



MONASH University

Trajectories of Mental and Physical Health in Ageing

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Abstract

The world's population of older people is growing at a rapid rate. Pressure is mounting to produce evidence informed theory, policy and practice to improve the health and well-being of older adults. There are many individual and societal benefits associated with elucidating the concept of successful ageing. Mental health is an important and underestimated component of successful ageing that is often neglected in theory and research. This neglect has substantial negative implications for effective policy and practice strategy creation.

This research investigated the relationship between mental and physical health over time in older people. This thesis involves two broad studies, both focussing on trajectories of health in older people: (i) a systematic review of the relevant literature and, (ii) secondary data analyses of a large-scale longitudinal study of ageing, the Dynamic Analyses to Optimise Ageing (DYNOPTA) project. Quantitative research methodologies are employed, and the DYNOPTA project specifically applies integrative data analysis (IDA): the synthesis of existing data from longitudinal studies to produce new knowledge. The work is informed by the theoretical perspective of Rowe and Kahn's model of successful ageing.

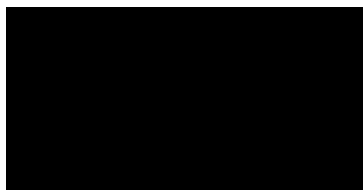
The systematic review indicated that mental health remains stable over time, with some evidence of a decline for men and older individuals. Modifiable lifestyle behaviours appeared to have a considerable influence on mental health outcomes. The results of the data analyses also showed that mental health remains stable over time, with men's mental health slightly worsening while women's slightly improved. Mental and physical health were consistently related to each other over time. In terms of magnitude of influence, the results indicated that the impact of mental health on physical health was the strongest effect.

Successful ageing theorists should endeavour to emphasise the critical role that mental health plays in older age. Efforts should be made to create policy and tailor service provision to improve mental health outcomes across the life-span, which this research suggests, will have associated substantial improvements on physical health. Mental health is a critical resource in an evidence and strength-based approach to the promotion of successful ageing.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signature:



Print Name: Susan Hunt

Date: 4 May 2017

Publications during enrolment

Thesis including published works declaration

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes one submitted publication. The core theme of the thesis is successful ageing. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the student, working within the School of Primary Health Care under the supervision of Colette Browning.

(The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.)

In the case of Chapter 3 my contribution to the work involved the following:

Thesis Chapter	Publication Title	Status (published, in press, accepted or returned for revision, submitted)	Nature and % of student contribution	Co-author name(s) Nature and % of Co-author's contribution*	Co-author(s), Monash student Y/N*
3	Systematic review of the use of the SF-36 MHI-5 in older populations	Submitted	85%. Concept, collecting data, analyses and writing	1) Colette Browning, feedback, 5% 2) Richard Burns, feedback, 5% 3) Jane Sims, feedback, 5%	No No No

I have not renumbered sections of submitted or published papers in order to generate a consistent presentation within the thesis.

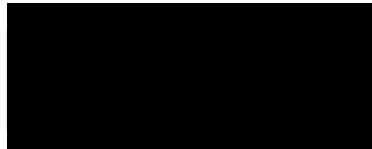
Student signature:



Date: 4 May 2017

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the student's and co-authors' contributions to this work. In instances where I am not the responsible author I have consulted with the responsible author to agree on the respective contributions of the authors.

Main Supervisor signature:



Date: 4 May 2017

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The data on which this research is based were drawn from several Australian longitudinal studies including: the Australian Longitudinal Study of Ageing (ALSA), the Australian Longitudinal Study of Women's Health (ALSWH), the Australian Diabetes, Obesity and Lifestyle Study (AusDiab), the Blue Mountain Eye Study (BMES), the Canberra Longitudinal Study of Ageing (CLS), the Household, Income and Labour Dynamics in Australia study (HILDA), the Melbourne Longitudinal Studies on Healthy Ageing (MELSHA), the Personality And Total Health Through Life Study (PATH), and the Sydney Older Persons Study (SOPS). These studies were pooled and harmonized for the Dynamic Analyses to Optimise Ageing (DYNOPTA) project. DYNOPTA was funded by an NHMRC grant (#410215). All studies would like to thank the participants for volunteering their time to be involved in the respective studies. Details of all studies contributing data to DYNOPTA, including individual study leaders and funding sources, are available on the DYNOPTA website (<http://dynopta.anu.edu.au>). The findings and views reported in this thesis are those of the author and not those of the original studies or their respective funding agencies.

