Cognitive ageing and decline: Insights from recent research

Australian Government
Australian Research Council

UNSW SYDNEY
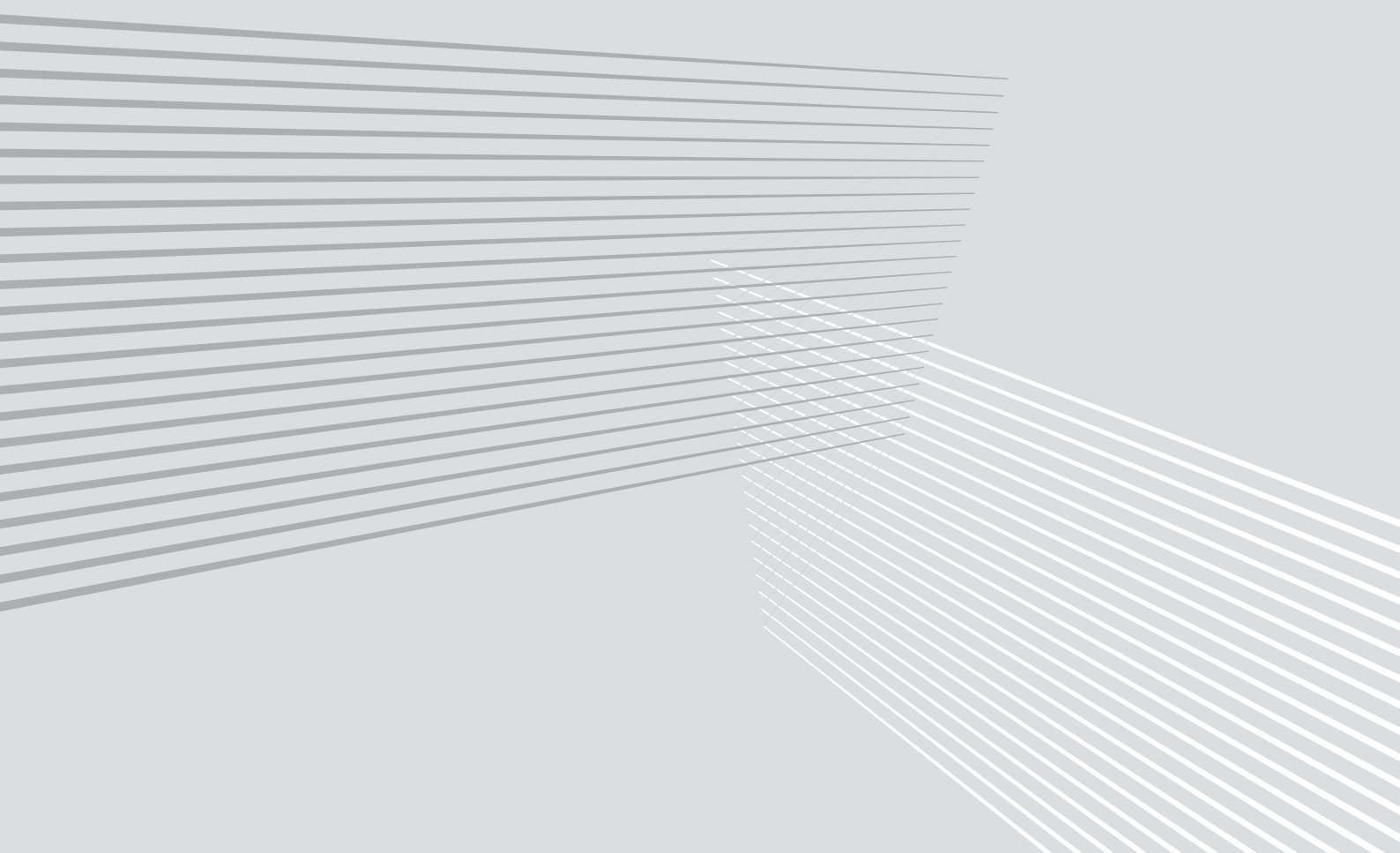
Australian National University

THE UNIVERSITY OF MELBOURNE

THE UNIVERSITY OF SYDNEY

THE UNIVERSITY OF WESTERN AUSTRALIA

Summary of brief

- ***Cognitive ageing and dementia:*** *Cognitive ageing is a spectrum, from healthy function to mild cognitive impairment (MCI), which entails slight changes in a person's memory, decision-making and ability to solve problems; and dementia, which interferes with day-to-day tasks.*

- ***Diagnosing dementia:*** *Diagnosing dementia is an imperfect process and many avoid diagnosis due to a fear of ostracisation or shame if found to have dementia.*

- ***Prevalence of dementia:*** *The longer one lives the greater the risk of developing dementia. Dementia prevalence is therefore increasing alongside increasing life expectancies. On some estimates there are over 400,000 Australians currently living with dementia and this number is projected to double over the next twenty years.*

- ***Impacts of dementia:*** *Dementia is the second leading cause of death and the leading cause of disability for those over 65 in Australia. Impacts extend beyond the individual — the direct costs alone of dementia were almost $9 billion in Australia in 2016.*

- ***Cognitive ageing and work:*** *Early retirement can be detrimental to cognitive function and can increase the risk of dementia. It is in society's best interests to keep older people engaged in different activities, including work.*

- ***Combating dementia:*** *The social burden of dementia can be minimised by curbing the growth in prevalence and minimising mortality rates and health costs of those diagnosed. Key strategies include greater public awareness of risk factors, timely diagnoses, and up-to-date training for health care professionals.*

- ***Research directions:*** *Identifying more specific risk factors, adapting workplaces for older workers, finding solutions to the problem of financial decision-making in older age, and better diagnosis tests, are all areas of future research being explored at CEPAR and elsewhere.*

Summary of featured CEPAR research

- *Mild cognitive impairment (MCI) and residential care: MCI is a good predictor of residential care need four to five years in the future (Box 1).*

- *Identifying MCI early: Study of individuals in their 60s showed 8% had MCI, indicating symptoms may present themselves earlier than expected (Box 2).*

- *Undetected dementia: Meta-analysis of studies outside Australia found over 60% of dementia cases in high income countries were undetected (Box 3).*

- *Estimating prevalence: Unique dataset signals that current estimates of dementia in Australia may be too conservative (Box 4).*

- *Risk factors for dementia: A series of studies identify risk factors of dementia such as obesity and depression, some of which may be gender-specific (Box 5).*

- *Reducing the burden on carers: Programs in which occupational therapists work with home carers to tailor activities for people with dementia can reduce carer distress (Box 6).*

- *Managing finances: Studies indicate a high level of 'confusion' in financial decision-making among retirees. Default settings for superannuation may mitigate this (Box 7).*

- *Dementia awareness: A lack of awareness regarding dementia risk factors and best-practice treatment is found among general public and occupational therapists that treat dementia (Box 8).*

- *Productive ageing: Research shows that increasing pension age is not detrimental to health and statistics show a relationship between poor cognitive health and low volunteering rates among the elderly (Box 9).*

- *Research directions: Areas of CEPAR research include better diagnosis techniques, better driver safety for those cognitively impaired, and understanding the links between dementia prevalence and location (Box 10).*

1. Introduction

Cognitive decline is feared by many as they approach old age. Yet the severe cognitive decline associated with dementia is not a normal part of ageing. In Australasia, the prevalence of dementia in those aged 60 and over is less than 7% (Alzheimer's Disease International, 2015). Nevertheless, the personal and economic costs associated with dementia are considerable, and due to Australia's ageing population, an increasing number of Australians require treatment and exit the workforce due to cognitive impairments.

So, how do we combat this? How do we lower the risks or delay the development of dementia, and design care and treatment interventions that reduce the personal and economic costs of the disease?

This research brief explores the impacts of cognitive ageing and decline on individuals, as well as on the wider Australian economy. The brief emphasises how cognitive impairment is a significant barrier to those over sixty staying in the workforce and managing their finances properly. The brief also discusses the current and proposed future ways to diagnose and prevent cognitive impairment before it becomes severe.

2. Normal cognitive ageing

Understanding a person's cognitive ageing is not as simple as answering the question of whether they have dementia or not. Nor is cognitive ageing a uniformly negative process. There are many cognitive functions that are maintained, and often continue to grow, well into a person's eighties and nineties.

Cognitive capacities can be roughly grouped into two categories: *fluid intelligence* and *crystallised intelligence* (Cattell, 1963). *Fluid intelligence* refers to things like problem-solving and pattern recognition. It can be thought of as the raw processing power, and speed, of your brain. This type of cognitive ability usually decreases with age after peaking in a person's mid- to late-twenties (Fig. 1).

Crystallised intelligence, on the other hand, refers to specific expertise and knowledge that accumulates over time. This type of knowledge usually does not decline the way *fluid intelligence* does. A common example is a person's vocabulary, which explains why our parents are often much better at crosswords than we are.

1 On average, fluid intelligence decreases after age 30
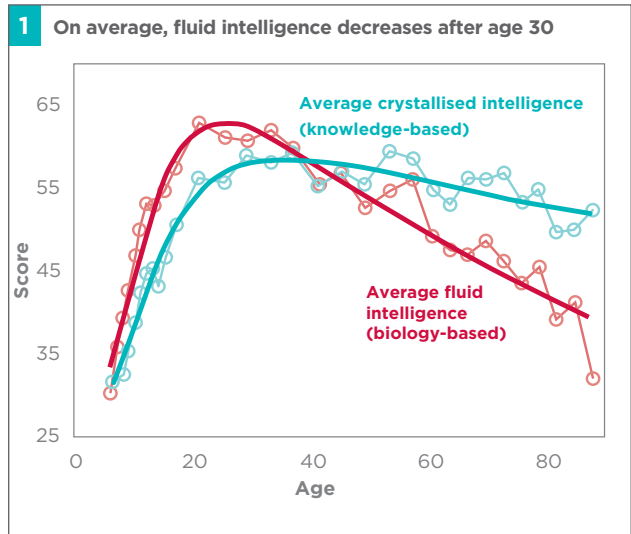
Source: Adapted from Li et al. (2004).

The average trajectories of these two types of intelligence, however, disguise how cognitive ability varies across individuals, cohorts and over time. One study of broad cognitive function – both fluid and crystallised – in 70-year-olds found a wide variance in cognitive trajectories (Yaffe et al., 2009). The study grouped the participants into three categories: those who maintained their overall function over an eight year period, those who experienced a slight decline, and those who suffered a major decline in ability.

