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ABSTRACT

This booklet is divided into seven sections that include the following topics: (a) physical performance, (b) adaptation to inactivity and activity, (c) physiological and medical motives for regular physical activity, (d) training, (e) physical fitness for everyday life, and (f) testing physical fitness and condition. Section one discusses energy output, neuro-muscular function, psychological factors, and age and sex. Section two discusses the changes in our bodies in adjusting to inactivity. Section three discusses cardio-vascular diseases, obesity, diet and choice of calories, hot environment and water balance, diseases and troubles of the back, joints, and posture. Section four includes the four principles of training, and a discussion of a simple training ground, and equipment. Section five discusses active recreation. Section six describes how the bicycle ergometer measures performed external work. The summary describes the responsibility of government and society for creating recreational areas and lists five points to remember. The author concludes that neglect of regular physical activity during adolescence cannot fully be compensated for later in life and that young people should acquire knowledge and experience of activities suitable for their future in school. These activities should include running, cycling, swimming, and skiing rather than the more organized team sports. A 49-item bibliography is included. (PD)

Council of Europe

COUNCIL FOR CULTURAL CO-OPERATION

SPORT FOR ALL

EXERCISE AND HEALTH

1969

The Council of Europe was established by ten nations on 5 May 1949, since when its membership has progressively increased to eighteen. Its aim is "to achieve a greater unity between its Members for the purpose of safeguarding and realising the ideals and principles which are their common heritage and facilitating their economic and social progress". This aim is pursued by discussion of questions of common concern and by agreements and common action in economic, social, cultural, scientific, legal and administrative matters.

The Council for Cultural Co-operation was set up by the Committee of Ministers of the Council of Europe on 1 January 1962 to draw up proposals for the cultural policy of the Council of Europe, to co-ordinate and give effect to the overall cultural programme of the organisation and to allocate the resources of the Cultural Fund. It is assisted by three permanent committees of senior officials : for higher education and research, for general and technical education and for out-of-school education. All the member governments of the Council of Europe, together with Spain and the Holy See which have acceded to the European Cultural Convention, are represented on these bodies [1].

In educational matters, the aim of the Council for Cultural Co-operation (CCC) is to help to create conditions in which the right educational opportunities are available to young Europeans whatever their background or level of academic accomplishment, and to facilitate their adjustment to changing political and social conditions. This entails in particular a greater rationalisation of the complex educational process. Attention is paid to all influences bearing on the acquisition of knowledge, from home television to advanced research ; from the organisation of youth centres to the improvement of teacher training. The countries concerned will thereby be able to benefit from the experience of their neighbours in the planning and reform of structures, curricula and methods in all branches of education.

Since 1963 the CCC has been publishing, in English and French, a series of works of general interest entitled "Education in Europe", which record the results of expert studies and intergovernmental investigations conducted within the framework of its programme. A list of these publications will be found at the end of the volume.

These works are now being supplemented by a series of "companion volumes" of a more specialised nature, including catalogues, handbooks, bibliographies etc., as well as selected reports of meetings and studies on more technical subjects. These publications, to which the present study belongs, are also listed at the end of the volume.

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The opinions expressed in these studies are not to be regarded as reflecting the policy of individual governments or of the Committee of Ministers of the Council of Europe.

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1. For complete list, see back of cover.

SPORT FOR ALL

EXERCISE AND HEALTH

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FOREWORD

" Sport for All " is the major theme underlying the action of the Council for Cultural Co-operation's Committee for Out-of-School Education in the field of physical education.

This action approaches the problem of enabling as many Europeans as possible, whatever their age, sex or personal means, to practise sport during their whole lifetime — or at least such a minimum amount of physical exercise as has become indispensable in today's industrialised society.

Further publications in this series will be devoted to various aspects of the Council's " Sport for All " programme. How to provide sports facilities at the lowest cost is an example.

The purpose of the present work is to try to give some medical and biological answers to the fundamental question, " Why Sport for All ? " and to offer some simple, but scientifically based suggestions in answer to the individual's question, " How ? ".

In 1964, the Council of Europe granted a Research Fellowship to Professor Per-Olof Åstrand to write a study on the general relationship between sport and work. Sweden is one of the most advanced countries in this field through co-operation between employers, trade unions, doctors, athletes and scientists ; and the study was intended for extensive distribution to just such circles throughout the member countries of the Council for Cultural Co-operation.

It was soon recognised that Professor Åstrand's findings were of far wider significance than had been defined in his original brief. The definition given to " workers ", for instance, had excluded all those who were not in paid employment ; the conclusions he reaches apply to office workers but equally to housewives, to factory employees and equally to the aged and convalescent. They apply, in fact, to every citizen of our modern world, each going about the business of his or her own everyday life. What is the amount of physical exercise that is needed, and why is it indispensable in today's industrialised society ?

Drawing on Swedish experience and that from many other countries, Professor Åstrand deals with these questions and, reaching across the linguistic gap that has so often left medical justifications inaccessible to the non-medical world, presents his answers in a lively manner, readily understandable to the layman.

INTRODUCTION

The build or " construction " of the body of most animals is dominated by a demand for locomotion. This applies equally to the human being. Muscle accounts for about 40 % of the total body, and the skeleton a good 15 %. Important organs and functions, for example the heart and circulation, and respiration, are dimensioned to give service to the muscles during activity. When the body is at rest the heart pumps out about five litres of blood per minute (the cardiac output) while in the same time 5 to 8 litres of air are breathed. Its " construction ", however, permits the cardiac output to be raised to 15 to 20 litres per minute or even higher, and pulmonary ventilation may exceed 100 litres per minute.

The central nervous system receives impulses from outside but also from receptors located within the body. A very high proportion of these impulses result in muscular activity : speech, writing ; eye movements, movements of the head, gestures, walking, running and so on as the situation demands. The brain would have been much smaller and less complicated in its anatomy and function had it not been its important task to co-ordinate muscular movements.

This simple introduction ends with the conclusion that the human body is " constructed " for and adapted to muscular activity — not for rest and inactivity. This was a necessity historically and in the process of evolution, as a successful struggle for life presumed a highly developed locomotive faculty. However, to maintain the performance of the body at an optimum and satisfying level, the heart, circulation, respiratory organs, muscles, skeleton and nervous system must all regularly be exposed to a load, as when training.

In modern society, machines have taken over much of the work previously performed manually by muscle power. We readily fall subject to an existence dominated by inactivity, spending, as we do, most of the day lying down, sitting, standing and being transported about by an assortment of vehicles. Thus the natural and beneficial stimulus to tissues and organs that physical work and exercise provide is little by little eliminated from our daily lives. Man has not yet become adapted to a modern, technically highly developed society, he retains his antiquated construction, needing activity for its optimum development and for the maintenance of good performance — and health.

CHAPTER I

PHYSICAL PERFORMANCE

In competitive sport, the athlete is evaluated according to his performance. Frequently the assessment is objective, with measurements of time or distance. In many cases, such as gymnastics, figure skating or diving, judgment may be subjective.

For some events the decisive factor is technique, for others endurance, speed or something similar is paramount. In the latter instance an athlete's actual performance is limited by his individual capacity to respond to the demands of the event. Thus, broadly, physical performance is based on the following factors :

1. Energy output (" motor power ")
   — aerobic processes
   — anaerobic processes
2. Neuro-muscular function
   — strength
   — technique
3. Psychological factors
   — motivation
   — tactics

Readers may find some explanation of these factors and how they determine physical performance levels helpful at this point.

ENERGY OUTPUT

Every cell in the human body is essentially a combustion engine. The carbohydrate glycogen and fatty acids provide the fuel, and as with any combustion engine or fire oxygen is needed to produce the energy yield. Carbon dioxide and water are liberated. With the inhalation of air oxygen is supplied to the alveoli of the lungs. From there it is transported to the body cells by the haemoglobin in the red corpuscules of the blood. The cells consume the oxygen and the carbon dioxide released is carried back to the lungs by the blood and exhaled. Every litre of oxygen consumed corresponds to an energy yield of 5 Kcal (kilogram-calories).

As oxygen uptake can be measured both when the body is at rest and when it is working, its calorie output and *aerobic effect* (" with oxygen ") can be determined. Measurements of oxygen uptake during some 5 to 6 minutes of maximal exercise can be made in the laboratory, frequently with the subject working on a bicycle ergometer (see Chapter VI) or a treadmill while breathing through a valve that allows his exhaled air to be collected in a rubber bag. The volume and oxygen content of the exhaled air are subsequently measured. In this way the maximal power of the individual's " combustion engine ", that is, his maximal aerobic power, can be evaluated. As the oxygen is carried by the blood, oxygen uptake also gives a rough measurement of the load on the heart and the circulation. The higher his maximal aerobic power, the better is the pumping ability of the individual's heart.