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Chapter 1

OVERVIEW OF THESIS

1.1 Introduction

The purpose of this research was to investigate the relationship between mental and physical health over time in older people. This thesis involves two broad studies, both focussing on trajectories of health in older people: (i) a systematic review of the relevant literature and, (ii) secondary data analyses of a large-scale longitudinal study of ageing, the Dynamic Analyses to Optimise Ageing (DYNOPTA) project. Specifically, the research questions investigated are i) how and why does mental health change over time for older people, ii) does the Mental Health Index (MHI-5) of the SF-36 (Ware, Snow, Kosinski, & Gandek, 1993) function homogenously across groups, iii) how does physical health influence mental health over time, iv) how does mental health influence physical health over time, and v) how does physical health influence depression over time. Quantitative research methodologies are employed, and the DYNOPTA project specifically applies integrative data analysis (IDA): the synthesis of existing data from longitudinal studies to produce new knowledge. The work is informed by the theoretical perspective of Rowe and Kahn's model of successful ageing (1987), along with the collective works of Jeste and Depp (2010) on successful emotional ageing and Bowling's (2005) work on lay perspectives on ageing.

Successful ageing is an important concept from a policy and individual perspective. It has been operationalised and measured in many ways; however, mental health has largely been ignored as a component. Additionally, there have been few longitudinal investigations of successful ageing over multiple time points. To address these issues, the quantitative component of this thesis aims to investigate the longitudinal relationship between physical and mental health ageing.

This chapter introduces the overall thesis topic, including the context, scope and rationale for the research. A brief overview of the aims and methods that drove the research is also included.