2 Most people experience a minor decline in ability during their 70s
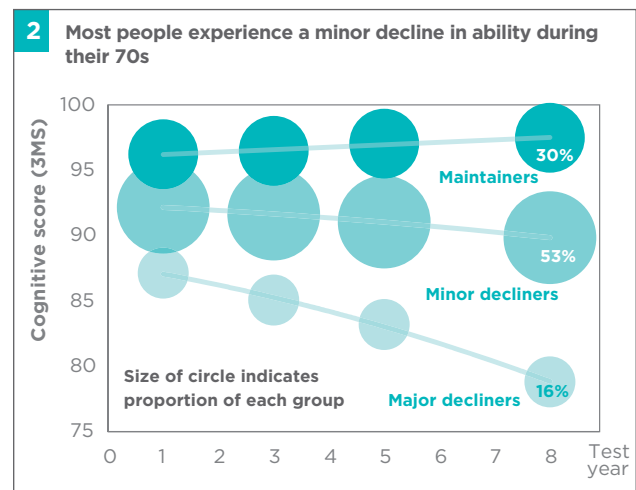
Source: Adapted from Yaffe et al. (2009)

Those who experienced 'normal' cognitive ageing, i.e., those who experienced no significant decline, were found to generally be more educated, exercise more often, have better self-rated health and are less likely to suffer from health issues such as diabetes and high blood pressure.

The identification of mitigating factors like these (see Box 5) is essential to curbing the number of older people who transition from experiencing normal cognitive ageing to developing mild cognitive impairment (MCI) or dementia.
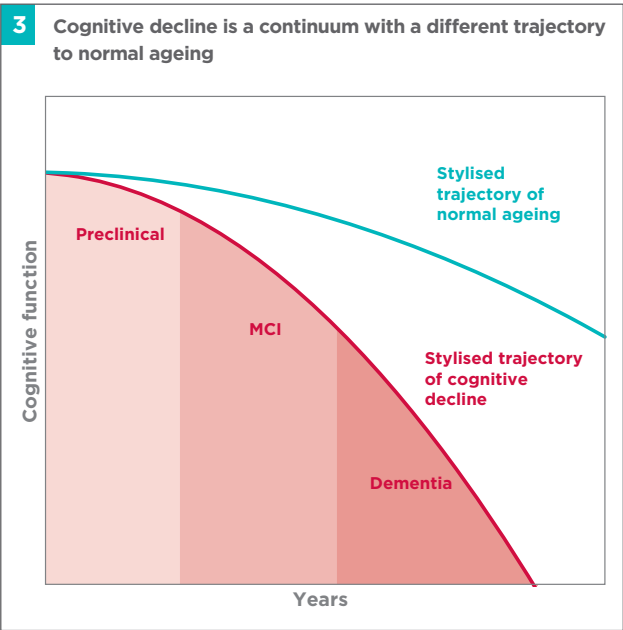
3. Mild cognitive impairment (MCI)

When a person's cognitive function has fallen below the normal range, but is not yet impeding essential daily activities, they may be experiencing **mild cognitive impairment (MCI)**. MCI involves small declines in a person's memory, decision-making and ability to solve problems. These declines are relatively small, but noticeable to the individual or their family, and measurable by a professional.

A 2013 study in the US (Plassman et al.) found 20% of those aged 70 and over had MCI. A similar study in China found 18.5% of those aged 60 and over had MCI (Su et al., 2014). In 2009, a study in Australia by CEPAR Chief Investigator Kaarin Anstey and colleagues found that 8% of those in their 60's had MCI (Box 2). This increased to 37% for those aged between 70 and 90 (Brodaty et al., 2013).

These differences between countries for the same age groups are partly due to differing criteria, but can also be attributed to contrasting rates of heart disease, education levels and lifestyle choices. For example, older Australians are broadly healthier than older Chinese people.

Cognitive impairment is most often thought of as a continuum, with healthy cognitive function at one end, severe dementia at the other, and MCI in between (see Fig. 3). This does not mean that MCI is a definite precursor to dementia. Around 40% of those with MCI develop dementia within 10 years of diagnosis, and about 40% recover their normal function (Dementia Australia, 2014a).

In saying this, MCI is still a good predictor of future deterioration. Without intervention, cognitive impairment can get worse with age. Regardless of whether it does or does not deteriorate into dementia, however, MCI can have a significant impact on daily life. Even if, by definition, MCI does not significantly impact a person's home life, it is often serious enough to impact on the ability to work. Anstey et al. (2013) found that those in their sixties with MCI had an employment rate that was one-third of the rate of those of the same age who did not have any impairment.

**3** **Cognitive decline is a continuum with a different trajectory to normal ageing**

Stylised trajectory of normal ageing

Preclinical

Cognitive function

MCI

Stylised trajectory of cognitive decline

Dementia

Years

Source: Sperling, Mormino & Johnson (2014)

A study by CEPAR Chief Investigator Robert Cumming and his colleagues highlights how MCI is a strong indicator of a person requiring formal care years in the future (Gnjidic et al., 2012).

They examined the link between MCI and entry into residential care. They found that a diagnosis of MCI was a good predictor of entry into care about four to five years after assessment. In a sample of over 1705 men, 12% of those diagnosed with MCI entered care in an average of 5 years after follow up. Of those who weren't diagnosed with MCI, only 5% entered care.

% of those who entered care by cognitive function

Dementia	31%
Mild cognitive impairment	12%
Normal function	5%
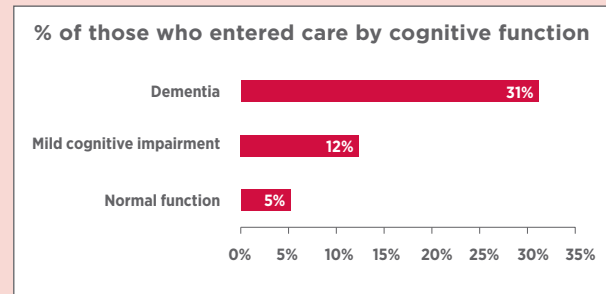
Source: Gnjidic et al. (2012)

Box 2 **CEPAR Research Spotlight** **Identifying MCI early**

Most of the research on dementia and MCI is conducted among adults over 70. To explore the effects of the early onset of cognitive decline, CEPAR Chief Investigator Kaarin Anstey and Associate Investigators Nicholas Cherbuin and Kerry Sargent Cox, and their colleagues, chose instead to look at the cognitive function of a cohort of individuals in their 60s (Anstey et al., 2013). In doing so, they found that a significant proportion (8%) were experiencing MCI, indicating that the disease may be present in many for a long period of time before being officially diagnosed.
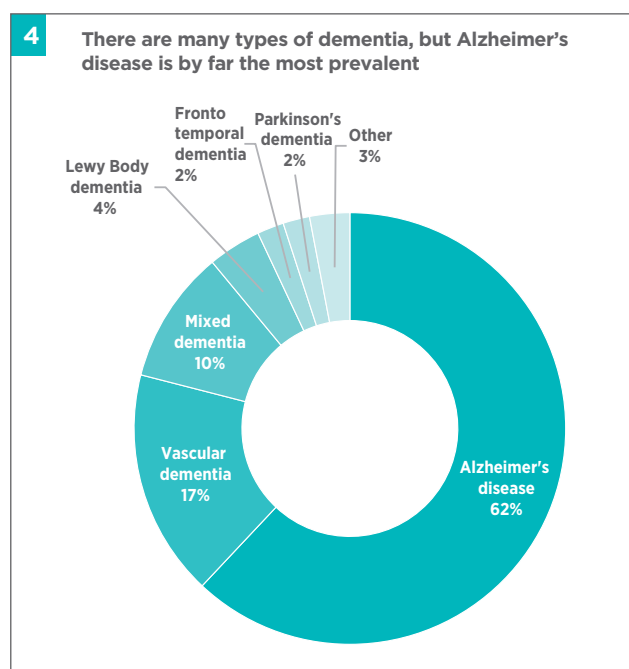
Anstey's study followed 2,500 people from the ages of 60-64 through to 68-72, assessing them every four years. The study showed that impairment may often begin earlier than expected, but that cognitive function is very unpredictable at this age. Almost half of the MCI diagnoses made in the study were unstable, meaning that in a later period the person was deemed to have reverted back to normal function.

Despite this instability, the study makes clear how early cognitive decline symptoms can emerge and how large an impact they can leave. Those for whom cognitive status did not revert back to normal were much less likely to be employed, and reported difficulty with complex activities of daily life like reading, shopping, taking medication, and making phone calls.

4. Dementia

Dementia is an umbrella term that accounts for over 100 different neurological diseases, though in more than half of cases dementia refers to Alzheimer's disease. What links these many diseases, and separates dementia from MCI, is the way they interfere with a person's ability to complete day-to-day tasks. Dementia can be mild, moderate or severe. Mild dementia is similar to MCI while severe means the individual requires regular supervision and has difficulty with basic functions such as eating and dressing themselves.

The four most common types of dementia are Alzheimer's disease, vascular dementia, Lewy Body disease, and Frontotemporal dementia (see Fig. 4).

4 **There are many types of dementia, but Alzheimer's disease is by far the most prevalent**

Fronto temporal dementia 2%
Parkinson's dementia 2%
Other 3%
Lewy Body dementia 4%
Mixed dementia 10%
Vascular dementia 17%
Alzheimer's disease 62%

Source: Adapted from Alzheimer's Association (2017).

Alzheimer's disease accounts for approximately two-thirds of dementia cases. Alzheimer's is believed to be partially genetic, and is characterised by a shrinking of the outer layer of the brain and by plaque and tangles that stop nerve cells from communicating and cause them to die. Signs of the disease include the loss of the ability to co-ordinate movements (apraxia), to articulate ideas and comprehend words (aphasia), and to interpret sensory stimuli (agnosia).

Vascular dementia is related to problems of circulation of blood to the brain. The two most common sub-types are Multi-infarct Dementia and Binswanger's disease. Vascular dementia is associated with modifiable lifestyle factors such as high cholesterol and high blood pressure.

Lewy Body disease is caused by abnormal clumps of protein called 'Lewy bodies' developing in nerve cells. The disease is characterised by fluctuations in attention and cognitive ability and has a high co-morbidity rate with Parkinson's disease.

Frontotemporal dementia occurs as a result of progressive damage to the frontal and/or temporal lobes of the brain. If the damage occurs to the frontal lobe, it can affect social behaviour, whereas damage to the temporal lobe generally impacts a person's ability to understand and verbalise language.

5. Diagnosing dementia

Diagnosing dementia is a multi-step process. As a catchall term for a variety of impairments, there is no definitive means of assessment. In most cases, a detailed medical history and a routine physical are completed, blood and urine samples are taken, and a neuropsychological assessment is made using a variety of clinical tools.