When physical work is commenced there may be a discrepancy between the oxygen demand of the working muscles and their oxygen supply. For these moments of oxygen deficiency the muscles are able to utilise an alternative source of energy. Glycogen stored in the muscles is broken down into pyruvic acid, and finally lactic acid releasing energy, which is available for the muscle contraction. This is the *anaerobic* (" without oxygen ") energy yield. Most of the glycogen is re-synthetised after the exercise, the energy required for this process being supplied by aerobic means ; an oxygen debt is repaid. Oxygen supply to the muscles will also be deficient during extremely heavy exercise and the anaerobic processes will need to contribute. The capacity to work anaerobically is, however, very limited, and the period of maximal work lasts for only a few minutes. In a way the lactic acid formed acts as a poison on the muscle cells. Anyone who has run a quarter of a mile at full speed will know what I mean, the leg muscles become stiff and may more or less refuse to obey.

In summary, energy required for severe exercise lasting from a few seconds to some minutes is principally provided through anaerobic processes (the splitting down of glycogen into lactic acid). For prolonged work aerobic processes, involving the combustion of carbohydrates and free fatty acids in the presence of oxygen, become the essential energy supplier. The higher the maximal oxygen uptake, the higher is the aerobic work power. Athletes who compete in events that require intensive work from large muscle groups for a minute or longer are without exception characterised by a very high maximal oxygen uptake (maximal aerobic power).
(References 5, 6, 7, 9, 11, 12, 13, 14, 45 and 47.)

NEURO-MUSCULAR FUNCTION

All bodily movement is based on a very complicated interplay between various muscle groups. The central nervous system can be compared with an enormous telephone exchange and computer. Nerve cells called motoneurones are located in the spinal cord and extend their nerve fibres to the muscle cells of the trunk and extremities. Impulses may be generated in these motoneurones and transmitted via the nerve cells to activate a few or many muscle cells. The greater the number of muscle cells that are stimulated and the higher the impulse frequency, the stronger will be the muscle contraction.

There are also nerve cells which may reduce the frequency of the impulse traffic to the muscle, in which case the force becomes less or the muscle may even relax completely. Thanks to well co-ordinated stimulation and inhibition of the nerve cells contacting various muscle cells, effective and skilful movements can be performed. When, for instance, the flexors of the arm are activated there is an automatic and simultaneous relaxation of the extensors. Within the muscle there are receptors, the muscle spindles, reporting the length-tension of the muscle to the central nervous system. These receptors are very important for the co-ordination of the muscles. If the initial muscle force has not been sufficient to overcome a resistance, reflex action by the muscle spindles can indirectly effect a correction by evoking a further stimulation of the motoneurones involved.

Many movements are inborn reflexes but the majority result from learning. A more or less rigid pattern of activation and inhibition of motoneurones according to a very critical time schedule develops. Movements are guided by various receptors and reflex centres and in fact the consciousness may "interfere" only when the movements are initiated and stopped.

Against this background it should be clear that technique and strength depend not only on the muscle characteristics but to a high degree on the functioning of the central nervous system. While increase in muscular strength during training is due to some extent to an increase in the muscle mass and improved muscle quality, it also results from a more effective discharge of nerve impulses (actually with the inhibition of otherwise inhibiting impulses). Consequently the muscles are stimulated by more impulses and the force of the contraction is increased.

It is thus understandable that an increase in muscle strength will be most pronounced in the particular movement that has been subject to training. A different movement involving the same muscle groups but stimulated by a different combination of nerve cells may derive very limited benefit from the training.

In brief, muscular strength does not only depend on how large and bulky the muscles are, the functioning of the central nervous system is of decisive importance. Normally there seems to be a partial inhibition of the muscles, but this inhibition may disappear in the face of danger or as the result of training. The effect of training to increase strength is largely confined to the movements involved in the exercises. Technique training is similarly rather specific. Learning complicated gymnastics movements does not lead to an improvement in the execution of other types of tricky movement. Some individuals are by natural endowment very gifted at any ball game, but it is not presently possible to describe or define the physiological or psychological quality that distinguishes these from mere mediocrities.

(References 24, 25 and 29.)

PSYCHOLOGICAL FACTORS

Sometimes we may be in the mood for physical exercise, sometimes we are definitely against it; sometimes we feel that we could move mountains, but at other times nothing seems to be in tune. Certain areas of the brain hold a key position in the co-ordination of the muscles. The sensitivity of the muscle spindles, for instance, is regulated from such areas. Activity within these nerve centres is influenced by the state of mind.

A person cannot normally at will throw all of his muscle cells into maximum contraction. However sometimes, for instance when under hypnosis or the influence of some pharmacological agency, when an award is promised, when the cheers of spectators ring in the ears, or when danger threatens or the situation is particularly stressing, strength may be exceptional. As already mentioned, this can be explained by the removal of an inhibition that would normally act as brake on the muscles. Training can have a similar effect, impulse traffic to the muscles being increased and muscle performance improved.

It is recognised that physical performance varies from day to day without any disease being involved and without any change in physical condition or state of training. Also, individuals differ in their inclination for physical exercise. Some actually enjoy working themselves " all out " while others are lazy and give up as soon as they feel physical resistance.

Tactics are also of importance to performance. His time in a 5,000 metre race will inevitably be poor if a runner starts at the speed he would go at if he had only 200 metres to cover; normally a steady speed results in the shortest running time. A patient with marked insufficiency in respiration or cardio-circulatory function can improve his ability to do physical work by introducing frequent " micropauses ", that is interspacing 10 to 30 seconds of work with rest periods of the same duration. With such a routine and work technique a physically rather demanding job may easily be tolerated, and leisure time can become more meaningful.

(References 11, 28 and 29.)

AGE AND SEX

It can be concluded that during work involving large muscle groups for a minute or more, the aerobic energy yield, or " combustion engine ", is of great importance. It should be emphasised that, as already stated, every litre of oxygen consumed corresponds to a definite energy output, or about 5.0 kilogram-calories.

The higher the individual's maximal oxygen uptake during exercise, the higher is his " motor " power. In laboratory tests the oxygen uptake (maximal aerobic power) of 350 male and female subjects ranging from 4 to 65 years of age has been measured during exercise on a treadmill or bicycle ergometer. The mean values for each age group was established to demonstrate how maximal oxygen uptake varies with age within this range. These subjects were moderately trained, and separate evaluations of three athletes and a group of 86 physical education students provided a comparison with them.

The graph of the results obtained shows a fairly steep rise in maximal oxygen uptake during childhood and adolescence, reaching its peak by the late teens, whereafter it descends steadily with age. The rate of decline is more marked, although still not dramatic, in the decade immediately following the peak than in later years. The averages for girls and boys are very similar up to the age of 12, but with adolescence, boys show a considerable and rapid improvement while girls are already near their peak. From there on the maximal aerobic motor power remains higher for the average male than for the average female, the figures for women being about 30 % below those for men. The variation between the individuals within each age group is, however, very pronounced; the female athletes are characterised by a maximal motor power superior to that observed in the majority of men.

A 25-year-old woman has on average the same or a somewhat higher maximum than a 65-year-old man; an individual of 65 may be better than a 25-year-old of the same sex. A job regarded as physically too demanding for a woman will also be too heavy for the older man. The decrease in maximal motor power with age does not necessarily imply that the work output of a 60-year-old worker is inferior to that of one aged 20, but the older the individual the closer he must work to his ceiling. He or she must utilise a greater proportion of the maximum, and this relatively high work load will inevitably give rise to fatigue. In many cases however, the older worker has a better technique, that is, higher mechanical efficiency, thus saving calories — and strain.

Training can increase maximal oxygen uptake by 10 to 20 %, perhaps even more. However the importance of natural endowment is such that the maximal oxygen uptake of an absolutely untrained individual may still be above the average for his age group. Similarly a well-trained man may have a relatively low maximal oxygen uptage and consequently a low performance capacity.

Many studies have proved that regular training can counteract (although not completely prevent) the decrease in oxygen transport capacity with age. Take two individuals, both 50 years of age and with exactly the same natural endowment and body build, but one well trained, the other untrained. The one in good physical condition will have a maximal oxygen uptake (motor power) equivalent to that which the other had when he was 35 to 40 years old. In other words from regular, but by no means severe, physical training there may result a biological " rejuvenation " of some 10 to 15 years !