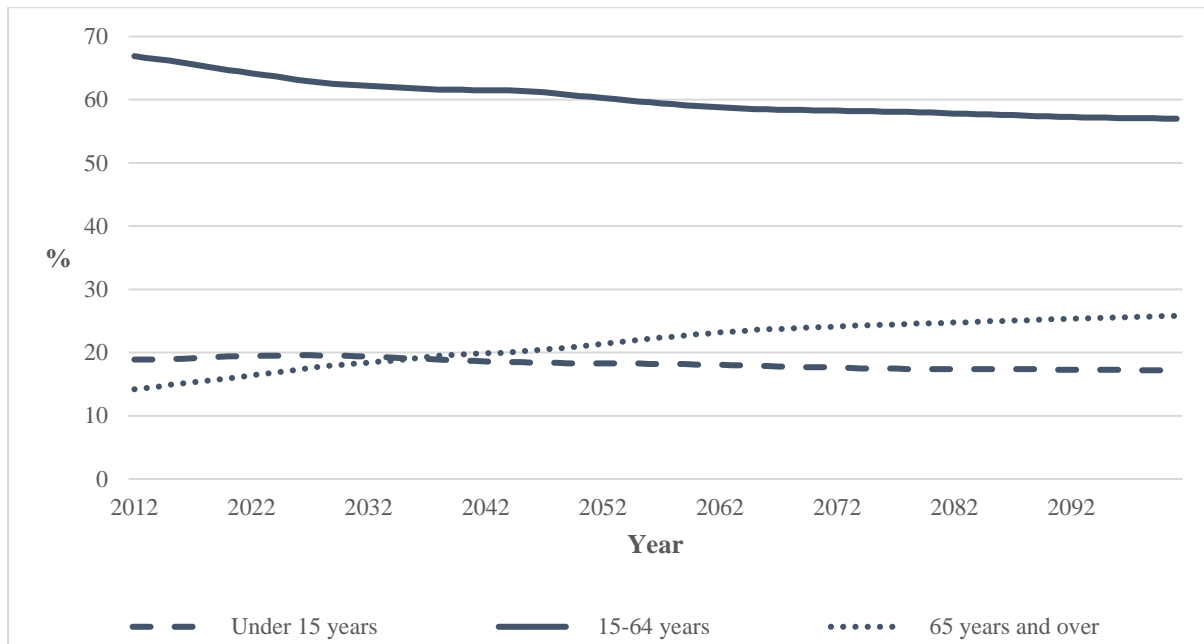
1.2 Social and political context

The world's population of older peopleⁱ is growing at a rapid rate, and the number of people aged over 65 will soon exceed the number of children aged under five for the first time in history (Kinsella & He, 2009; World Health Organization, 2012c). Globally, people are living longer than ever before as the life expectancy in many countries continues to increase. A baby born in nearly any country can expect to live longer than ever before (Kontis et al., 2017; C. J. L. Murray et al., 2015). Australia is a notable exemplar of this pattern, ranked as having one of the highest life expectancies in the world (Australian Institute of Health and Welfare, 2016). It should be noted, however, that this statistic is not applicable to Indigenous Australians, who have a life expectancy approximately 10 years less than non-Indigenous Australians (Australian Institute of Health and Welfare, 2014, 2016).

Figure 1.1 provides a graphical depiction of the predicted changes in Australia's population; note the increase in the proportion of older people and associated decline in the proportion of people of younger ages, both adults and children.

ⁱ Throughout this thesis, the term 'older' generally refers to people aged 65 years and over, arguably a definition only applicable to the developed world where the concept of old age is equated with retirement from paid employment (Randel, German, & Ewing, 1999). This is appropriate given the majority of past research is from developed countries and the quantitative data analysed in this thesis has been collected in a developed country and the majority of participants are non-Indigenous. This definition also reflects the Australian government's definition of older non-Indigenous people, and will enable comparisons to be made with government findings. However, it is acknowledged that there is a wide variability in the ageing experience and different cultures have varying concepts of older age, based on societal and economic circumstances.

Figure 1.1. Projected proportions of population of Australia by age group (graph created using data from Australian Bureau of Statistics (2013)).



Although a positive societal achievement, this increased longevity does not necessarily translate into improved quality of life (Australian Institute of Health and Welfare, 2006). With improved health, hygiene and living standards, the leading cause of mortality has changed, shifting from infectious diseases, such as influenza, to non-communicable diseases associated with increased age, such as cardiovascular disease (Australian Institute of Health and Welfare, 2008; Depp, Vahia, & Jeste, 2010). This shift, in combination with the increasing older population, means that more people are at risk of developing the diseases and disability associated with ageing (Australian Institute of Health and Welfare, 2006). Currently, it is predicted that there will also be significant societal and economic consequences from the increased need for health and aged care services and the reduced proportion of working age people (Commonwealth of Australia, 2010). It is not surprising then that ageing has been referred to as the largest current global public health challenge (Cutler & Mattson, 2006; Depp et al., 2010).

The Australian government's initial response to this challenge was to produce the National Strategy for an Ageing Australia (K. J. Andrews, 2001). The Strategy emphasised the need

for a sound research evidence base to support policy and administrative decisions regarding the ageing population:

Ongoing research to inform and guide our responses to population ageing will be an important part of the monitoring and review process. Research will be required to guide policy development, set future priorities for action, identify best practice, identify barriers to change, evaluate the impact of policies, programs and services, and guide individual and social action. We will need a strong evidence base to understand not only how to mobilise our response to an ageing nation, but also how to adjust our responses as we move through the next fifty years. (K. J. Andrews, 2001, p. 4)

The overarching theme was the need for an increased focus on older Australians in public policy development and the need to understand what happens as the population ages. The Strategy also stressed that the areas of depression and mental health issues in old age needed ongoing attention given the prevalence of mental illness and associated impacts.

