Jogging in middle age

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SUMMARY. The risks and possible cardiovascular benefits of beginning a programme of jogging in middle age are critically reviewed. A lifelong habit of vigorous exercise results in lower incidence rates of ischaemic heart disease. There is, however, no direct evidence that the same is true when sedentary middle-aged people decide to begin exercise. Exercise can have a beneficial effect on the risk factors for ischaemic heart disease but whether this reduces the likelihood of death from ischaemic heart disease remains unproven. There are approximately 12 sudden deaths per 100 000 male joggers in the USA attributable to jogging annually, while almost a third of all joggers report a musculoskeletal injury in a 12-month period.

Introduction

IF a man aged 50 years asks whether jogging would be good for his heart, how would the general practitioner respond? Regular exercise can be beneficial in several ways. Those who participate in and adhere to programmes of exercise report an improvement in work performance, increased stamina, feeling more healthy, a decrease in stress, and an increased ability to sleep and rest.[1] Another possible benefit of regular exercise is derived from the hypothesis that exercise protects against the development of ischaemic heart disease. The epidemiological work surrounding this hypothesis has recently been reviewed.[2,3] The purpose of this paper is to examine the possible benefits and risks of beginning a programme of exercise in middle age.

Evidence that exercise protects against ischaemic heart disease

There is epidemiological evidence that a lifelong habit of vigorous physical activity results in a reduction of cardiovascular disease. This protective effect has been demonstrated in longitudinal studies of work activity in San Francisco longshoremen,[4,5] leisure time activity in executive grade British civil servants,[6-8] activity indices in college alumni,[9,10] the Framingham study,[11] and studies of Iowa farmers[12] and rural Puerto Ricans.[13] The type of activity which is beneficial has been determined indirectly. Benefit from exercise or work activity only begins when individuals surpass a threshold of energy expenditure of about 7.5 kcal min^{-1} for 15 minutes three times a week,[7] or a total weekly expenditure of 2000 kcal.[10] Exercise must be regular to protect against ischaemic heart disease and individuals who are physically fit in early life but become sedentary lose any benefit from their former exercise. One recent study has suggested that individuals who were sedentary in early life and become active in later life may reduce their risk of ischaemic heart disease.[14]

Exercisers — problems with generalization

In the past 10 years surveys in the USA have shown that about 50 per cent of the population undertakes some form of regular exercise.[15-18] Of these 14 per cent engage in walking, 13 per cent in jogging, and 9 per cent in callisthenics. In general, younger people exercise more than older people and men exercise more than women. A striking feature is the inverse relationship between education levels and attitudes to health. Those individuals with less than a high school education were more likely to smoke cigarettes, be overweight, be dissatisfied with their physical condition, and to undertake half the rate of sport of those who had completed high school. A study of British civil servants[19] showed a clear relationship between social class and ischaemic heart disease, the lower social classes having a higher incidence rate of this disease. This social class gradient could not be fully explained by adjusting for the variables of blood pressure, cholesterol levels, blood glucose levels, height, weight, and cigarette smoking. It may be that the differences in physical activity between the social classes in Britain could account for another portion of this gradient.

The effect of social class on activity and of ischaemic heart disease rates is dealt with in part by longitudinal studies conducted in homogeneous social strata.[4-10] A study in Israeli kibbutzim where the diet and environment are the same for all members was able to study the effects of some social factors as well.[20] These studies have all shown that exercise is beneficial but the fact remains that those at greatest risk from ischaemic heart disease are the least likely to exercise.

Longitudinal studies relating work activity to the incidence of ischaemic heart disease do not fully account for the possibility that individuals may be selected for jobs because of certain physical attributes and that individuals may change jobs for health reasons.[21] Healthier people may be able to carry out more active jobs and it is not relative inactivity *per se* that has caused poor health.