As the transport of oxygen from the air to the cells within the body is so inextricably bound up with the blood circulation, the results of the observations of maximal oxygen uptake values also mirror the functioning and capacity of the heart and circulation. There can be several reasons for the decreasing maximal oxygen uptake after the age of 30. Gas exchange in the lungs becomes less effective, maximal breathing capacity decreases. Reduced elasticity of the blood vessels induces an increased load on the heart and at the same time the blood supply to the heart muscles may be insufficient.

The maximal heart rate decreases from about 210 beats per minute for youngsters to about 160 for the 70-year-old. The fewer the number of heart-beats per minute the lower of course is the cardiac output, since there is a limit to the extent to which the heart can compensate by increasing the volume of blood pumped per beat (the stroke volume). The muscle mass decreases and strength is reduced with age in a way approximately similar to that of maximal oxygen uptake. As already mentioned this reduction in power is partly an inevitable consequence of ageing, but is probably to some extent the result of a change in the way of life. Engaging in sport and various outdoor activities becomes less frequent among older people in a modern society. The physical demands of the job being almost negligible for most employees, they will become inactive and sedentary. The human body adapts to reduced demand on it, and maximal work power and physical work capacity will diminish. Regular physical training can counteract this impending deterioration.

(References 1, 2, 3, 4, 10, 11, 12, 27, 39, 40 and 41.)

CHAPTER II

ADAPTATION TO INACTIVITY - AND ACTIVITY

It is often said that one can get used to anything, a fortunate quality for the human psyche as well as for the human physique. One adjusts to high altitudes, to both arctic and tropical climates, to heavy manual labour, to sports activities, but also, unfortunately, to a life characterised by much sitting, driving and resting. We are quite unaware of all the changes actually occurring in our bodies after a more or less sudden change in our way of life, but these changes, pronounced as they often are, can be detected and measured.

The extreme type of inactivity is continuous bed rest. Many experiments have been made to try to explain what happens in the body during protracted *inactivity*. In one example observations were made of healthy student volunteers kept in bed for between 3 and 6 weeks. Careful examinations were made of the subjects both before and after their stay in bed. The inactivity resulted in decreased muscle mass, decreased skeletal calcium concentration, diminished blood and heart volume, impaired reaction time, and reduced maximal cardiac output and oxygen uptake. Before the period of bed rest a given task on a bicycle ergometer could be performed easily, with a heart rate of 120 beats per minute. After six weeks in bed the same task was performed but this time with much more strain. The heart rate rose by 50 beats, reaching 170 beats per minute.

The elevated heart rate is partly explained by a decrease in the strength of the heart muscle. In order to compensate for a diminished stroke volume the heart must beat more frequently. This is unfortunate as the higher the heart rate is at a given cardiac output the more energy and therefore blood and oxygen it needs. A second factor behind the increase in heart rate after prolonged inactivity is less efficient regulation of the circulation (cf. the dizziness often felt when standing up).

Six weeks is not very long, and no illness was involved. However a definite and profound impairment in the physical condition nevertheless occurred. It took about six weeks of training after the experiment for the pre-test values to be regained. In a way the adaptation occurring here is physiologically only expedient. It would be poor economy to support a large muscle mass or a powerful skeleton when it was not being used. This adaptation is not really felicitous, however, as it increases the load on the heart, it reduces the ability to perform work and it may in the long run be a definite health risk (see below).

Anyone who has ever had to wear a bandage or plaster cast for some time will surely have noticed the decrease in joint mobility and the speed with which the muscles and strength fade away, even though the muscles themselves may not have been injured. This rapid atrophy and deterioration of certain tissues creates many problems, particularly among the sick. Physicians nowadays are extremely conscious of the disadvantages of prolonged bed rest and other types of inactivity. They avoid prescribing it as far as possible and try to stimulate the patient to exercise. For example, patients are now got up on their feet after an operation as soon as is feasible. Blood clots (thrombosis) in the veins of the legs and pneumonia are not at all unusual complications connected with protracted bed rest. Actually, movement is the best prophylactic, increasing both circulation and "airing" of the lungs.

If the period of convalescence after an illness is not used for effective training, for instance by taking walks and other types of exercise, the first days back at work will probably impose a sudden load. Fatigue may result, particularly in physically demanding jobs carried out at a hard pace or involving much standing etc. The worker then risks collapse and a prolongation of convalescence, with further impairment of his physical condition. There are in fact cases of people remaining invalid for years, even for life, through having failed to "get going" after an illness.

Thus in most cases convalescence should include systematic physical training, and close co-operation between patient, physiotherapist, and physician can certainly result in more rapid recovery. Good physical condition definitely cannot be attained just by resting and the traditional, very passive convalescence. Moreover the care of old people would be facilitated if they could be made active. From an economic point of view these problems are most important, but sadly neglected.

Any muscular activity that increases the oxygen uptake will also to an extent have the effect of training the heart and circulation. This effect is the reverse of that induced by inactivity; muscle mass, blood volume, heart muscle strength and the number of blood vessels increase. The untrained person may have a resting heart rate of 70 beats per minute but after some weeks' training the frequency may have fallen to below 60, proof that the training has been effective. A given work load, for instance one demanding an oxygen uptake of 1.5 litres per minute, or about six times the resting consumption, would result in a heart rate of say 150 in the untrained state, but after training it may be 140, 130 or even lower depending on the severity of the training.

As mentioned, the lower heart rate implies that the work being done by the heart is more efficient and more lenient on it. Unfortunately, active training is the only "medicine" that can induce this beneficial effect physiologically. It is possible for the heart rate to be recorded continuously over 24 hours. Such recordings have shown that even moderate training (as suggested below) can save some 10,000 to 20,000 heart-beats per day! The training itself costs only some 2,000 extra heart-beats per day. (The medical consequences of this are difficult to evaluate but the figures are of great interest as an illustration of how heart work can be modified.)

To summarise, certain tissues such as muscle, bone and blood and also a number of bodily functions can adapt to inactivity — and to stress. Inactivity impairs the capacity for physical work, while a well-adjusted load improves it. The degree of improvement is not determined by the duration of work or training. The decisive factors are the intensity and tempo of training. This will be discussed further in a later chapter.

(References 5, 17, 18, 20 [*a*], 26, 34, 42, 46 and 48.)

CHAPTER III

REGULAR PHYSICAL ACTIVITY
PHYSIOLOGICAL AND MEDICAL MOTIVES

The athlete has a very great incentive to train; he knows that to have any chance of putting up a good performance he must prepare himself very carefully. For him the essential question is *how* he should train in order to put the often limited time available for his training to the best effect. Up to now science has helped him in his preparations to some extent, but very much remains to be studied.

But the non-athlete, why should he keep himself physically fit? In the introduction it was emphasised that animals, including human beings, are "constructed" for activity, and regular activity is absolutely necessary for optimum functioning of the heart and circulation, muscles, joints etc. This activity is comparable with the servicing the need for which we take for granted for cars and other complicated mechanical designs. Situations arise, for instance emergencies at sea or in the mountains, where with a high level of physical fitness one can save one's life or the lives of others. Exercise undoubtedly counteracts the tissue atrophy that otherwise comes with age. Exercise in the form of sport and outdoor life constitutes an excellent leisure activity.

It should be emphasised that the aim of this training and activity is not the attainment of high maximal motor power. It is much easier, more efficient and less expensive to make use of electricity and machines when energy is required to do a job or during leisure time. The essential and important aim is to benefit from the "by-products" of training.

CARDIO-VASCULAR DISEASES

In many countries cardio-vascular troubles cause more deaths than any other disease, and often account for more than 50 % of all deaths. Naturally this fact motivates the intensive research presently being carried out to discover the genesis and treatment of such diseases. They certainly cause personal suffering and their social and economic consequences are enormous. Here let it merely be pointed out that several factors such as heredity, diet and way of life seem to be of importance in the development of cardio-vascular diseases. Individuals showing high blood pressure or obesity or a high concentration of cholesterol in the blood or a combination of these run a higher risk of death from cardio-vascular diseases than the non-obese with normal blood pressure and a low cholesterol level.

In recent years interest has been focused on the possible role of physical inactivity in the genesis of these diseases. In studies published so far it has been shown that the risk run by individuals characterised by inactivity of death from a cardio-vascular disease is two to three times greater than that run by the active. The probability of surviving the first heart attack is statistically two to three times greater for those who have previously been physically active than for those who have been inactive. These are statistical correlations and do not prove that the degree of physical activity has actually been the sole and decisive factor. The studies were carried out on selected groups of individuals, and it is possible that certain factors that determined choice of profession or degree of activity during leisure time may also have independently given rise to some sort of prevention against cardio-vascular diseases.