Cognitive ability is typically assessed using a range of standardised tests of memory and thinking abilities. In addition to psychometric testing, an interview is often conducted with the person and/or family members to glean information about the person's previous occupational level, education and interests. Diagnosis is found to be much more accurate if medical professionals have information about the person's cognitive ability and psychology prior to the onset of symptoms. This allows for a direct measure of the decline in brain function that has occurred.

Diagnosis is usually based on comparisons to population norms and only made after repeated assessments are conducted, though there is never 100% accuracy in diagnoses. One of the most common tests used in the assessment of dementia is the Mini-Mental State Examination (MMSE). It is often used in the initial diagnosis process, as well as in tracking the progression of the disease, and gives the patient a score out of 30 that can be compared to a baseline. The MMSE tests a person's memory, attention and language abilities, and involves questions such as:

What is the year? Season? Date? Day? Month?
Repeat the phrase: 'No ifs, ands, or buts.'
Spell "WORLD" backwards.
On a piece of paper, please copy this picture:
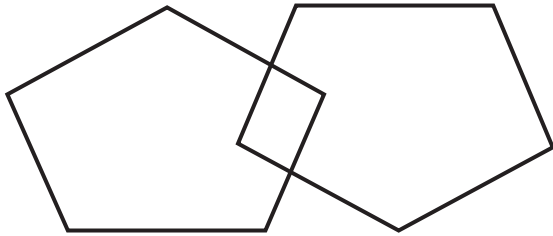
A barrier to improved diagnosis rates is the fact that people are often poor judges of their own cognitive function. This was found in a recent report by National Seniors (2017), which also reported that those with lower cognitive function were less likely to seek help from their family or their GP than those with higher function. Furthermore, those who were aware of their cognitive decline often delayed treatment due to a fear of losing their driver's license or being ostracised as a result.

CEPAR research found a link between an individual's cognitive decline being reported by someone close to them, and the individual engaging in activities that support their cognitive health (Hosking et al., 2017). The finding suggests that utilising early reports given by spouses, family or friends may benefit the development of personalised activities that will minimise cognitive decline.
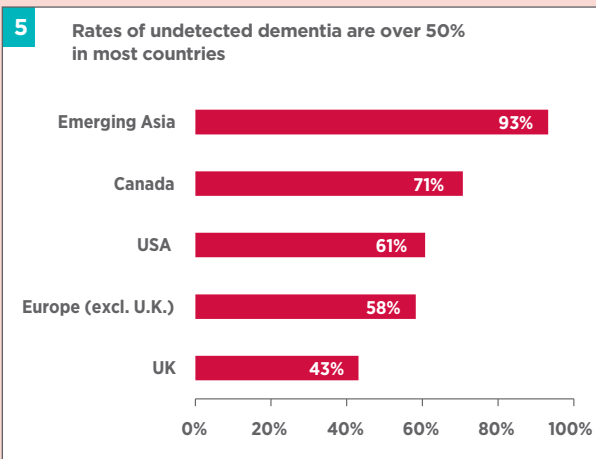
Box 3 CEPAR Research Spotlight Undetected dementia

A recent study by CEPAR Chief Investigator Kaarin Anstey and her colleagues (Lang et al., 2017) found that over 60% of dementia cases in high income countries have not been officially detected.

The researchers completed a meta-analysis of studies outside Australia, reporting the levels of undiagnosed dementia. In addition to the overall high rate of undetected dementia, they found that rates were higher in China and India compared to Western nations, and that dementia was more likely to go undiagnosed among men, those aged under 70, or people living in the community rather than in care.

The study also suggests that people in high-risk groups, such as those of low socio-economic status, non-native language speakers and those who live alone, should be actively offered screening and diagnosis by medical practition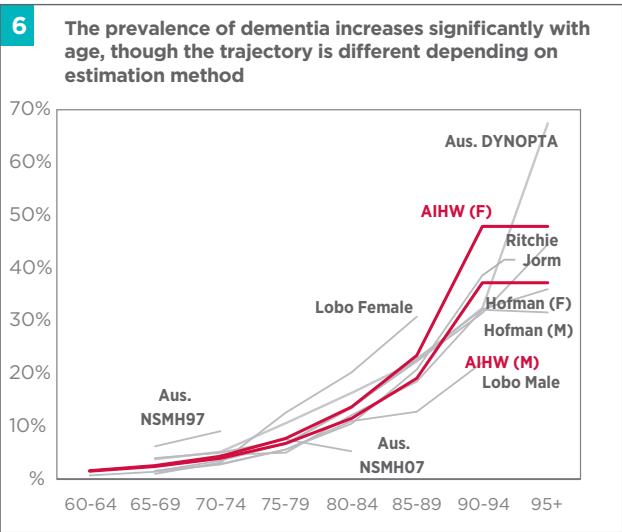ers. Due to the deteriorating nature of the disease, timely intervention is key to inhibiting MCI from developing into dementia, and to mitigating the extent to which mild dementia becomes severe.

5 **Rates of undetected dementia are over 50% in most countries**

Country	Rate
Emerging Asia	93%
Canada	71%
USA	61%
Europe (excl. U.K.)	58%
UK	43%

Source: Adapted from Lang et al. (2017). Note: Emerging Asia includes China and Thailand. Europe includes Spain, Germany, Netherlands, Sweden, Finland, Norway and Switzerland.

6. Prevalence of dementia

The longer you live the more likely you are to develop cognitive impairment. CEPAR research indicates that the rate of dementia doubles every five years between the ages of 70 and 84 (Box 4; Fig 6). A combination of this and Australia's ageing population has led to an increasing number of Australians with the disease. According to some estimates, more than 400,000 Australians are currently living with dementia (Brown, Hansnata, and La, 2017 ; Fig. 7) and this is projected to double over the next twenty years.

6 **The prevalence of dementia increases significantly with age, though the trajectory is different depending on estimation method**

Sources: Adapted from Anstey et al. (2010), AIHW (2012)

This trend is replicated around the world. In most countries, low fertility rates and high life expectancy are causing the share of older people in the population to increase, resulting in greater numbers of dementia patients and higher rates as a proportion of the total population.

7 **Projected number of Australians with dementia is expected to increased significantly by 2050**
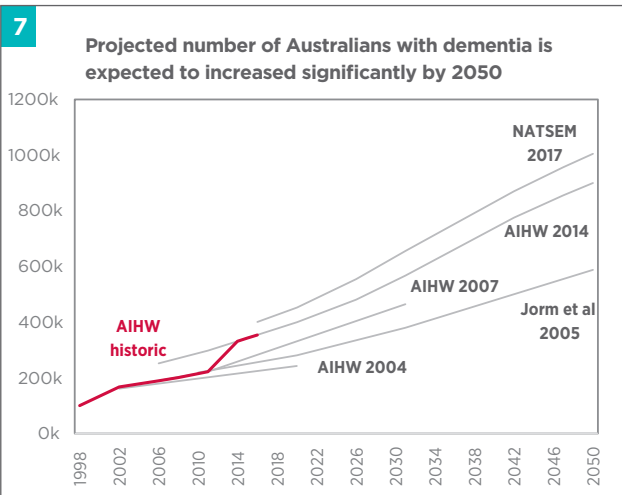
Sources: Adapted from AIHW (various years), Jormet al. (2005), Brown, Hansnata, and La (2017).

The impact of this is clear in the dementia rates of countries with differing life expectancies. Mexico has a life expectancy of 77 and less than 1 case of dementia per 100 people. Japan, on the other hand, has a life expectancy of 84 years, and more than 2 cases per 100 people. In total, approximately 50 million people are living with the disease worldwide (ADI, 2017).

While the future of dementia prevalence is uncertain, there may be some positive changes due to the Flynn Effect: the observed increase in cognitive ability of each successive generation (Flynn, 2007), which in turn may mean lower cognitive decline at each age than was the case in the past.

Box 4	CEPAR Research Spotlight

Estimating prevalence

Accurate projections of dementia rates are crucial. Small deviations can have a huge impact when estimating future costs. But due to a lack of national data on dementia, most official Australian estimates, such as those by the Australian Institute of Health and Welfare (AIHW), are approximated based on European data collected decades ago.
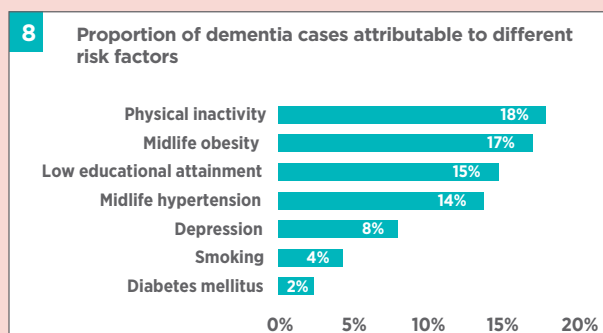
Since European data is unlikely to accurately represent Australian society, Chief Investigator Kaarin Anstey, Associate Investigators Richard Burns and Kim Kiely, and their colleagues took an innovative approach to estimating dementia prevalence in Australia (Anstey et al., 2010). They combined data from a series of national surveys that collected Mini-Mental State Examination (MMSE) scores (Fig. 6).

These new estimates indicate that the often circulated rates of cognitive impairment in Australia may be too conservative. The MMSE scores potentially suggest that more people aged 65-84 are suffering from dementia than previously thought. Also, contrary to other data, the rates among women and men were equivalent. The results did confirm, however, the often-found correlation between high rates of dementia and low education.

Former CEPAR PhD student Kimberly Ashby-Mitchell, Kaarin Anstey and CEPAR Associate Investigator Carol Jagger have also examined the prevalence, and consequences, of dementia in Latin American and Caribbean countries. Their research found that age, female sex and low education were all predictors of higher impairment, suggesting that the patterns observed in high-income countries are also present in low- and middle-income nations.

Box 5 **CEPAR Research Spotlight** **Risk factors for dementia**

In 2017, Former CEPAR PhD student Kimberly Ashby-Mitchell, CEPAR Chief Investigator Kaarin Anstey, Associate Investigator Richard Burns, and their colleagues (Ashby-Mitchell et al., 2017) estimated that about half of dementia cases can be attributed to seven key modifiable lifestyle factors – depression, midlife hypertension, diabetes, low educational attainment, smoking, physical inactivity, and midlife obesity. In addition, they predicted how decreases in the prevalence of these risk factors could translate into decreases in the prevalence of dementia. They highlight that a 10% decrease in all of these factors per decade would decrease the prevalence of dementia by over 10% come 2050.