Another problem arises when the results of studies of athletes are examined. Athletes, and especially marathon runners, are a unique subgroup of the population. They tend to be better educated, thinner, more highly motivated, and to have more healthy habits than the rest of the population (virtually no runner smokes cigarettes). Most of the studies of athletes have been cross-sectional[22,23] and the associations between risk of ischaemic heart disease and exercise may not be causal. Physical activity may serve as a marker for sociological attributes which are determinants of the disease.

Volunteers have been used in virtually all studies of the effect of exercise on coronary risk factors. Only one study has attempted to look at the problem of volunteer bias in physical activity studies.[24] Volunteeers are more likely to be non-smokers, married, and to believe that exercise is in some way related to myocardial infarction than non-volunteers. Volunteers and non-volunteers showed no difference in cholesterol levels, blood pressure, relative weight, behaviour variables, and work activity levels.

Similarly, selection bias may occur in studies of cohorts of middle-aged joggers. Of 6860 Japanese males living in Hawaii, aged 50 to 70 years, 450 took up jogging during an eight-year follow-up period.[25] Joggers were taller, younger, from higher social classes, and more highly educated than their non-jogging counterparts. After beginning their programme, joggers were more frequently on low sodium – low cholesterol diets and had slower heart rates than non-joggers. Interestingly, electrocardiogram abnormalities and ischaemic heart disease were more prevalent among joggers. No morbidity or mortality data were presented, but the authors concluded that in this cohort of middle-aged Japanese men the presence of ischaemic heart disease may be a motivation to exercise. To date there is no evidence to suggest that jogging was helpful for this group.

The effect of jogging on coronary risk factors

Fitness

Regular aerobic exercise results in a cardiovascular training effect[26] and improved physical fitness (the ability to perform more work at a given heart rate). Cross-sectional studies have shown that those who are more physically fit (as determined by exercise treadmill testing) have higher levels of high-density lipoprotein (HDL)-cholesterol, lower blood pressures, and smoke cigarettes less often then less fit individuals of the same age.[27] A prospective study of 6000 exercisers found that over a median time of four years, those with the lowest level of fitness were 1.5 times more likely to develop high blood pressure than those with a high level of fitness.[28] In another prospective study it was found that asymptomatic Los Angeles policemen with a below median capacity for exercise were 2.2 times more likely to develop a myocardial infarction in the next five years than those with an above median capacity for exercise.[29] These studies show an association between level of fitness and risk of ischaemic heart disease.

Hypertension

In a small six-month study of 23 middle-aged males with essential hypertension it was found that a walking–jogging programme alone reduced their systolic blood pressure by a mean value of 14 mmHg and their diastolic blood pressure by a mean value of 12 mmHg.[30] In a comparison group of normotensive males undertaking the same programme there was no change in their systolic pressures, but their diastolic blood pressure decreased by a mean value of 6 mmHg. Longitudinal studies of Harvard alumni have shown that continued participation in vigorous exercise results in an incidence rate for hypertension that is 75 per cent of the rate of those not engaged in such activities.[31]

Weight changes and cigarette smoking

Obesity is an independent risk factor for the development of ischaemic heart disease.[32] The effects of obesity are moderated by the age of onset and its duration. Longitudinal studies have repeatedly shown that weight loss is associated with an improvement in coronary risk factors — there is a resultant decrease in cholesterol levels and blood pressure, and an improvement in glucose intolerance.[33,34] The resultant changes in these risk factors are accompanied by changes in the risk of ischaemic heart disease.[35] Continuing an exercise programme results in a sustained weight loss. This weight loss is seen within three months of starting to exercise and in a jogging programme the weight loss is proportional to the miles run each week.[35]

Cigarette smoking and weight changes are considered together because they are often related. Cross-sectional studies of Welsh steelworkers have demonstrated that cigarette smokers are lighter than their age matched non-smoking peers.[36] Cessation of cigarette smoking clearly results in a reduction in the risk of ischaemic heart disease independent of changes in other risk factors, especially in younger age groups.[37] In the Framingham study ceasing to smoke resulted in a mean short-term weight gain of 1.72 kg and insignificant increases in blood pressure and cholesterol levels.[38] A Norwegian study demonstrated that those who began smoking tended to lose weight (a mean loss of 0.6 kg) and those who reduced their cigarette smoking tended to gain weight (a mean gain of 0.4 kg) — the magnitude of the weight changes varied with the magnitude of the change in the number of cigarettes smoked.[39] People who stop smoking often start to exercise in order to control the subsequent weight gain; it is not known if smokers who begin exercising are more likely to give up cigarette smoking.