However there are physiological explanations as to how physical activity could be beneficial. Investigations on animals and observations on man have revealed that physical training can open up more blood vessels in the arterial tree in the heart muscle, that is collaterals may develop in the coronary arteries. Similarly collaterals may develop in peripheral arteries. A narrowing or occlusion of a vessel due to arteriosclerosis will not mean the same catastrophe if there are other vessels that can take over the transport of blood with its oxygen and nutriments to the tissue peripheral to the damaged vessel.

Research in this area is very complicated and it may take a hundred years or more of intensive study to demonstrate with certainty that there is or is not a connection between cardio-vascular diseases and inactivity. The question is then critical whether we should wait so long for final proof one way or the other. In my opinion there is so much indirect evidence that regular physical activity, or training, has a beneficial effect on the functioning of the heart that the opportunity must be seized now actively to affect health in a positive way through a systematic improvement in physical fitness by training.

Once again I repeat the more teleological approach : we are constructed for activity ; we once had to run in order to survive and if we are to maintain ourselves in a state of optimum function we must from time to time be physically active ; we still have to run for our lives !

Training of the oxygen transport system, including the heart and circulation, is particularly important then both as a prophylactic measure and as treatment.

(References 16, 20, 21, 22, 23, 31, 33, 34, 35.)

OBESITY

People in most European countries (and also in North America) show a definite tendency to put on weight after the age of thirty. At the same time there is some decrease in muscle mass, and there will therefore be a more or less marked increase in body fat. Obesity may lead to aesthetic problems, but it is also a drawback from the medical point of view. It is still an open question whether there is any direct connection between obesity and various diseases, but so far the incidence of cardio-vascular diseases has been higher among the obese than the non-obese. Unfortunately there is no simple table of body weight and height that can be used to assess whether an individual is over or underweight. One can be heavy but not obese or light yet still obese. A good rule of thumb is to avoid an increase in weight after the age of twenty.

It is frequently announced that " new, sensational research " has solved the problem of the obese. Sometimes it is fats should be avoided, sometimes carbohydrates get the blame. However body weight is a question of simple mathematics. If the number of calories eaten is equal to the number of calories expended, weight remains constant except for day to day variations of within 2 pounds (1 kg), which are mainly due to fluctuations in the water content of the body. Whether the consumed calories were fats, protein or carbohydrates is of minor importance in this connection. The intermediate metabolism of protein does demand some extra energy output, but it can be ignored. If the calorie intake is excessive it does not matter whether it is in the form of fats, protein or carbohydrates as it will be converted into fatty tissue anyway.

For overweight to be due to pathological causes is exceptional. Obese children and adults are generally less physically active than the non-obese. One kilogram of fatty tissue contains about 6,000 kilogram-calories (Kcal). A person who is sedentary both in his professional life and during his leisure time attains an output of some 2,000 to 2,500 Kcal per day. Individuals normally engaged in heavy manual labour and athletes in hard training consume some 5,000 Kcal or more per day. Energy consumption therefore corresponds to the combustion of from a third to one kilogram of fatty tissue a day, according to the amount of physical activity. With plenty of food available the demand for calories is easily and fairly exactly covered by food and beverages.

Studies on animals have shown, however, that if forced to inactivity they eat a little bit more than they need, and gradually put on weight. In man the situation is evidently similar, the appetite is regulating a food intake for an energy expenditure that exceeds demand in a sedentary individual. In a sense there are two ways to maintain a normal body weight : be physically inactive but often hungry or be physically fairly active and eat as much as desired !

Below are listed the calorie contents of some items of food :

4 lumps of sugar (each about 12 grams or 0.4 oz)	**50 Kcal**
1 pastry or tart	**250 »**
6 grams (0.2 oz) of butter or margarine	**50 »**

1 piece of bread and butter	**100 Kcal**
100 grams (3 1/2 oz) of potatoes	**100 »**
100 grams (3 1/2 oz) pure chocolate	**350 »**
1 bottle of beer	**100-150 »**
4 centilitres (1/4 gill) of cognac	**240 »**
0.2 litres (1/3 pint) of whole milk	**120 »**
0.2 litres (1/3 pint) of skim-milk	**70 »**

A person with a body weight of 70 to 75 kg (11 to 12 stone) spends about 50 Kcal walking or running about 1 kilometre. The speed is of minor importance in so far as the energy output is concerned ; distance covered and body weight are the factors that determine how many calories are required. A daily intake of 50 Kcal in excess of expenditure will end up within a year as a surplus of 18,000 Kcal, equivalent to 3 kg or about half a stone of extra fatty tissue. The same excess over a period of 10 years would result in 30 kg or nearly 5 stone of extra fatty tissue ! It is no wonder that obesity can so to speak sneak in very gradually, often starting the very day the first car was bought, or there was a change to a more sedentary job, or the successes at athletics became less frequent and therefore training and competitions were dropped ! In this connection the ages of 25 to 30 are fairly critical.

The most lenient way to reduce weight involves allowing plenty of time for measures to take effect. Diet should be critically examined and an attempt made to eliminate some 100 Kcal per day, for instance by substituting artificial sweetenings for sugar, or skim-milk for whole milk. Furthermore a two kilometre (1 1/4 mile) walk or run per day would add 100 Kcal to the expenditure, the result being a total net reduction in fatty tissue equivalent to 200 Kcal per day. Everything else being equal, after a month the body will be holding 6,000 Kcal less than before, equivalent to 1 kg of fatty tissue. After a year the body weight would be reduced by 12 kg or nearly two stone.

To achieve a rapid reduction in weight a strict diet of no more than some 800 to 1,000 Kcal per day must be combined with increased physical activity. Such a programme is hard. There is unfortunately no diet as low in calories available that is also satisfying. With a low-calorie diet the initial reduction in weight is often very pronounced, but the loss is mainly water, not fat (or calories). This condition is often craftily exploited by advertisers of various diets and drugs for slimming.

In summary, increased physical activity during which neither intensity nor speed need be high and a change from a diet rich in fat to one containing relatively more protein is the best regime for maintainin (or reducing down to) normal weight, which for most middle-aged or older people is what they weighed when they were about 20 years of age. It is a mistake to avoid carbohydrates (for instance in potatoes, bread or rice) completely as muscle and nerve cells need carbohydrates in their metabolism. This is particularly important for anyone who is physically active.

(References 8, 10 [*a*], 19, 32, 33 and 49.)

DIET - CHOICE OF CALORIES

It is appropriate here to include a brief comment on another, different aspect of diet. Studies have shown that middle-aged and older people, particularly women, often take in fewer than 2,000 and sometimes as little as 1,500 Kcal per day. This low calorie consumption is partly explained by the reduced basal (resting) metabolic rate with age, but also of significance is the fact that such people are very inactive. Their routine becomes very set and physically undemanding — for instance the car to the place of work, the lift up to the office and down again, the car home, dinner, television and bed.

Even those who claim to be active may possibly turn out to have had a round of golf two or three weeks ago and plan to play again within the next two weeks ! In Scandinavia at least (and the situation is probably similar in many other countries), the traditional diet is such that it actually requires an intake of more than 2,000 Kcal per day to ensure an adequate supply of the vitamins, iron and other minerals, and essential amino-acids necessary to prevent malnutrition and disease. If the food preferred has a low content of essential nutriments the risk of deficiency is aggravated. Such is the case when the diet is rich in fats, sugar, sweets, pastries and biscuits. To recommend that "low-calorie consumers" should simply eat more to guarentee a complete diet is fundamentally wrong, for they would then become obese.

The proper way to improve their nutritional status, and a very sound one from the physiological point of view, would be to encourage them to become "high-calorie consumers" by increasing their energy expenditure with exercise. They would then eat more and their nutrition improve correspondingly, provided of course that the additional calories consisted of the proper food. This is another example of how increased physical activity such as walking, cycling, skiing, swimming etc. can have an efficient prophylactic or therapeutic effect.

In summary, if the body's demand for nutriments is to be covered the calorie intake must not be too low, but these calories should be expended to prevent overweight. In a modern society there is a definite risk that many individuals will take in and expend fewer calories than are actually needed to prevent malnutrition. This risk is a particular threat to the older woman. It is difficult to bring about the change required in the habitual composition of food to ensure that "low-calorie consumers" get a well balanced diet. A very attractive solution to the problem is to encourage them to become more physically active in their leisure time, change them into "high-calorie consumers" and their diet would more or less automatically be adequate.

(References 8, 33 and 49.)

