7. Sport for special groups

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Within certain guidelines, sport is beneficial for the young, the old, and those affected by cardiovascular disease

ABSTRACT

- Sports participation among children is declining.
- Sport and physical activity are important in childhood for optimising bone mass and reducing obesity and insulin resistance.
- Physical activity reduces cardiovascular risk factors in adults, and can improve survival in patients with cardiac failure.
- Musculoskeletal injury is the most common complication of sports participation in adults — not cardiac events.
- Some of the decline in function which occurs with ageing can be positively affected by regular physical activity.

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The roles of sport and physical activity in children, people with cardiac disease, and older people deserve special attention. Physical activity provides important benefits at both ends of the age spectrum. Further, increasing rates of childhood obesity, the ageing population, and the prevalence of cardiac disease in our community dictate the need for exercise guidelines for people in these groups. Here, we outline the benefits and risks of physical activity, and provide guidelines for prescribing exercise in these population subgroups.

Children

Benefits of exercise

Preventing obesity: There has been a marked decline in sports participation among Australian children since 1985, when 86% of children aged 5–14 years were active in sport. In 2003, these levels had fallen to 69% of boys and 54% of girls.[1,2] During this same period there has also been an increase in the incidence of childhood overweight and obesity.

Obesity affects 19%–23% of Australian children and adolescents.[3] Obesity in adolescence is associated with increased risk of mortality from all causes (independent of adult weight).[4] To date, exercise interventions aimed at reducing childhood obesity have been disappointing. Preventing obesity through daily physical activity appears to be a more rewarding approach.

Bone mineral accrual: Recent research suggests that the greatest bone mineral accrual occurs when weight-bearing exercise is performed in the early pubertal years[5] (evidence level II; based on the National Health and Medical Research Council system for assessing evidence[6]). Inactivity during these years may result in children failing to realise their potential for peak bone mass.

Lipid profile and insulin sensitivity: The incidence of type 2 diabetes in children and adolescents is increasing.[7] Aerobic exercise improves insulin sensitivity in overweight children (evidence level II),[8] and may produce beneficial changes in blood lipid profiles (increased level of high-density lipoprotein [HDL] and decreased level of low-density lipoprotein [LDL]) in children. Cross-sectional studies in young athletes show a positive correlation between aerobic fitness (VO_2 peak) and HDL levels.[9] With life expectancy potentially falling for the first time in many years because of the effect of the obesity epidemic on adult disease, measures need to be taken earlier to improve insulin sensitivity and blood-lipid profiles.[10]

Psychological and social reasons: Involvement in team sports is beneficial in promoting socialisation skills and in enabling children to function in a team environment. Physical activity and sport are also very important in children with chronic illness or disability, as a means of "normalising" their lifestyle and improving quality of life.

Risks of exercise and sports participation

How much is too much? There are few sports with evidence-based guidelines on this issue. In baseball, however, it was observed that many promising pitchers in the junior baseball leagues were not progressing to senior ranks because of upper limb overuse injuries.[11,12] As a result of these findings, there are now strict guidelines

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Case study 1 — heel pain in an obese child

An obese 12-year-old boy presents with activity-related heel pain, worse with running and in the mornings. He gives no history of a specific injury. He has recently started playing soccer because his general practitioner advised him to exercise more to lose weight.

On examination he has pes planus (flat feet), tight calves, mild swelling over the posterior aspect of the calcaneum, tenderness at the calcaneal insertion of the Achilles tendon, and pain with walking on his heels.

Provisional diagnosis: Sever disease (traction apophysitis of the calcaneum).

Investigations: Not required. X-ray will not be useful unless a stress fracture or osteoid osteoma are suspected. Changes in the calcaneal apophysis on x-ray are common even in asymptomatic heels.

Management: There is a need to reduce pain, but not to recommend reduced activity, given his obesity. Therefore, the aim would be to reduce impact loading (modified training). It is usually not necessary to stop training altogether (evidence level IV).[13] Swimming and cycling could be substituted for running sports.

