

PHYSICAL ACTIVITY FOR BRAIN HEALTH AND FIGHTING DEMENTIA

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FOREWORD

I am increasingly impressed with the evidence that reinforces the importance of a healthy lifestyle in reducing our risk of chronic diseases such as diabetes, vascular disease and dementia.

There is now a good evidence base to show that what is good for our physical health is good for the brain. We know that by keeping our brains challenged, being fit and healthy, and looking after our heart, we may be able to reduce our risk of developing dementia.

One area that has been a focus of interest for many researchers is the link between physical activity and dementia.

We now know that being physically active is not only important for our physical health but also our brain health. Physical exercise increases blood flow to the brain, stimulates the growth of brain cells and connections between them, and is associated with larger brain volume. This paper is a summary of findings from international and Australian studies on dementia and physical activity, and provides guidance on how best we should keep physically active.

By engaging in regular physical activity, we can improve our brain health and reduce our risk of developing dementia. It can be simply going for a walk, or even learning to salsa dance. Whatever the activity, the aim is to be active regularly.

Health surveys consistently show that too many Australians are not physically active – we spend too much time on the couch and not enough time moving about.

One recent study estimated that a 25 per cent reduction in physical inactivity rates could potentially prevent nearly one million cases of Alzheimer's disease worldwide. Such a simple solution that can have such tremendous benefit!

There are no guarantees however against people of any age developing dementia, particularly those with unexplained younger onset dementia.

I hope that this paper provides you with the incentive to get moving! Physical activity is good for the brain, body and heart.

My congratulations to the authors Dr Maree Farrow, Research Fellow at Alzheimer's Australia Vic, and Dr Kathryn Ellis, Senior Research Fellow at the University of Melbourne, for this informative publication.



Ita Buttrose, AO, OBE
President, Alzheimer's Australia

September 2013

EXECUTIVE SUMMARY

WHAT IS THE TAKE HOME MESSAGE?

Engaging in regular physical activity is great for your brain, body and heart. Physical inactivity has emerged as an important risk factor for cognitive impairment and dementia. The good news is that you can do something about this. People doing regular physical activity at all ages on average have better cognitive abilities, better brain health and a lower risk of developing dementia. Physical activity may also help maintain abilities and slow decline in people with mild cognitive impairment or dementia. Whatever your stage of life, being fit and healthy matters. And it is never too late to start.

Alzheimer's Australia's Your Brain Matters program [1] provides evidence-based advice that healthy and active lifestyles are associated with better brain function and lower dementia risk. One important element of Your Brain Matters is regular physical activity. Physical activity includes planned exercise and sport, as well as other activities that involve bodily movement and are done as part of playing, working, transport, household chores and leisure activities.

The benefits of physical activity for the health of your body and your heart are well known. Physical activity also has a significant positive impact on your brain health. People who do regular physical activity on average have healthier brains, better memory, more efficient planning and other thinking skills, and less chance of developing dementia [2].

WHY ARE WE CONCERNED ABOUT BRAIN HEALTH?

We would all like to maintain good memory and a sharp mind throughout life, and this depends on the health of our brains. We expect brain function to slow down as we grow older, but studies have shown us that many people fear being affected by dementia [3].

Dementia is characterised by a decline in cognitive abilities (the thinking functions of the brain) that impacts significantly on daily life. Lost abilities may include memory, attention, language, planning, judgement, spatial skills and social skills. Dementia is not a normal consequence of ageing; it is caused by brain disease, most commonly Alzheimer's disease, but there are over a hundred causes of dementia.

Someone with dementia experiences a progressive decline in functioning as their brain is damaged by disease. However, there is evidence that additional factors contribute to the symptoms of dementia and that by keeping your brain as healthy as possible, you may be able to delay the onset of dementia and slow its progression [4].

It is estimated that over 320,000 Australians are living with dementia in 2013 [5]. Without a significant medical breakthrough, that is expected to increase to around 900,000 by 2050 [5]. While approximately 1 in 11 people over the age of 65 have dementia [5], a further 1 in 5 have mild cognitive impairment [6] and are at significantly increased risk of progressing to dementia.

CAN WE MAKE A DIFFERENCE?

There is no cure for Alzheimer's disease, but you can reduce your risk. Research has found that about half of Alzheimer's disease cases are potentially attributable to risk factors you can change [7]. Around 13% (over 4 million) of Alzheimer's disease cases worldwide were found to be attributable to physical inactivity. In the USA, a higher 21% of cases were found to be attributable to physical inactivity, a figure that is likely to be similar for Australia where our modern lifestyle means we're less active than we should be. The researchers found that if a quarter of inactive people became physically active, this could prevent nearly 1 million cases of Alzheimer's disease worldwide.

An Australian study showed that if 5% of inactive people became active every 5 years, this would reduce Australian dementia prevalence by 11% in 2051 [8]. That equates to around 100,000 fewer Australians living with dementia, simply by getting more of us to do regular physical activity.

HOW DOES PHYSICAL ACTIVITY HELP YOUR BRAIN?

We are still learning how physical activity affects brain biology and function. We now know that the brain continues to grow new cells and connections between them throughout life, helping us continue to learn. This is sometimes referred to as brain plasticity. We also know that the brain requires adequate blood flow to receive the oxygen and nutrients it needs to function well. Physical activity supports both these important aspects of brain biology.

Physical activity enhances brain plasticity and the growth and survival of brain cells. Brain imaging studies have shown that people doing regular moderate-intensity physical activity, compared to those who are inactive, have increased brain volume in regions important for memory, learning, concentration and planning [9]. They also have increased connectivity between brain regions, and they have better cognitive function [9,10]. This suggests that they have more brain cells and more connections between them, helping their brain to function more effectively. It is normal for the brain to shrink a little as we grow older, but this age-related shrinkage is reduced in people who do regular physical activity [2]. Older adults who are physically active have brain volumes and connectivity typical of younger adults.

The health of blood vessels in the brain is vital for healthy brain function. Diabetes, high blood pressure, high cholesterol and obesity can damage blood vessels and lead to vascular disease in the brain, a major contributor to dementia. Physical activity reduces the risk of these conditions, helps to keep blood vessels healthy, and supports the growth of new small blood vessels [10]. Physical activity also increases blood flow to the brain, providing both long-term and immediate benefits. Studies have demonstrated improved cognitive performance in the hours following physical exercise [11].

Interestingly, some recent studies suggest that physical activity also plays a role in reducing the brain damage of Alzheimer's disease. Beta amyloid is a protein that forms deposits in the brains of people with Alzheimer's disease. Studies have found less of the amyloid changes associated with Alzheimer's disease in older adults who are physically active than in those who are inactive [2].

Other studies have investigated what happens when inactive people start exercising, and some have shown that after 6 to 12 month exercise interventions, brain volume increases and cognitive function improves [9]. These effects have been shown in children as well as older adults [10], so no matter what your age, increasing your physical activity has the potential to improve the health and function of your brain.

CAN PHYSICAL ACTIVITY REDUCE YOUR RISK OF DEMENTIA?

Many studies have investigated the relationship between how much physical activity people do at different stages of life and their chances of developing dementia in late-life, and there is now evidence demonstrating that physical activity at all ages may protect against dementia. Most of the evidence comes from studies involving older

adults whose level of physical activity and cognitive abilities are measured and then they are followed up a few years later. These studies show that older adults doing regular physical activity have a lower risk of decline in their cognitive abilities and of developing dementia, compared to those who are inactive [2,10].

Fewer studies have investigated the association between midlife or earlier physical activity and late life cognitive impairment. Most have found that midlife exercise is associated with a lower risk of later developing dementia [12]. Given that the diseases that cause dementia gradually damage the brain over many years before symptoms emerge, it makes a lot of sense to address brain health as early as possible.

