental movement skills and a variety of positive exercise and sports experiences, and physical activities, we suggest that the responsibility for improving and measuring fitness lies elsewhere. For example, central and local government supported schemes for structured exercise, sports, physical activity and active transport could be combined with expertise available within the large number of sport and exercise science graduates and University departments specialising in this subject. It should be the collective responsibility of sport and exercise science graduates and University staff supported by strategic government funding to assess fitness directly (peak $\dot{V}O_2$) and indirectly (20-mSRT). It should be possible to use indirect assessment methods at a stratified population level in the first instance (also serves to assess annual trends), but to target direct measurements at young people identified as being 'at risk' for poor cardio-metabolic health. This will only be possible with adequate funding and adherence to appropriate ethical and safe-guarding guidelines for working with young people and parental support.

Left: Treadmill-based measurement of $\dot{V}O_2$
Courtesy Associate Prof Craig Williams FBASES

Practical recommendations

- Identify low fit young people using the 20-mSRT initially and then confirmed with direct measurement of peak $\dot{V}O_2$
- Recognise that low fit young people need a vigorous exercise programme to improve their fitness that includes a variety of exercise modes (continuous and interval), at least 3 sessions per week, 85 to 90% of maximum heart rate, 30 to 60 min duration, and lasting at least 3 months
- Provide young people, particularly those with low fitness, with more opportunities for vigorous physical activity and structured exercise
- Recognise that an activity skill-set, from high quality physical education provision, is required to engage fully in an active life-style
- Help responsible adults to appreciate that the baseline level of fitness all young people should be aiming for is for health purposes rather than for competitive sports participation, although it may eventually support both
- Encourage all young people to be physically active and aspire to attain international recommendations for daily accumulated activity
- Recognise that the influence of fitness and a balanced, nutritious diet and energy intake must be considered in combination. ■

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1. All future references to fitness from hereon are aerobic fitness unless stated otherwise.