In keeping with the objectives of the National Strategy, in 2003 the Prime Minister's Science, Engineering and Innovation Council produced a report describing the goal of adding "10 years of healthy and productive life expectancy" to Australians' lives by 2050 (p. 7). The report also proposed the research agenda, including a focus on longitudinal data, needed to achieve this goal. To partially address this goal, in 2003 'Ageing Well, Ageing Productively' was announced as a National Research Goal under the National Research Priority 'Promoting and maintaining good health'. The Australian Research Council (ARC) and the National Health and Medical Research Council (NHMRC) funded the Research Network in Ageing Well and targeted research to inform policy and practice in this priority area. The research reported in this thesis is a product of one of the projects funded under the NHMRC Ageing Well, Ageing Productively Grants Scheme: the DYNOPTA project.

More recently, in their Ageing and Aged Care in Australia report, the Australian government has prioritised a "consistent national effort to reduce lifestyle health risk factors and promote good health and healthy ageing" (Department of Health and Ageing, 2008, p. 4). The government has emphasised a 'whole-of-government' position in response to population ageing, inclusive of superannuation and retirement income support, workforce, housing,

social inclusion and lifelong education, as well as medical, health and aged care services (Department of Health and Ageing, 2008). The 2010 Intergenerational Report ‘Australia to 2050: Future Challenges’ aimed to provide a detailed description of the challenges that Australia will face in the next forty years (Commonwealth of Australia, 2010). The key conclusion was that an ageing population is a “significant long-term risk for the economy and sustainability of government finance” (p. iii) and thus health has been emphasised as an economic priority (Commonwealth of Australia, 2010).

The reform plan ‘Living Longer. Living Better’ (Department of Health and Ageing, 2012b) presents a substantial modification of the Australian aged health care system with the aim of “keeping older people out of hospital, helping people stay well in their community and ensuring the health and well-being of Australians as they age” (Department of Health and Ageing, 2012a, p. 1). The government has provided \$3.7 billion over five years for the reform package. \$19.4 million of this funding is to improve knowledge translation from research into evidence-based practice to improve aged care. In addition, the Australian Bureau of Statistics’ Survey of Disability, Ageing and Carers will be conducted every three years rather than every six years. This aims to improve knowledge of the attributes and needs of older people to aid future planning and enhance care.

The policy document and allocated budget has a significant focus on residential aged care and keeping individuals in their own home as long as they can through support service provision to older people and their carers. Within this goal, other related target areas include palliative and dementia care, and older people from culturally and sexually diverse backgrounds. Notably, mental health is mentioned only broadly in reference to veterans and the psychological symptoms of dementia. Given the importance of good mental health to quality of life and the prevalence of mental illness and associated economic and individual costs, this is a prominent and surprising omission. For example, depression and anxiety (indicators of mental health) have been reported to be two of the most prevalent conditions in older people (R. Stewart & Lindesay, 2011).

In a shift from previous government reports, the reform plan makes a point of not viewing the impacts of an ageing population as problem or inconvenience, instead as an opportunity to adapt and harness the contributions that older people are able to make to business, education and community. Indeed, the reform is explicitly stated in terms of an “Active Ageing Agenda” for Australia to “maximise the potential of an ageing population” (Department of Health and Ageing, 2012b, p. 36). The government established an Advisory Panel on the Economic Potential of Senior Australians in 2011, which identified seven key themes of importance, depicted in Box 1.1 and Figure 1.2.

Box 1.1. The seven themes of importance identified for the positive ageing agenda in Australia.

An **Active Ageing Agenda** will provide an overall strategy to maximise the potential of an ageing population.

Housing, particularly home environments, are fundamental to older people’s capacity to participate in society.