However, it is also never too late to start. Studies of exercise intervention programs for older inactive people have confirmed that even moderate exercise can improve cognitive performance. A review of the evidence concluded that people who were not previously physically active can show improved cognitive functioning after exercising for as little as four months [13].

CAN PHYSICAL ACTIVITY SLOW THE PROGRESSION OF DEMENTIA?

Regular physical activity may also reduce the rate of cognitive decline in people with mild cognitive impairment or dementia. Some studies of physical activity programs for people with dementia have demonstrated either improvements in cognitive function or slower decline in cognitive abilities [14]. Demonstrated benefits have also included slower decline in activities of daily living (things like mobility, personal hygiene, dressing and grooming), improved physical fitness, and improved wellbeing [14]. Other physical activity intervention studies have involved people with mild cognitive impairment, and most of these have shown that improvement in cognitive function is associated with increased physical activity [9].

WHAT SORT OF PHYSICAL ACTIVITY AND HOW MUCH DO YOU NEED TO DO?

It is not currently possible to provide a physical activity formula that is optimum for brain health and function, or for lowering dementia risk. The evidence to date comes from a wide variety of studies. These measure physical activity in different ways, look at different types and intensities of activity, and use different durations and frequencies of exercise sessions. The good news is that when we put the evidence together, it does show that many forms of physical activity are beneficial for brain health and cognitive function.

Physical activity is generally grouped into four categories. Because each of these focus on improving particular functions of the body, you'll get the most benefit from regularly engaging in some of each kind.

Aerobic or endurance exercise is physical activity that increases your breathing rate and heart rate. Performed regularly it improves physical endurance and the health and fitness of your lungs, heart and blood vessels. It includes moderate-to-high intensity activities like walking, jogging, swimming, cycling and even energetic housework. Aerobic activity has been shown to enhance brain plasticity, increase brain blood flow and improve cognitive function, and is associated with reduced dementia risk [2,9]. Guidelines recommend adults do at least 30 minutes and children at least 60 minutes of moderate-intensity aerobic activity on most days of the week, preferably every day.

Strength or resistance training is physical activity that utilises weights or resistance, including your own body weight, to work muscles. Performed regularly it improves muscle strength and tone, as well as the health and fitness of tendons, bones and joints. Only a few studies have investigated the effects of strength training on brain function, and results have been mixed [2,9]. Strength training has been shown to be beneficial in preventing and managing diabetes, an important risk factor for dementia. Guidelines recommend adults do strength exercises for each major muscle group at least twice a week.

Flexibility exercises are those that stretch your muscles. Performed regularly they help your joints and muscles to stay limber and flexible. There are numerous types of stretching exercises you can do, and activities like yoga, Pilates and tai chi include controlled stretching often in conjunction with strength and balance exercises. Stretching alone is not thought to provide as much benefit for the brain as other types of physical activity, but is very important for your muscles. Flexibility exercises can be done as often as you like and are an important component of aerobic and strength training programs.

Balance exercises help to improve balance and coordination and reduce the risk of falls. They include movements that test your balance and activities like tai chi. Lower-body strength exercises, yoga and Pilates can also help improve your balance. As with stretching, balance exercises may not be essential for brain health, but are nonetheless very important to include in your routine, especially for older people. Guidelines recommend older adults do balance exercises at least 3 times a week.

Of course, many physical activities combine elements of more than one of these types of exercise. Experts classify the four types because it is important to consciously try and include all four in the activities you choose to do. It is also very important to choose activities that you enjoy and will be able to stick with for long-term benefits. And seek the advice of your doctor and an exercise professional for guidance on safety, planning and getting the most out of your physical activity.

1. INTRODUCTION

In 2012, Alzheimer's Australia launched its new brain health and dementia risk reduction program, Your Brain Matters [1]. This preventative health program aims to educate Australians about the lifestyle and health factors that could help them maintain brain health into old age and reduce their risk of dementia. There is compelling evidence that healthy, active and mentally stimulating lifestyles along with prevention or control of cardiovascular risk factors, are associated with better cognitive function and lower dementia risk [4].

Physical inactivity has emerged as an important modifiable risk factor for cognitive decline and dementia. Higher levels of physical activity in early, mid and late life have been associated with better cognitive function, better brain health and a lower risk of later developing dementia [15,16]. Physical activity has also been shown to be associated with maintaining function and slowing decline in people with cognitive impairment or dementia [14].

The benefits of physical activity for the health of our body and our heart are well known. There is mounting evidence that physical activity also has a significant impact on the health of our brain. This paper outlines current evidence and research directions for understanding the role of physical activity in brain health and fighting dementia.

COGNITIVE IMPAIRMENT AND DEMENTIA

Dementia is an umbrella term, used to describe a syndrome that can have many different causes. The syndrome is characterised by gradual decline in cognitive abilities (the thinking functions of the brain, e.g. memory, attention, language, planning, judgement, spatial skills, social skills) and behavioural or psychiatric symptoms (e.g. depression, anxiety, delusions, agitation, apathy). Dementia is not a normal consequence of ageing; it is caused by brain disease, most commonly Alzheimer's disease, but there are over one hundred causes of dementia. Other common contributors to dementia include Lewy body disease, cerebrovascular disease and frontotemporal degeneration. These diseases begin to damage the brain many years before symptoms become apparent and cause a progressive decline in functioning as more of the brain is damaged.

In new diagnostic criteria published in May 2013, the term dementia is replaced by major neurocognitive disorder to reflect the severity of cognitive impairment at this stage of disease [17].

A person with dementia, or major neurocognitive disorder, has cognitive deficits sufficient to interfere with their independence and activities of daily living.

Because conditions such as Alzheimer's disease have a gradual onset, many affected people begin to experience cognitive problems that are not severe enough to significantly interfere with their daily functioning, and so do not meet the criteria for dementia. This has been termed mild cognitive impairment (MCI), or cognitive impairment – no dementia (CIND). In the new diagnostic criteria this stage of impairment is termed mild neurocognitive disorder [17].

There is also an initial stage of disease in which cognitive function remains normal. In this earliest stage, damage begins to build up in the brain, but is not yet sufficient to cause noticeable changes in brain function. New brain imaging techniques and measures of proteins in cerebrospinal fluid (the fluid that surrounds the brain and spinal cord) allow this preclinical phase to be detected for Alzheimer's disease [18]. It is this preclinical stage that future therapies may target, in order to stop the disease before it affects cognitive and behavioural function. Even therapies that could slow down the progression of brain damage and its effects on function would be enormously beneficial.

While drug discovery research and clinical trials are continuing, there is much community interest in what other strategies might help people to avoid or at least slow down cognitive decline and dementia, and much research is happening in this area. One important focus of this research is how physical activity may improve brain health and prevent or slow cognitive decline.

CAN WE MAKE A DIFFERENCE?

It is estimated that over 320,000 Australians are living with dementia in 2013. Without a significant medical breakthrough, that is expected to increase to around 900,000 by 2050 [5]. The reason for the increase in dementia cases is the increase in numbers of older people in the community. Old age is the biggest risk factor for dementia, we are living longer, and the baby boomers are growing older.

While approximately 1 in 10 older people (over the age of 65) have dementia [5], a further 1 in 5 have mild cognitive impairment and are at significantly increased risk of progressing to dementia [6].

Cognitive impairment and dementia already place significant burden on individuals, the health system and the economy, and this impact is set to rapidly increase as the population ages.