8 Proportion of dementia cases attributable to different risk factors

Physical inactivity — 18%
Midlife obesity — 17%
Low educational attainment — 15%
Midlife hypertension — 14%
Depression — 8%
Smoking — 4%
Diabetes mellitus — 2%

Source: Adapted from Ashby-Mitchell et al. (2017)

In another study (Anstey et al., 2015), Anstey, along with CEPAR Research Fellow Diane Hosking, and their colleagues, provides an overview of 25 different risk factors for dementia, summarising the evidence for each factor's connection to dementia risk. In addition to the seven key factors mentioned above, the study focuses particularly on diet-based risk reduction. Regular consumption of oily fish and a Mediterranean diet – high consumption of olive oil, nuts, legumes, seafood and vegetables, and low consumption of red meat and processed sugar – are both found to be protective against cognitive decline. That being said, a separate CEPAR-affiliated study conducted by Anstey and Associate Investigator Nicolas Cherbuin in 2012 found that a Mediterranean diet did not protect against cognitive decline in healthy adults.

CEPAR researchers have conducted many other factor-specific studies as well, shedding light on the nuances of each factor's influence on cognitive function. In a 2017 study with colleagues, Cherbuin and Anstey found that higher Body Mass Index (BMI) in middle age is associated with increased cortical thinning, which places individuals at higher risk of developing Alzheimer's disease. Meanwhile, Cherbuin and his colleagues reviewed the literature regarding meditation and the practice's effect on cognition (Kurth, Cherbuin and Luders, 2017). The authors point out that, while preliminary, the evidence suggests meditation is associated with less age-related cognitive decline.

CEPAR researchers are also exploring the links between risk factors and cognitive development in midlife, a critical time for addressing lifestyle issues prior to the potential onset of cognitive decline. Anstey and Cherbuin, along with Associate Investigators Kerry Sargent-Cox and Peter Butterworth and their colleague Ellen Garde, followed individuals over an eight-year period in their forties and found a link between cardiovascular risk factors and a slowing in cognitive speed (Anstey et al., 2014).

Anstey and her colleagues also found that a gender-specific approach may be necessary in devising optimal interventions to mitigate dementia risks (McDermott et al., 2016). For example, responses that target depression among men and increase social activity of women appear to be more effective than the reverse. Another study by Cherbuin, Anstey and their colleagues, also found that high blood pressure was correlated with better cognition in men, while the opposite was true for women (Cherbuin et al., 2014). McDermott et al. (2016) conclude that as dementia research develops, tailored advice for each gender will be considered best practice for health care professionals.

Table 2	Factors that predict resilience to dementia
Female only	Living with someone
	Being married
	Lower pulse pressure
	Higher peak expiratory flow
	Faster walking time
	Faster turning time
	Volunteering more often
Male only	Less depressive symptoms
Both genders	Younger age
	Higher education
	Stronger grip
	More cognitive activity

Source: Adapted from McDermott et al. (2016)

Regardless of the many studies and their individual findings, Anstey et al. (2015) state that, on the whole, existing evidence supports blanket public health recommendations for increasing education and cognitive activity, regular socialising, reducing cardiovascular risk, treating depression, and adopting healthy diet and exercise habits.

7. Impacts of dementia

Dementia has a considerable impact on a person's life. Those diagnosed often have to give up their careers, confront changes in their personality, forget cherished memories, and lose the ability to enjoy their favourite activities. Dementia also has a high mortality rate. It was the second leading cause of death in Australia in 2014, accounting for 10% of female deaths and 5% of male deaths between 2012 and 2014 (AIHW, 2017). The risk of death increases significantly with age, causing up to 15% of deaths in those older than 90.

9 Dementia mortality rate is higher for women than men and increases steeply with age after 70
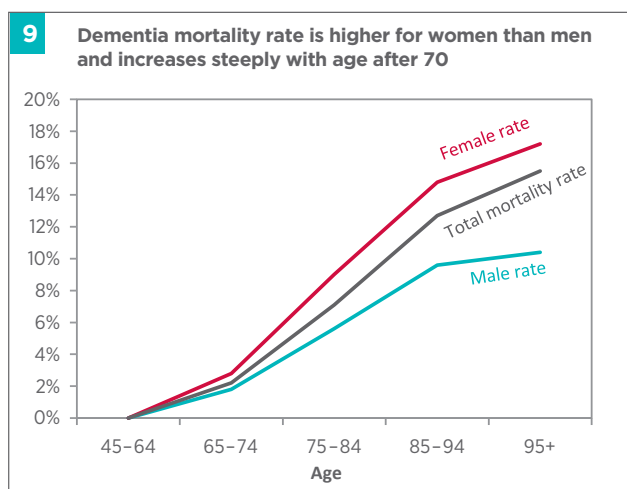
Source: Adapted from AIHW (2014)

Dementia is also the single largest cause of disability in Australia for people aged 65 and above (AIHW, 2012). The Lancet's (2016) Global Burden of Disease Study estimates the impact of diseases in regard to disability-adjusted life years (DALYs) – the number of healthy years a person loses due to a disease either through premature death or disability. The study estimates that dementia accounts for 9.5% of all neurological-related DALYs worldwide, but that this proportion is significantly greater in developed nations such as Australia. The World Health Organisation (2004) point out that dementia is not in the top 20 leading causes of DALYs around the world, but is in the top 4 for high-income countries.

The impacts of dementia also go far beyond individual health. There are direct, indirect and intangible costs of dementia for wider society. Direct costs refer to money spent on treatment and care for those with the disease. The estimated direct cost in Australia was almost $9 billion dollars in 2016. Managing this financial impact has proven difficult for the Government in recent times. This is

exemplified in the Aged Care Financing Instrument (ACFI), which is a tool for appraising the needs and funding requirements for aged care residents where dementia cases tend to be more severe (Fig. 10) and increase over time (Fig. 11).
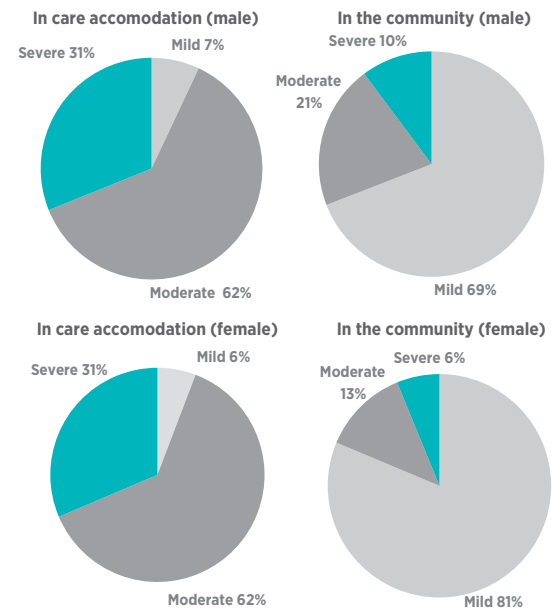
The instrument was intended to categorise cases into clear 'types' with different funding, and to redistribute funds to individuals requiring higher levels of care (Chomik and MacLennan 2013, Rosewarne et al., 2017).

Under the guidelines of the ACFI, individuals with dementia, on average, required a higher degree of support with daily activities and their behaviour, leading them to receive significantly more funding than those who do not have dementia. In 2009, 87% of those with dementia were classified as requiring 'high level' care, while 68% of other residents were in this category. This translated to an average annual government subsidy for those with dementia of $38,100, as opposed to an average of $31,600 for those without the disease (AIHW, 2011). Furthermore, the length of stay in residential care for those with dementia is higher than for those without it, increasing costs further.
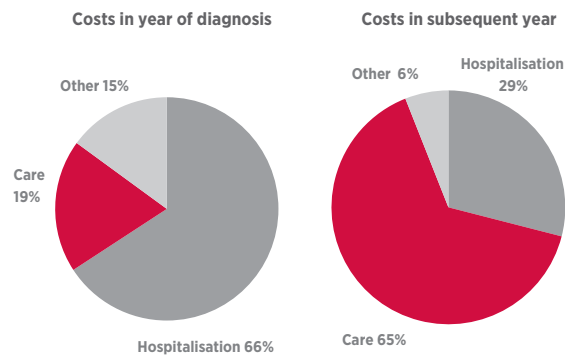
In 2014, the large costs involved in funding the care of those with dementia led the Government to cut the Dementia and Severe Behaviours Supplement, which was an additional $16 for aged care facilities, per day, per resident with dementia or related issues. Many dementia groups, such as Dementia Australia, expressed disappointment at the reduction, and continue to express a need for specialist dementia services and funding (Dementia Australia, 2014b). The fact that dementia is this financially burdensome, for the government or for budget-restricted carers, is a clear motivation for reducing prevalence and encouraging timely diagnosis.

There are also significant indirect costs of dementia on Australia's economy. For example, dementia patients, and those who care for them, often withdraw from the workforce (see section 8). There are also significant foregone earnings for carers. The estimates regarding this for Australia are limited, but a 2001 study by Langa et al. found that care hours required for someone with moderate dementia was 17 per week on average, while severe cases involved hours that were similar to full time jobs. It is estimated the cost of foregone work hours due to dementia was $5.5 billion in 2016 (Brown, Hansnata, and La, 2017).

10 Dementia patients in residential care have more severe dementia on average than those living in the community
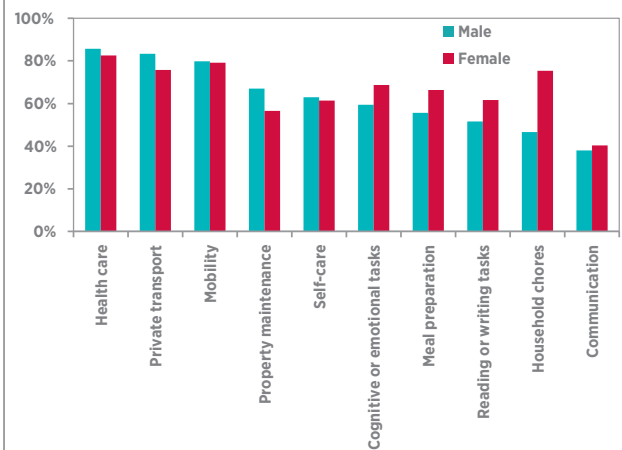
In care accomodation (male)

Severe 31%
Mild 7%
Moderate 62%

In the community (male)

Severe 10%
Moderate 21%
Mild 69%

In care accomodation (female)

Severe 31%
Mild 6%
Moderate 62%

In the community (female)

Severe 6%
Moderate 13%
Mild 81%

11 Composition of dementia costs changes significantly after the first year

Costs in year of diagnosis

Other 15%
Care 19%
Hospitalisation 66%

Costs in subsequent year

Other 6%
Hospitalisation 29%
Care 65%

Source: Adapted from Brown, Hansnata, and La (2017)

Cognitive decline also causes intangible distress, grief and exhaustion for carers and others close to individuals who are experiencing it. The UK's Alzheimer's Society interviewed a group of individuals under 30 who had parents suffering from dementia, and found that it had a considerable effect on the child's personal education, career, relationships and mental health (Hall and Sikes, 2016).

