3. Is exercise good for you?

Peter D Brukner and Wendy J Brown

The benefits of regular exercise, tailored to your age and condition, far outweigh any risks

ABSTRACT

- Physical activity can significantly reduce the risk of cardiovascular disease, diabetes, some forms of cancer, osteoporosis, obesity, falls and fractures, and some mental health problems.
- While the benefits of physical activity are clear, there is a slightly increased risk of sudden death while exercising (compared with while sedentary), especially in untrained people undertaking unaccustomed vigorous activity.
- Routine exercise testing yields a significant number of false-positive results, and has not been shown to prevent exercise-related acute cardiac events.
- There is no convincing evidence that exercise is itself associated with osteoarthritis, but significant joint injury which occurs during sport is associated with an increased risk of subsequent development of osteoarthritis.

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In 1982, British epidemiologist Jeremy Morris wrote "Exercise is today's best buy public health".[1] But is exercise really good for you? In this article, we summarise the evidence that physical activity (and its subset, "exercise", defined as "planned, structured and repetitive physical activity conducted for the purpose of improving or maintaining physical fitness"[2]) is beneficial for health, and explore the growing body of evidence suggesting that some forms of exercise may be detrimental to some aspects of good health.

Benefits of physical activity

Primary prevention: In the early 1980s, Morris relied on evidence from early cohort studies, including his own studies of London transport and postal workers, to show that the most active members of the workforce (bus conductors and postmen) were less likely to develop heart disease than their sedentary counterparts (bus drivers and mail sorters).[3] Twelve years after Morris' claim, a landmark report of the United States Surgeon General (USSG) on physical activity and health summarised the growing body of evidence that physical activity plays a significant role in primary prevention of heart disease and diabetes.[4] Since then, evidence from large cohort studies (including the US Nurses' and Health Professionals' Studies) has shown that physical activity can also significantly reduce the risk of some forms of cancer, osteoporosis, falls and fractures, and mental health problems.[5]

Secondary and tertiary prevention: In the past 5 years, there has been an increased focus on evidence from randomised trials to support the role of physical activity in secondary prevention and management of chronic health problems. Most notably, three large randomised controlled trials have clearly shown the effectiveness of moderate-intensity activity in preventing the progression of impaired glucose tolerance to type 2 diabetes.[5] In one of these trials, the lifestyle intervention was almost twice as effective as the drug metformin in reducing the incidence of type 2 diabetes.[6] Other notable randomised trials have demonstrated the efficacy of physical activity in the *management* of heart disease, diabetes, depression, and breast and colon cancer. This evidence is summarised in Box 1.

Burden of disease: The Australian Institute of Health and Welfare has concluded that the burden of illness attributable to physical inactivity is the highest among any of the common behavioural and biological risk factors for women, and second only to tobacco smoking for men. In 1999, it was estimated that physical inactivity accounted for 6.75% of the total burden of disease and injury in Australia.[8] Since activity levels are now lower than in 1999,[9] it is likely that the current burden of disease attributable to inactivity is even greater.

The right "dose" of physical activity

The current (1999) Australian *Physical Activity Guidelines* recommend that, for health benefit, every adult should accumulate at least 30 minutes of moderate-intensity activity on most days of the week, and that people already achieving this would benefit further from participation in more vigorous activity.[10] These guidelines are based primarily on evidence from large prospective cohort studies which shows that regular moderate-intensity (at least three times resting metabolic rate) activity can significantly reduce the risk of developing cardiovascular disease by about 30%–50%.[4,5]

The "dose" of activity required for primary prevention and management of some other health problems, including breast and colon cancer, is currently under review. For example, evidence from cohort studies suggests that at least 45–60 minutes of additional activity per week may be required for preventing these cancers.[11] For weight loss, the required dose of activity will vary according to energy intake and individual metabolic differences, but evidence suggests that 60 minutes of activity every day would be sufficient to re-establish energy balance in most of the Australian population.[12] Conversely, for prevention of weight gain, it has recently been suggested that as little as 2000 additional steps, or 20 minutes walking, each day would have a significant impact at the population level.[13,14] Notwithstanding current debates about the actual amount of physical activity required for specific health benefits, it is clear that the greatest health benefits will be seen if

SERIES EDITORS: JOHN ORCHARD AND PETER BRUKNER

Centre for Health, Exercise and Sports Medicine, University of Melbourne, Melbourne, VIC.
Peter D Brukner, MB BS, FACSP, Associate Professor in Sports Medicine.
School of Human Movement Studies, University of Queensland, Brisbane, QLD.
Wendy J Brown, BSc(Hons), MSc, PhD, Professor in Physical Activity and Health.
Reprints will not be available from the authors. Correspondence: Associate Professor Peter D Brukner, Centre for Health, Exercise and Sports Medicine, University of Melbourne, Melbourne, VIC 3010.
p.brukner@unimelb.edu.au

