INTENSIVE TRAINING OF THE YOUNG IN SPORT AND RECREATION

Medical Aspects

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Selection

Young people selected for intensive training in sport or recreation will already have had at least a little experience of the sport in question and have shown a keenness to continue the sport and develop their skill; that is, they will be highly motivated before embarking on any *intensive* scheme of training. The age of the young person ought to be taken into consideration. While it is reasonable to interest pre-adolescent children in a sport or recreation and to allow them to develop skills and neuromuscular coordination, it is certainly of little value to embark on intensive training before the adolescent growth spurt. In females this occurs from the age of 11 or 12 until 15 and in the male from 14 until 16 or perhaps even 18. In general, intensive training will begin towards the end of this adolescent growth phase or perhaps even after it is over.

Physique.

It may be helpful to determine the individual's somatotype and the strength of local muscle groups to assess if he is the suitable type for a particular event, but such measurements may alter with growth and there is no doubt that there are exceptions to the concept of "body types for specific events". For example, our Olympic pentathlon champion, Mary Peters, does not fit in from the somatotype point of view with a typical sprinter or hurdler, and in particular with our concept of a typical high jumper. We have had other examples too of unusual body types excelling at events for which they would not be expected to excel. One example which comes to mind is of one of the leading Scottish half mile track runners some years ago who was extremely small and slim and on the basis of somatotyping should fairly certainly have been recommended to become a marathon runner or perhaps even a feather weight boxer.

Physiques develop for or with the event and we can think of many examples of this in weight lifting, in athletics heavy events, in running events, the pole vault and in the case of the rugby forward or the rower. There is no doubt that we will know much more about the value of somatotyping after a number of years when the results of longitudinal studies will be available; that is, studies which will show whether it is the somatotype before or after intensive training which is important.

Medical Screening

Before intensive training is begun it is important to exclude serious heart disease such as congenital heart disease and rheumatic heart disease. It is dangerous for individuals with certain forms of valvular disease, for example, to engage in strenuous effort and from time to time one encounters tragedies when this advice is ignored. The case comes to mind of a 19 year old girl of athletic build who was a keen badminton player and who was found to have mitral stenosis, in which the mitral valve is tightly narrowed and the cardiac output is reduced and in particular is less able to respond to the sudden demands of physical exertion. This girl was advised not to play badminton and ignored the advice and after a strenuous match she was admitted to hospital with acute left heart failure and pulmonary oedema which proved quite intractable and from which she died within a few hours. This type of tragedy is totally avoidable and naturally would bring a bad name upon the sport concerned if it were a common occurrence. Among other serious illnesses which ought to be excluded are epileptic fits, and there was one recent example of a young boy who died during a cross country run fairly certainly because he suffered an epileptic fit followed by vomiting and suffocation. The mechanism here is that very strenuous exertion may produce sufficient anoxia of the brain to trigger off the fit. It is therefore advisable that persons with such a history should be dissuaded from the more strenuous forms of effort. It is also wise to have the blood pressure checked and to have the chest x-rayed to exclude diseases such as pulmonary tuberculosis. The blood count should also be done before intensive training is begun, particularly in girls in whom anaemia is more common. This anaemia of course is easily corrected by means of iron therapy and need not preclude the individual from intensive training for any length of time.

There are a few diseases which pose difficult problems. Diabetes, for example, is not often compatible with very strenuous athletic effort although examples have been known of professional footballers and leading tennis players who have been insulin-requiring diabetics. However, more generally it will be found that diabetics who have developed the disease early in life have a relatively limited exercise tolerance since they readily develop hypoglycaemia. Another disease which poses a problem is bronchial asthma and here our attitude is

rather more optimistic. It is true that a minority of asthmatic young people may have their attacks induced by exercise but in the great majority this is not true and the attacks have an allergic or infective basis. Exercise even of a vigorous type may in fact be of considerable benefit to such young people. It appears that the development of the lungs following exercise may lead to improvement in the asthma.

Effects of Training

The learning of skills

Childhood is the age of choice for learning complex neuromuscular skills and in particular those which demand coordination of the eye with either the hand or foot. Examples are golf, soccer, tennis, gymnastics and diving and in many ways the learning of these complex skills is comparable to the learning of musical skills, and we know that many of the best musicians have begun their career at a very early age.

