Cardio-respiratory fitness: the role of the PE sector

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There is strong evidence that the basic causes of coronary heart disease due to blockage and hardening of the arteries can occur in childhood, and, once established, these are not reversible. Poor diet, abuse of the body, and a sedentary way of life are contributory factors. It is suggested that the PE sector should be promoting 'health and fitness' programmes which encourage young people to adopt a more physically active life-style.

Atherosclerotic coronary heart disease, caused by 'hardening of the arteries', is responsible for the death of 180,000 Britons annually. How relevant is this information to the teacher? I suggest that it is highly relevant, as there is a growing conviction among doctors and scientists that atherosclerotic coronary heart disease is a paediatric problem, the onset of which can occur at a very young age.

Blood is supplied to the heart by the coronary arteries, and if the flow through these vessels becomes restricted, there is danger of a heart attack. Atherosclerosis is essentially the narrowing of these arteries, and, in addition to the narrowing effect, the arteries so afflicted often become stiff or hardened (arteriosclerosis). This narrowing is progressive, and in advanced stages the blood flow through the artery stops completely, causing that part of the heart muscle supplied with blood by the artery to 'die' – a heart attack. The severity of the heart attack is determined by the exact location of the block within the artery.

This narrowing of the arteries starts as an accumulation of lipid (fatty deposits), and results in fatty streaks under the inner lining of the arterial wall. What is not widely appreciated is that these streaks have been found in the aorta (principal artery) of children only 3 or 4 months old; by the age of 5 they are relatively common, and are normal features by the age of 10. These fatty streaks become evident in the other coronary arteries during the second decade of life, and, regardless of geographic or ethnic origin, most people have developed coronary artery fatty streaks by the age of 20 (1).

The risk factors

The progression from fatty streaks to a heart attack cannot be documented by longitudinal studies in human subjects, but an accumulation of cross-sectional data supports the belief that *atherosclerosis commences early in life,* and is promoted by so-called 'risk factors'.

The primary risk factors have been identified as *high serum cholesterol* (excessive cholesterol in the blood), *high blood pressure,* and *cigarette smoking.* Secondary factors include obesity, physical inactivity, a family history of

premature vascular disease, and various other less well-established phenomena from stress level to caffeine intake. People displaying a combination of these risk factors have a susceptibility to coronary heart disease which is increased by a factor substantially greater than the sum of their individual contributions. In earlier papers (1, 2) Davies and I reviewed in detail the prevalence of coronary risk factors in children, and concluded that *although risk factors are frequently present, they may be modified by suitable exercise and nutrition programmes.*

High serum cholesterol, and lipoprotein

There is no safe level of cholesterol, and, regardless of age or sex, it is generally accepted that the lower the serum cholesterol level the better. Nevertheless, a critical level below which risk of premature coronary artery disease would not be likely has been established as 5.20 mmol/l. Children with levels above this critical value have regularly been identified; detailed scrutiny of the published data to date reveals that *1 in 4 of the children examined have serum cholesterol levels exceeding this criterion.*

Recent evidence, however, suggests that this is too simplistic an analysis, and that in addition to the total cholesterol level its distribution amongst the *lipoproteins* is critical. Lipoprotein is a vehicle by which cholesterol is transported in the blood and either low-density (LDL-C) or high-density (HDL-C) lipoprotein serves this function. It is LDL-C which contributes to the atherosclerotic process, whereas HDL-C is becoming recognised as conferring protection against this condition, since it interferes with the binding and uptake of LDL-C and facilitates the transport of cholesterol from peripheral tissues to the liver. It is then broken down and excreted as bile acids or as free cholesterol. Taking this factor into account, Wilmore et al. (8) assessed a strictly random sample of 308 boys (11-15 years) and concluded that *30% had HDL-C levels compatible with coronary risk.*

It has been clearly shown that increasing amounts of dietary saturated fats elevate the serum cholesterol level, while polyunsaturated fats decrease it. Cholesterol restriction and an alteration of the polyunsaturated/saturated fat ratio results in significant decreases in the serum cholesterol level. Furthermore, a consistent finding in adult studies is that sustained, vigorous aerobic exercise increases HDL-C levels. The data linking exercise with increased HDL-C concentrations in children are not unequivocal, but evidence is accumulating to support the premise that *regular, intensive exercise during childhood will promote favourable changes in plasma lipoprotein patterns* (2).

Hypertension

As with cholesterol concentration, there does not appear to be a simple critical level, and the greater the blood pressure the greater the atherosclerotic risk. As it is known that blood pressure rises with age, any adult criteria are probably inappropriate for application to children. However, since estimates suggest that approximately 20% of adults have blood pressure levels placing them at risk, it seems reasonable to suppose that children with blood pressures greater than the 80th percentile for their age may eventually prove to be hypertensive adults.