As they reach retirement older workers may wish to **participate** in the workforce longer.

Lifelong learning increases the employability and productivity of older workers.

Senior Australians contribute the highest number of **volunteer** hours of any age group and make substantial contributions to **philanthropic** endeavours.

Age discrimination and stereotyping of older people acts as a barrier to senior Australians realising their potential. (Department of Health and Ageing, 2012b, p. 36)

Figure 1.2. The seven themes of importance identified for the positive ageing agenda in Australia (adapted from Department of Health and Ageing, 2012b, p. 34).



The reform received a generally positive, if cautious, response from consumer groups and aged care providers (Aged & Community Services Australia, 2012); the Council on the Ageing (COTA) deeming it an “excellent beginning” (2012, p. 8) an opinion reflected by other organisations seeing the reform as an important and overdue initial step towards the future of aged care (Grant Thornton, 2012).

More recently, the 2015 Intergenerational Report (Commonwealth of Australia) references the increasing ageing population in Australia and the lowering of the proportion of people participating in the labour force. The change in “population age structures” impact the sustainability of “Gross Domestic Product growth, tax base, provision of health and care services and welfare pensions” (Strazdins, Welsh, Hinde, & Butterworth, 2016, p. 1).

However, the importance of the changes ahead is somewhat hedged and minimised by a section dedicated to emphasising that the ageing population in Australia is not as substantial as other comparable countries that have a greater proportion of older people. This comparison seems somewhat irrelevant, as we will still have an ageing population that will have a substantial impact on our industry and economy.

Additionally, older people are mainly mentioned only in the context of the need to keep them in the workforce. This argument is presented in the name of “active ageing” (p. viii), and is presented with the purpose of enabling economic and income growth. Given the conclusions of the Australian Human Rights Commission (2016) inquiry report into age discrimination in the workforce, a component of enabling older people to stay in the workforce will need to include an attempt at reducing ageism and prejudicial stereotyping of older people. Age discrimination has been found to be widespread and is associated with negative impacts on mental health (Australian Human Rights Commission, 2015). Older people face substantially longer periods of unemployment and a third of those who experience age discrimination stop seeking paid employment (Australian Human Rights Commission, 2015, 2016).

The Intergenerational Report does acknowledge the health care requirements of older people:

Both pharmaceutical benefits and public hospitals expenditure, spending on the average person aged 85 years and older is over four times the spending on the average person across all ages. (Commonwealth of Australia, 2015, p. 62)

Despite this acknowledgment and the passing reference to active ageing, little is said about what will actually be done to enable older people to participate in the workforce for as long as possible. This participation is dependent on both the health of older people and societal attitudes towards older people, including internalised attitudes.

While Australia’s response to population ageing rarely acknowledges the role of mental health, global responses are similar or have a focus on responding to mental illness and providing appropriate services. For example, in the Organisation for Economic Co-operation and Development (OECD) Health Working Paper on Healthy Ageing Policies (Oxley, 2009),

mental health is included in the definition of healthy ageing (p. 9). The paper also states that greater attention to mental health is needed in policy (p. 11). However, this is primarily in the context of responding to mental illness. In the Global Health and Ageing report produced by the National Institutes of Health and World Health Organization (2011), neither mental health nor illness is mentioned.

Conversely, the Strategy and Action Plan for Healthy Ageing in Europe 2012-2020 does indeed include mental health as a dimension of healthy ageing. However, the strategies generally then discuss mental illness as opposed to promoting positive mental health ageing (World Health Organization, 2012b).