Reducing dementia risk factors has the potential to reduce risk and delay onset of dementia for individuals, and reduce the incidence of dementia in the population [4]. Researchers Deborah Barnes and Kristine Yaffe from the University of California, San Francisco, recently estimated that up to half of Alzheimer's disease cases are potentially attributable to seven risk factors (diabetes, midlife hypertension, midlife obesity, depression, physical inactivity, smoking and cognitive inactivity) [7]. They further estimated that 3 million cases of Alzheimer's disease could be prevented worldwide by reducing the incidence of these risk factors by 25%.

Barnes and Yaffe calculated that worldwide, about 13% (over 4 million) of Alzheimer's disease cases are potentially attributable to physical inactivity. In the USA, 21% of cases may be attributable to physical inactivity, a figure that is likely to be similar for Australia where our modern lifestyle means we're less active than we should be. A 25% reduction in the number of physically inactive people could potentially prevent nearly 1 million cases of Alzheimer's disease worldwide [7].

Estimates also suggest significant impacts can be achieved by modifying the risk factor profile in the Australian population. University of Canberra researchers Binod Nepal and colleagues calculated that a decline in the number of physically inactive Australians of 5% every 5 years would reduce dementia prevalence by 11% in 2051 [8]. That equates to around 100,000 fewer Australians living with dementia, as a consequence of addressing just one risk factor, simply by getting more of us to do regular physical activity.

Addressing health and lifestyle risk factors in those already living with cognitive decline or dementia may also be beneficial. Treatment of hypertension, high cholesterol, diabetes and depression, and maintaining cognitive, physical and social activities may help slow cognitive

decline, or at least ensure cognitive impairment is not exacerbated [4,19]. Regular physical activity is recommended in clinical guidelines for management of dementia [19].

YOUR BRAIN MATTERS

Your Brain Matters is an Alzheimer's Australia program that provides Australians with three key messages about the modifiable risk and protective factors for cognitive decline and dementia [1].

- Keeping your brain active matters
- Being fit and healthy matters
- Looking after your heart matters

The program aims to educate people that there is more to maintaining cognitive function than doing crossword puzzles, that in fact a holistic approach looking after your brain, body and heart will give you the best chance of cognitive health into old age. It also aims to raise awareness that what is good for the heart is good for the brain. The 'Brain' component of the program highlights that those who are more mentally and socially active on average have better cognitive function and lower dementia risk. The 'Body' component shows that healthy choices related to alcohol consumption, diet and physical activity are associated with better cognitive function and lower dementia risk. And the 'Heart' component encourages abstinence from smoking, maintaining a healthy weight, regular health checks and good control of diabetes, high blood pressure and high cholesterol to reduce the risk of vascular contributions to dementia. For more information about the program, visit yourbrainmatters.org.au.

This paper focusses on just one of the factors that influence brain health, cognitive function and dementia risk – physical activity. It is not meant to suggest that physical activity is more important than the other factors. It is meant to raise awareness that whether we undertake regular physical activity is a choice we all make that has a significant role to play in the health and function of our brain.

2. PHYSICAL ACTIVITY

Physical activity is defined by the World Health Organization as any bodily movement produced by skeletal muscles that requires energy expenditure [20]. It includes all types of incidental and planned movement including activity that occurs during work, play, transportation, household chores, recreation, exercise and sport. Exercise is a subcategory of physical activity that is planned, often with the objective of improving or maintaining aspects of physical fitness.

Increased physical activity can be built in to everyone's daily life and does not have to be strenuous to provide significant health benefits. While the more you can do the better, doing some physical activity every day is better than doing none.

TYPES OF PHYSICAL ACTIVITY

Physical activity is generally grouped into four categories. Because each of these different kinds of exercise focus on improving particular functions of the body, you'll get the most benefit from regularly engaging in some of each kind.

Aerobic or endurance exercise is physical activity that increases your breathing rate and heart rate. Performed regularly it improves physical endurance and the health and fitness of your lungs, heart and blood vessels. It includes moderate-to-high intensity activities like walking, jogging, swimming, cycling and even energetic housework. Guidelines recommend adults do at least 30 minutes and children at least 60 minutes of moderate-intensity aerobic activity on most days of the week, preferably every day [21-23].

Strength or resistance training is physical activity that utilises weights or resistance, including your own body weight, to work muscles. Performed regularly, it improves muscle strength and tone, as well as the health and fitness of tendons, bones and joints. Guidelines recommend adults do strength exercises for each major muscle group at least twice a week [21,23].

Flexibility exercises are those that stretch your muscles. Performed regularly they help your joints and muscles to stay limber and flexible. There are numerous types of stretching exercises you can do, and activities like yoga, Pilates and tai chi include controlled stretching often in conjunction with strength and balance. Flexibility exercises can be done as often as you like and are an important component of aerobic and strength training programs.

Balance exercises help to improve balance and coordination and reduce the risk of falls. They include movements that test your balance and activities like tai chi. Lower-body strength exercises, yoga and Pilates can also help improve your balance. Guidelines recommend older adults do balance exercises at least 3 times a week [21].

Of course, many physical activities combine elements of more than one of these types of exercise. Experts classify the four types because it is important to consciously try and include all four in the activities you choose to do. It is also very important to choose activities that you enjoy and will be able to stick with for long-term benefits. And seek the advice of your doctor and an exercise professional for guidance on safety, planning and getting the most out of your physical activity.

THE HEALTH BENEFITS OF PHYSICAL ACTIVITY

Engaging in regular physical activity has many benefits for our physical and mental health and wellbeing. Research has demonstrated that being physically active reduces the risk of cardiovascular disease, diabetes, stroke, high blood pressure, high cholesterol, obesity, osteoporosis, falls and fractures, and some cancers [21-23]. It has also been shown to promote better sleep, reduce stress and anxiety, improve concentration, help manage pain, and reduce symptoms of depression [21-23]. Physical activity supports the health of your muscles, bones, joints, lungs, heart and brain. Engaging in regular physical activity also improves and maintains strength, fitness, wellbeing and your ability to carry out and enjoy everyday activities.

Aerobic or endurance activity in particular is important for cardiovascular health and fitness, and is sometimes called 'cardio' exercise. Regular aerobic activity has been shown to lower blood pressure and cholesterol levels, and reduce the risk of diabetes and obesity [23]. For example, a recent review of 15 studies found that aerobic training interventions resulted in significant reductions in systolic and diastolic blood pressure [24]. The benefits of aerobic activity go beyond reducing the risk for cardiovascular disease, however. What is good for the heart is also good for the brain. Aerobic activity is associated with lower risk for depression and cognitive impairment [23].

Strength or resistance training has also been shown to provide health benefits beyond muscle strengthening. For example, the Australian Diabetes, Obesity and Lifestyle (AusDiab) Study found that people who participated in strength training at least once a week were significantly less likely to have impaired glucose metabolism (including type 2 diabetes) [25]. Strength training has also been shown to assist with weight control, reduce pain in arthritis, reduce blood pressure and reduce cardiovascular disease risk [23,26].

A study by Kay Cox and colleagues from the University of Western Australia compared the effects of swimming and walking on fitness, body weight, cholesterol, glucose and insulin. 116 sedentary women aged 50 to 70 years completed 3 sessions per week of moderate-intensity exercise, either swimming or walking, supervised for 6 months then unsupervised for 6 months. After the initial 6 months, waist and hip measurements and insulin levels were lower in the swimmers than the walkers [27]. At 12 months, fitness was maintained and body weight and cholesterol levels were lower in the swimmers than the walkers. These findings suggest that the type of exercise can influence health benefits, and it is likely that participating in a variety of physical activities including aerobic, strength, flexibility and balance components would provide the best results for overall health and fitness.