HOT ENVIRONMENT AND WATER BALANCE

It is not unusual to hear people claim that water intake should be kept to a minimum when the weather is hot or they are working hard for long periods of time. They argue that the smaller the quantity of fluid intake the lower is the perspiration rate. Studies have shown, however, that perspiration occurs relatively independently of whether or not the body is in water balance. Furthermore, perspiration is the mechanism that can prevent overheating on exposure to heat or heavy work. If fluid is not replaced at the same rate as it is lost, performance capacity and fitness will be impaired and the feeling of strain will increase. Heart rate and body temperature rise to abnormal levels.

So when perspiring one should deliberately drink, possibly even more than thirst "orders", but not too much fluid should be taken in at a time and the water or beverage should not be too cold. It is becoming more and more popular among people in the northern part of Europe to spend their holidays in the south where they can enjoy the sun and warm climate. The recommendations made concerning fluid intake should be remembered. Frequent exposure to the hot environment of a sauna for a couple of weeks beforehand will provide partial adaptation to the heat and make the actual stay in the warm climate that much more comfortable.

(References 5, 6, 7, 9 and 44.)

DISEASES AND TROUBLES OF THE BACK

Diseases in the spinal column rank very high on the list of common diseases. They are responsible for many days of sick-leave, and thus give rise to economic problems, and they cause much suffering. Often lesions can be observed in the discs of the spinal column, in the small joints between the vertebrae or in the tendons, but the genesis of these lesions and the accompanying pain is unsolved.

The trouble frequently begins with no noticeable initiating factor, but sometimes an accident, the lifting of a weight, cooling or an infection may be known to have started it. It may fade away spontaneously after a time, but in some cases intensive care, possibly including surgery, must be tried. As the genesis of diseases of the back is obscure it is very difficult to suggest effective treatment that is respectively prophylactic and curative. We are to a great extent forced to act from experience and assumptions.

It has been pointed out that the spinal column may be considered to have both intrinsic and extrinsic stability, the former provided by the rigid or elastic components of the spine bound together by ligaments, while the muscles of the spine and trunk provide the latter. In fact the forces to which the back is subjected in actual life situations can be greater than the load that the spine as such can tolerate. This discrepancy can be explained by the role played by the trunk.

If a heavy weight is lifted in a forward bending position the trunk forms a long anterior lever to the assumed fulcrum of the movement, the fifth lumbar disc. If this disc were to take the strain alone, the force acting on it could be 10 to 15 times greater than the weight lifted. This might be considerably more than segments of the unaided spine can stand without structural failure, particularly in older subjects. However it has been shown that since the spinal column is attached to the sides of, and within, two chambers, namely the abdominal and thoracic cavities, the action of contracting trunk muscles converts these chambers into nearly rigid-walled cylinders containing air, liquid and semi-solid material. Thus these cylinders are capable of transmitting a considerable proportion of the forces generated in loading the trunk. thereby relieving the load on the spine itself. So in other words, when a load is lifted or carried a reflex mechanism calls the trunk muscles into action to fix the rib-cage and to compress the abdominal contents. The intra-cavitory pressures are thereby increased and aid the support of the spine.

Such observations emphasise the important role that the trunk muscles have in supporting the spine. While flabby abdominal muscles may leave the spine exposed to injurious stress, can prevent damage to the spinal column and its resultant backache etc. To be sure, the trunk can prevent damage to the spinal column and its resultant back ache etc. To be sure, the trunk muscles probably have no influence on the inevitable changes in the spinal column that come with age, but if they are well developed and trained these muscles can to a great extent prevent the occurrence of symptoms caused by a weak back.

Walking or running upstairs or uphill (see the programmes on pages 24 and 27 will train the leg and trunk muscles. Simple but if possible daily exercises, as detailed on the aforementioned pages, will also strengthen these muscles. As back troubles are so common it is important to encourage workers to keep the trunk muscles fit.

It is also important that everyone should know how to lift and carry loads in a way that reduces the force on the spinal column. As far as possible lifting should be avoided when bending forwards ; the leg muscles are stronger than those of the back and are therefore more efficient to use ; the centre of gravity of the load should be kept as close to the axis of the body as possible to minimise the moment of the force ; twisting or turning while lifting should be avoided ; it is important that the feet be firmly placed to prevent slipping.

Chairs should provide good support for the lumbar region of the back. They must permit frequent variations and changes in position to avoid tension and fatigue.

(Reference 36.)

JOINTS

A prolonged load on a joint will compress the cartilage covering the bone and its nutrition and metabolism may be impaired. Movement in the joint, on the other hand, increases the thickness of the cartilage and improves the exchange of nutriments. Degeneration of the cartilage may already have set in by the age of 20, and we are faced with the problem of whether it can be counteracted. It has ben suggested that protracted static loads should be avoided and that movement is beneficial. Decreased flexibility is one consequence of inactivity as this results in changes in the structure of adjacent ligaments, connective tissue, and synovial capsules.

For optimum functioning in any joint dynamic movement is necessary, although how much and how often is not presently known. Any place of work should be so organised that it permits some movement, and working positions should not be too static. From time to time movements should be performed up to the limit set by the joints, especially those of the shoulders and hips (see pages 25-27). These movements should not be too vigorous or jerky and must not induce pain. There are orthopaedic surgeons who object to excessive bending and twisting in the spinal column and as these activities are not particularly effective in strengthening the trunk muscles they can be omitted.

Physical activity during regular short breaks and free time at places of work is an excellent refreshment of both body and mind and allows the joints to get their "treatment". I would like to see short programmes of exercises broadcast five to ten times a day on radio and television to give anyone who wishes a chance to participate.

The athlete's warming up before a competition probably improves the resistance of his articular cartilage by making it more efficient as a buffer.

(References 27 [a] and 29 [a]).

POSTURE

It has been emphasised that a sustained load has a detrimental effect on the functioning of muscles and joints. In the erect position moreover there is a tendency to blood stagnation in the legs. Patients whose cardiac function is impaired are particularly prone to such adverse blood distribution, resulting in oedema of the lower leg. The contraction of muscles during movement compresses the veins and thus promotes the flow of blood towards the heart.

This beneficial effect of dynamic muscular activity on the blood flow leads to the important conclusion that sitting or standing postures should not be too fixed but should permit movement. When driving long distances, it is necessary to stop regularly, get out of the car and stretch the legs! No place of work should in fact be so well organised that everything is too comfortably within reach; it is good from a physiological point of view to get up from time to time, to walk a few steps, to climb the odd flight of stairs and so on.

In essence, well developed muscles can promote the circulation of the blood. Training will increase the volume of blood, which is also a definitive advantage. However, it should be pointed out that a period of rest in the middle of the day, lying down with the legs raised, may also work miracles, especially for the aged and those suffering from heart disease.

CHAPTER IV

TRAINING

THE PRINCIPLES OF TRAINING

A combination of proof and circumstantial evidence demonstrating that everyone needs regular physical activity for optimum functioning and health has been given, and now it is time to turn to the question of *how* to train. From medical and physiological viewpoints I consider training of the heart and circulation to be the most important. And, as has been pointed out, the trunk muscles should also be in good trim. From thes points of view it is less evident that the biceps should be strong, but all-round training of the muscles and extended movements in the joints are advisable. My main recommendations follow.

1. Calorie expenditure

To prevent obesity and to ensure an adequate supply of essential nutriments the individual should attain a calorie output that is not too low. Muscular activity is the most efficient way to increase the metabolism. The larger the active muscle mass the higher is the calorie output at a given subjected strain. Within wide limits the work load or speed makes little difference to the energy demand, the determining factor being the total work done, the distance. A slow walk from A to B demands no fewer extra calories than a fast run over the same distance.

Therefore walking a few kilometres a day will in the course of time be very effective in keeping the body weight down. One can easily leave the bus or underground a few stops from the office in the morning, and walk back a similar distance in the afternoon.

2. Training of physical condition : the oxygen transport system

A walk at an easy speed will have some conditioning effect, and a patient or untrained person should in fact start his training slowly. The effect of training will be more pronounced however if the speed is higher. The basic principle behind this training is an engagement of large muscle groups in fairly heavy *but not maximal* exercise for a few (2 to 5) minutes, a similar period of rest or mild exercise, heavier work again, and so on repeated up to 3 to 5 times. Brisk walking, running, cycling, rowing, cross-country, skiing, swimming, skipping, running on the spot or jumping may be chosen for the heavier work.