Serum lipoproteins

Cross-sectional studies have shown a direct correlation between the amount of physical activity and the serum levels of HDL-cholesterol, the component of cholesterol associated with decreased risk of ischaemic heart disease.[22,23] This correlation is striking: HDL-cholesterol levels are reduced below the fifth percentile of the normal population levels for those with spinal cord injuries, and are consistently elevated for marathon runners.[40]

It has been shown that jogging lowers total serum cholesterol and raises HDL-cholesterol levels slightly. Short-term longitudinal studies (three months to one year) of exercise in volunteers have shown that the weight of the volunteers and their serum triglyceride levels decrease significantly. Total cholesterol levels decrease significantly in some studies (a mean value of 80–100 mg l^{-1}) but not in others, and HDL-cholesterol levels rise (about 10 mg l^{-1}) but this rise may not be statistically significant.[41,42] Several randomized controlled trials of exercise have reported similar results. A Finnish study of 110 men aged 40–45 years found a small but significant rise in levels of HDL-cholesterol but no change in the total serum cholesterol in the exercise group at the end of four months.[43] Two studies in the USA showed a three per cent reduction in total cholesterol levels at the end of six months of exercise[44] and no change in cholesterol levels at the end of 18 months.[45] Two further randomized controlled studies showed no significant difference in the serum lipid levels of exercisers and controls at the end of 12 months.[35,36] An increase in the level of HDL-cholesterol was found for the exercisers, but this increase was not noticeable until the groups had been jogging for between nine and 12 months and was only found in those individuals who were running between eight and 14 miles per week. Interestingly, those who had a high level of HDL-cholesterol initially were the most likely to run the extra distance which resulted in a further increase in HDL-cholesterol levels.[35]

The results relating jogging and exercise with total serum cholesterol and HDL-cholesterol levels are inconsistent. It may be that the studies were too short to show any benefit, or that the intensity and duration of the exercise needed to clearly change serum lipid levels is beyond that which the average jogger would wish to pursue.

The fibrinolytic system

The relationship between the level of physical activity and its effects on the fibrinolytic system remains to be fully explored. Cross-sectional studies have shown that fibrinolytic activity is decreased in the aged, the obese, the lower social classes, and smokers — all groups that are likely to be more sedentary.[47] In addition, it has been suggested that platelet adherence may be decreased by exercising — this may have some importance in the pathogenesis of atheromata.[48]

In summary, exercise can potentially reduce the risk of ischaemic heart disease by improving fitness, blood pressure, and body weight. The possible effects of exercise on cigarette smoking behaviour are indirect but no less important. Moderate exercise, sufficient to produce a training effect, does not appear to be beneficial in terms of changing serum lipoprotein levels.

There have been no studies of sufficient size to fully assess the effects of beginning an exercise programme on the risk of ischaemic heart disease in middle-aged people. Such trials were considered in the late 1960s and pilot studies were carried out.[44,45] The idea was abandoned because the participants would not adhere to the programmes of exercise. The drop-out rates varied from 24 per cent to 50 per cent and therefore approximately 24 000 people would have to be randomized and

followed in a study expecting to detect a significant difference in rates of ischaemic heart disease.[44]

Risks of jogging

Jogging is not risk free. A small number of cardiovascular deaths occur while running and there are a larger number of injuries and accidents. Problems such as hyperthermia and other metabolic abnormalities are beyond the scope of this paper.