1 Evidence for the benefits of physical activity*

Health problem	Primary prevention†	Secondary prevention‡	Management§
Cardiovascular disease (including hypertension, coronary artery disease and stroke)	✓✓	✓✓	✓✓
Type 2 diabetes	✓✓	✓✓	✓✓
Colon and breast cancer	✓	–	✓
Mental health problems (especially depression)	✓	–	✓
Obesity (effects of activity must be considered in light of energy intake)	✓✓	✓✓	✓✓
Asthma	–	–	✓
Cognitive function in older people	✓	–	–
Osteoporosis	✓	✓	–
Falls and fractures	✓	–	–

* Levels of evidence assigned using National Health and Medical Research Council recommendations for developers of guidelines.[7] † Level II evidence from prospective cohort studies. ‡ Level II evidence from randomised control trials. § Level II evidence from both prospective cohort studies and randomised controlled trials.
✓✓ = Good evidence; ✓ = More limited, but increasing evidence; – = No evidence. ◆

those who are currently completely sedentary could be persuaded to do *some* physical activity, and the challenge remains to activate the groups in the sedentary population who are most at risk of developing these health problems.

Type of physical activity

Importantly, the health benefits described here are based on evidence from large population studies, and therefore on the most commonly reported forms of physical activity. It is clear that health benefits can accrue from brisk walking and cycling (for transport or for recreation), as well as from participation in a range of active recreation and sporting activities, which we refer to here as "exercise". For older people, there is accumulating evidence to support the benefits of resistance training and less vigorous forms of activity (including Tai Chi) in maintaining functional capacity and preventing falls and fractures.[15]

Risks associated with physical activity and exercise

While the benefits of physical activity are clear, there can also be significant risks, especially if the activity is vigorous and involves potential for injury, as is the case with some sports. In the following section, the risks of exercise-related cardiovascular complications and osteoarthritis are considered.

Cardiovascular risk

Sudden death during exercise when under the age of 30 is extremely rare and is usually associated with a cardiac abnormality such as hypertrophic cardiomyopathy, Marfan syndrome or abnor-

Case study — resumption of exercise in a former athlete

A 45-year-old former club-level AFL (Australian Football League) player wants to start exercising, but is concerned he might have a heart attack (his father had a heart attack aged 55); as well as this, his knees hurt. He has not done any regular physical activity for 15 years because of family commitments and long work hours, has gained 10 kg in the past 10 years and is concerned he is not in the shape he once was! He has a history of arthroscopic menisectomy 20 years earlier.

His GP took a thorough history and conducted a physical examination. Abnormal findings were a blood pressure reading of 150/95 mmHg and a large waist circumference (102 cm). Blood tests showed blood sugar and lipid levels at the upper level of the normal range. The GP felt that no further tests (eg, stress test) were required and advised the patient to commence a graduated exercise program beginning with brisk walking for 15 minutes twice a day, or to use a pedometer to increase the number of daily steps by 2000 each week, building to a target of 10 000 steps a day after 3–4 weeks. The GP advised that if his knee pain was aggravated by this regimen, he should alternate his walking with non-weightbearing exercise such as cycling or swimming. He was also given dietary advice to reduce his overall caloric intake and to reduce his intake of saturated fats by reducing his intake of fast foods and increasing his intake of fruit and vegetables. He was also advised to reduce his high alcohol intake.

On review 6 weeks later, the patient had managed to steadily increase his activity and was now alternating walking and riding an exercise bike for 30 minutes each day. He had lost 2 kg and his blood pressure reading was 140/90 mmHg. ◆

malities of the heart valves or coronary arteries.[16] In those over the age of 30, nearly all exercise-related sudden deaths and myocardial infarctions (MI) are due to atherosclerotic coronary artery disease. Preventing these deaths will therefore ultimately depend on reducing the known risk factors and preventing this disease from developing.

Only two population-based studies have considered the risk of cardiovascular exercise complications.[17,18] Both show the incidence of sudden death during exercise to be in the order of 1 in every 15 000–18 000 previously healthy physically active men. Although this incidence is low, the relative risk of sudden death was seven times higher in men during jogging than during more moderate or sedentary activities.[17,18] There are no good studies of exercise-related sudden cardiac death in adult women.

Cardiac prodromal symptoms such as chest discomfort and unexpected dyspnoea are frequently present in individuals who suffer sudden cardiac death or acute MI during or following vigorous activity.[19,20] Although these prodromal symptoms can help identify individuals at risk for exercise-related events, the symptoms are variable and may be less frequent among athletes, possibly because of the rapid progression of previously non-critical coronary lesions in active patients.