While regular physical activity improves health, physical *inactivity* is a risk factor for poor physical and mental health, and for premature death. Worldwide, physical inactivity has been identified as the fourth leading risk factor for mortality, causing an estimated 3.2 million deaths annually (6% of deaths globally) [21]. Cardiovascular disease is the leading cause of death in Australia, and people who are not physically active are almost twice as likely to die from heart disease as those who are active [28]. Physical inactivity accounts for nearly 7% of the total burden of disease in Australia, the fourth highest contribution after smoking, high blood pressure and obesity [29]. In 2007-08, physical inactivity was estimated to be responsible for over 16,000 deaths in Australia and for \$719 million in direct health care costs [30].

The evidence is clear that physical activity is one of the most important things we can do for our health, especially to help prevent or delay the deterioration in function and the illnesses associated with ageing [31]. It is also beneficial for helping to manage a variety of conditions, in some cases being as effective as medications in alleviating symptoms or avoiding complications [32]. Physical activity also has the benefit of being relatively low risk for side effects when

compared to some medications, particularly when undertaken in consultation with a doctor or exercise professional about what type and level of activity is safe. Regular physical activity is something we should all try to engage in, no matter what our age, abilities, weight or health problems.

ARE WE DOING ENOUGH PHYSICAL ACTIVITY?

Results from the latest Australian Health Survey [33] reveal that only about one-third of Australian adults are doing recommended amounts of physical activity, and that participation in physical activity falls with age. In 2011-12, 35% of Australians aged 15 and over were classified as sedentary and a further 32% were doing low levels of exercise. Older people did less exercise than younger people, with 57% of people aged 75 years and over being sedentary and a further 26% having low levels of exercise. Men were generally more active than women. In particular, young females (15-17 year olds) were nearly twice as likely as young males to be sedentary (29% compared to 15% respectively).

And it seems that we know we are not doing enough and are good at finding excuses not to be physically active. Results from a Heart foundation survey [34] revealed that in 2011, more than half (54%) of Australians aged 30-65 felt they do not do enough physical activity to stay healthy. The main barriers that discouraged people from doing regular physical activity included lack of time (45%), not enjoying exercise (40%), being put off by the weather (28%) and preferring to do other things (26%).

ARE WE DOING TOO MUCH SITTING?

Recently, research has found that people who sit less during their daily activities have a lower risk of diabetes, obesity, cardiovascular disease, and premature death [35]. This is independent of how much physical activity you do. It seems doing the recommended 30 minutes of physical activity every day by going for a run or to the gym, while very beneficial for health, will not undo the damage caused by sitting for most of the other 15 ½ waking hours of the day. On average, adults spend more than half their waking hours sitting [36].

The good news is that research suggests breaking up sitting time with regular interruptions (even as little as standing up briefly) may reduce the risk of heart disease and diabetes, regardless of total sitting time [37]. As well as thinking about how much physical activity you do, you need to be aware of how much you sit and try to move more throughout the day.

3. PHYSICAL ACTIVITY AND YOUR BRAIN

We are just beginning to understand the underlying mechanisms by which physical activity has a positive impact on the structure and function of the brain. But the research in this area has provided some exciting evidence that physical activity has a range of direct beneficial effects on the brain, supporting its health and function.

HOW PHYSICAL ACTIVITY AFFECTS THE BRAIN

It was believed for a long time that the adult brain could not be improved, but we now know that the brain continues to grow new cells and connections between them throughout life, helping us continue to learn and adapt. We also know that the brain requires adequate blood flow to receive the oxygen and nutrients it needs to function well. Physical activity appears to support both these important aspects of brain biology.

Neurons are the brain cells responsible for brain functions and there are around 100 billion of them in the adult human brain. The growth of new neurons is called neurogenesis, and this continues throughout life but does decline with age. Neurons communicate with each other via connections called synapses. When we learn something new, new synapses are formed and this is sometimes called plasticity. This allows the brain to adapt to internal changes (due to damage or disease) or external changes (new environments or information) to optimise its function.

The normal process of ageing causes the loss of some neurons and synapses and the brain shrinks slightly, but this is far more pronounced in Alzheimer's disease. A protein called beta amyloid is aggregated into clumps called plaques in the brain as part of Alzheimer's disease, and evidence suggests that this is related to damage to neurons and synapses. Another protein called tau forms tangles inside neurons which subsequently stop working properly and die. Neurons and synapses are also damaged by chemical processes including oxidative stress and inflammation.

Physical activity has been shown to enhance the health and survival of neurons, neurogenesis, the number of synapses, and plasticity. It may also play a role in reducing the protein changes that occur in Alzheimer's disease. Much of what we know to date has come from non-human animal studies, but evidence is emerging that the same processes occur in the human brain when we do regular physical activity.

In healthy mice given the opportunity to use running wheels, compared to sedentary mice, we see [9,10,38]:

- increased neurogenesis and reduced age-related decline in neurogenesis
- increased synapses and connections
- growth of new capillaries (small blood vessels)
- increased chemicals needed for neurogenesis and the health and survival of neurons
- increased chemicals that protect against oxidative stress and inflammation

In mice with a genetic mutation that causes Alzheimer's disease, those given the opportunity for regular physical activity have [9,10,38]:

- reduced amyloid plaques
- reduced loss of neurons in the hippocampus, a brain region vital for memory and damaged by Alzheimer's disease
- increased chemicals needed for clearing amyloid from the brain

While we cannot count neurons and synapses in a living human brain, the results of brain imaging studies suggest neurogenesis and plasticity are enhanced by physical activity in humans as well. Studies have shown that people engaging in regular physical activity, compared to those who are sedentary, on average have [9,10,38]:

- increased brain blood flow
- increased brain grey matter volume, suggesting more neurons and synapses
- increased volume in the frontal lobes, important for executive functions such as planning and concentration
- increased volume in the hippocampus, important for learning and memory and significantly affected by Alzheimer's disease
- increased brain connectivity, suggesting improved plasticity
- brain volume and connectivity typical of people a few years younger
- increased brain derived neurotrophic factor (BDNF), a chemical important for neurogenesis and the health and survival of neurons
- reduced age-related brain shrinkage
- less amyloid deposition in the brain
- less of the amyloid and tau changes associated with development of Alzheimer's disease in the cerebrospinal fluid (the fluid that surrounds the brain and spinal cord)

Other studies have investigated what happens when sedentary people become more active, and have shown that after 6 to 12 month physical activity interventions, brain volume and BDNF levels are increased, and cognitive functions are improved [9,10]. These effects have been shown in children as well as older adults, so no matter what your age, physical activity can improve the health and function of your brain.

Physical activity affects brain health in another very important way. Regular physical activity reduces risk for diabetes, high blood pressure, high cholesterol, obesity and heart disease, and has a role in their treatment and management [23,38]. Each of these conditions increases the risk of cerebrovascular disease (damaged blood vessels in the brain), which is particularly important because cerebrovascular disease can damage neurons and is a significant contributor to cognitive impairment and dementia [38,39]. There is growing evidence that these conditions may also increase the risk of Alzheimer's disease [38-40]. Keeping your heart healthy through physical activity also helps to keep brain blood vessels healthy and the brain functioning efficiently.

In the Australian Imaging, Biomarkers and Lifestyle (AIBL) Study of Ageing, 116 healthy people aged 60 or older completed the International Physical Activity Questionnaire to measure their weekly physical activity habits and underwent a positron emission tomography (PET) scan to measure the extent of beta amyloid in their brain. Higher levels of physical activity were associated with lower brain amyloid load, especially for people with a genetic variation that increases risk for Alzheimer's disease [40]. Those doing more physical activity also had healthier measures of insulin and cholesterol in their blood. This study highlights

the growing evidence for a link between physical activity, cardiovascular health and reduced risk of Alzheimer's disease.

