PHYSICAL ACTIVITY AND AGING*

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SUMMARY

The effects of exercise on aging are discussed under 4 headings viz. whether there is evidence that exercise might delay aging, the physiological and biochemical factors that alter with age, how exercise training influences these factors and ends with advice on how to start exercising at an older age. The author concludes that regular exercise is of great benefit to preserve physical well-being into old age.

OPSOMMING

Die uitwerkings van oefening op die verouderingsproses word onder 4 hoofde bespreek nl. of oefening die verouderingsproses mag vertraag, die fisiologiese en biochemiese faktore wat met ouderdom verander, hoe oefening hierdie faktore beïnvloed en ten slotte word daar raad gegee hoe om op 'n gevorderde ouderdom met oefening te begin. Die skrywer kom tot die gevolgtrekking dat gereelde oefening tot op 'n hoë ouderdom van groot baat sal wees.

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INTRODUCTION

There are two ways to look at aging: The Canadian humorist, Stephen Leacock said "About the only thing you can say about it (age) is, it's better than being dead". On turning 61, the American Philosopher Ralph Waldo Emerson wrote; "Within, I do not find wrinkles or a used heart, but unspent youth".

In the context of physical activity and aging, we believe that Emerson's interpretation is the more valuable. For there is now good evidence that a significant proportion of the aging process is not that we *wear out* (Emerson's wrinkles or a used heart), but that we may be exercising too little (Emerson's unspent youth). In discussing this topic, consideration will be given to four main questions:—

1. Is there any evidence that exercise might delay those processes that cause physical work capacity to deteriorate with age?
2. What are the physiological and biochemical factors that alter with age and which explain why our physical abilities deteriorate as we age?
3. How does exercise training influence these factors?
4. How might one start exercising particularly at an older age?

1. EVIDENCE THAT REGULAR EXERCISE REDUCES THE EFFECT OF AGE ON PHYSICAL WORK CAPACITY.

Everyone is aware that the ability to perform physical work decreases with age. Part of this deterioration is unquestionably due to the aging process. Yet there is another component of this process which is usually ignored. For as people age, they also become less active. Thus at least part of the age-related fall in physical work capacity could be related to inactivity. Evidence for this possibility comes from studies of world long distance running records which show that, over the past five to ten years, the rate of improvement of the runners 40 years and older greatly exceeds that of the younger runners aged between 20 and 30 years (Figure 1).

The explanation for this unlikely phenomenon must simply be that the growth of the Masters athletic movement, particularly in the United States which provides serious athletic competition for athletes over 40 years of age has provided these "older" runners with an irresistible incentive to perform better. Thus they train harder and their performances must improve more rapidly than those of the younger runners who are already trained to their limits.

RUNNING SPEED AND ENDURANCE DECREASE WITH AGE

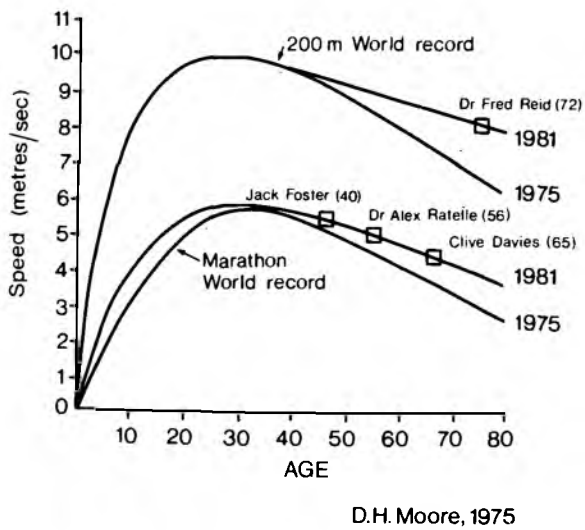

Fig. 1

This figure shows the influence of age on the speeds of the world's 200 m and 42 km Marathon records. The data for the 1975 curve comes from Moore.

With age, there is a steady decline in the speed at which either distance can be run. Note, however, the dramatic improvements that have occurred in both events in the past 7 years for runners older than 40. These improvements can almost certainly be traced to the rapid growth of competitive athletic opportunities for Master (over 40) runners which has increased the incentive for older runners to train harder and to remain active for longer.

Table 1

42 KM MARATHON

Runner	Age	Time Hrs:Min	% Fall-off	% Fall-off per decade
Alberto Salazar	23	2:08	—	—
Jack Foster	40	2:11	2	1
Dr. Alex Ratelle	56	2:30	17	6
Clive Davies	62	2:42	27	6

Table 1 shows that the performance of the world's best 40-year old marathon runner is less than 2% worse than the worlds best 23 year old runner, and is equivalent to a performance deterioration of about 1% per decade. The performances of Dr. Ratelle (56 years old) and Clive Davies (62 years old) suggest that performance then falls off at about 6% per decade. However, it is probable that this rate of performance deterioration *exceeds* the true rate of biological deterioration because:—

1. The older athletes probably still do not train as hard as they could. Nor do they enjoy the financial incentives available to the younger "amateur" runners.
2. The three top older athletes (Foster, Ratelle and Davies) only began running late in life and their performances are probably not equivalent to those that might have been achieved by athletes who were world-record holders in their youth and who continued to compete until old age.