Physiological Effects

Children operate at higher heart rates and higher respiratory rates than adults but most of the physiological adaptations to exercise are similar. There is one difference which ought to be remembered. In children there is greater heat loss and therefore a greater danger of exposure in cold wet situations such as may be encountered on mountains. It is also wise to realise that children in general are mentally less tough when endurance is demanded, particularly under adverse circumstances; this of course is a psychological and not a physiological or medical problem.

Heart

The trained athlete has a larger heart than the average individual. At rest there is a greater end-diastolic and end-systolic volume and the same stroke volume, and during exercise there is a smaller end-systolic volume than the average and a greater stroke volume. This means that the heart of the athlete shows dilatation as well as hypertrophy. It should be noted that this hypertrophy is a safe type of hypertrophy in contrast to the pathological hypertrophy which may accompany raised blood pressure or valvular disease of the heart. In such pathological forms of hypertrophy the muscle overgrowth may outrun the capillary overgrowth so that there are parts of the cardiac muscle which are poorly supplied with blood. This is not the case in the physiological type of hypertrophy found in athletes in which the capillaries do increase in proportion and the blood supply to the heart muscle is enriched. In general, heart size is proportional to the athletic standard achieved. Olympic standard athletes for any particular event are known to have rather larger hearts than national athletes who in turn have larger hearts than club

competitors. However, heart size is not strictly proportional to achievement in individuals so it is obvious that it is not the only determinant of athletic achievement. The size is greatest in competitors in endurance events such as the marathon and long distance rowing events. The result of this dilatation and hypertrophy is of course a capacity for a much increased cardiac output.

Other Changes

The lungs also develop so that overall lung function is improved; that is, the capacity to carry oxygen to the tissues and to clear carbon dioxide from the tissues via the lungs is enhanced and static measurements such as the vital capacity are increased following training. Other changes include an increase in the total muscle mass, a decrease in the muscle fat content and an increase in the total circulating haemoglobin.

Professor Jokl who is the "grand old man" of sports medicine has said that "you cannot store training like money in a bank". This is largely true of adults in that changes in the heart, haemoglobin and in the proportions of muscle and of fat in the body are all reversible if exercise is discontinued for any length of time. But his statement is not so true of the intensive training of children because we do know that growth is affected by training.

Training of Adolescents

The body changes in adolescents have been studied following controlled trials in which one group has been subjected to intensive training and a control group has continued with their usual activities. There is an increase in the lean tissue with training and a reduction of the fatty tissues and these changes apply both to the absolute quantities of these tissues and to the percentage change. The overall change in weight varies. For example, in girls excessive fat which is fairly common in this age group is lost, and this loss may exceed the gain in weight in lean tissue and there is therefore an overall and healthy loss of weight. However, with training there is more commonly an absolute gain in weight. Growth is enhanced, and a study of young swimmers has shown that they were bigger and heavier than their untrained contemporaries. It has recently become apparent why this should be. It is known that growth hormone which is produced by the pituitary gland is released if exertion approaches the point of exhaustion. This hormone leads to mobilisation of fat from depots in the form of non-esterified fatty acids which circulate in the plasma and are available as fuel for the muscle of the skeleton and of the heart. Growth hormone also increases the uptake of amino acids for protein synthesis and this is the mechanism which enhances growth. It is useful to keep in mind that this protein synthesis will include

bone as well as muscles and this enhanced growth of the skeleton is certainly "training which can be stored in the bank". Leg length and chest size for example may be increased and be of advantage in many forms of exercise. Growth will also depend upon demand. The particular muscles which are exercised and the heart will develop selectively.

Mechanical Efficiency

Quite apart from these physiological effects of training the highly trained athlete will learn economy of effort. This is very true of runners and swimmers and we even see it in the skill with which a boxer facing ten or fifteen rounds will "pace" himself.

Assessment of Fitness and Capabilities

It is a well known maxim that training must be graduated. In the past this was done by rule of thumb methods but it is now more common for several simple physiological measurements to be made such as the heart rate after a given exercise and the recovery rate of this tachycardia. When exercise produces less tachycardia or is followed by a quicker recovery it is possible for the athlete to move on to exercise of higher intensity or greater duration. Conversely any deterioration in these cardiac responses should lead to a cautious approach. There may be some simple explanation such as tiredness through lack of sleep or over-training or there may be some intercurrent illness.