The vast majority of research into the effects of physical activity on the brain has involved moderate-to-high intensity aerobic activity. This is especially so for non-human animal studies, where it is not really possible to measure strength training or balance exercise. Aerobic activity has been shown to enhance brain plasticity, increase brain blood flow and improve cognitive function, and is associated with reduced dementia risk [9,10,16,38]. Only a few studies have investigated the effects of strength training on brain health, and results have been mixed [2,38]. Strength training has been shown to be beneficial in preventing and managing diabetes [25,26], which is an important risk factor for dementia. Stretching and balance exercises are not thought to provide as much benefit for the brain as other types of activity, but they are nonetheless very important to include in your routine. Future research needs to focus on determining the biological effects on the brain of different types of physical activity, especially aerobic versus strength training, in order to develop evidence-based advice [2]. In the meantime, regular participation in a variety of physical activities is likely to provide the best results for brain health.

The positive effects of physical activity on the health of the body and the heart are well documented. It makes sense that there would also be significant benefits for brain health, which we now know is very closely linked to overall health. And the evidence clearly demonstrates that regular physical activity does improve the health of neurons, synapses and blood vessels, to help keep the brain healthy and functioning well.

4. PHYSICAL ACTIVITY AND COGNITIVE FUNCTION

The many positive effects regular physical activity can exert on brain health should lead to better cognitive function, and potentially maintenance of healthy cognition into old age and reduced risk of developing dementia. There is a growing body of research evidence to suggest this is the case.

PHYSICAL ACTIVITY FOR IMPROVING COGNITION

A number of clinical trials have been conducted to examine whether physical activity interventions can improve cognitive function in healthy adults. Some have found that increased physical activity does improve cognitive function, while others have failed to show a beneficial effect. Discrepancies in findings may be due to the wide variety of both physical activity interventions and measures of cognitive function that are employed in these trials. Despite these inconsistencies, the results are very promising.

Patrick Smith and colleagues from Duke University in the USA reviewed the research in this area and combined results from 29 studies involving over 2,000 participants [41]. The researchers examined whether type, duration and intensity of physical activity, age of participants, and whether they had mild cognitive impairment (MCI) affected the outcome. They examined four kinds of cognitive skills – attention and processing speed (sustained concentration and rapid processing of information), executive function (planning, initiation, sequencing and monitoring of complex, goal-directed behaviour), working memory (short-term storage and manipulation of information), and memory (retention, recollection and recognition of previously encountered information).

Overall, physical activity was associated with modest improvements in executive function, memory, attention and processing speed, but not in working memory [41]. The duration and intensity of physical activity interventions did not influence the outcome for any cognitive function. Combined interventions that included aerobic exercise and strength training improved working memory and attention and processing speed to a greater extent than aerobic only interventions. Participants' age affected the outcome only for working memory, which improved more for older than younger participants. People with MCI showed smaller improvements in executive function and larger improvements in memory compared to those with normal cognition.

Other similar reviews have also concluded that physical activity interventions can improve cognitive function, although they vary in the size of the effect reported [13,42,43]. The majority of studies in this area have employed aerobic activity interventions and it seems aerobic exercise does have benefits for cognition. Interestingly, a review combining findings from 18 studies concluded that combined aerobic and strength training programs had a larger beneficial effect on cognitive function than aerobic only programs [42]. A few studies have found benefits for non-aerobic activity as well. One found significant improvements in memory performance following a 6 month strength training intervention, with equal benefits from moderate and high intensity strength training [44]. Another found that a combination of resistance and balance exercises undertaken for 6 months resulted in significant improvements in response inhibition [45]. The effect of strength or resistance training on cognitive function has been inadequately studied to date and further research is needed [38].

In the Australian Imaging, Biomarkers and Lifestyle (AIBL) Study, 217 participants aged 60 or older underwent a comprehensive cognitive assessment and wore an actigraph unit for one week. The actigraph unit was worn on a waist band and recorded movement to provide measures of the amount and intensity of physical activity performed during the week. Higher overall amount of physical activity was associated with better cognitive function, but not significantly after controlling for other factors that might affect cognitive performance. However, higher intensity of physical activity was associated with better performance on tests of attention, working memory, spatial abilities and word fluency [46]. While the review discussed above found that exercise intensity did not influence the benefits of physical activity on cognitive function [41], the AIBL Study and other results indicate that intensity may be important. The AIBL researchers concluded that additional studies are required to establish the optimum intensity of physical activity for benefits to cognitive health [46].

While the optimum duration, frequency and intensity of physical activity are yet to be determined, findings that different types and intensities of physical activity can improve cognitive function for people of all ages should encourage everyone to be physically active.

PHYSICAL ACTIVITY FOR DEMENTIA RISK REDUCTION

If physical activity can improve cognitive function, can it help to prevent cognitive decline and dementia? Several studies have now investigated the potential role of physical activity as a protective factor against the risk of dementia. While further research is needed, there is evidence that older people who are physically active demonstrate less cognitive decline and a lower risk of dementia than people who are sedentary [9,47].

Most of the evidence comes from studies involving healthy older adults whose level of physical activity and cognitive abilities are measured at baseline, and then they are followed up a few years later and assessed for dementia. Mark Hamer and Yoichi Chida from University College London combined the results of such studies and found that across 6 studies and 13,771 participants, those in the highest physical activity category had an average 45% less chance of developing Alzheimer's disease compared to those in the lowest physical activity category [48]. Across 11 studies and 23,168 participants, higher physical activity was associated with a 28% lower risk of developing any type of dementia. High and low levels of physical activity are defined differently in different studies, and the authors of this review concluded that future studies should examine the optimal dose of physical activity to promote protection against dementia. A lower risk of developing MCI for those undertaking regular physical activity has also been demonstrated in several studies [38].

Another review by Francesco Sofi and colleagues from the University of Florence, Italy, combined the results of studies that assessed participants for cognitive decline rather than for dementia or MCI. Cognitive decline, especially memory decline, is often an early sign of MCI or dementia, but may occur as a consequence of ageing. This review found that across 15 studies and 33,816 participants, those who performed physical activity at baseline had a significantly reduced risk of cognitive decline during follow-up [49]. People who reported performing a high level of physical activity had a 38% reduced risk of cognitive decline compared to those who reported being sedentary. People performing low to moderate levels of physical activity had a 35% lower risk of cognitive decline compared to people who were sedentary.

Although fewer studies have investigated the association between midlife physical activity and the risk of late life cognitive impairment, most have found that midlife physical activity is associated with a lower risk of developing dementia [12,38]. For example, physical activity

at ages 36 and 43 years was associated with slower decline in memory and visual search speed over 20 years in 1018 people in a British study [50]. Another study found that regular physical activity in early life (15 – 25 years old) was associated with faster cognitive processing speed in men in late life [51]. Since Alzheimer's and other diseases that cause dementia develop over a long time, it is logical to assume that earlier adoption of regular physical activity would exert a longer-term protective effect, as it does for cardiovascular disease [52]. As discussed earlier, Belinda Brown and colleagues from the AIBL study found potential biological evidence of this effect. Participants undertaking the lowest levels of habitual physical activity had significantly more beta amyloid in their brain (the protein that abnormally accumulates in Alzheimer's disease) than those undertaking the highest levels of physical activity [40].

Although these findings suggest physical activity is related to lower dementia risk, many questions remain to be answered.

Are there gender or other individual differences?
Some studies suggest the protective effect of physical activity is stronger for women than men, although it is clear that both males and females do benefit [2,49]. Other studies suggest the level of benefit from physical activity may depend on genetic variations associated with the risk of Alzheimer's disease, but findings are inconsistent [40,53,54].