Thus we can safely assume that the maximum rate of performance deterioration in active persons is about 6% per decade after age 20. To put this into context, a person able to run 10 miles in 60 minutes at age 20, would be able to run the same distance in under 75 minutes up to his 70th birthday. (It is of interest that this long-term deterioration over 50 years is of equal magnitude to that which would occur in a young athlete who stopped training for a few months. That is, a 20 year old who runs 10 miles in 60 minutes when fully-trained would probably run 75 minutes when he had not trained for some months. This shows that the physical deterioration that occurs with age is really not all that dramatic).

We have therefore established that performance deteriorates with age, that the extent of this deterioration is much less than is generally accepted, and that it is almost certainly reduced by a programme of regular exercise that is maintained for life.

2. ALTERATIONS IN WHICH PHYSIOLOGICAL AND BIOCHEMICAL FACTORS CAUSE PHYSICAL WORK CAPACITY TO DETERIORATE WITH AGE

1. Endurance exercise

The ability to maintain a high energy output (work rate) for a prolonged period is known as *endurance*. Endurance athletes are those who participate in activities which

continue for prolonged periods of time (long distance runners, cyclists, rowers, swimmers, etc). The ability to perform endurance-type activities is closely related to the ability to transport oxygen via the blood-stream to the working muscles.

In the laboratory, we can measure the maximum ability of the body to transport oxygen. This is known scientifically as the *maximum oxygen utilization capacity* or, in scientific shorthand, the $\dot{V}O_2$ max.

$\dot{V}O_2$ max is a measure of the heart's ability to pump sufficient blood to the muscles. Top-class endurance athletes have very high $\dot{V}O_2$ max values, which are largely determined by genetic factors. However $\dot{V}O_2$ max does fall with age (Figure 2) and this probably explains some of the reduction in endurance capacity that occurs with age (Figure 1).

The fall in $\dot{V}O_2$ max probably reflects deterioration in peak heart function with age. The aged heart has a reduced maximum heart rate, and a reduced pumping capacity possibly due to a reduced activity of the myocardial enzyme myosin ATPase, the enzyme that correlates best with peak heart function.

2. Speed/Strength

Reference to Figure 1 shows that of the 1975 curves, the upper curve, (the curve describing the relationship between the speed of the 200 metres world running records and age), falls more steeply with age than does the lower curve (which describes the same relationship, but for the 42-km standard marathon distance). This suggests that running speed deteriorates more rapidly with age than does endurance. (Note however that the 1981 curve for the 200 metres' records shows a great improvement over the 1975 curve so that the gradient of fall with age is reduced. This indicates that once the oldies, like world-record holder Dr. Fred Reid from Johannesburg, get out and do some training, the true potential of the human body becomes apparent!)

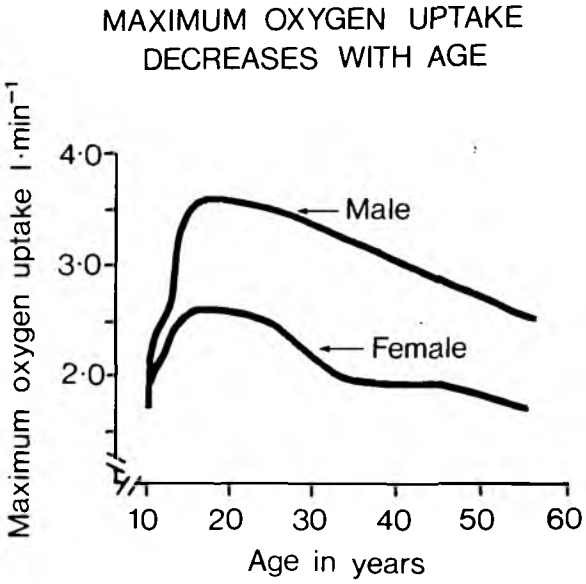

Fig. 2

This figure shows that maximum oxygen uptake decreases with age. Note also that females have lower $\dot{V}O_2$ max values than males, After McCardle, Katch and Katch[2].

We believe that speed is determined by the type of fibre that constitutes the major portion of the appropriate muscles. Muscles are made of 2 principle fibre types — the red and white muscle fibres. The white fibre has the ability to contract rapidly, so they have been called the *fast twitch* (FT) fibres. The red fibre, on the other hand, is a *slow twitch* (ST) fibre. It is found that athletes who excel in particular sports have predictable muscle fibre compositions (Table 2) — in general, the faster the athlete, the more fast-twitch fibres he has. Endurance athletes have a predominance of slow-twitch fibres because the ST fibre is designed for endurance, not for speed.