Although much of the evidence available at the present time must, because of shortcomings in their methodology, be interpreted with caution, recent studies have clearly demonstrated *the value of dietary modification and aerobic exercise in reducing the arterial blood pressure of hypertensive children.*

Cigarette smoking

Although there has been a reduction in adult smoking since the late 1970s, recent reports indicate a 3% increase in schoolchildren's smoking since 1982 (3). About half of all boys and a third of all girls have tried their first cigarette by the age of 11, but it is during adolescence that the habit takes a firm hold, and children aged between 11 and 16 manage to smoke about £60 million worth of cigarettes a year. The largest increase in smoking is among adolescent girls, and evidence from some parts of the country suggests that smoking is now more prevalent among 15-16 year old girls than among boys of the same age (4). By the age of 16, about 27% of British schoolchildren are regular smokers (5). Data collected by the HEC Schools Health Education Unit between 1982 and 1984 show that amongst 1,259 boys and 1,198 girls in the 5th year (age 15+) 24.4% of boys and 24.6% of girls considered themselves 'smokers', with 9.5% of the boys and 8.1% of the girls saying that they did not want to give it up.

Anti-smoking educational programmes need to begin at an early age, with a high priority for the 11-13 age group, and programmes based on education for personal growth are probably preferable to purely information-giving approaches (6). As smoking severely restricts aerobic performance, frequent practical demonstrations of the adverse effects of smoking in the cardio-respiratory system may help to motivate children to adopt more prudent habits.

Obesity

Due to the difficulties of estimating children's body composition, and the fact that there is no universally-accepted criterion of what specific percentage of body fat constitutes obesity, its prevalence among children has been variously reported as from 2.5% to 28%.

In the United Kingdom, using a reasonable criterion, between 5% and 6% of children can be classed as obese – on average, between one and two pupils in every class. The evidence of a marked increase in childhood obesity in recent years is overwhelming, and longitudinal data has demonstrated the remarkable persistence of obesity: some 70%-80% of these children develop into obese adults. The success of balanced nutrition and aerobic exercise programmes in the prevention and reduction of obesity is well established (references will be found in Ref. 2).

EXERCISE GUIDELINES FOR THE DEVELOPMENT AND MAINTENANCE OF CARDIO-RESPIRATORY FITNESS

Frequency: 3-5 times a week
Intensity: 75-90% of maximum heart rate*
Time (duration): 15-60 minutes of continuous aerobic activity each week
Type: Any activity, using large muscle groups, which can be maintained continuously and is rhythmical and aerobic in nature (jogging, cycling, swimming, etc.)

*Maximum heart rate may be estimated from the formula (220-age). Therefore, the intensity of exercise recommended for a healthy 20-year-old would elicit heart rates of between 150 [(220-20) x .75] and 180 [(220-20) x .90] beats per minute.

Measuring physical activity

Children are very willing subjects, and it is relatively easy to analyse their fitness in a laboratory (7). The use of laboratory tests, however, provides limited insights into children's physical activity patterns, and only through continuous observation and recording over an extended period of time can free living physical activity be quantified, and an understanding of its determinants developed. The problems involved in examining patterns of physical activity have, however, been identified, and data concerned with the amount of schoolchildren's regular physical activity is accumulating.

This data, unfortunately, indicates that children are not as active as they might appear, and their habitual activity is seldom of a sufficiently high intensity to promote cardiovascular health (suggested criteria are shown in the accompanying box). Furthermore, when 16-year-olds leave school, physical activity tends to decrease, especially among girls. Data is difficult to interpret, since there is no agreed criterion of 'inactivity'; recent laboratory studies have, therefore, reported the proportion of 'inactive' children to range from 3% to 35%. The higher figure is based on data obtained from a strictly random sample of 308 boys (8): this is, perhaps, a more realistic estimate of the value for the whole population,

since most samples tend to be convenience samples which often exclude 'unfit' children.

Some 'activity' studies

Observation of children's habitual activity is probably more informative than laboratory analysis, and several studies of this type are worthy of note. Seliger et al. (9) monitored a group of 12-year-olds and found that heart rates of over 150 were rarely and only fleetingly encountered. They concluded that very little circulatory activity was required to support their daily activity. Gilliam et al. (10), using Holter monitoring, reported that 7-year-old boys and girls achieved heart rates high enough to promote cardiovascular health for only 21 minutes and 9 minutes respectively, during a 12-hour period. As noted elsewhere in this issue, Dickinson (11) surveyed a sample of 500 11-16 year old children from six large comprehensive schools in the West Midlands, and concluded that 80-85% had less than 5 minutes' 'vigorous' activity during the school week sampled.

Combinations of risk factors may also occur during childhood, and presumably, as with adults, carry a disproportionately increased risk. There is, however, a dearth of studies identifying multiple risk factors in children, although reports from America suggest that in their society only just over a third of children are free from all risk factors. One study, Gilliam et al. (12) reported that 20% of the sample exhibited 3 risk factors, 10% exhibited 4 factors, and one child had 5. No major UK studies have been reported, but we are currently undertaking work in Exeter which should help to clarify the extent of the problem in this country.

The teacher's challenge

It is highly probable that schoolchildren share many of the sedentary habits of their parents and teachers, and that few experience the intensity, frequency, and duration of physical activity that is required to foster the development of a strong, healthy heart.

Atherosclerosis usually manifests itself in adult life, but the evidence outlined above strongly suggests that it has its origins in childhood. Factors known to be associated with a significantly increased risk of adults developing this condition are common in children. Regular, vigorous aerobic exercise, and dietary modifications, have been shown to exert beneficial effects on these factors. Teachers are, therefore, well placed to make a significant contribution to coronary prevention by implementing health and fitness programmes at an early age.

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