Assessing physiological responses to training in young children

Roy J Shephard

Health professionals are currently concerned about what seem to be low levels of habitual activity and poor aerobic fitness among young children in developed countries.1,2 There are claims that many youngsters already show not only many cardiac risk factors, but also overt coronary vascular and hypertensive disease.3,4 However, the ability of prepubescent children to respond to aerobic training remains controversial.5-10 Those who find little or no response argued that the prepubescent child is naturally active,11 or that there is a threshold age of maturation12 below which training cannot be initiated successfully. The issue has important implications for the allocation of resources to school physical education programmes.13 If young children cannot be trained, then there may be reason to reorient programmes of health promotion and physical education. However, before we accept the concept of a lack of trainability in preadolescent children, it is important to exclude technical explanations of this finding, including limitations in the selection of subjects, the choice of conditioning programmes and the methods used to assess their effectiveness.

Choice of subjects

Some studies have examined responses in children attending summer sports camps.14 However, such individuals often begin these programmes with high fitness levels, and moreover the focus of the camp may be on the acquisition of skills or muscle strength rather than the development of aerobic fitness. Other investigators have drawn both experimental and control subjects from ordinary schools. This ensures good initial matching of students, but there is a danger that over the course of the experiment, purchases of equipment or facilities, and contacts with parents may contaminate the control group with an increased interest in physical activity.15 In prolonged experiments, there may also be a substantial number of drop outs from both experimental and control groups; in general, unfit children will defect from the training programme, and fit individuals will refuse to maintain their control status.

Programmes

Experimental interventions have often lacked the intensity, frequency, and duration of exercise necessary to an aerobic training response. Too often, a standard elementary school period of physical education is spent mainly in changing, listening to instructions, and waiting to use equipment.16 It is important to verify by heart rate monitoring that children are receiving an adequate aerobic stimulus for periods of at least 20-30 minutes, three and preferably five times per week.17 Perhaps because they have been conducted by graduate students, many studies have persisted for no more than 8-12 weeks. This is unfortunate on two counts. Data analysis is then complicated by substantial seasonal variations of fitness.18 Moreover, young children initially lack the motor skills to benefit from many types of physical activity, although a response does emerge if the programme is continued for months and even years.19 Finally, almost no studies have controlled for activities undertaken outside of the experimental programme. Rigorous school programmes may enhance participation in active leisure pursuits at the weekend, but on the days when the required activity is performed, the children compensate by spending extra time watching television when they return home.20

Assessment of programme effectiveness

Assuming that the programme induces a 10-15% gain in oxygen transport, and the peak oxygen intake measurements have a 5% coefficient of variation, it should be possible to detect a training response using a relatively small sample of subjects.

Assessment has generally been based on changes in the child's peak oxygen intake, as measured on a treadmill or a cycle ergometer. Unfortunately, many observers have had difficulty in bringing young children to an objective plateau of oxygen consumption.21 Moreover, ancillary criteria of maximal effort such as blood lactate levels and peak heart rates are unsatisfactory in the young child.22 However, oxygen intake data do not differ systematically between children who reach a plateau and those who do not; the oxygen consumption at the ventilatory threshold is a similar fraction of peak values in the two subgroups of subjects.23 and peak values cannot be augmented by “supramaximal” testing.24,25 There have also been claims of test/retest consistency in adolescents,26,27 although in young children,
anxiety may give a high heart rate at the first test visit. During a second visit, a child may push closer to a true maximal effort, and yet because of less anxiety may achieve this at a similar or even a lower peak heart rate. Predictions of aerobic power from submaximal data are open to similar criticism, and attempts to use performance measures found upon problems associated with the learning of technique and pace.

Even in studies of only 8–12 weeks, comparisons are affected by growth. Linear growth is affected little by a programme of moderate aerobic training, but if training is heavy enough to deplete energy reserves, comparisons may be vitiated by a slowing of the pubertal growth spurt.

**Policy implications**

Despite technical problems, there is a growing consensus that a well designed training programme can enhance the fitness of an average prepubescent child by 10–15%, less than in an adult, but significantly greater than zero. It is less certain how far this implies that we need to change physical education programmes for young children. We need more information on the tracking of fitness and lifestyle from the prepubescent period into adult life. Activity patterns show little consistency even over a two year interval. but there does appear to be some relationship between an active lifestyle as a child and aerobic power or an active lifestyle as an adult. Some adults remember compulsory physical education programmes with distaste, and there is often a substantial drop in both participation and fitness levels once physical education is no longer a required subject. Rather than focusing upon the development of maximal oxygen intake, it seems important to emphasize attitudes and behaviour, allowing the child to try a wide range of active pursuits. Physical education then becomes an exploration of self, rather than a battle against body fat and a low maximal oxygen intake. Activity is perceived as something enjoyable, and skills are acquired in areas appropriate to personality, body build, and interests. Such programmes should increase the likelihood that physical activity will be maintained into adult life, and recently reported data from Quebec support such a hypothesis. However, the challenge to future investigators is to move beyond eight week studies; we will only be certain that we are on the right track when we have data from several more twenty year studies of adults who received this type of instruction during their prepubescent years.

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OBITUARY

George Nightingale

George Nightingale was educated at Campbell College and Queen's University, Belfast. He joined the RAF Medical Branch in May 1943, seeing service in the Middle East and the Persian Gulf. He resumed his surgical career at Belfast City Hospital from 1946 to 1949. For the next 10 years he worked in the Cameroons and Sierra Leone. Surgery started very early to avoid the heat of the day and was of necessity very varied. One list, for example, included a cataract, a hysterectomy, a dental extraction, and a hernia.

In 1960 he moved to Shepton Mallet and joined the general practice at nearby Oakhill, where he remained until his reluctant retirement on his 70th birthday in 1985. He is remembered in Oakhill for visiting snowed in patients by tractor in a bad winter, and for many local events at which he did duty, including the Royal Bath and West Show.

He was a supporter of the British Limbless Exservicemen, and was made an Honorary Member of their organisation. He had a long interest in sports medicine, and was delighted when his son, Danny, was one of the gold medal winners in the modern pentathlon at the Montreal Olympics in 1976. Although his final illness was short, he had made an excellent recovery from heart attacks and extensive chest surgery about 15 years earlier.

His interests outside medicine included classical music, and he was an accomplished pianist. He enjoyed the restoration of his ancient cottage at North Wootton where he had an immaculate garden decorated with ammonite fossils, and a weed-free lawn. Although not noted for his tolerance of fools gladly or otherwise, George was a generous and entertaining companion. He died aged 78 and leaves a wife, Joan, four sons, a daughter, and 10 grandchildren.

A L WALBY
45 Derryvogle Avenue
Belfast BT9 6FP
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Br J Sports Med 1997 31: 159-161
doi: 10.1136/bjsm.31.2.159

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