Table 2

MUSCLE FIBRE COMPOSITION OF ATHLETES

Sport	% FT Fibres	% ST Fibres
Sprinters	74	26
Sprinters/Jumpers	61-63	39-37
Weightlifters	51-56	49-44
Middle distance runners	45-52	55-48
Elite long distance runners	12-21	88-79
Cross-country skiers	11-18	79-72

From: Noakes (1979)

Again, it is believed that muscle fibre composition is largely determined by hereditary (genetic) factors. Thus, one is born to run fast or slowly. Age causes a gradual decline in the % and size of the fast-twitch fibres and this is likely to be the major explanation for the fall of maximum speed with age. But, again, regular training probably reduces the rate at which this deterioration occurs (see example of Dr. Fred Reid in Figure 1).

Another factor which may explain why speed falls with age, is that aging causes a reduction in the rate at which a response is initiated to an incoming stimulus. Thus, the aged sprinter responds more slowly to the crack of the starter's pistol, and therefore takes longer to get out of his starting blocks!

Body composition also tends to alter with age. As we age, we tend to get heavier, and this is solely due to the deposition of body fat (Figure 3).

A final aging problem is that recovery from severe exercise or training definitely takes longer as one ages. Thus many athletes complain that even in their early 30's they are unable to recover as quickly after hard training or competition, as they had in their twenties.

3. HOW DOES REGULAR EXERCISE INFLUENCE THESE FACTORS?

Exercise has been shown to influence the following aging process:—

1. $\dot{V}O_2$ max. The rate of fall of $\dot{V}O_2$ max is reduced by training. Furthermore $\dot{V}O_2$ max can be dramatically improved, at any age, by the appropriate training programme.

   Professor Herbert De Vries[3] from California persuaded 112, 70 year old male inmates of a "leisure world" retirement community, to stop watching television, playing cards and generally acting old, and to start an exercise programme. After 12-15 months' exercise, these former bench-warmers had improved their $\dot{V}O_2$ max values by 20%, an improvement equivalent to that which would be expected in untrained 20-year olds. Thus even at 70, the body retains the ability to adapt to an exercise programme.

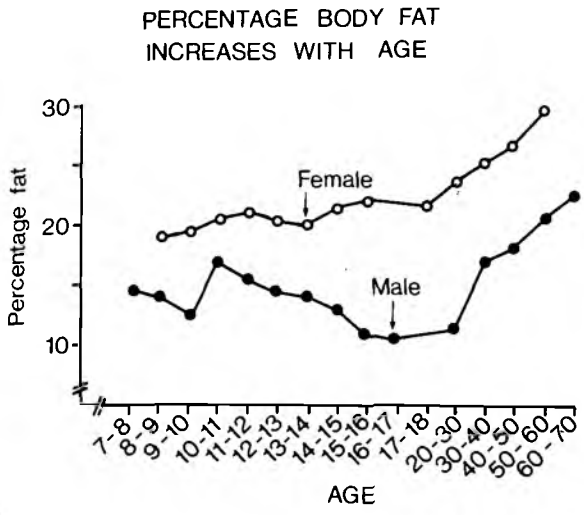

Fig. 3

Percentage body fat increases with age. Note that females are fatter than males at all ages, and that body fat increases rapidly after age 20 - 30, in both sexes. It is of interest that most people stop doing meaningful exercise in their twenties. Thus the increase in body fat may be due to too little exercise, rather than too much age. After McArdle, Katch and Katch[2].

2. Body composition.
   Exercise training probably prevents the accumulation of body fat that normally occurs with age (Figure 3). Persons who exercise for life maintain low body fat levels and exercise is one of the most effective ways to lose body fat at any age.[4]
3. Reaction time.
   Training improves the reaction time of the elderly[5].
4. De-calcification of bones.
   With age, the bones lose their calcium. Regular exercise dramatically reduces the rate of this calcium loss.[6] This is an exceptionally important consideration in view of the high rate of bone fractures particularly of the femoral neck, in the elderly. It is a reasonable assumption that regular exercise should reduce the likelihood of age-related fractures in the elderly.
5. Longevity.
   From a study of 1712 persons who had lived more than 100 years, Easton[7] concluded that "it is not the rich and great nor those who depend on medicine who become old: but such as use much exercise. For an idler never attains a great age."
   Other studies[8] of centurions have lead to similar advice.
   "To be as much as possible in the open air, and especially in the sunshine, and to take plenty of exercise, taking special care to breathe deeply and regularly".
   These studies only suggest, they do not prove, that regular lifelong exercise may increase longevity.
6. Psychological benefits.
   Professor Herbert De Vries's studies,[3] noted earlier, also found that when his 70 year old benchwarmers became athletes, their psychological status improved as did their interest in life.
   Readers interested in the psychological benefits that have been ascribed to exercise training are referred elsewhere.[9]

4. HOW MIGHT ONE START EXERCISING AT AN OLDER AGE?

We have therefore established that exercise is beneficial for virtually all people. But how does one start? A more detailed description, is available elsewhere,[10] here only the important principles will be discussed.