The reason for recommending that the rate of exercise should not be maximal is as follows : let us take as an example a man running at a speed of 12 km/hr (7 1/2 mph) for 4.0 minutes. His energy demand is covered by his " combustion engine ", i.e. carbohydrates and fatty acids are burned in the presence of oxygen. For this subject this speed has loaded his oxygen transport to the maximum. However he can actually run the same distance at a still higher speed, say 13 or even 14 km/hr (over 8 1/2 mph). As he cannot further increase his oxygen uptake the extra energy demand must be met by anaerobic processes. Thus in this case the speed of 12 km/hr can provide the maximum training effect on the heart and circulation. A still higher speed would improve the person's ability to utilise his anaerobic power, including his tolerance towards the accumulating lactic acid. This training of anaerobic power by maximal effort for one or several minutes is certainly a very exhausting and laborious task. It is an inevitable part of the athlete's training programme, but in my opinion it is wise to exclude it from the training of others. The conclusion is that a distance that can be run in about 3.0 minutes can be covered in 3 1/2 or even 4.0 minutes without being less effective in conditioning the cardio-vascular function. The lower speed is acknowledged with relief !

3. Training of strength

As mentioned earlier, muscular strength is dependent on both muscle mass *and* the function of the central nervous system. The repetition of a given movement will result in an improvement in that particular activity, but will have much less effect on a different movement even if it happens to be related. The transfer effect, as it is called, is fairly weak. We distinguish between static (or isometric) and dynamic contraction. (The latter is also referred to as isotonic work, but this is incorrect however.) When a muscle works isometrically there is no movement in the joint involved, in dynamic work there is. The simple rule is that anyone who wants to improve his isometric strength must train isometric activities, but if the aim is to increase dynamic strength, this type of contraction should be given preference. To improve maximal force, training must consist of striving to overcome an extremely high resistance, while ability to sustain prolonged exercise demanding strength is improved by work against lighter weights over long periods of time.

For general training of the muscles for normal individuals as well as for patients the accepted programme comprises work against a resistance that can be overcome some 5 to 10 times. Apparatus such as springs, rubber straps or weights may be used, or simply the body weight handled. A strong man may do 5 to 10 press-ups with the hands on the floor. The weaker woman makes it easier by placing the hands higher up, for instance on a table or sofa, or against a wall. As her strength gradually improves she may place the hands at a lower level.

The abdomical muscles (the " muscle corset ") can be strengthened by lying down on the back and performing " sit ups ". A support under the feet makes this easier. The exercise is repeated some 5 to 10 times on each occasion, and possibly again after a period of rest. Another exercise for the abdominal and hip muscles is included in the recommended exercise programme (page 25).

The back muscles are forced to work when we try to lift the trunk and legs from the floor in a face-downwards prone position. Anyone who is rigid in the spinal column should place a firm pillow beneath the pelvis and try to stretch out to a horizontal position. This exercise should be repeated some 5 to 20 times (see page 25).

Leg muscles, and also trunk muscles, are trained by walking or running upstairs, skipping, running on the spot, or jumping. The classic step test, stepping onto and off a bench, is also efficient. Running uphill some 25 strides at maximal speed, walking down, a fresh burst of activity uphill, and so on repeated about five times provides most effective training in this respect.

Personally, I believe that dynamic exercises have a more allround effect than isometric training. Certainly the trunk muscles work predominantly isometrically in daily activity, but they will become trained for these tasks, for in so many of the activities that engage the arms and legs they will be working statically to stabilise the pelvis and thorax. (Actually very few activities are truly exclusively dynamic as many muscles are forced to work isometrically to provide perfect conditions for those working dynamically.)

(References 24, 25, 29 and 37.)

4. Training of flexibility

It has been emphasised that there must be movement, and even to the extreme, in many joints to counteract stiffening and impairment of the metabolism of the cartilage. The limbs should be moved as far as they will go, gently and with no force applied. No pain should be caused by these movements.

Some suitable exercises are included in the recommended training programme. Aged or immobile individuals should do the exercises several times a day, unless a doctor or physiotherapist recommends otherwise. Anyway, movements such as those given in the recommended training programme would have a beneficial effect on anyone.

A SIMPLE TRAINING GROUND

An example of a simple but very efficient way to train is illustrated on page 24. Any community should try to find a piece of ground convenient for walking or running. Training can more or less entirely be devoted to outdoor activities.

My personal training is almost exclusively arranged as follows. I change at home into suitable clothing and drive to a golf course where I train on the perimeter so as not to interfere with the golfers' game! To warm up I walk and run at a slow pace (jogging) for about five minutes. On a steep slope I run about 25 strides uphill at maximum speed, walk down again and then repeat the uphill effort, in all about seven times. This training of the leg and trunk muscles lasts about five minutes. It is a moderately severe exercise as the actual work time is so short.

Next, with the idea of training the cardio-vascular function, I do three to four minutes running at a high *but not maximum speed*. I then take two to three minutes rest before running again. Altogether my track provides four opportunities to improve cardio-vascular fitness. In all it takes up some 30-35 minutes of my time, and afterwards I enjoy a shower at home.

The track should be well prepared to avoid sprained ankles or other accidents. Running fast downhill must be "prohibited", its training effect is negligible while the risk of injury is considerable. In the northern countries such tracks can be very convenient for cross-country skiing in the winter. In fact in many places in Finland, Norway and Sweden they are electrically illuminated to provide training facilities even when it is dark.

The aim is definitely to encourage every individual to spend some two to three of the 336 half-hours available per week in effective training. Actually, walking and running are very natural types of motion, for which we are "constructed". The feeling of strain is moderate although the training is effective.

This exercise can be carried out independently, as is not the case with soccer, basket ball and similar sports, for which schedules have to be made to fit in with those of one's team mates — and opponents. Whether training is undertaken in the morning, afternoon or at night is of no importance physiologically. Many practical aspects have to be considered. As for the intensity or speed of the exercise, this must be adjusted to the individual's physical condition, health and age. A gradual increase in the work load should not be aimed for, on the contrary when a suitable level has been reached, the speed and pattern of training should be rather monotonous from time to time. Checking speed against a stop watch is in my opinion unnecessary.

It should be emphasised that less energy and effort is required to maintain good physical condition than to attain it starting from scratch. So regular weekly training is important. Initially training every day or very other day will result in a substantial improvement in fitness, after which this level can be maintained with less effort and fewer training sessions.

A very wise approach for the previously very inactive is to start the training during a holiday, as there is then usually plenty of time available for activity — and rest. The previously inactive should choose walking as their basic activity when training on a track similar to that illustrated on page 24, substituting a brisk walk where running is indicated. Two important principles of effective training are emphasised by this illustration: large muscle groups should be active and intensity (speed) should be varied. Other types of activity can of course be carried out to a similar plan. Gymnastics for muscles and joints are easily undertaken at home (pages 25-27). It is never too late to start training; even the older individual can improve his functional capacity by regular training.

CLOTHING AND EQUIPMENT

The most suitable clothing for walking and running outdoors is a track suit and training shoes with proper heels to avoid damage to the Achilles' tendon. This light clothing can easily be slipped into the luggage when travelling!

In countries where good snow conditions are found in winter, everyone should try cross-country skiing with the proper equipment. It makes an excellent combination on holiday to spend most of the day downhill skiing using the lifts for the uphill ascent, but devoting the final half-hour or hour to cross-country skiing, wich is more efficient at training the circulation of the blood. The heavy skis and boots necessary for downhill skiing, however, are definitely unsuitable for cross-country skiing.

IN THE OPEN : EXAMPLE OF TRAINING ON A SIMPLE TRACK

BEST COPY AVAILABLE

1. Five minutes warming up by walking and slow running (jogging).

2. About 25 steps running uphill at top speed (or according to fitness) ; walking down ; sprinting uphill again etc., about five times in all. This takes some five minutes and develops strength in the leg and trunk muscles.

3. Three or four runs at about 80 % of top speed for three to four minutes, interspersed with rests of similar duration. (Conditioning of the oxygen transport system.)

This training programme takes 30 to 40 minutes altogether, and for anyone in fairly good physical condition two or three such periods of training a week are enough.

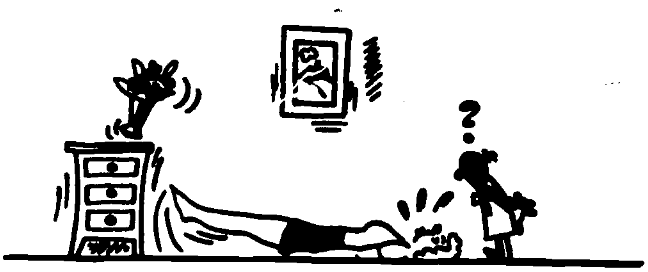
(BASTU = SAUNA)

AT HOME : RECOMMENDED EXERCISES

1

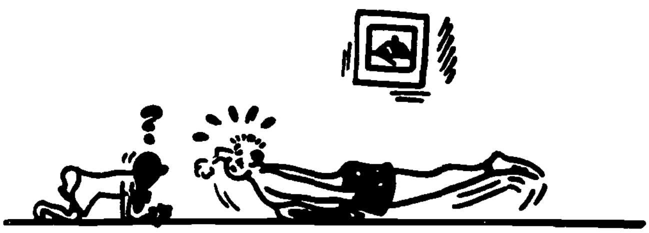
1. Skipping or running on the spot or " step test " .... 1 min.
   Rest .... $^1/_2$ min.
   Repeat exercise .... 1 min.