Cardiovascular death while jogging

It was argued at one time that regular vigorous exercise (on the level of marathon running) could offer almost complete immunity from ischaemic heart disease.[49] However, subsequent studies have shown that marathon runners can have symptomatic ischaemic heart disease[50] and that middle-aged joggers who suffer sudden death during or shortly after running have stenotic atherosclerotic lesions in more than half of their coronary arteries.[51-53]

Koplan has estimated how many sudden deaths may be expected for male joggers in the USA.[54] If a person-year of running is taken to be 20 minutes three times a week for one year and if it is assumed that jogging does not confer additional risk, then it can be estimated that 14.9 deaths would occur annually while jogging due to chance alone. If the two hour post-exercise period is included, then 104.3 deaths per year would be expected. When adjustments are made for thinness and non-smoking, then the estimates of expected deaths for the running and running plus post-exercise periods fall to 4.3 and 29.8 deaths per year, respectively. Using the estimate of 29.8 expected deaths per year there would be approximately 0.8 deaths per 100 000 joggers annually. These figures can be used for comparison with incident deaths in a jogging population.

Twelve men died while jogging in Rhode Island between 1975 and 1980 — 11 of the deaths were due to ischaemic heart disease.[55] This represents one death per 7920 jogging males per year (aged 30–64 years). This mortality rate for ischaemic heart disease while jogging is seven times greater than the expected age adjusted rate during more sedentary activities in the Rhode Island population, and is 17 times greater than the estimates produced by Koplan. A case-control study of married men (aged 25–75 years) in Seattle, Washington, found that they were 56 times more likely to die during vigorous exercise if they were habitually sedentary and five times more likely to die during vigorous exercise if habitually active.[56] There is therefore a small but measurable risk from jogging — the relative risk is greatest in those habitually sedentary while the overall attributable risk of death from ischaemic heart disease while jogging is of the order of 12 deaths per 100 000 male joggers per year in the USA.

A study of 2935 volunteer exercisers (mean age 37 years) who recorded 66 per cent of their running activity reported only two cardiac arrests and no deaths in 374 798 person hours of exercise.[57] Maximum risk estimates ranged from 0.3 events per 10 000 exercise hours in young men to 2.7 events per 10 000 hours in men aged over 60 years. These figures for events and not deaths are impressive but must be interpreted correctly. They come from people who are already exercising in a supervised setting — they are volunteers and socioeconomically well off and their rates may not be applicable to the general population.

Sudden death during exercise may be due, in part, to cardiac arrythmias. Premature ventricular contractions occur during exercise in 35 per cent of men[58] and their prevalence during exercise increases with age (50 per cent in men aged over 50 years) and with heart rate (60 per cent when heart rate greater than 140 beats per minute). Complex arrythmias (asymptomatic) were noted in three per cent of males aged over 40 years. The prevalence of premature ventricular contractions was not changed by the presence or absence of cigarette smoking or coffee drinking, nor by the level of physical fitness in males aged 40–59 years.[58] The occurrence of arrythmias may be mediated by the increase in plasma catecholamines which occurs during exercise. The catecholamine levels (especially noradrenaline) continue to rise in the immediate post-exercise period which may account for some sudden deaths which occur in that period.[59]

Jogging may 'unmask' asymptomatic coronary artery disease and possibly precipitate sudden death. Therefore some authors have recommended a screening exercise test prior to beginning an exercise programme so that individuals may know at what level of activity they may safely begin training.[29,49] Placing asymptomatic individuals on a treadmill for this purpose seems unwarranted for three reasons. First, the attributable risk for cardiac death due to jogging is small, and there is no evidence that the use of an 'exercise prescription' will reduce this risk. Secondly, the incidence of death and hospitalization following treadmill testing is in itself one in 10 000 and four in 10 000 tests, respectively.[60] However, these figures are for persons with known or suspected heart disease and the risks may actually be much lower in asymptomatic individuals.[61] Thirdly, the sensitivity and positive predictive value of exercise testing in asymptomatic men is low. In the study of asymptomatic Los Angeles policemen aged 35–55 years, bicycle ergometry had high specificity and negative predictive values (93 per cent and 99 per cent, respectively) but a sensitivity of 19 per cent and a positive predictive value of 4 per cent for the subsequent development of a myocardial infarction in the next five years.[29] The latter two values are too low to justify exercise testing as a screening procedure for ischaemic heart disease in asymptomatic individuals about to start a jogging programme.[62] However, there are subgroups of asymptomatic persons in which the prevalence of ischaemic heart disease is high enough (men over 50 years of age with risk factors) to make exercise testing efficacious and cost effective.[63]