The child and parents should be reassured that Sever disease is a self-limiting condition which does not cause problems in adult life, but which may cause intermittent symptoms during times of high activity and growth.

Recommendations would include applying ice to the heel after exercise, wearing shoes which raise the heel (to unload apophysis), and beginning a calf-stretching program (evidence level IV),[13] as well as giving advice about diet. ◆

on how many balls it is safe to pitch at various ages. Unfortunately, guidelines for other children's sports are based on "best practice" rather than scientific evidence. Improved injury surveillance in children's sport will help in the development of such guidelines.

Sports injuries: Trauma produces different injuries in children compared with adults. The cartilaginous growth plates in the immature human skeleton close at different ages, and are more vulnerable to injury at certain times, depending on times of peak growth and age of closure. Mechanisms of injury that tear ligaments in adults are also more likely to cause growth-plate injuries or avulsion fractures in children.

Osteochondroses: These are a group of conditions that affect the growing skeleton and articular cartilage. They are more common in boys than girls, and they may be intra-articular (eg, osteochondritis dissecans), physeal (eg, Scheuermann disease) or extra-articular (eg, traction apophysitis).

They vary in their aetiology and frequency of occurrence. Although the causative factors are not fully understood, it appears that stress, ischaemia and genetics are all implicated to varying degrees. The osteochondroses differ in their treatment and prognosis, with some resolving spontaneously while others require surgical intervention.

Traction apophysitis is common in active children, and is caused by the combination of growth and excessive loading of the vulnerable tendon growth-plate interface, resulting in traction of a muscle–tendon unit on the apophysis. Osgood–Schlatter disease (affecting the tibial tuberosity) is the commonest traction apophysitis followed by Sever disease (affecting the calcaneum; see Case study 1).

Fractures: Peak fracture risk in children coincides with the adolescent growth spurt in both sexes. This is thought to be the result of increased cortical bone turnover at this time of high calcium demand for longitudinal bone growth.[14] While weight-bearing activity in childhood may be protective against fractures in adult life, participating in sports at higher levels is associated with increased risk of fracture in prepubertal children.[15]

Heat-related illness in children: Children are more susceptible than adults when exercising in the heat because they have:

- a higher surface-area to body-mass ratio, so that children absorb more heat from the environment (and, conversely, experience greater heat loss in a cold environment);
- lower exercise efficiency, producing more heat for a given work load;
- a higher sweating threshold and lower sweat rate;
- slowness to acclimatise; and
- a tendency to dehydrate, requiring reminders to drink while exercising.

The risk of heat-related illness in children is increased by obesity, medications such as antihistamines, phenothiazines and anticholinergics, and some diseases (diabetes, cystic fibrosis and cardiac conditions). The risk is also increased in a child who gives a history of previous heat-related illness.

Injury prevention

Implementation of injury prevention strategies requires injury surveillance data in children's sport. One area where successful preventive strategies have been implemented as a result of injury data is in the sport of rugby union. Changes in the scrummaging rules were made in Under-19 rugby in response to a review of spinal cord injuries, which showed an increased number of paralysing injuries in Australian schoolboy rugby since the introduction of the power scrum.[16]

Improved injury surveillance will enable the establishment of evidence-based guidelines on safe levels of activity and will identify risk factors for injury.

Weight training in children

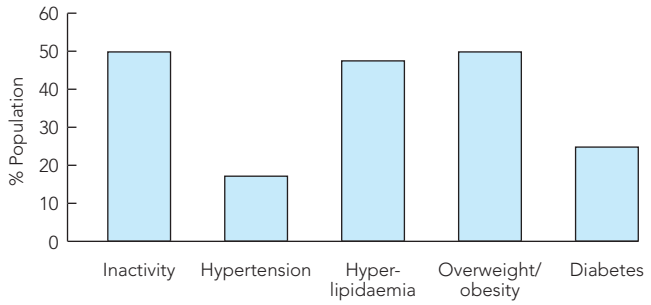
Weight training in children has always been a controversial topic. Its detractors say that it is injurious and does not produce strength improvements in the pre-adolescent child. However, studies now show that weight training can produce strength gains, even in prepubertal children, and that the injury risk is low when training is well supervised (evidence level III-2).[17]