12 Percentage of dementia patients that need assistance with basic daily activities

Legend: Male, Female

Categories (x-axis): Health care, Private transport, Mobility, Property maintenance, Self-care, Cognitive or emotional tasks, Meal preparation, Reading or writing tasks, Household chores, Communication

Source: Adapted from AIHW (2014)

Box 6 **CEPAR Research Spotlight** **Reducing the burden on carers**

Reducing the impact of dementia on home carers and aged care facilities is area of future research. For the government, and, therefore, the average tax-payer, it is economically favourable for those with dementia to remain at home for as long as possible. It is often also what individuals themselves want. However, delaying or stopping those with dementia from transitioning into care shifts responsibility onto home carers.

Former CEPAR PhD student Claire O'Connor, Associate Investigator Lindy Clemson, and their colleagues (O'Connor et al., 2014; O'Connor et al., 2017), have researched one potential solution to this issue: the Tailored Activity Program (TAP).

TAP involves an occupational therapist working with an individual with dementia and their carer to tailor their daily activities to meet the individual's capacities and interests. An American pilot found that the TAP increased the function of people with dementia and reduced caregiver distress, which has been identified as a significant factor in transitioning people with dementia into facility care (de Vugt et al., 2005). O'Connor and her colleagues replicated benefits from TAP for individuals with frontotemporal dementia, and their carers, in Australia. The results of this pilot are preliminary, as the sample size was only 20 and larger studies will be needed to further test the cost-effectiveness of such programs.

Box 7 **CEPAR Research Spotlight** **Managing finances**

Making the right financial decisions is difficult at any age. Investment, insurance and health care choices all require significant time, attention to detail and financial literacy. To make a truly informed decision means knowing what options are available, and what each option entails.

CEPAR Chief Investigator Hazel Bateman, Associate Investigators Fedor Iskhakov, Jordan Louviere and Susan Thorp, and their colleagues explored the ways in which individuals make these financial decisions (Agnew et al., 2016). They found that decision-makers are highly susceptible to first impressions, and fall into the trap of confirmation bias – taking the advice of those who express the same views as them – irrespective of the quality of the advice. They also found that the less financially expert were more likely to follow bad advice.

Another CEPAR-affiliated study (Bateman et al., 2014) found that individuals with low numeracy and financial literacy skills were less sensitive to both investment risk presentation and the underlying risk level and less likely to benefit from asset diversification of their superannuation accounts.

Whether older people are more susceptible to poor financial decision-making than the general population is unclear. Agnew, Bateman and Thorp (2012) asked over 1,000 individuals three questions that tested their financial literacy. Those over 65 on average outperformed all younger cohorts, with a general increase in results with age.

On the other hand, CEPAR Chief Investigator Michael Keane and Susan Thorp (2015) point out that the decrease in fluid intelligence with age is often accompanied by a decrease in financial ability, and a higher likelihood of being confused by the options available and their payoffs when faced with a new situation.

What is clear, however, is that those with cognitive impairment are more susceptible to poor financial decision-making. Keane, CEPAR Research Fellow Timothy Neal, and their colleagues, studied consumer Prescription Drug Insurance Plan choices in the United States (Keane, Ketcham, Kuminoff and Neal, 2017). They discovered that the vast majority of consumers make 'confused' choices, placing too much weight on the upfront premiums of insurance plans and not rationally calculating how much they can expect to pay over time. Individuals who suffered from Alzheimer's disease or depressions were even more likely to be 'confused'.

Figure 13 shows the proportion of decision-makers at different ages that chose a Prescription Drug Plan that was not the best option available to them. The likelihood of this increases with age and clearly increases if one has depression, dementia or both.

13 **Dementia and depression are correlated with poor financial decision-making**
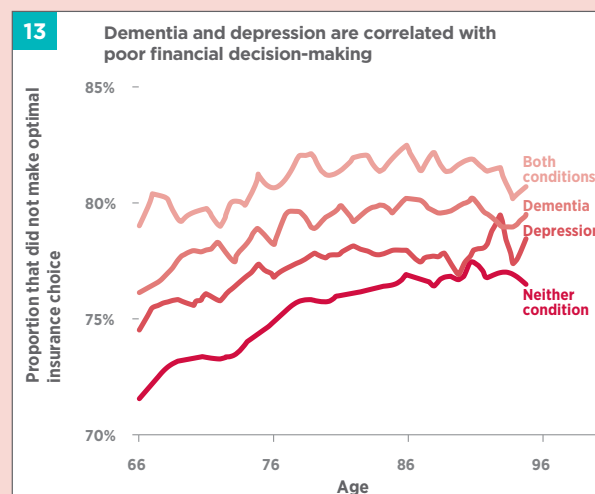
Source: Keane, Ketcham, Kuminoff and Neal (2017)

These findings suggest that there may be benefit in restricting individuals' decisions to some degree, as it may minimise sub-optimal choices. Keane and Thorp do, however, emphasise that such restrictions may have unintended negative consequences. Australia's superannuation system is an example of a positive 'restriction' since it includes mandatory participation and a minimum contribution. But, as Bateman (2016) highlights in a comprehensive overview of Australia's retirement income system, retirement savers must still make many complex decisions over their lifetime, such as the super fund they use, their investment option, their level of voluntary contribution, the form of the drawdown, and the financial advice they seek.

In another project a team that included Bateman, Thorp, and Associate Investigators Loretti I. Dobrescu and Ben Newell, found that the default settings of superannuation plans are sticky and therefore have a large influence on the decisions made by savers, leading to both optimal and sub-optimal outcomes. This suggests that defaults may be a good alternative to address poor decision-making, provided the default is well designed (Dobrescu et al., 2016). On the whole, the need to allow individuals their financial freedom, while also mitigating their often 'confused' decision-making, is something that has yet to be reconciled in the literature and in policy.
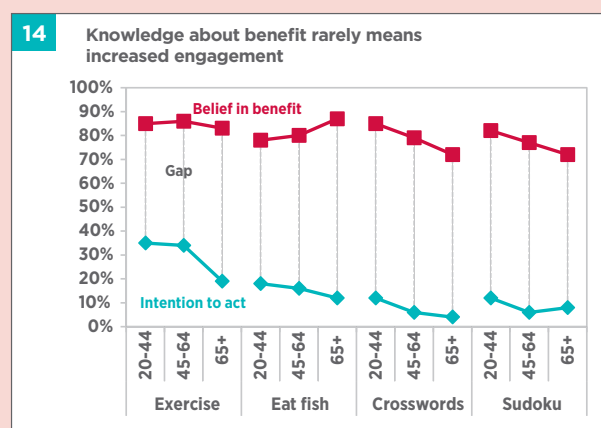
Box 8 | **CEPAR Research Spotlight** | **Dementia awareness**

Multiple CEPAR research projects have identified that a lack of information about, and an awareness of, dementia are primary barriers to reducing the impact of the disease. Former CEPAR PhD student Sarang Kim, CEPAR Chief Investigator Kaarin Anstey, and Associate Investigator Kerry Sargent-Cox, interviewed a group of people who did not have dementia about their understanding of the disease and its risk factors (Kim, Sargent-Cox and Anstey, 2015). Many participants showed significant misunderstanding – some did not know what dementia was, some did not know that it was not the same as normal cognitive ageing, and many did not know that there were different types of dementia with different causes. For example, one interviewee said:

"...I think (dementia) is a natural process of ageing for a lot of people and it isn't necessarily linked to a particular malfunction."

In another 2015 study, CEPAR Research Fellow Diane Hosking, along with Sargent-Cox and Anstey, surveyed 900 individuals from age 20 to 89 about their perceptions regarding cognitive health. While some detrimental factors such as alcohol consumption were noted by many of those surveyed, many factors connected to cognitive health, such as blood pressure, were unknown to over 95% of the sample (Hosking, Sargent-Cox and Anstey, 2015).

Additionally, the study found that while the majority of individuals knew activities like crosswords and physical exercise were good for cognitive health, very few expressed an intention to engage more in these activities. Figure 14 shows the disparity between beliefs and intentions in the survey. Those over 65, and most at risk of cognitive decline, had no greater intention to invest in their cognitive health than younger groups.
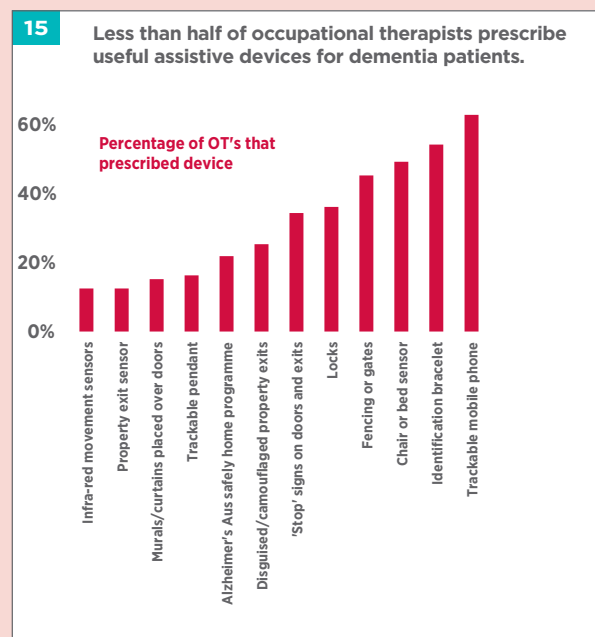
In another CEPAR-affiliated study, Associate Investigator Lindy Clemson and her colleagues discovered a lack of knowledge among occupational therapists that treat dementia (Jarvis, Clemson and Mackenzie, 2016). The majority of occupational therapists surveyed in the study did not prescribe any of the many assistive devices that are available to help dementia patients with day-to-day living.

This is despite the research, including that by CEPAR Chief Investigator Robert Cumming, Anstey, and colleagues (Laver et al. 2017), that finds that modifying patient environments and developing problem solving strategies to optimise daily living were among the most effective actions that occupational therapists can take.

The most commonly prescribed devices by occupational therapists surveyed were those that were freely available and had been widely used for some time (Fig. 15). There was little indication of innovative problem solving or case-specific ideas. Additionally, therapists in hospital settings lagged behind those in community settings in terms of the frequency of evaluating patient needs. Time and resource constraints were concluded to be the most important factors in the uptake of forward-thinking and effective dementia treatment solutions.