More recently, however, the Global Strategy and Action Plan on Ageing and Health (2016-2020) developed by the World Health Organization (2016) refers to the importance of promoting psychosocial health:

In developing a public health response to ageing, it is therefore important to consider strategies that reinforce resilience and psychosocial growth. (World Health Organization, 2016, p. 7)

Interestingly, the strategy frames healthy ageing in terms of functional ability, including mental health as a core component:

This functional ability is determined by the intrinsic capacity of the individual (i.e. the combination of all the individual's physical and mental – including psychosocial – capacities), the environments he or she inhabits (understood in the broadest sense and including physical, social and policy environments), and the interaction between these. (World Health Organization, 2016, p. 7)

This perspective is also reflected in the World Report on Ageing and Health (World Health Organization, 2015), which includes a number of health promotion strategies designed to improve socioemotional health in addition to responses to mental illness.

The socio-political landscape of the 21st century has given some, albeit limited attention, to the role of mental health in the lives of older people. The following section provides a brief overview of how mental health has featured in the research context.

1.3 Research context

To move from the societal and political context to take a more individualist view, achieving optimal quality of life throughout the lifespan is what the majority of people strive towards. In relation to older people, this important concept has been extensively researched in many disciplines. The terminology used to describe the concept of optimal well-being in ageing has varied in the research literature, with terms being used such as “active ageing” (World Health Organization, 2002), “ageing well” (Vaillant, 2002) and “healthy ageing” (Clark, 2008). These adjectives are not interchangeable; they have different connotations. The term used has implications for the definition of the concept, and a full discussion of this issue is included in this thesis.

“Successful ageing” (Havighurst, 1961; Rowe & Kahn, 1987) is the term that has been chosen for use in this research, as it is used extensively in the research literature that forms the theoretical framework for this thesis. The term arose from, and is well established in the disciplines that this research is most relevant to, namely the psychological sciences and gerontology (Depp et al., 2010; European Network on Longitudinal Studies on Individual Development, Baltes, & Baltes, 1990; Havighurst, 1961; Rowe & Kahn, 1997).

1.3.1 Key theoretical perspectives

Successful ageing was first described in the biomedical literature by Havighurst (1961), in the first issue of the journal *Gerontologist*. Havighurst postulated that successful ageing is more than simply maximising longevity and preventing disease and disability, an observation generally accepted in the contemporary literature (Depp & Jeste, 2006; T. A. Glass, 2003).

In keeping with Havighurst's (1961) proposition that successful ageing is above and beyond life expectancy, Rowe and Kahn (1987) provided what is currently the prevailing (Depp & Jeste, 2006), although not uncriticised (see for example Masoro, 2001; Rubinstein & de Medeiros, 2015; Stowe & Cooney, 2015), model of successful ageing. Their influential work has been referenced in thousands of scientific articles, and continues to be cited (Thomson Reuters, 2017). Rowe and Kahn (1987) conceptualised successful ageing as: i) low risk of experiencing disease and disability, and ii) high cognitive, physical and social functioning. Rowe and Kahn's theory of successful ageing has been operationalised and debated at length.

1.3.2 Empirical perspectives

Rowe and Kahn's theory was famously empirically investigated by the MacArthur Foundation Research Network on Successful Aging. Successful ageing was operationalised in terms of high physical and cognitive functioning, and no mental health components were included in the operationalisation. The MacArthur studies are a useful demonstration of a number of theoretical and methodological issues characteristic of the successful ageing empirical literature, which is fully reviewed in this thesis, discussed in more detail in Chapter 2.

Many researchers have gone on to similarly operationalise theories, definitions and models of successful ageing using measurable variables as indicators of components of successful ageing. This has mostly been undertaken in cross-sectional studies in order to determine the proportion of successfully ageing older people in the population (G. Andrews, Clark, & Luszcz, 2002; Hamid, Momtaz, & Ibrahim, 2011; V. Lamb & Myers, 1999; S. J. Lee & Song, 2015; Montross et al., 2006). When different conceptualisations of models have been applied to classify older people using different variables as indicators of successful ageing, the prevalence of successful ageing varies remarkably (Depp & Jeste, 2006; Peel, Bartlett, & McClure, 2004), from as little as 0.4% (Garfein & Herzog, 1995) to 80% (V. Lamb & Myers, 1999). The majority of operationalised models have been based on the theory of successful ageing proposed by Rowe and Kahn (1987) and have also focussed on measures of physical health (for example S. J. McLaughlin, Jette, & Connell, 2012).