Some of the events due to ischaemic heart disease which occur while jogging may be prevented by gradually increasing the level of exercise and paying attention to prodromal symptoms when they occur.[53]

Injuries

Running injuries are common. The pilot studies which randomly allocated subjects to supervised programmes of exercise found that between 12 and 15 per cent of the participants dropped out owing to the development of musculoskeletal injuries.[45] In one study of supervised exercise the overall incidence of injury was 49 per cent.[44]

A survey of a random sample of 1423 joggers capable of running a 10 km road race revealed that 35 per cent of the joggers had experienced a musculoskeletal injury attributable to running in the past year.[64] While all injuries led to a decrease in running activity 14 per cent of the injuries were severe enough to warrant medical attention. The prevalence of injury increased with the mileage run; of runners who log 50 miles per week 70 per cent of men and 58 per cent of women report having had some form of musculoskeletal injury in the preceding year. The most commonly affected sites of injury are the knees (25 per cent), achilles tendon (18 per cent), forefoot (10 per cent), shin (10 per cent), ankles (9 per cent), arch of foot (8 per cent), heel (8 per cent) and hamstring muscles (5 per cent).[65] The economic impact of these injuries (days lost from work, and so on) has not been assessed.

In addition to orthopaedic injuries, there are a variety of environmental hazards for the jogger.[58] In Atlanta, Georgia, 7.4 per cent of surveyed joggers there reported being hit by thrown

objects, 4.3 per cent were bitten by dogs, 0.3 per cent were involved in accidents with bicycles, and 0.5 per cent were involved in some sort of motor vehicle accident. An analysis of 60 deaths where joggers were hit by cars revealed that more than half were hit from behind and two-thirds of the accidents occurred between 15.00 and 24.00 hours.[66] This data is difficult to interpret without accompanying denominator information on the distribution of jogging activity throughout the day.

The majority of these injuries and accidents could be avoided by proper training techniques and the selection of safe places and times to run.

Conclusion

What advice should a doctor give to a 50-year-old man about jogging and the potential benefits for his heart? Based on available information any advice should include the following points:

1. A lifelong habit of vigorous physical exercise results in lower incidence rates of ischaemic heart disease. It has not yet been shown that incidence rates are lowered when sedentary middle-aged individuals decide to become exercisers.
2. There is much evidence to suggest that exercise might be beneficial by altering the risk factors for ischaemic heart disease. The changes brought about by exercise — improvement in physical fitness, reduction in blood pressure and weight and the possibility of giving up cigarette smoking — make this an attractive procedure for risk factor modification in the motivated person.
3. There may be other coronary risk factors (such as socioeconomic factors or a family history of ischaemic heart disease) that jogging will not alter.
4. There is a small risk of death from ischaemic heart disease due to jogging — about 12 deaths per 100 000 male joggers per year in the USA.
5. Screening treadmill tests for the detection of asymptomatic ischaemic heart disease are unnecessary prior to beginning a programme of jogging. If the level of exercise is gradually increased and any prodromal symptoms heeded, then the number of unexpected deaths from ischaemic heart disease associated with jogging may be minimized.
6. Beginning an exercise programme and adhering to it is a major change in behaviour for most people. Training programmes should begin slowly with warm up and cool down periods at each session. Individuals should gradually build up to greater levels of exercise to avoid the musculoskeletal injuries which occur in as many as one-third of joggers.

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