Clinical audits suggest that research is not reaching care facilities and hospitals either (Laver et al., 2017). Most professionals in these facilities were found to have insufficient training, and few residents with dementia had advanced care plans.

14 Knowledge about benefit rarely means increased engagement

Source: Adapted from Hosking, Sargent-Cox and Anstey (2015)

15 Less than half of occupational therapists prescribe useful assistive devices for dementia patients.

Source: Adapted from Jarvis, Clemson and Mackenzie (2016)

13

8. Cognitive ageing & work

Since fluid intelligence and the speed with which new tasks can be learned drops with age, even regular cognitive ageing can affect job prospects. This can be a challenge when searching for a new job, transitioning roles late in life, or adapting to new technologies.

But increasing *crystallised intelligence* can offset the decrease in *fluid intelligence*, allowing older workers to continue to perform well. Technology can also compensate reductions in processing ability or recall. In the language of economics, productivity is affected by the effort exerted (akin to *fluid intelligence*), and the human capital built up through training and experience (equivalent to *crystallised intelligence*), and the physical capital at their disposal (e.g., IT). Policy should therefore encourage investment in lifelong human capital and adaptive technologies, rather than simply short-term effort.

Empirical studies find no decrease in a worker's productivity at later ages (Koettl and Fengler, 2015; Gobel and Zwick, 2013; Malmberg et al., 2008; Borsch-Supan and Weiss, 2016). Indeed, at the level of the firm, tasks can be allocated between senior and junior workers to reflect their comparative advantage in fluid or crystallised intelligence.

Work and cognition can also be mutually reinforcing: Rohwedder and Willis (2010) compared the average cognitive ability and retirement ages across countries and found that retirement has a negative impact on cognitive ability of those in their early 60's (see also CEPAR research below in Box 9 that has shown increasing the pension age is not detrimental to life expectancy).

Box 9	CEPAR Research Spotlight	Productive ageing

CEPAR Chief Investigator John Piggott, with Associate Investigators Erik Hernaes and Simen Markussen, examined a unique Norwegian dataset and found that increasing the pension eligibility age had no negative effect on individuals' health, as measured by mortality (Hernaes et al 2013). Importantly, their methodology overcame selection effects which confound analyses where only healthy workers remaining in the labour force are observed.

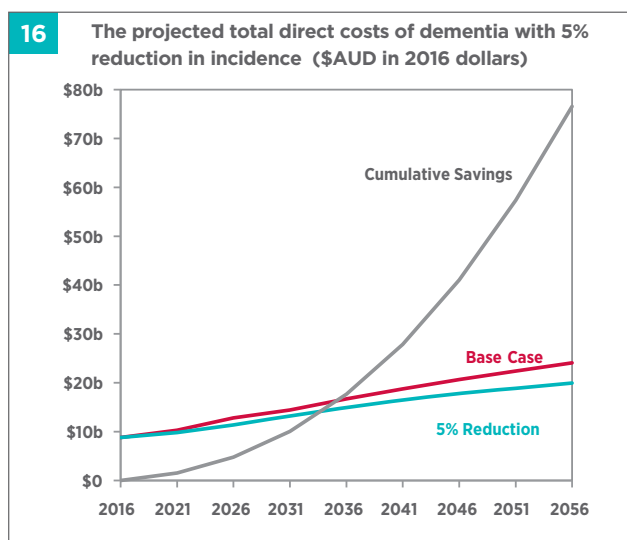Unpaid work is also relevant. For example, CEPAR Chief Investigator Kaarin Anstey and Research Fellow Diane Hosking (2016) examined the link between cognitive function and volunteering in Australia and found a significant relationship between cognitive impairment and reduced volunteering hours. Cognitive impairment was associated with undertaking about 1 hour less volunteering per week, which, combined with their estimates of impairment rates, translated to a national loss of over $300 million per year.

9. Combating dementia

There are two components to reducing the social burden of cognitive decline. The first is the reduction of dementia prevalence. The second is minimising the mortality rates, health impacts and societal costs of those who are already diagnosed.

Reducing incidence rates will dramatically decrease the costs of dementia in Australia. A hypothetical reduction of 5% in the annual incidence rate of dementia for those older than 65 would translate into a drop of 13% in the number of Australians with dementia in twenty years. Such an intervention would save the Australian economy almost $80 billion dollars by 2056 (Fig. 16).

As dementia is related to a combination of modifiable and non-modifiable factors, many cases could be prevented through individual lifestyle changes and cultural shifts in regard to exercise and diet.

As also noted by Dementia Australia (2017a, 2017b), a multi-pronged approach is necessary. Greater public awareness about the disease as well as timely diagnosis and intervention are key parts of the strategy required. On top of this, better, more up-to-date, training is needed for health care professionals, as well as better ongoing treatment, rather than just treatment at the diagnosis stage. Much of the CEPAR research presented here points to enduring deficits in the field.

16 **The projected total direct costs of dementia with 5% reduction in incidence ($AUD in 2016 dollars)**

Source: Adapted from Brown, Hansnata and La (2017)

In regard to minimising the cost of treating dementia once it has been diagnosed, a 10% reduction in hospital costs related to dementia would lead to over $23 billion dollars in savings over the next 20 years (Brown, Hansnata, and La, 2017). These reductions in hospital costs could be realised through better strategies for managing dementia patients, such as occupational therapy or simple home exercises that reduce the severity or onset of cognitive deterioration. Similarly, more effective hospital treatment could reduce the length of visits and related expenditure (e.g., see Box 8 on responses in hospital settings).

10. Research directions

Dementia Australia (2018) also highlights that increasing research funding is necessary in the fight against dementia. Research provides evidence-based policy advice and clinical practice guidelines. Box 10 outlines areas of interest related to cognitive decline that are currently being researched at CEPAR in addition to those already mentioned. Some research highlighted earlier, such as identifying cognitive decline risk factors, cognition and decision-making, and adapting workplaces for older workers, will continue to be areas of focus. For example, an evolving area at CEPAR (led by CI's Michael Keane, Kaarin Anstey, Hazel Bateman, Sharon Parker) will be to incorporate insights from the psychology of ageing and behavioural finance into economic models and workplace design solutions.

While further analyses are vital in the fight against dementia, it must be noted that research on its own only goes so far. As pointed out in Anstey et al. (2015), research findings need to be rigorously tested, translated for non-academics, and evaluated in commercial settings if they are to have any influence on dementia care and reducing the disease's burden in Australia.

A series of expert workshops conducted by the OECD in 2015 and 2016 declared the main goal of clinical research into dementia to be the development of therapies that will curb the disease's progression. But they noted that there also must be much more done to ensure patients are receiving these up-to-date therapies (e.g., see Box 8).

Box 10 | **CEPAR Research Spotlight** | **Research directions**

Risk Assessment

Chief Investigator Kaarin Anstey, Associate Investigator Nicholas Cherbuin and CEPAR research student Pushpani Herath (2013) have developed an online Alzheimer's disease Risk Index that the public can use to measure their exposure to the disease's risk factors. Since 2013, Anstey and her colleagues have continued to refine the index, testing different versions to improve efficiency and reliability (Kim, Cherbuin and Anstey, 2016). The fact that this resource is online enables individuals to assess their own risk factors and get advice.

In addition, former CEPAR PhD student Jacqueline Wesson and CEPAR Associate Investigator Lindy Clemson have been examining the validity of instruments used to measure functional cognition, which is associated with the ability to perform everyday activities. Wesson et al. (2016) presents a systematic review of 21 different instruments and finds most to be lacking in validity and reliability. Wesson et al. (2017), on the other hand, focuses on one instrument, the Large Allen's Cognitive Level Screen-5. The authors find that this instrument adequately differentiates those suffering from dementia from those with normal function and those with MCI, but does not differentiate those with MCI from those with normal function.

Driving

Kaarin Anstey and her colleagues have begun preliminary research into the effect of cognitive decline on driving ability. They have found that while driving ability appears to decrease with age (Anstey and Wood, 2011), this does not appear to be worse for those with MCI or mild dementia (Anstey et al., 2017). Those with moderate to severe dementia, however, are generally considered to be unfit to drive.

Anstey highlights that there needs to be much more research into interventions to improve driver safety with age. Currently, she points out, the focus is on cessation, despite this often being a source of depression and increased isolation, factors that may advance cognitive decline.

Geographical hotspots

Anstey, Cherbuin and their colleagues have also begun to explore whether dementia clusters geographically, and the relationship this has to socio-economic factors. In Bagheri et al. (2017) they identify areas in the city of Adelaide that have high rates of dementia, and high rates of activities that put individuals at high risk of developing the disease. Studies such as this will aid policy makers in deciding where to target prevention strategies.

References

ADI [Alzheimer's Disease International] (2017) 'About Dementia', https://www.alz.co.uk/

ADI [Alzheimer's Disease International] (2017) 'World Alzheimer Report 2015', https://www.alz.co.uk/"

Aggarwal, N. T., M. Tripathi, H. H. Dodge, S. Alladi and K. J. Anstey (2012) 'Trends in Alzheimer's disease and dementia in the Asian-Pacific region'. International Journal of Alzheimer's Disease

Agnew, J. R., H. Bateman and S. Thorp (2013) 'Financial literacy and retirement planning in Australia' numeracy, 6(2), 7

Agnew, J. R., H. Bateman, C. Eckert, F. Iskhakov, J. Louviere and Thorp, S. (2016) 'First impressions matter: an experimental investigation of online financial advice' management science, http://dx.doi.org/10.1287/mnsc.2016.2590

AIHW (Australian Institute of Health and Welfare) (2011) 'Dementia among aged care residents: first information from the Aged Care Funding Instrument' Aged care statistics series no. 32. Cat no. AGE 63, Canberra

AIHW (Australian Institute of Health and Welfare) (2012) 'Dementia in Australia' Cat no. AGE 70, Canberra

AIHW (Australian Institute of Health and Welfare) (Various Years) 'National Mortality Database', Canberra

Alzheimer's Association (2017) '2017 Alzheimer's disease facts and figures' Alzheimer's & Dementia, 13(4), 325-373

Ansell Strategic (2016) 'ACFI Modelling – Summary Findings', Perth

Anstey, K. J., and J. Wood (2011) 'Chronological age and age-related cognitive deficits are associated with an increase in multiple types of driving errors in late life' Neuropsychology, 25(5), 613

Anstey, K. J., and L. F. Low (2004) 'Normal cognitive changes in aging' Australian Family Physician, 33(10), 783