Strength gains in prepubertal children are thought to be a result of neuromuscular adaptations in the absence of muscle hypertrophy. High-repetition (13–15 repetitions), moderate-resistance programs produce greater increases in strength than low-repetition (6–8 repetitions), high-resistance programs (evidence level III-2).[18]

Part of the controversy surrounding weight training in children stems from confusion as to the difference between weight training and weight lifting. Weight lifting is a competitive sport where maximal lifts are performed and is unsuitable for children before adolescence.[19] Weight training (also called strength training or resistance training) involves repetitive submaximal muscle contractions with the aim of improving strength.

There is currently no good evidence that weight training improves performance or prevents injury in children's sport.

1 Prevalence of selected risk factors for cardiovascular disease



Patients with cardiac disease

Benefits of exercise

Primary prevention of cardiovascular disease: In 2001, physical inactivity was second only to tobacco smoking as a cause of total disability and death in Australia.[20] Sedentary patients have a 1.5–2.0 times greater risk of cardiovascular events. Recent activity rather than being active earlier in life confers greater benefit.[21] Box 1 illustrates the high prevalence of physical inactivity as a cardiovascular risk factor when compared with other well accepted risk factors.

Physical activity can provide benefits in a number of these risk factors:

- Diabetes — exercise increases insulin sensitivity and reduces the incidence of type 2 diabetes.[22]
- Obesity — activity has had a more significant impact in men than in women, and is generally more easily achieved in men; its effect is greater in overweight rather than in severely obese patients for whom mobility is difficult.
- Lipids — activity lowers triglyceride levels, increases HDL levels and lowers total cholesterol levels.[23]
- Hypertension — sustained exercise (of at least 50% of achievable activity) typically produces a 5–10 mm fall in both diastolic and systolic blood pressure, although it is less effective in those who are normotensive.

Secondary prevention of cardiovascular disease: While supervised cardiac rehabilitation programs have been shown to improve survival and well being after a cardiac event,[24] there is evidence (level II) that continued exercise reduces mortality in patients after myocardial infarction.[24]

Habitual physical activity improves functional capacity and well being in patients with cardiovascular disease. Recent studies suggest that physical activity improves functional capacity and survival in patients with heart failure.[25]

Other benefits of physical activity: These include reduced risk of mortality from all causes, and improved quality of life after myocardial infarction (evidence level II).[21,26] Physical activity may also reduce depression.[27]

Risks of exercise

Musculoskeletal injury: This is the most common adverse outcome associated with adults participating in exercise programs. Injuries occur in both men and women, affecting the lower limbs and, in particular, the knee. Sports participation is associated with a higher incidence of musculoskeletal injuries than involvement in a tailored exercise program (eg, walking, jogging).[28]

Sudden cardiac death or acute cardiac event: Although habitual physical activity reduces the risk of sudden cardiac death in the asymptomatic population, the increased risk of sudden death during an *acute* bout of physical activity is well documented.[29]

People with the following cardiovascular problems should be advised against exercising:

- unstable angina;
- dyspnoea or chest pain with low activity;
- arrhythmia at rest;
- uncontrolled hypertension;
- severe aortic stenosis; or
- uncontrolled heart failure.

Patients with established coronary artery disease should not undertake *competitive* sports unless they have normal left ventricular function and have received appropriate revascularisation therapy.[30]

Patients should be advised to stop exercising if they experience:

- chest tightness, discomfort or pain;
- dizziness or light-headedness;
- difficulty breathing or shortness of breath;
- nausea;
- claudication; or
- palpitations or exercise tachycardia.