What is the optimal frequency, duration and intensity of physical activity?

Some reviewers of the research in this field have concluded that there is no strong evidence for a 'dose' effect and that even moderate levels of physical activity are protective for cognitive function [38,48,55]. However, while most studies have investigated moderate intensity physical activity, which consistently shows benefits, some studies suggest that higher intensity physical activity may be even more beneficial [46,56,57]. Some research suggests physical activity sessions may need to be at least 30 minutes in duration for cognitive benefits [55]. Potentially, the more you can do the better, but even small increases in physical activity from a sedentary state can reap benefits [54].

At what stage of life is physical activity most important?

The brain changes that lead to dementia can begin in midlife, so more research is needed to examine the effects of midlife physical activity. Studies with longer term follow ups more consistently find positive effects, suggesting that long-term or midlife physical activity may confer the greatest benefits in terms of cognitive health [2].

However, the many studies demonstrating the positive effects on cognition of physical activity performed in late life make it clear it is never too late to start. And, as discussed in the following section, physical activity may also benefit cognitive function in people with mild cognitive impairment or dementia.

While the optimal dose and timing of physical activity and who may benefit the most are yet to be determined, and not all studies find a significant protective effect, the combined evidence suggests that the risk of cognitive decline and dementia could be reduced by a third to a half for those continuing to engage in regular physical activity [48,49].

PHYSICAL ACTIVITY FOR SLOWING DEMENTIA PROGRESSION

A number of trials have investigated the effects of physical activity in people with MCI or dementia. While most are small studies and findings are not always consistent, the available results are promising and suggest people with MCI or dementia can benefit from physical activity, both in cognitive and physical function [14,38,58]. A review of 30 studies involving 2020 participants with cognitive impairment or dementia found significant improvements in strength, physical fitness, functional performance, cognitive function and behaviour following physical activity programs [59].

Studies have demonstrated that the positive effects of physical activity interventions for people with dementia can include better physical functioning and mobility, less decline or improvements in activities of daily living, improved communication, and less cognitive decline or improvements in cognitive function [14,38,58,60]. The evidence for any improvements in mood and quality of life is less clear [61]. The studies to date have limitations, including small numbers of participants and lack of suitable control groups, and more research is needed.

Studies investigating the effects of physical activity interventions for people with MCI, who are at significantly increased risk of experiencing further cognitive decline and developing dementia, suggest cognition may be improved or cognitive decline slowed [9,58]. The Australian Fitness for the Ageing Brain Study (FABS) included 170 people aged 50 or older who reported memory problems or had MCI, and found improvement in cognitive function in the participants who underwent a 6 month home-based physical activity program, compared to decline in cognitive function in the control group [62].

The participants were able to choose the type of activity to undertake, and most chose walking. They were asked to do at least 150 minutes of moderate intensity physical activity per week, consistent with the Australian physical activity guidelines. The improvement in cognition was maintained 12 months after the intervention was completed. These findings demonstrate that the recommended minimum amount of moderate intensity physical activity can slow cognitive decline in MCI, and that improvements in cognition can be maintained over time. Nicola Lautenschlager from the University of Melbourne and colleagues are now undertaking FABS II, investigating a similar physical activity intervention for people with Alzheimer's disease [63].

It has also been shown that cognitively impaired older adults who participate in physical activity programs have the same outcomes in terms of improved strength and fitness as cognitively healthy older participants [64]. There is therefore no reason why those with cognitive impairment or dementia should not be given an opportunity for their general health to benefit from physical activity. The potential for slowing cognitive and functional decline adds further incentive. Findings that physical activity can slow decline in activities of daily living or even improve performance for people with dementia suggest that the usual decline may not be due only to disease progression, but also to physical inactivity [60].

Importantly, several studies have involved participants with dementia living in residential care facilities, and in the more moderate to severe stages of the illness [14,60]. These studies demonstrate not only that physical activity programs for people with advanced dementia are feasible, but also that physical activity provides significant benefits even in the later stages of dementia.

The majority of studies have employed aerobic activity as a component of their intervention for people with MCI or dementia, often in combination with strength, balance and/or flexibility training. Few studies have examined non-aerobic activity specifically, but a trial of twice-weekly strength training in people with MCI showed improved performance on an attention task and enhanced patterns of brain plasticity [65]. Further studies are needed to investigate which types or combinations of physical activity might yield the greatest benefit for people with dementia at various stages of the illness [14,60]. Despite this, the available evidence demonstrates that physical activity offers benefits for people with MCI and dementia, for cognition and physical health [58].

LINKING BRAIN HEALTH AND COGNITIVE FUNCTION

The findings of a study by Kirk Erickson from the University of Pittsburgh and colleagues illustrate the links between physical activity, its biological effects on the brain, and its effects on cognitive function [66]. This study involved 120 healthy adults aged between 55 and 80. Half the participants undertook an aerobic walking program and half a stretching program (the control condition), for one year. They had a fitness assessment, a brain scan, a test of spatial memory ability, and a blood test to measure brain derived neurotrophic factor (BDNF), before and after the exercise intervention.

The size of the hippocampus typically shrinks 1-2% each year in older people without dementia [67], and this is associated with poorer memory function and increased risk for cognitive decline. In the Erickson study, the aerobic exercise group demonstrated a 2% increase in volume of the

hippocampus over the one year period, whereas the stretching control group displayed a 1.4% decrease in the volume of the hippocampus over the same time [66]. In the aerobic exercise group, greater increases in hippocampal volume were associated with greater improvements in aerobic fitness, greater increases in BDNF, and greater improvements in spatial memory task performance. These findings demonstrate the beneficial effects of physical activity on brain chemistry, structure and function.

Even though hippocampal volume declined in the control group, participants with higher pre-intervention fitness demonstrated less hippocampal volume loss, suggesting that fitness protects against brain shrinkage [66].

These results demonstrate that regular moderate-intensity aerobic exercise and increasing fitness is effective at reversing age-related hippocampal volume loss and improving memory function [66].

5. RECOMMENDATIONS

It is not possible to provide a physical activity formula that is optimum for brain health and function, or for lowering dementia risk, and it is important to consult your doctor and perhaps an exercise professional when intending to commence a physical activity program so that your individual health and fitness status and goals can be considered. The evidence to date comes from a wide variety of studies. These measure physical activity in different ways, look at different types and intensities of activity, and use different durations and frequencies of exercise sessions. And we are all different, with differing needs, abilities and preferences for physical activity. The good news is that when we put the evidence together, it shows that many forms of physical activity are beneficial for brain health and cognitive function.

Health authorities internationally provide recommendations for the minimum amount of physical activity we should aim for to benefit our overall health. Generally, higher levels of physical activity are associated with greater health outcomes, but just as importantly, doing something is better than doing nothing. It is also important to remember that physical activity does not always have to be planned exercise, but can also include activity done as part of work, transport, housework, recreation and other daily activities. And it is never too late to start increasing your physical activity.

THE NATIONAL PHYSICAL ACTIVITY GUIDELINES FOR AUSTRALIANS

The National Physical Activity Guidelines for Australians [22] outline the minimum levels of physical activity required to gain a health benefit, and ways to incorporate physical activity into your everyday life. There are specific recommendations for children of different ages, adults and older adults. The guidelines can be found at the Australian Government Department of Health and Ageing website, health.gov.au.

There are four physical activity recommendations for better health for Australian adults aged 18 to 64 years [22].

1: Think of movement as an opportunity, not an inconvenience

Look at any form of movement of your body as an opportunity for improving health, rather than seeing it as a time-wasting inconvenience.