Anstey, K. J., N. Cherbuin and P. M. Herath (2013) 'Development of a new method for assessing global risk of Alzheimer's disease for use in population health approaches to prevention' Prevention Science, 14(4), 411-421

Anstey, K. J., N. Cherbuin, R. Eramudugolla, K. Sargent-Cox, S. Easteal, R. Kumar, and P. Sachdev (2013) 'Characterizing mild cognitive disorders in the young-old over 8 years: prevalence, estimated incidence, stability of diagnosis, and impact on IADLs' Alzheimer's & Dementia, 9(6), 640-648

Anstey, K. J., R. A. Burns, C. L. Birrell, D. Steel, K. M. Kiely and M. A. Luszcz (2010) 'Estimates of probable dementia prevalence from population-based surveys compared with dementia prevalence estimates based on meta-analyses' BMC Neurology, 10(1), 62

Anstey, K. J., R. Eramudugolla, D.E. Hosking, N. T. Lautenschlager, and N. T. Dixon (2015) 'Bridging the translation gap: from dementia risk assessment to advice on risk reduction' The Journal of Prevention of Alzheimer's Disease, 2(3), 189–198

Anstey, K. J., R. Eramudugolla, S. Chopra, J. Price and J. Wood (2017) 'Assessment of driving safety in older adults with mild cognitive impairment' Journal of Alzheimer's disease, (Preprint), 1-9

Ashby-Mitchell, K., C. Jagger, T. Fouweather and K. J. Anstey (2015) 'Life expectancy with and without cognitive impairment in seven Latin American and Caribbean countries' PLOS One, 10(3), e0121867

Ashby-Mitchell, K., R. Burns, J. Shaw and K.J. Anstey (2017) ' Proportion of dementia in Australia explained by common

modifiable risk factors' Alzheimer's Research & Therapy, 9(1), 11

Bateman, H. (2016) 'Retirement income strategies for an ageing population' in H. Kendig, P. McDonald and J.Piggott (Eds.) Population Ageing and Australia's Future, ANU Press, Canberra

Bateman, H., C. Eckert, J. Geweke, J. Louviere, S. Satchell, and S. Thorp (2014) 'Financial competence, risk presentation and retirement portfolio preferences' Journal of Pension Economics & Finance, 13(1), 27-61

Börsch-Supan, A., and M. Weiss (2016) "Productivity and age: Evidence from work teams at the assembly line" Journal of the Economics of Ageing, 7, 30-42

Brodaty, H., M. Heffernan, N. A. Kochan, B. Draper, J. N. Trollor, S. Reppermund, M. Slavin and P. S. Sachdev (2013) 'Mild cognitive impairment in a community sample: the Sydney Memory and Ageing Study' Alzheimer's & Dementia, 9(3), 310-317

Brown, L., E. Hansnata and H. A. La (2017) 'Economic cost of dementia in Australia 2016-2056' Alzheimer's Australia. Institute for Governance and Policy Analysis, University of Canberra, Canberra

Cattell, R. B. (1963) 'Theory of fluid and crystallized intelligence: A critical experiment' Journal of Educational Psychology, 54(1), 1-22

Cherbuin, N., M. E. Mortby, A. L. Janke, P. S. Sachdev, W. P. Abhayaratna and K. J. Anstey (2014) 'Blood pressure, brain structure, and cognition: opposite associations in men and women' American Journal of hypertension, 28(2), 225-231

Cherbuin, N., and K. J. Anstey (2012) 'The Mediterranean diet is not related to cognitive change in a large prospective investigation: the PATH Through Life study' The American Journal of Geriatric Psychiatry, 20(7), 635-639

Chomik, R., and M. MacLennan (2013) 'Aged Care in Australia: Part 1 – Policy, demand and funding' CEPAR, Sydney

Dementia Australia (2014) 'Mild Cognitive Impairment', www.dementia.org.au

Dementia Australia (2014) 'Statement: Cessation of the Dementia and Severe Behaviours Supplement', www.dementia.org.au

Dementia Australia (2017) 'Dementia awareness alarmingly low, new survey finds', www.dementia.org.au

Dementia Australia (2017) 'Dramatic new dementia figures reveal multi-billion dollar cost', www.dementia.org.au

Dementia Australia (2018) 'Ongoing investment into dementia research vital', www.dementia.org.au

de Vugt, M. E., F. Stevens, P. Aalten, R. Lousberg, N. Jaspers and F. R. J. Verhey (2005) 'A prospective study of the effects of behavioural symptoms on the institutionalization of patients with dementia' International Psychogeriatrics, 17, 577–589

Dobrescu, L. I., X. Fan, H. Bateman, B. R. Newell, A. Ortmann, and S. Thorp (2016) 'Retirement savings: A tale of decisions and defaults' The Economic Journal, onlinelibrary.wiley.com/doi/10.1111/ecoj.12447/full

Earl, J. K., P. Gerrans and M. Hunter (2017) 'Better ways of assessing cognitive health', National Seniors, Brisbane

Fang, H., M. P. Keane and D. Silverman (2008) 'Sources of advantageous selection: Evidence from the Medigap insurance market' Journal of Political Economy, 116(2), 303-350

Flynn, J. R. What is intelligence?: Beyond the Flynn effect. Cambridge University Press, 2007

Gnjidic, D., F. F. Stanaway, R. Cumming, L. Waite, F. Blyth, V. Naganathan, D. Handelsman and D. G. Le Couteur (2012) 'Mild

cognitive impairment predicts institutionalization among older men: a population-based cohort study' PLOS One, 7(9), e46061

Göbel, C., and T. Zwick (2013) "Are personnel measures effective in increasing productivity of old workers?" Labor Economics, 22, 80–93

Hall, M., and P. Sikes (2016) 'From "what the hell is going on?" to the "mushy middle ground" to "getting used to a new normal" young people's biographical narratives around navigating parental dementia' Illness, Crisis & Loss

Hamer, M., and Y. Chida (2009) 'Physical activity and risk of neurodegenerative disease: a systematic review of prospective evidence' Psychological Medicine, 39(1), 3-11

Hay, S. I., (2017) 'Global, regional, and national disability-adjusted life-years (DALYs) for 333 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016' The Lancet, 390(10100), 1260-1344

Hernaes, E., S. Markussen, J. Piggott and O. Vestad (2013) 'Does retirement age impact mortality?' Journal of Health Economics, 32(3), 586-598

Hosking, D. E., D. Jiang, K. A. Sargent-Cox and K. J. Anstey (2017) 'Informant-reported cognitive decline and activity engagement across four years in a community sample' Gerontology

Hosking, D. E., K. A. Sargent-Cox and K. J. Anstey (2015) 'An Australian survey of cognitive health beliefs, intentions, and behaviours through the adult life course' Preventive Medicine Reports, 2, 498-504

Hosking, D. E., and K. J. Anstey (2016) 'The economics of cognitive impairment: volunteering and cognitive function in the HILDA survey' Gerontology, 62(5), 536-540

Jarvis, F., L. M. Clemson and L. Mackenzie (2017) 'Technology for dementia: attitudes and practices of occupational therapists in providing assistive technology for way finding' Disability and Rehabilitation: Assistive Technology, 12(4), 373-377

Jorm, A. F., K. B. Dear and N. M. Burgess (2005) 'Projections of future numbers of dementia cases in Australia with and without prevention' Australian and New Zealand Journal of Psychiatry, 39(11 12), 959-963

Keane, M. P., and S. Thorp (2016) 'Complex decision making: the roles of cognitive limitations, cognitive decline, and aging' Handbook of the Economics of Population Aging, 1, 661-709

Keane, M. P., J. Ketcham, N. Kuminoff and T. Neal (2017) 'Evaluating consumers' choices of medicare part d plans', working paper.

Kim, S., K. A. Sargent Cox and K. J. Anstey (2015) 'A qualitative study of older and middle aged adults' perception and attitudes towards dementia and dementia risk reduction' Journal Of Advanced Nursing, 71(7), 1694-1703

Koettl, J., and W. Fengler (2015) 'Should we work forever?', www.brookings.edu

Kurth F., N. Cherbuin and E. Luders (2017) 'Aging mindfully to minimize cognitive decline' Journal of Cognitive Enhancement, 1-7

Lang, L., A. Clifford, L. Wei, D. Zhang, D. Leung, G. Augustine ... and R. Chen (2017) 'Prevalence and determinants of undetected dementia in the community: a systematic literature review and a meta-analysis' BMJ Open, 7(2), e011146

Laver, K., R. Cumming, S. Dyer, M. Agar, K. J. Anstey, E.

Beattie, ... and M. Dietz (2017) 'Evidence Based occupational therapy for people with dementia and their families: What clinical practice guidelines tell us and implications for practice' Australian Occupational Therapy Journal, 64(1), 3-10

Laver, K., R. Cumming, S. Dyer, M. Agar, K. J. Anstey, E. Beattie, ... and M. Dietz (2016) 'Clinical practice guidelines for dementia in Australia' The Medical Journal of Australia, 204(5), 191-193

Li, S. C., U. Lindenberger, B. Hommel, G. Aschersleben, W. Prinz and P. B. Baltes (2004) 'Transformations in the couplings among intellectual abilities and constituent cognitive processes across the life span' Psychological Science, 15(3), 155-163

Malmberg, B., T. Lindh and M. Halvarsson (2008) 'Productivity consequences of workforce aging: stagnation or horndal effect?' Population and Development Review, 34, 238–56

Mathers, C., (2008) 'The global burden of disease: 2004 update' World Health Organization, Geneva

McDermott, K. L., G. P. McFall, S. J. Andrews, K. J. Anstey and R.A. Dixon (2016) 'Memory resilience to alzheimer's genetic risk: sex effects in predictor profiles' Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 72(6), 937-946

O'Connor, C. M., L. Clemson, H. Brodaty, L. F. Low, Y. H. Jeon, L. N. Gitlin, O. Poguet and E. Mioshi (2017) 'The Tailored Activity Program (TAP) to address behavioral disturbances in frontotemporal dementia: a feasibility and pilot study' Disability and Rehabilitation, 1-12.