Intensity of exercise

There are three identified levels of physical activity:

- Low — no noticeable increase in breathing and heart rate with constant movement (eg, slow walking or playing bowls). One could easily whistle while undertaking a low-intensity activity.
- Moderate — slight but noticeable increase in breathing and heart rate, and possible light sweating (eg, brisk walking or slow swimming). One would be able to talk during this activity, but not whistle.
- Vigorous — hard breathing, such as puffing (eg, singles tennis or jogging) making it difficult to talk.

Recommendations for exercise in patients with cardiac disease

Acute cardiac disease: Following an acute myocardial infarction, a supervised cardiac rehabilitation program is recommended. There is good evidence (level II) that these supervised, exercise programs improve quality of life, reduce total cholesterol levels and reduce subsequent cardiac mortality.[24]

The exercise program will depend on the patient's clinical condition. It should commence in a hospital setting, and will usually involve a graded walking activity. The duration and intensity of walking should gradually increase over a 6-week period, building up to 30–60 minutes of exercise a day (see Case study 2).

Chronic cardiac disease: Commence with short-duration (5–10 minutes), low-to-moderate-intensity exercise with regular rest periods interspersed. Gradually increase the duration of exercise if the patient remains asymptomatic. The higher the premorbid level of fitness, the more rapid the progression.

The aim of exercise in this population is to increase the volume of existing activity, and not to introduce new or more intense activities. If symptoms occur, then referral should be arranged.

2 Effects of ageing versus physical activity on major organ systems[33,34]

Organ system	Effect of ageing	Effect of physical activity
Cardiovascular	Decrease maximum oxygen consumption, maximum heart rate, and stroke volume	Increased maximum oxygen consumption, maintenance of heart rate and stroke volume, increased exertional capacity
Respiratory	Decrease in vital capacity and FEV_1	Increased sensitivity to ventilatory response, improved functional lung parameters
Neural	Decrease number of axons, nerve transmission speed, and proprioception	Maintenance of response time, improved balance (fewer falls)
Connective tissue	Decreased flexibility	Increased collagen turnover and pliability
Muscle	Decreased strength and endurance	Increased muscle mass and strength
Skeletal	Decreased calcium content	Increased calcium content and bone strength
Cartilage	Atrophy	Thickened cartilage and improved joint protection
Endocrine	Impaired glucose uptake	Decreased insulin resistance

FEV_1 = forced expiratory volume in 1 second. ◆

Case study 2 — angina on exertion

A 60-year-old man presents with stable angina during above-normal levels of activity. His medical history includes a myocardial infarction 10 years ago and coronary artery bypass grafts 6 years ago. Coronary angiography 1 year ago confirmed satisfactory revascularisation with some disease in small vessels unsuitable for surgical intervention. He has mild left ventricular dysfunction with an ejection fraction of 40%.

His cardiovascular risk factors include a body mass index (BMI) of 27, a sedentary lifestyle, being an ex-smoker of 10 years, and hypercholesterolaemia controlled with statin therapy.

Management: An exercise test should be performed (if he hasn't had one in the past 12 months) to exclude any new myocardial ischaemia and to provide some measure of exercise capacity.

Regular physical activity alone could reduce his risk of death by 27%,[25] and could increase his ischaemic threshold by improving his peripheral utilisation of oxygen, thus decreasing his cardiac exercise demand. However, there is no current evidence that activity changes the existing coronary artery disease.

The benefits of moderate physical activity outweigh the risks. Most of the risks stem from musculoskeletal injury, and these are decreased if the exercise is swimming or walking. The risk of a cardiac event is very small, particularly if the exercise is graduated.

In addition to his usual medical therapy, this man should be advised to commence with low-intensity activity (eg, walking on the flat), initially for 10 minutes at a time, with regular periods of rest, gradually increasing to 30 minutes. This exercise should be performed most days of the week, and for 6 weeks. At end of the 6-week period, he should report any symptoms (angina, dyspnoea, fatigue or palpitations) to his general practitioner. If he reports any of these symptoms, review by a cardiologist is recommended.