2



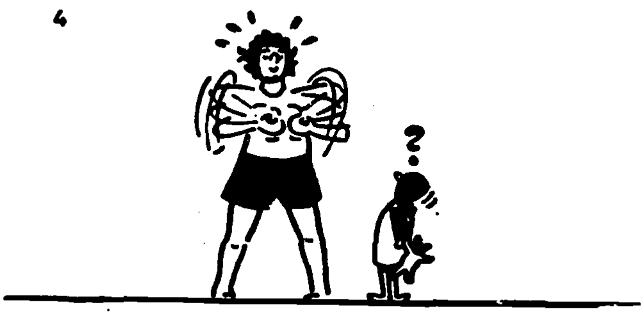
2. Lying on the back, lift upper body and, or both legs some inches off the floor, hold for 3 sec., relax for 3 sec., repeat up to 16 times .... $^1/_2$ to 2 mins.

3



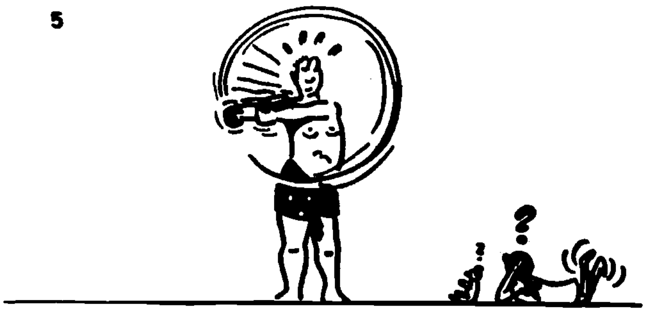
3. Lying on the stomach with a pillow under the pelvis, lift legs and upper body so that weight rests on the pillow, with arms either held against the sides or outstretched. Repeat up to 16 times as with exercise 2 .... $^1/_2$ to 2 mins.

4



4. Standing with feet apart, roll shoulders about 24 times, changing direction every fourth roll .. $^1/_2$ min.

5



5. Standing with feet apart, swing arms in front of the body about 24 times as with exercise 4.... ½ min.

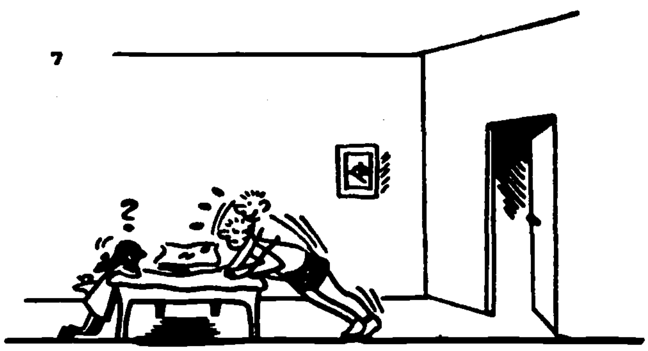
6a

6. (*a*) Standing with oue hand as a support, swing leg and arm 24 times, changing sides every fourth swing. The heels may be raised to the tiptoe position.

6b

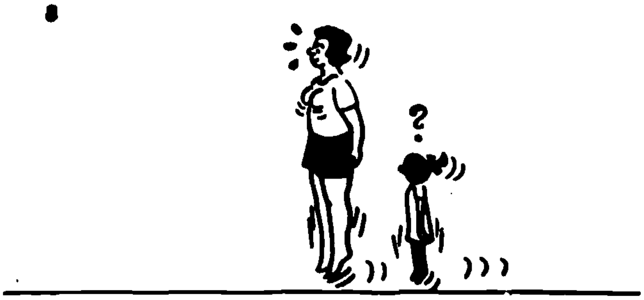
6. (*b*) Standing with feet apart, hands on hips, roll hips .... 1 min.

7



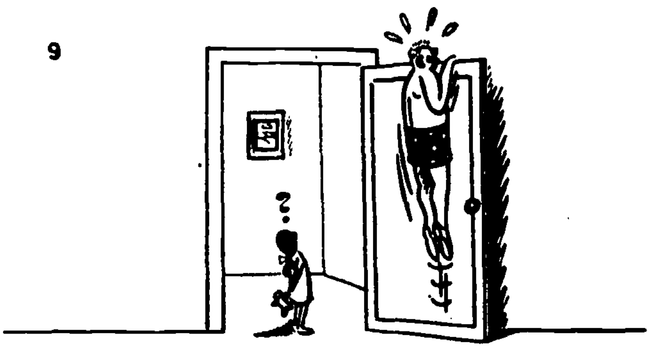
7. On the floor (for those strong enough), or leaning against a sofa or bed, press-ups, as many or half as many as you can do ...... ½ min.

8



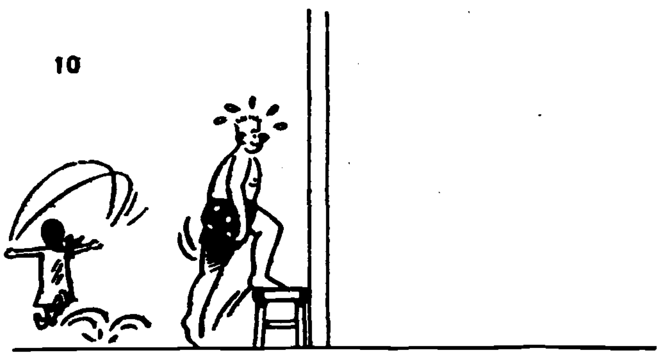
8. Easy skipping or jogging .. 1/2 min.

9



9. Pull-ups if apparatus is available (under a table, between doors, or a trapeze etc.), as many or half as many as you can do ...... 1/2 min.

10



10. Skipping or running on the spot or "step test" ...... 1 to 5 mins.

TOTAL TIMES - 8 to 15 mins.

Step height for the "step test" 20 to 40 cm (8 to 16 inches): make 20 to 30 climbs per minute. Avoid straining and exagerated, jerky movements during the back exercices. If possible, exercise to music. Try to carry out this programme at least twice a week. Exercise 10 may be omitted if the programme is used as only a part of more extensive training.

CHAPTER V

PHYSICAL FITNESS FOR EVERYDAY LIFE

Those occupied in jobs demanding physical effort have on average better maximal aerobic power and physical condition than, for instance, white-collar workers. Observations and resulting estimates have shown that lumber-jacks have high maximal aerobic power, follwed by rock blasters, labourers and carpenters ; drivers and white-collar workers have relatively low values. This difference is partly due to selection, but it also reflects the training effect of the job itself.

Manual labour is definitely not injurious to the health of the healthy individual. For many reasons, however, it is convenient, efficient and therefore desirable to replace the power of human muscles with that of machines, and to ensure a measure of comfort on the job. Some feeling of fatigue is inevitable after eight hours of physically heavily demanding work. With the elimination of the heavy loads the job becomes easy — at least it does to start with. The worker was well trained and now suddenly has a broad margin of safety between his capacity and what is being demanded of him physically. As time goes by, however, he will become adapted to the reduced demand, he will to an extent " deteriorate ", as did the bedridden students discussed earlier. Consequently, his safety margin between capacity and demand will progressively narrow, and subjectively the job will become more heavy. He may once again find the same feeling of tiredness at the end of a day's work.

One important aim of regular physical training is to achieve a physical condition and degree of fitness that is well above that required for the routine job. If the exigencies of the job occasionally require the heart to pump out ten litres of blood a minute at a rate of 120 beats, it is an evident advantage if it has been trained to attain an output of fifteen litres a minutes at a rate of 150. This is essentially what is meant by being fit for everyday life. From this point of view, occasional brisk walks may be sufficient for a teacher or clerk, but a lumber-jack, steelworker or housewife should exercise somewhat harder a couple of times a week.

To conclude, with decreasingly demanding work some physical activity must be included during leisure time to give the body the stimuli it needs to function at its best and for health.

(Reference 3.)

ACTIVE RECREATION

By active recreation is meant a stimulating hobby or activity with some muscular activity involvement, as opposed to passive recreation which, while it may still be stimulating, lacks any marked demand on the circulation or locomotor organs. Watching television, reading a book, playing cards or chess, stamp collecting and listening to music are all examples of passive recreation. It is extremely important to have something exciting to look forward to every week, and possibly every day, and passive recreations are in this respect very valuable. They should, however, be supplemented by active recreation.