O'Connor, C. M., L. Clemson, H. Brodaty, Y. H. Jeon, E. Mioshi and L. N. Gitlin (2014) 'Use of the Tailored Activities Program to reduce neuropsychiatric behaviors in dementia: an Australian protocol for a randomized trial to evaluate its effectiveness' International psychogeriatrics, 26(5), 857-869

OECD (Organisation for Economic Cooperation and Development) (2017) 'Health at a Glance 2017: OECD Indicators', OECD Publishing, Paris

OECD (2015) 'Enhancing translational research and clinical development for alzheimer's disease and other dementias' OECD Science, Technology and Industry Policy Papers, No. 22, OECD Publishing, Paris

OECD (2016) 'Global action to drive innovation in alzheimer's disease and other dementias: connecting research, regulation and access' OECD Science, Technology and Industry Policy Papers, No. 31, OECD Publishing, Paris

Petersen, R. C., and J. O'Brien (2006) 'Mild cognitive impairment should be considered for DSM-V' Journal of Geriatric Psychiatry and Neurology, 19(3), 147-154

Plassman, B. L., K. M. Langa, R. J. McCammon, G. G. Fisher, G. G. Potter, J. R. Burke, ... and K. A. Welsh Bohmer (2011) 'Incidence of dementia and cognitive impairment, not dementia in the United States' Annals of Neurology, 70(3), 418-426

Prince, M., R. Bryce, E. Albanese, A. Wimo, W. Ribeiro and C. P. Ferri (2013) 'The global prevalence of dementia: a systematic review and metaanalysis' Alzheimer's & Dementia, 9(1), 63-75

Rohwedder, S., and R. J. Willis (2010) 'Mental retirement' The Journal of Economic Perspectives, 24(1), 119-138

Rosewarne, R., J. Opie, R. Cumpston, V. Boyd, A. Kikkawa (2017) 'Review of the Aged Care Funding Instrument Report' Applied Aged Care Solutions Pty Ltd

Shaw, M. E., W. P. Abhayaratna, K. J. Anstey and N. Cherbuin (2017) 'Increasing body mass index at midlife is associated with increased cortical thinning in alzheimer's disease-vulnerable regions' Journal of Alzheimer's Disease, (Preprint), 1-8

Sherod, M. G., H. R. Griffith, J. Copeland, K. Belue, S. Krzywanski, E. Y. Zamrini,... and D. C. Marson (2009) 'Neurocognitive predictors of financial capacity across the dementia spectrum: Normal aging, mild cognitive impairment, and Alzheimer's disease' Journal of the International Neuropsychological Society, 15(2), 258-267

Sperling, R., E. Mormino and K. Johnson (2014) 'The evolution of preclinical Alzheimer's disease: implications for prevention trials' Neuron, 84(3), 608-622

Su, X., L. Shang, Q. Xu, N. Li, J. Chen, L. Zhang, ... and Q, Hua (2014) 'Prevalence and predictors of mild cognitive impairment in Xi'an: a community-based study among the elders' PLOS One, 9(1), e83217

Wesson, J., L. Clemson, H. Brodaty and S. Reppermund (2016) 'Estimating functional cognition in older adults using observational assessments of task performance in complex everyday activities: A systematic review and evaluation of measurement properties' Neuroscience and Biobehavioral Reviews, 68, 335-360

Wesson, J., L. Clemson, J.D. Crawford, N. A. Kochan, H. Brodaty, and S. Reppermund (2017) 'Measurement of functional cognition and complex everyday activities in older adults with mild cognitive impairment and mild dementia: validity of the Large Allen's cognitive level screen' The American Journal of Geriatric Psychiatry, 25(5), 471-482
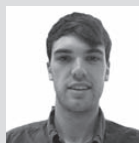
Wood, J. M., P. F. Lacherez and K. J. Anstey (2012) 'Not all older adults have insight into their driving abilities: evidence from an on-road assessment and implications for policy' Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences, 68(5), 559-566

Yaffe, K., A. J. Fiocco, K. Lindquist, E. Vittinghoff, E. M. Simonsick, A. B. Newman... and T. B. Harris (2009) 'Predictors of maintaining cognitive function in older adults The Health ABC Study' Neurology, 72(23), 2029-2035

About the authors

Rafal Chomik is a Senior Research Fellow at CEPAR and is responsible for the Centre's research translation program. He has worked as an economist at the OECD and for the British Government.

**Roderick Gawthorp** is currently studying a Masters of clinical psychology and has worked as a research assistant at Macquarie University.

Simon Graham works on research translation for CEPAR. Prior to this, he was an Honours student in Economics at UNSW.

Kaarin J. Anstey is a Chief Investigator and Deputy Director at CEPAR. Kaarin also holds a Chair in the School of Psychology at UNSW and is the NHMRC Principal Research Fellow at NeuRA (Neuroscience Research Australia).

Contributing researchers
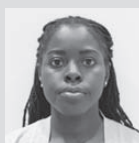
Kimberly Ashby-Mitchell is a Senior Technical Officer at the Caribbean Public Health Agency. Her research interests are nutrition and health disease outcomes. She completed her PhD through CEPAR and the Australian National University in 2016.

Richard Burns is an Associate Investigator at CEPAR and Research Fellow at the Australian National University College of Health and Medicine. His research interests include mental health, geriatrics and gerontology.

Nicolas Cherbuin is an Associate Investigator at CEPAR. He is also an Associate Professor and Director of the Neuroimaging and Brain Lab at the Australian National University College of Health and Medicine.

Robert Cumming is a Chief Investigator at CEPAR and a Professor of Epidemiology and Geriatric Medicine at the University of Sydney. Much of his research brings together biological, psychosocial and medical aspects of ageing.

Pushpani Herath was a CEPAR-affiliated PhD student at the Centre for Research in Ageing, Health and Wellbeing at the Australian National University College of Health and Medicine. She currently works as a General Practitioner for the National Health Co-op.

Diane Hosking was a Research Fellow at CEPAR until the end of 2017. She is also a Postdoctoral Fellow at the Centre for Research Ageing Health and Wellbeing at the Australian National University College of Health and Medicine.

Carol Jagger is an Associate Investigator at CEPAR and Professor of Epidemiology of Ageing at Newcastle University, UK. Her research focuses on trajectories of mental and physical functioning, measuring disability and life expectancy.

Hazel Bateman is a Chief Investigator and Deputy Director at CEPAR, and a Professor in the School of Risk and Actuarial Studies at UNSW. She is one of Australia's leading experts in superannuation and pensions.

Peter Butterworth is an ARC Future Fellow and Professorial Fellow at the Centre for Mental Health and the Melbourne Institute for Applied Economic and Social Research. He was an Associate Investigator at CEPAR until the end of 2017.

Lindy Clemson is a Professor in Ageing and Occupational Therapy and Joint Head of the Ageing, Work & Health Research Unit at the University of Sydney. She was an Associate Investigator at CEPAR until the end of 2017.

Loretti Isabella Dobrescu is an Associate Investigator at CEPAR and an Associate Professor at the UNSW School of Economics. Isabella's research focuses on issues related to savings and cognition in older age.

Erik Hernaes is an Associate Investigator at CEPAR and a Senior Research Fellow at the Frisch Centre for Economic Research in Oslo, Norway. His research focuses on unemployment, education and retirement.

Fedor Iskhakov is an Associate Investigator at CEPAR and a Senior Lecturer at the Research School of Economics at the Australian National University. His research interests concern labour economics and household finance.

Michael Keane is a Chief Investigator at CEPAR, a Professor of Economics and an Australian Laureate Fellow at UNSW. He is a world leading expert in choice modelling, and his research spans topics from individual decision-making to macro-demographic dynamics.

Hal Kendig is an Honorary Professor at CEPAR and an Emeritus Professor at the Australian National University. He is a sociologist and gerontologist with an interest in research on aged care, health and productive ageing and social determinants of health over the life course.

Sarang Kim was a PhD student at CEPAR. She is currently a Research Fellow at the Centre for Research in Ageing, Health and Wellbeing at the Australian National University, and was awarded the 2016 Alzheimer's Australia Hazel Hawke Research Grant in Dementia Care.

Simen Markussen is an Associate Investigator at CEPAR and a Senior Research Fellow at the Frisch Centre for Economic Research in Oslo, Norway. His research explores labour economics, social insurance programs and health.

Timothy Neal is a Research Fellow at CEPAR and at the School of Economics at UNSW. He holds a PhD in Economics from UNSW and his research is focused on applying panel data methods to topics such as the rationality of insurance choice.

Claire O'Connor completed her PhD through CEPAR and the Faculty of Health Sciences at the University of Sydney. She is currently a Research Fellow at HammondCare and a Conjoint Lecturer at UNSW.

Kerry Sargent-Cox is a Research Fellow at the Centre for Research in Ageing, Health and Wellbeing at the Australian National University College of Health and Medicine. She was an Associate Investigator at CEPAR until the end of 2017.

Jacqueline Wesson was a CEPAR-affiliated PhD student at the Ageing, Work and Health Research Unit at the University of Sydney. She is currently a Honorary Postdoctoral Research Fellow there, and also a Dementia Specialist and Research Co-ordinator at Sir Moses Montefiore Jewish Home.

Kim Kiely is an Associate Investigator at CEPAR as well as a Senior Research Fellow in the School of Psychology, UNSW, and at Neuroscience Research Australia (NeuRA).

Jordan Louviere is an Associate Investigator at CEPAR and a Research Professor in the School of Marketing at the University of South Australia. He is an internationally recognised expert in consumer choice modelling.

Peter McDonald is a Chief Investigator at CEPAR and Professor of Demography and Head of the Demography and Ageing Unit in the Melbourne School of Population and Global Health, University of Melbourne. In 2008, he was appointed as a member of the Order of Australia.
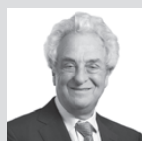
Ben Newell is an Associate Investigator at CEPAR and a Professor of Cognitive Psychology and Deputy Head of the UNSW School of Psychology. His research focuses on the cognitive processes underlying judgment, choice and decision-making.

John Piggott is the Director of CEPAR and Scientia Professor of Economics at UNSW. His research interests include the economic and financial aspects of population ageing focused on the Australasian region.

Susan Thorp is a Professor of Finance at the University of Sydney and an Associate Investigator at CEPAR. Susan researches household and consumer finance with a particular focus on retirement savings and decumulation.

About CEPAR

The ARC Centre of Excellence in Population Ageing Research (CEPAR) is a unique collaboration between academia, government and industry, committed to delivering solutions to one of the major economic and social challenges of the 21st century.

Funded primarily by an initial seven-year grant from the Australian Research Council (ARC), with generous support from the collaborating universities and partner organisations, the Centre was established in March 2011 to undertake high impact independent multidisciplinary research and build research capacity in the field of population ageing.

Renewed funding awarded for an additional seven-year term from 2017-2023 supports an exciting new research program which will deliver comprehensive outcomes with the potential to secure Australia's future as a well-informed nation with world-best policy and practice for an ageing demographic.

Contact

CEPAR, UNSW Business School, Kensington Campus,
UNSW, Sydney NSW 2052

cepar@unsw.edu.au | +61 (2) 9931 9202 | www.cepar.edu.au

CEPAR Partners

Launch Partner