Can exercise stress testing identify those people most at risk? Both the American College of Sports Medicine and Sport Medicine Australia recommend that "high-risk" individuals (ie, men over 45 and women over 55, individuals with more than two cardiovascular risk factors, and those with known disease) undergo exercise stress testing before starting a *vigorous* exercise program.[21] However, the American College of Cardiology and the American Heart Association suggest that the use of screening exercise tests is not well-established by evidence, and that the tests are a poor predictor of the major cardiac complications (MI and sudden cardiac death) during exercise.[22] Routine exercise testing has not been shown to prevent exercise-related acute cardiac events, and also yields a significant number of false-positive results. A true-positive exercise test result requires the presence of a pre-existing haemodynamically significant coronary obstruction, whereas acute coronary events often involve plaque rupture and thrombosis at the site of previously unobstructive atherosclerotic plaque.[23] It is very rare for this to occur during *moderate-intensity* activities such as brisk walking.

Risk of osteoarthritis

There has long been debate over the role that participation in sport may have in the development of osteoarthritis (OA). The only agreed causative requirement is that excessive activity with high impact and torsional loading, in the presence of an abnormally aligned joint or with abnormal biomechanics, may lead to joint degeneration and OA.[24]

A recent review of the association between participation in sports and the development of OA concluded that most studies were limited by poor design, lack of control groups and the presence of several confounding factors.[25] Only three studies showed a significantly increased relative risk for both hip and knee OA with previous high-level sporting participation, and considerable counter-evidence suggests that regular sports participation at a recreational level does not cause OA.[26,27] Most studies have also found no contributory evidence to suggest that running leads to OA in later life.

Evidence-based practice tips

- Encourage all patients (who are not already doing this) to engage in regular moderate-intensity activity (eg, brisk walking, swimming, cycling, sport, aerobics) for at least 30 minutes on most (if not all) days of the week; this 30 minutes of activity can be accumulated in 2 x 15 minute bouts (evidence level II).[4,5]
- For patients who are able, participation in more vigorous activity will confer greater health benefits (evidence level II).[4,5]
- For older people, participation in progressive resistance training activities will help to maintain muscle and bone mass, and promote healthier ageing (evidence level II).[4,5]
- People who want to undertake *moderate-intensity* activity (eg, walking) do not require a clinical examination or stress test unless they have signs or symptoms of a condition that would put them at increased risk of exercise-related complications (mixed evidence).[21] ◆

However, the picture is different in contact team sports, particularly in the various codes of football. For example, studies of retired soccer players have shown an increased incidence of both knee and hip OA.[28-30] One study, which investigated the incidence of functional and radiologically evident OA in former elite Australian Rules Football players, showed an increased risk of OA compared with control subjects matched for age, height, weight and body mass index. When the rate of OA in those who had sustained a significant knee injury was compared with the rate in those who had not, there was no significant difference. However, when the intra-articular knee injuries (cruciate and meniscal injuries) were compared with either no knee injury or collateral ligament injury, the risk of functional OA was increased by a factor of 8.1 and the incidence of moderate-to-severe radiologically evident OA was increased 105 times.[31] The footballers in these studies were older players who had sustained their injuries before the advent of anterior cruciate reconstruction and arthroscopic techniques which preserve as much meniscus as possible. It remains to be seen whether these surgical advances will reduce the long-term development of OA in those with significant knee injuries. It is clear that a significant joint injury is a major factor in subsequent development of OA in former footballers. Presumably, once the articular surface has been damaged, further weight-bearing and shear forces will accelerate the degenerative process.

It may not only be major joint injuries that are important risk factors for the development of OA. It has been suggested that minute injuries to the joint surface of bones trigger the stimulation of articular mechanoreceptors within the articular surface and joint ligaments, resulting in a decrease in voluntary activation of the muscles that cause movement across the damaged joint surface.[32] It is believed that this mechanism is intended as a failsafe for the body to prevent further damage to a compromised joint, no matter how subtle the initial injury. However, in the case of minor injury,

where there is not sufficient injury to cease activity, the joint continues to be exercised while a major impact cushioning mechanism (that of eccentric muscle contraction and impact absorption) is not operational. It is believed that this series of events will lead to degeneration of the joint surface and inflammation, leading to continued joint pain and the clinical diagnosis of OA. This is known as the muscle dysfunction theory of OA development, which has more support from clinical studies than the "wear and tear" hypothesis.[33]

Conclusion

Regular moderate physical activity is extremely beneficial to health and most activity-related musculoskeletal injuries are preventable. When injury and serious cardiovascular events do occur, they are usually associated with pre-existing problems or with unaccustomed activity for which people are inadequately prepared or trained. While serious cardiovascular events can occur with exertion, and significant joint injury which occurs in some sports is associated with an increased risk of subsequent development of osteoarthritis, the net benefit of regular moderate-intensity physical activity at the population level far outweighs the risks of any ill-effects associated with it.

Competing interests

None identified.

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