(a) There are two forms of exercise — dynamic and static. Dynamic exercise (walking, running, swimming, cycling, rowing, skipping, squash) improves endurance, whereas static exercise (weight-lifting) improves muscle strength.
   Although endurance training is by far the more important, gentle strength training should not be ignored, particularly in the elderly.

(b) Training programme.
   To achieve a training effect, the training programme must be of the correct intensity, frequency and duration. It must also be specific.

(i) Intensity.
   The exercise intensity can be assessed by measuring heart rate or by the technique of *perceived exertion* . The correct intensity is one at which you are able to hold a conversation (the talk test) and at which you feel completely comfortable. Remember that the key is to train, not to strain.

(ii) Frequency.
   Exercise should be undertaken 3 - 5 times a week.

(iii) Duration.
   This should be for up to 30 minutes a session. The *addictive* dose is somewhat longer than 30 minutes. Therefore, to become addicted to exercise one will need to exercise for more than 30 minutes at each session.

(iv) Specificity.
   Fitness is specific. Running makes one fit for running, swimming for swimming, and so on. There is little transference of fitness from one sport to another. Thus it is important to choose the appropriate exercise.

Finally, it is appropriate to ask whether there are any dangers. Yes, there are. If the exercise programme is unnecessarily enthusiastic, musculo-skeletal injury or something more serious, including precipitation of heart attack may very rarely occur.

All these problems are prevented by starting easily and progressing slowly, "listening to your body" and reporting any symptoms that may develop. Most older people are wise enough to follow this advice naturally. It is usually only the impetuous middle-aged who ignore such wisdom and get into trouble.

A CONCLUDING VIEW

The words of Paavo Nurmi, Olympic champion and one of the greatest athletes of all time: "Standing water and a man who does not move are the same as death. You have to move. Otherwise, you are bound for the grave!"

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THE SOUTH AFRICAN SOCIETY OF PHYSIOTHERAPY
DIE SUID-AFRIKAANSE FISIOTERAPIE-VERENIGING

REPORT

NATIONAL EXECUTIVE COMMITTEE

This Committee has met twice since the National Council Meeting, and will be meeting once more before the end of 1983.

Several matters were referred to the Professional Board for Physiotherapy, which met on 9 August 1983. These matters were referred by the Board to the South African Medical and Dental Council, which had not yet met at the time at which this report was written. We are still, therefore, awaiting confirmation of further adjustments to the tariff of fees, as well as answers to queries raised at the National Council Meeting. These queries included the allocation of registration fees, the possibility of inspecting hospitals and other clinical facilities, the possibility of altering the name of the S.A. Medical and Dental Council and several matters related to physiotherapy assistants.

Career and salary structure

The conditions of the new dispensation are regarded as being far from satisfactory, especially when consideration is given to the salary scales for certain allied professions with similar or even lesser educational qualifications. The National Executive Committee is now generating a two-pronged approach. Firstly a new memorandum is being prepared, which will have been submitted by the time this report is published. Secondly an investigation has been initiated in order to establish the long-term physiotherapy needs throughout the Republic. When this has been completed, a memorandum stressing the inadequacy of present physiotherapy services will be drawn up. The newly formed Remuneration Committee, established by Council, will play an important role in compiling both these documents.

The National Executive Committee is of the opinion that the Commission for Administration has grossly underestimated the opportunities for physiotherapists in the private sector and that the Commission has thus been mislead into offering non-competitive scales and conditions of service.

Objectives of the Society

At the 15th National Council Meeting two motions were passed requiring the Society to delineate its objectives for the future with a view to long-term planning. It is hoped that the Branches and Special Groups/Associations will rise to this challenge and submit their ideas. The future of the Society is the concern of each one of its members, not only the members of the National Executive Committee.

The scope of physiotherapy

This is being revised and updated, and once again contributions have been requested from the Branches and the Special Groups/Associations. It is disturbing to note that the Scope of the Chiropractors as gazetted in Government Gazette No. 1745 of 12 August 1983, reflects comprehensive overlap with both traditional and modern physiotherapeutic modalities.

Post-registration courses

The Society is negotiating with several specialist practitioners from overseas countries, to run courses on such wide-ranging subjects as neuro-developmental therapy, functional anatomy and the newer electrotherapy modalities. These courses will be advertised as soon as details are finalised.