A good example is ornithology. It is an outdoor activity. The bird being watched may move to the next tree, and in order to be identified must be followed. Further examples of active recreation are gardening, botany and, of course, sport, including fishing, hunting and mountaineering. In the northern countries the climate does not favour outdoor hobbies all the year round.

It is therefore necessary to substitute regular " contrived " training such as the cross-country walking and running illustrated on page 24. As it is important that the tempo be varied, the eyes and ears can be kept open for all the surprises that nature may present.

If during the " four minutes' running " the attention should be caught by an interesting flower or bird, it will certainly not upset the training to stop and have a closer look.

An important beneficial effect of active recreation is thought to be that impulses generated in the working muscles are probably essential to the optimum functioning of the central nervous system to which they are conveyed. There are unfortunately many jobs for which it may be difficult to create conditions in which the worker can feel real satisfaction from the job itself. It is then essential that leisure time can be spent in a meaningful and satisfying way.

TESTING PHYSICAL FITNESS AND CONDITION

In another little booklet, *Ergometry - test of physical fitness*, I have presented a more comprehensive and detailed discussion of a simple test of the function of the oxygen transport system, particularly the heart, than can be included in the present work.

The term "ergometry" stems from the Greek *ergon* (work) and *metron* (measure), and may rather literally be translated as "work measurement". The instruments of work measurement are ergometers, and they vary in their construction according to the form of analysis. Bicycling has proved to be a very suitable work form, since, among other things, at a given (submaximal) load, it demands about the same energy output whether the subject be young or old, trained or out of condition, elite cyclist or unfamiliar with the sport.

The bicycle ergometer was invented several decades ago and has been widely used in physiological laboratories ever since. This instrument provides an exact measurement of the performed external work, and thus a graded and measurable load can be applied to the subject. The load is adjusted quite simply by varying the tension of a belt running around the rim of the one wheel of the machine, acting as a mechanical brake, while the subject pedals a constant speed in time with a metronome.

On a stationary bicycle ergometer a standard, submaximal work load is applied for 6 minutes, the heart rate being counted during the last minutes of exercise and noted. In principle the lower the heart rate, the better is the pumping power of the heart. The heart rate of an untrained subject may reach 150 beats per minute during the test. If he then starts to train a couple of times a week, and after a month is again tested on the bicycle ergometer, his heart rate may be found to have fallen to 130 beats per minute, showing that the training has been effective.

This test has proved to be a valuable pedagogical and psychological tool for stimulating people to start and to continue training. In Sweden there are now (1967) about 3,000 bicycle ergometers in use in schools, sports clubs, factories and offices ; anyone who is interested can take the submaximal test and follow his physical condition over the years.

There are several reasons why, if I were in general practice, I would equip myself with a bicycle ergometer. It would enable me to observe the patient while he was exercising at standard loads, providing me with a fair knowledge of his corresponding oxygen uptake, the mechanical efficiency for this type of exercise being more or less constant. I could adjust the load to simulate any leisure or work activity that may be of interest to him. I could count his heart rate (and record the electrocardiogram and make other measurements during the exercise, if of interest) at a standard load every time he returned to my consulting room, and thus learn the physical condition of my patient with a fair degree of precision.

The doctor in fact holds a key position in this business of improving people's physical condition.

(References 3 [*a*] and 10 [*b*]).

CHAPTER VII

SUMMARY ANL CONCLUSIONS

Man is built for movement, for physical ac ity. The last centuries, and particularly the more recent decades, have witnessed a revolutio 1 the lives of most Europeans, whereby mechanical implements have taken over tasks earlie rformed by human power. In all sections of life there is a breach between old and new custor The human body is a product of millions of years of evolution, but for a very long time this elopment has been at a standstill. Man has created a new world, with a different enviro t and different living conditions from those of his ancestors.

By and large these changes have been to our ben but we also face problems difficult to manage. One such problem lies in the banal truth t man who was built for the stone age must fit into the present extremely technical world. It has repeatedly been emphasised that we are "constructed" for activity and that regular activity is essential for our optimum functioning and health. Therefore a portion of our leisure time should be devoted to active recreation and training.

If too inactive, the individual will become less fit, atrophy of tissues such as muscle, articular cartilage, and even bone will appear, a risk will arise of malnutrition, obesity, certain cardio-vascular diseases, decreased immunity, and fatigue.

In a way man is a gambler taking a chance on cigarette smoking, consumption of alcohol, and narcotics; the dangers of sedentary life are not taken too seriously. In the long run we are more concerned with the fitness of our pet dog, the trimness of the car. The sociological and psychological aspect of health education are very important, but difficult to master. Our basic reaction to various stresses is in many ways primitive, many of our reaction patterns being actually inappropriate in a modern society.

Many of the situations with which we are faced in our daily lives, sometimes pleasant, sometimes unpleasant, evoke reflexes and effects that promote muscular activity. Strong stimuli may give rise to emergency reactions, as is the case with animals, where fight or flight is the natural response. But we must "behave" ourselves, remain more or less inactive in various situations of stress, and the effects of our reflexes are worthless. No use is found for the free fatty acids delivered from the fatty tissue, normally a fuel for working muscles. The heart beats more rapidly but its stroke volume is decreased, which means a less efficient working condition. The heart pumps out the blood against an elevated blood pressure resulting from vascular constriction in the abdomen and skin and also in the muscles. With exercise the vessels in the muscles will in fact dilate.

It could be that frequent stress-evoked repetition of the stimulation of a basic reflex mechanism, but with inhibition of the final-action-stage, leads to both psychological and organic disorders and disease. On the other hand it is biologically sound that from time to time the end product of this mechanism be muscular activity.

It is more important to add life to years than years to life; and a continuous process of balance and compromise is involved in the choice of ways of living, comfort or resignation of comfort, stimulating agents, and so on. Fitness is a definitive advantage to the enjoyment of meaningful and satisfying work and leisure time, and two to three half-hours a week spent on efficient and rational training can achieve — and maintain — good physical condition. Thanks to all our comforts, thanks to cars and other modern means of transport, we can really enjoy active recreation and train under more pleasant conditions than when struggling for existence.

The question is frequently raised whether a medical examination is advisable before commencing a training programme. Certainly anyone who is doubtful about his state of health should consult a physician. In principle, however, there is less risk in activity than in continuous inactivity.

In a nutshell, my opinion is that it is more advisable to pass a careful medical examination if one intends to be sedentary, in order to establish whether one's state of health is good enough to stand the inactivity !

THE RESPONSIBILITY OF GOVERNMENT AND SOCIETY

The cost of medical care is enormous. Any means of preventing disease and speeding convalescence will result in major economies as well as in less personal suffering. There is much evidence that the physically fit gain to an extent in their immunity to certain diseases, and that if afflicted may more easily be nursed back to health.

I therefore believe that money spent on facilities and effective propaganda for active recreation and regular training will be recovered tenfold from savings on medical care. We have to face the fact that most individuals are physically lazy from the age of puberty on. Therefore the various types of facility for training and active recreation must be offered in an appetising manner. The cost of simple sports grounds, including the track illustrated on page 24, possibly with changing rooms, showers and sauna, is low when compared with that of building and running a hospital, or of building a stadium for ice-hockey, soccer, athletics or similar sports.

It is very important that children and youth in general be introduced to the principles of training and active recreation, in theory as well as practice. Good habits and motivations must be developed early in life.

It is a pity that the time set aside for compulsory physical education in schools is gradually being reduced in many countries. There are essentially two main subjects on the school timetable : physical education and all other, theoretical, subjects. If more time should be considered necessary for mathematics or physics it should not be found at the expense of that devoted to physical education, as has often been the case.

There is evidence that neglect of regular physical activity during adolescence cannot fully be compensated later on in life. Furthermore, when at school young people should be acquiring knowledge and experience of activities that are suitable for their future, that they will continue to practise after they have completed their full-time education. It must be remembered that track and field events, soccer, ice-hockey and other team games are not so tempting to adults, and less easily organised outside the context of the school. Walking, running, cycling, swimming and skiing are much more " natural " and simple activities.

"DO REMEMBER"

Do take exercise and train if possible two or three times a week.

Do take the training gently to start with and increase the tempo slowly; do not aim too high when training the heart and circulation, speed should not be maximal!

Do not take part in any competition if you are untrained.

Do not train or compete when suffering from an infection or other disease.

Do forget from time to time the existence of lifts, escalators, cars, buses: do remember from time to time that you have legs and that there are forests, lakes and fields suitable for sport and recreation.

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