2: Be active every day in as many ways as you can

Make a habit of walking or cycling instead of using the car, or do things yourself instead of using labour-saving machines. Park further away from your destination and walk more, take the stairs instead of the lift, or wash the car by hand rather than going to the automatic car wash. More suggestions for swapping everyday activities for healthier choices can be found at swapit.gov.au.

3: Put together at least 30 minutes of moderate intensity physical activity on most, preferably all, days

You can accumulate your 30 minutes (or more) throughout the day by adding shorter sessions of around 10 to 15 minutes each. Try to do at least 10 minutes without stopping. Physical activity is moderate intensity when it increases your breathing and heart rate, to the point where you are able to comfortably talk but not sing.

4: If you can, also enjoy some regular, vigorous activity for extra health and fitness

This step does not replace steps 1-3. Rather it adds an extra level for those who are able, and wish, to achieve greater health and fitness benefits. For best results, vigorous activity should be carried out for a minimum of around 30 minutes, three to four days a week. Physical activity is vigorous when it makes it difficult to say more than a few words between breaths.

These Australian guidelines focus on aerobic activity. The World Health Organization's Global Recommendations on Physical Activity for Health [21] additionally recommend muscle-strengthening activities should be done involving major muscle groups at least twice a week. The WHO guidelines can be found at who.int.

There are five physical activity recommendations for older Australians (aged 65 or more) [22].

1. Older people should do some form of physical activity, no matter what their age, weight, health problems or abilities
2. Older people should be active every day in as many ways as possible, doing a range of physical activities that incorporate fitness, strength, balance and flexibility
3. Older people should accumulate at least 30 minutes of moderate intensity physical activity on most, preferably all, days

4. Older people who have stopped physical activity, or who are starting a new physical activity, should start at a level that is easily manageable and gradually build up the recommended amount, type and frequency of activity
5. Older people who continue to enjoy a lifetime of vigorous physical activity should carry on doing so in a manner suited to their capability into later life, provided recommended safety procedures and guidelines are adhered to

The WHO additionally recommend older adults should do strength exercises involving major muscle groups at least twice a week, and do physical activity to enhance balance and prevent falls on at least three days a week [21].

TIPS FOR GETTING STARTED AND TRACKING PROGRESS

Knowing you should be physically active is only the first step in achieving a more active lifestyle. Health authorities also provide evidence-based advice about getting started and building up to the recommended amount of physical activity for you, or more. The information provided here is taken from a variety of national and international sources including some of the organisations listed under *Additional resources and information*.

Check with your doctor about what type and level of activity is safe for you, especially if you have been sedentary for a long time, are older, have a medical condition or are considering vigorous exercise. An exercise professional can also provide guidance on making your physical activity safe and effective.

Find your starting point and plan to build slowly from there. Think about your typical day, how much time you spend sitting, and what kinds of activities you do when you're moving. Then think about ways you can increase your daily physical activity. If you are fairly sedentary, aim to start slowly, with a little extra activity each week, and build up gradually. If you are already pretty active, then you can be more ambitious about adding to your activities.

Next, set your goals. Most people find that having a firm goal in mind motivates them. Goals are most effective when they are specific, realistic and important to you. Set short-term goals to help you make physical activity a regular part of your daily life and then to increase your level of physical activity. For example, move gradually from low intensity to moderate intensity walking, increase the amount of weight you lift, or try a new kind of physical activity. After you write down your short-term goals, think about your long-term goals, the level of physical activity you want to be

doing in 6 months or a year from now. Long-term goals should be realistic and important to you.

Aim to increase your activity levels over time as the more physical activity you can do, the better. How you feel is the best indicator of a safe level of activity for you and you should review and revise your goals as needed. Do the best you can and don't worry if you need to slow things down. Build up gradually over a period of weeks. For example, gradually walk longer distances, then you can increase your pace, then you can try going uphill.

Once you've made a start, tracking your activities can help you stick with your plan and is a good way to make sure you're regularly including all four types of activity (endurance, strength, balance and flexibility). A record of your activities helps you see your progress over time and motivate you to keep going. When recording your progress, include the improvements you see in your energy, strength and fitness.

Once you are exercising regularly, you will need to update your goals to keep progressing. When you can lift a weight easily or your endurance activity no longer feels challenging, it's time to exercise a little longer or make activities a little more challenging.

TIPS FOR STAYING MOTIVATED AND ACTIVE

Making a start is important, but so is making physical activity a permanent part of your daily life. Several strategies have been shown to help people stick with their physical activity plan. These include the things mentioned above – having a realistic goal in mind, starting slowly and tracking your progress.

You could also:

- Do activities that you enjoy; make physical activity fun
- Don't push yourself too hard too early; do what you can manage and build up gradually
- Exercise while listening to your favourite music or audio book, or watching TV or a movie
- Do activities with family or friends to motivate each other, or join an exercise group. Social interaction is also great for brain health.
- Make physical activity a priority. It is just as important as the other things you need to do each day.
- Put your physical activity in your schedule; make it part of your routine; use reminders
- Use an incentive (make it a healthy one) or reward yourself when you achieve a goal; celebrate your successes
- Keep it interesting; try new activities or locations or people; vary your activities

- Do housework or gardening to see additional achievements from your activity
- Focus on the benefits, like feeling stronger, having more energy, and being able to do things easier or for longer than before
- Remind yourself of the benefits for your brain, body and heart

PEOPLE WHO CAN HELP

General Practitioners can assess your physical activity needs and provide advice about making your physical activity safe. They can write a physical activity prescription that is specific to you and your needs and can provide regular follow up to help you maintain your program and to measure the health benefits. GPs can advise how to safely increase your physical activity levels and they can refer you to a physiotherapist, exercise physiologist or other allied health professional if you need specialist help.

Exercise Physiologists are qualified Allied Health professionals who specialise in the benefits of exercise to help people get fitter for overall health, or to treat patients with a medical condition. Exercise physiologists are knowledgeable about the effects that exercise has on the body and can prescribe a course of exercises for fitness, rehabilitation or both. Developing new and healthy habits for patients to enable them to manage their medical condition in the best way possible is a large part of their job. All exercise physiologists in Australia should be accredited with Exercise and Sports Science Australia (ESSA). You can find an exercise physiologist in your area at the ESSA website essa.org.au, or you can be referred by your doctor.

Physiotherapists are qualified Allied Health professionals who can help assess your physical condition and develop a personalised physical activity program, and help monitor progress. Physiotherapists are experts in movement and function who can provide exercise programs and other treatments to help patients recover from injury, reduce pain and stiffness, strengthen muscles, improve muscle control and increase mobility. Physiotherapists are required to be registered with the Physiotherapy Board of Australia. You can find a physiotherapist in your area at the Australian Physiotherapy Association website physiotherapy.asn.au, or you can be referred by your doctor.

Your *Local Council* can provide information about sporting clubs, walking groups, swimming or cycling clubs, exercise groups and programs, and other facilities available in your local area.

Gyms or fitness centres provide facilities and guidance to help you exercise, for the cost of a membership. Gym staff can provide fitness assessments and programs, as well as advice and education to help you get the most out of the facilities. Most gyms provide group exercise classes, personal and small group training sessions, strength training equipment, and aerobic exercise equipment.

Personal Trainers can develop tailored exercise programs for clients with different needs. They can assess fitness, provide exercise guidance and instruction, help with motivation and setting goals, and provide feedback and accountability. They may also educate their clients in general health and nutrition. Personal trainers should be appropriately qualified and may work independently with suitable insurance or choose to be a member of a registering body (Fitness Australia or Physical Activity Australia).

ADDITIONAL RESOURCES AND INFORMATION

10,000 Steps is a free health promotion program that encourages the use of step-counting pedometers to monitor your daily physical activity levels. The website provides an extensive information library and resources for individual and group challenges.