After the initial 6-week period, he should undertake 30 minutes of physical activity most days of the week, and this should include steps, slopes and hills in a graduated form. He should return for review in 6 weeks, and if asymptomatic, should continue with this program.

The next phase is maintenance of physical activity. The difficulty of this phase is keeping the patient compliant with a regular exercise plan. Support and participation from partners should be encouraged, and the patient should be asked about this activity program when he comes for review or for any other reason. ◆

Older people

Benefits of exercise

Since the first epidemiological studies on the benefit of physical activity on cardiovascular disease, it has been well documented that physical inactivity is an important risk factor in population health.[31] Further, it is estimated that as much as half of the functional decline associated with ageing is actually a result of disuse and, in the case of the decline in muscle function, is at least partially reversible by resistance training.[32]

A combination of aerobic and resistance exercise can help counteract a number of the changes that occur in the human body with ageing (see Box 2). The degree of benefit achieved by physical activity depends on:

- the extent of any pre-existing medical condition;
- the type of program provided; and
- the frequency, duration and intensity of exercise (see previous section).

Encouraged by government-sponsored campaigns such as "Active Australia", "Participation" (Canada) and "Active for Life" (New Zealand), there has been a revolution in sport, with large numbers of older Australians participating in exercise and sport programs, including veterans' and masters' sporting competitions around Australia and worldwide.

Masters' competitors show great diversity across all social groups, medical status and history of sporting participation, with the rate of ageing shown to be a highly individual process.[35,36]

Risks associated with sport and competition

- Exacerbation of cardiac ischaemia (either asymptomatic or diagnosed);
- Cardiac arrhythmia, with sudden cardiac death (although the absolute risk of sudden cardiac death during any episode of vigorous exertion is extremely low[29]);
- Dehydration and electrolyte imbalance (may be exacerbated by medications such as diuretics);
- Deterioration of chronic medical condition, such as pulmonary and coronary artery disease, especially if associated with exposure to air pollution in urban environments;[37] and
- Musculoskeletal injury (this is the main medical cost of involvement in masters' competitions[38,39] — about one in 10 participants

Evidence-based advice

- Regular exercise (40 minutes, 5 days a week) without dietary change will reduce body fat in children with obesity (evidence level II).[8]
- A school-based exercise program will improve fasting insulin levels and reduce body fat in overweight children (evidence level II).[8]
- Exercise interventions in early puberty appear to have the most beneficial effect on bone mineral accrual (evidence level II).[5]
- Regular physical activity improves functional capacity and survival in patients with heart failure (evidence level I).[22]
- A supervised cardiac rehabilitation program (following acute myocardial infarction, coronary artery bypass or angioplasty) improves functional capacity and reduces risk of subsequent cardiac events (evidence level I).[20]

Levels of evidence (I–IV) are derived from the National Health and Medical Research Council's system for assessing evidence.[6] ◆

are injured to a degree sufficient for medical assessment; most injuries are acute and are associated with running and pivoting sports, most frequently involving the knee[40]).

Guidelines for safe participation

In addition to the usual guidelines for a person commencing sport, the older person should be advised about the following:

- Medical control of pre-existing health problems should be maximised, and older people should be aware of how their medications may affect their response to exercise. Medical assessment of cardiovascular risk factors before commencing an exercise program or sporting activity is advised.
- There should be appropriate graduated progression of training before competition.
- People need to monitor themselves and cease the activity if there are any associated symptoms such as excessive dyspnoea, palpitations, chest pain, syncope, or fatigue. Such symptoms need to be fully assessed before return to sport.
- Older people should avoid training excesses, and allow adequate recovery. They should aim for 10%–15% increments in training load.
- People need to allow adequate time for acclimatisation before competing in new environments.

Conclusion

Physical activity and sport produce health benefits at all ages and in many different disease conditions. It is important to recognise both the desired outcomes and potential risks of physical activity in different populations so that exercise can be tailored to suit the individual. The psychological effects of exercise and its role in reducing anxiety and depression in the patients with cardiac disease and in older people should not be underestimated.

Competing interests

None identified.

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