Cosco, Prina, Perales, Stephan, and Brayne (2014) conducted a systematic review of the operational definitions of successful ageing. The authors reported 105 operational definitions across 84 studies to examine the constituent components.

- 92.4% included physiological constructs (e.g. physical health and function)
- 49.5% included engagement constructs (e.g. paid and voluntary work)
- 48.6% included well-being constructs (e.g. life satisfaction)
- 25.7% included personal resources (e.g. resilience)
- 5.7% included extrinsic factors (e.g. finances)

The number of constructs included in the definitions varied between 1 and 5, with a mean of 2.2 and mode of 2 constructs included. The most common definition consisted of a single construct, physiological (28.8%) – strictly biomedical. The number of successful agers identified in each study varied from 0.4% to 91.7%. The authors conclude that there is a challenging amount of heterogeneity in the operationalisation of successful ageing.

A number of studies operationalising successful ageing have gone on to examine the determinants and predictors of successful ageing. The conclusions that can be drawn from the majority of work in this area are seriously limited, due to the cross-sectional nature of the studies meaning that the predictive relationships are purely speculative over time (for example Cha, Seo, & Sok, 2012). There is a distinct lack of longitudinal studies in this literature. A small number of studies have explored successful ageing over time (Haveman-Nies, de Groot, & van Staveren, 2003; Strawbridge, Cohen, Shema, & Kaplan, 1996). Although longitudinal, many of these studies do not account for mental health or other psychosocial components in their operationalisation of successful ageing.

This empirical focus on physical health is incongruous with the observation that the majority of researchers now acknowledge the fully multidimensional nature of successful ageing (Depp, Glatt, & Jeste, 2007). In addition to longevity and physical health, other primary components of successful ageing proposed include mental health, cognitive function, and social participation. Despite the acknowledgement of the multidimensional nature of successful ageing, the vast majority of empirical research into successful ageing models

mirror the MacArthur studies in describing physical health as the essential and primary component of successful ageing (Depp & Jeste, 2006), ignoring mental health.

One of the few longitudinal studies to investigate mental health components of successful ageing was hindered by the narrowness of the cohort studied (men living in a particular city), limiting the generalisation of the results (Vaillant & Mukamal, 2001). This issue is common across the literature. Another issue is research that reports on two time points of data, again limiting the conclusions that can be made regarding trajectories of successful ageing (Brandt, Deindl, & Hank, 2012). Shahar (2009) argues that “a model of changes between two time points is not testing anything conceptually different from a cross-sectional model” (p. 204). That is, studies that analyse changes between two time points are unable to describe longitudinal change and relationships, the primary advantage of longitudinal studies (Diggle, Liang, & Zeger, 1995).

Summary of methodological issues

Overall, the general literature investigating successful ageing is restricted by methodological issues, which the current thesis will aim to address. Primarily, there are few large representative sample populations investigated. In addition, the data tends to be cross-sectional as opposed to longitudinal and, as a potentially inevitable consequence of this design, simplistic statistical analyses have been applied. There is lack of multidimensional operationalisations of successful ageing, specifically neglecting intrinsic mental health components of ageing well. The contention of this thesis is based on these observations, arguing that the exclusion of mental health is a significant gap in the successful ageing literature that needs to be addressed using large representative longitudinal studies.