10000steps.org.au

The Australian Government *Department of Health and Ageing* website provides information on physical activity for improving the health of Australians, statistics on physical activity participation, physical activity reports, and the Australian physical activity guidelines.

health.gov.au

Exercise is Medicine Australia provides resources to help identify your current physical activity levels and what level of exercise you should begin with, and several factsheets on the role of exercise in the treatment of chronic conditions, including Alzheimer's disease. They also provide exercise prescription resources for health care providers and tools to encourage physical activity in the workplace.

exerciseismedicine.org.au

Fitness Australia is a national health and fitness industry association representing over 26,000 registered exercise professionals, fitness service providers and industry suppliers. The website provides industry policies, practice guidelines and tools. You can also search for a registered gym in your area or check whether your fitness instructor or personal trainer is registered.

fitness.org.au

healthinsite is a health information website funded by the Australian Government. The fitness and exercise section provides information on yoga, cycling, swimming and running, as well as tips for getting active and lots of links to additional information and resources.

healthinsite.gov.au

The *Heart Foundation* provides information, guidance, policy, programs and resources for active living. The website provides information about the importance of physical activity for cardiovascular health and a series of fact sheets. You can also find out where your nearest Heart Foundation Walking Group is or how to start one yourself, find out about the Heartmoves Physical Activity program, and find information about special events such as Walk to Work Day.

heartfoundation.org.au

Go4Life is a physical activity campaign from the National Institute on Aging in the USA, designed to assist and motivate older adults to become more physically active. However, the information is relevant for people of all ages. The website provides information, advice and resources for getting active and staying active, exercise guides and planners, tip sheets and audio-visual resources.

go4life.nia.nih.gov

The exercise section of the *myDr* website provides information about different types of physical activity including guides and examples for stretching and strength training, tips for getting started and staying active, and guides to exercise for helping manage a range of common medical conditions.

mydr.com.au

Physical Activity Australia is dedicated to supporting people to be more active and to representing exercise professionals. The website provides industry policies, guidelines and tools. For consumers there is information about finding and choosing an exercise professional or fitness centre, campaigns and events, lots of physical activity fact sheets, and lots of links to additional resources.

physicalactivityaustralia.org.au

The Australian Government's *Swap It* campaign website provides information on reasons and ways to swap less physical activity for more, an interactive activity finder to locate activity groups, places and opportunities in your area, planners for setting goals and tracking progress, and other resources and fact sheets.

swapit.gov.au

Your Brain Matters is Alzheimer's Australia's preventive health program, raising awareness about brain health and how to reduce one's risk of developing dementia. It is based on scientific evidence that a number of health and lifestyle factors that we can all do something about are associated with brain function and the risk of developing dementia.

yourbrainmatters.org.au

GLOSSARY

Term	Definition
Aerobic exercise	Aerobic or endurance exercise is physical activity that increases your breathing rate and heart rate. Performed regularly it improves physical endurance and the health and fitness of your lungs, heart and blood vessels. It includes moderate-to-high intensity activities like walking, jogging, swimming, cycling and even energetic housework.
Alzheimer's disease	Alzheimer's disease is a physical brain disease that causes dementia. It is named after Alois Alzheimer, who first described it in 1907. The brain degeneration that occurs in Alzheimer's disease affects memory, thinking skills, emotions, behaviour and mood. As a result, a person's ability to carry out daily activities becomes impaired. As the disease progresses, symptoms worsen. Alzheimer's disease is characterised by an abnormal build-up of a protein called beta amyloid, which forms "plaques" outside brain cells. Inside brain cells, another protein called tau builds up into "tangles".
Amyloid plaques	Amyloid plaques between nerve cells in the brain is a hallmark of Alzheimer's disease. They are sticky clumps that are formed from deposits of beta amyloid protein.
Beta amyloid	A protein fragment formed in the breaking down of a larger protein called the amyloid precursor protein. In Alzheimer's disease, these fragments stick together to form amyloid plaques.
Brain plasticity	Plasticity is the brain's ability to adapt to changes in the external environment (new information or the need for new responses) and/or its integrity (brain damage or disease) in order to maintain or recover and optimise its functions. Brain plasticity includes the potential of neurons (brain cells) to change their synaptic connections (their connections with neighbouring neurons).
Cerebrospinal fluid	A liquid that surrounds the brain and spinal cord, protecting them from injury.
Cerebrovascular disease	Disease that damages the blood vessels in the brain, which in turn damages brain cells and brain function.
Cognitive decline	Cognitive decline is a gradual decrease in cognitive abilities over time. This is what happens in dementia.
Cognitive function	The cognitive functions of the brain are the higher level thinking functions, including memory, learning, attention, language, decision making, reasoning, judgement, comprehension, spatial skills and planning.
Dementia with Lewy bodies	Dementia with Lewy bodies is a form of dementia characterised by the presence of Lewy bodies in the cortex of the brain. Lewy bodies damage nerve cells resulting in cognitive problems.
Exercise	Exercise is a subcategory of physical activity that is planned, often with the objective of improving or maintaining aspects of physical fitness.
Frontotemporal dementia	Frontotemporal dementia is a form of dementia that involves damage to the frontal and/or temporal lobes of the brain. Behaviour, language and other cognitive skills are affected.
Hippocampus	A small region of the brain, deep inside the temporal lobes, very important for memory and learning.

Term	Definition
Intervention study	A study where an action is taken to try to change outcomes for a group of people, e.g. a physical activity intervention to improve cognitive function in people with Alzheimer's disease.
Late-life or old age	Late life, or old age, is a normal developmental life stage and usually refers to those aged 65 and older.
Midlife	Midlife, or middle age, is a normal developmental life stage and usually refers to those aged between 40 and 65.
Mild cognitive impairment	Mild Cognitive Impairment (MCI) is a generally defined as impairment in cognitive abilities greater than expected for age, which does not significantly interfere with daily life and is not severe enough to warrant a diagnosis of dementia. People with MCI may experience some increased difficulty in daily activities, but are mostly able to function independently.
Neurocognitive disorder	The fifth version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) replaced the term dementia with major neurocognitive disorder, to reflect the severity of cognitive impairment at this stage of disease. Similarly, the term mild cognitive impairment was replaced with mild neurocognitive disorder.
Neuroimaging or brain imaging	Includes the use of various techniques to provide images of the structure or function of the brain.
Neurofibrillary tangles	Neurofibrillary tangles are twisted fibres inside brain cells made up of tau protein. They occur in some forms of dementia and cause a breakdown in the brain cell's ability to communicate with other brain cells.
Observational study	Observational studies collect real-life information about exposure to a risk or protective factor and subsequent development of disease. For example, an observational study might measure how much physical activity people do, then follow them up a number of years later to see who has developed dementia, and how that is related to their earlier physical activity habits.
Physical activity	Physical activity is any bodily movement produced by skeletal muscles that requires energy expenditure. It includes all types of incidental and planned movement including activity that occurs during work, play, transportation, household chores, recreation, exercise and sport.
Sedentary	A sedentary lifestyle is characterised by spending a lot of time sitting and doing little physical activity. Sedentary behaviour refers to any waking activity with a low energy expenditure and a sitting or reclining posture, such as TV viewing, video game playing, computer use (collectively termed "screen time"), driving and reading.
Vascular	Vascular means 'related to blood vessels'. Vascular risk factors are those that can affect the health and function of our blood vessels, including high blood pressure, diabetes and high cholesterol.
Vascular dementia	Vascular dementia is a form of dementia associated with problems of circulation of blood to the brain. It can sometimes result from a stroke or many mini-strokes, but more often occurs as a result of small vessel disease, which can be a consequence of poorly managed vascular risk factors.

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