Girls compared with Boys

We need hardly be reminded that girls are fundamentally different from boys, but it is useful to enumerate some of the differences which are relevant to the intensive training which we are considering.

1. Adolescence occurs earlier in girls.
2. Girls tend to be fatter than boys both in terms of the absolute amount of fat in the body and also the percentage of fat but we have already seen that this is a reversible situation.
3. In general males are more able to undertake endurance events.
4. The narrower male pelvis is of mechanical advantage, particularly in running. Outstanding female runners usually have the more masculine narrow type of pelvis and even the boyish physique overall.
5. Menstruation in women produces its own problems. There is an increased need for iron, and anaemia is more likely to develop. There may also be

impairment of athletic achievement in some women before and at the time of menstruation.

It is important to realise that training produces similar physiological and growth changes in the two sexes.

Diet

A study of Olympic athletes has shown that approximately forty per cent of their calories are derived from carbohydrate, forty per cent from fat and twenty per cent from protein. This means that to produce, for example, 2,500 calories their intake will be 250 G. of carbohydrate, 110 G. of fat and 125 G. of protein. Ideally the fat should consist of about fifty per cent saturated fat which is the fat derived from animal sources such as meat, butter, eggs and milk and fifty per cent of unsaturated fat from oils such as corn oil.

These diets in general are well balanced and are probably the ideal form of diet which we should be recommending. However, it is realised that some athletes, particularly those who engage in heavy events, indulge in a very high protein diet, and for example, eat vast amounts of meat, and this fairly certainly is part of the scheme used by those who hope to produce large muscle mass with the help of the anabolic steroids.

Risks of Intensive Exercise

The normal heart is said to be invulnerable to exercise but the concept of a strained heart is still encountered. This does occur but only if strenuous exertion is undertaken during an infection. It is now known that with bacterial infections and more particularly with simple viral infections such as influenza or gastro-enteritis, the heart shares in the toxic and inflammatory reactions of the infection. There is in fact a myocarditis and if the heart in this state is subjected to strenuous exertion it can be strained and permanently impaired. If the athlete is suffering from a significant infection he ought therefore to be advised not to engage in strenuous effort. In this connection poliomyelitis is a special case. If strenuous effort is undertaken while the individual is incubating the virus of poliomyelitis it will lead to severe paralysis of the muscles used in that exertion or even to death. Any vague illness in an athlete, particularly if it is prolonged over several weeks, should be checked quite fully. Pulmonary tuberculosis for example may afflict athletes and it is important to realise that athletes do not have any enhancement of the defences against infection. Another serious infection which is occasionally found is subacute bacterial endocarditis. This is an insidious infection which arises from septic foci, usually in teeth, leading to circulating organisms which light upon the heart, usually upon valves which have already been damaged by rheumatic valve disease.

Sudden Death

From time to time one hears of sudden death in a young person during sport and this is always distressing and tragic and always leads to recriminations against the organisation or the coach concerned. If the medical screening which I have outlined has been undertaken carefully, such tragic occurrences should be extremely rare. Study of such cases has always revealed some cause additional to the exertion. Most of the causes are cardiac. The myocarditis accompanying infection I have already mentioned. On occasions cardiac defects such as rheumatic valve disease or congenital defects have been found. On occasions one of the coronary arteries has been found to be congenitally small or absent. This is most unlikely to be detected during life since it may cause no symptoms, and it requires special radiological injection techniques for its detection; fortunately it is a rare occurrence. Very rarely tumours of the heart are found. Other causes include subarachnoid haemorrhage from an abnormal blood vessel or an aneurysm in the cerebral circulation.

Long-term benefits of exercise

Does exercise taken regularly allow the individual to live longer than his contemporaries? There have been several studies on this subject and it appears that prolonged and strenuous exercise certainly does not *shorten life*. In the earlier decades of life it is probably beneficial and the death rate in athletes is lower than the average. However, there is no very clear overall advantage to athletes in this respect and this is perhaps disappointing for one would expect some advantage since the athlete has presumably begun without any major disability and in the general population there is a proportion of persons with major disabilities.

We have become interested in recent years in the possibility that exercise will prevent coronary artery disease and there have been various studies which have suggested that this is the case. It is fairly certain that the exercise requires to be continued into middle life with reasonable regularity to confer this benefit, so even after the young person has finished his competitive life he should be encouraged to continue his athletic pursuit in a more limited way.