1.3.3 Lay perspective

To add weight to the argued importance of the neglected area of mental health, lay definitions of successful ageing will now be discussed. Older people’s own definition of successful ageing has also been widely studied and documented (Bowling, 2006, 2009; Bowling & Iliffe, 2011; Fernandez-Ballesteros et al., 2008; Phelan, Anderson, LaCroix, & Larson, 2004;

Westerhof, Dittmann-Kohli, & Thissen, 2001). Researching older people's beliefs about what successful ageing entails is important because lay opinions can further develop academic models of successful ageing, thus making them more comprehensive. These models, in turn, can be used to inform policy, health care, and interventions to promote successful ageing in a way that is meaningful to the majority of older people. This aim is consistent with the objectives of person-centred care, the current prevalent construct informing health care delivery in Australia (National Health and Hospitals Reform Commission, 2008).

In their research into the lay perspective, Phelan and colleagues (2004) reported that older adults' perceptions of successful ageing were typically multidimensional, encompassing beliefs about physical, functional, social and psychological health. Typically, there are discrepancies between lay and research models of successful ageing. Lay models tend to emphasise mental health more than research models (Phelan et al., 2004; Reichstadt, Depp, Palinkas, Folsom, & Jeste, 2007), and have been shown to be more predictive of quality of life in older age (Bowling & Iliffe, 2006). The focus of the lay definition on mental health appears to make practical sense at face value, in that while avoiding chronic disease and disability in later life may not be a realistic expectation, developing emotional adaptation to changes in health states may be achievable (Depp et al., 2010).

As another example of the discrepancies between lay and research models, as mentioned above, when operationalised, Rowe and Kahn's (1987) research theory categorises only a minority of older people as ageing successfully (Minkler & Fadem, 2002; Montross et al., 2006; Strawbridge, Wallhagen, & Cohen, 2002). This observation is difficult to reconcile with the finding that a large proportion of older people categorise themselves as ageing successfully according to their own criteria (von Faber et al., 2001). Interestingly, the majority of older Australians report themselves in good, very good or excellent health (Australian Bureau of Statistics, 2010a) and continue to contribute substantially to the economic and societal framework of Australia (Australian Bureau of Statistics, 2010b; National Seniors Australia Productive Ageing Centre, 2009).

Taken together, these observations indicate the need for future examination and inclusion of mental health as a component of successful ageing. The following section will discuss the mental health component of successful ageing in more detail.

1.4 Mental health

In arguing for the inclusion of mental health as a component of successful ageing, and acknowledging the gap in the research literature, the concept of mental health used in this research must be delineated.

Mental health is a complex construct, and like successful ageing, can be labelled and conceptualised in different ways. Some researchers have proposed conceptualisations of mental health that have focussed on negative measures such as depression, anxiety, guilt, negative mood (Eussen et al., 2002; Heesch, Burton, & Brown, 2011; Sargent-Cox, Butterworth, & Anstey, 2011). Other proposed conceptualisations have included subjective well-being, life satisfaction, and positive feelings and functioning (C. L. M. Keyes, 2002; Shiovitz-Ezra, Leitsch, Graber, & Karraker, 2009).

This thesis will firstly apply a broad definition of mental health in systematically reviewing the relevant empirical literature, looking at trajectories of mental health as measured by the Mental Health Index (MHI-5) of the SF-36 (Ware et al., 1993). As such, mental health will be defined as the absence of psychological distress and the presence of well-being. The quantitative analyses used in this thesis will also use the MHI-5 as the indicator variable to represent mental health. The MHI-5 is a measure of psychological distress and well-being. Psychological distress is represented by three items, one each tapping anxiety, depression, and behavioural/emotional control. Psychological well-being is measured by two items representing positive affect (McHorney & Ware, 1995).

This thesis is investigating mental health, as in any conceptualisation, it is an under-researched component of successful ageing. Again, one of the only longitudinal studies

looking specifically at successful mental health ageing is limited by a narrow cohort (men of a particular city) and by the inclusion of data collected at two time points only (Almeida, Norman, Hankey, Jamrozik, & Flicker, 2006).

Furthermore, men and women have been shown to have different mental illness outcomes in past research. Men are at greater risk of depression as they age and in the years preceding death (Anstey & Luszcz, 2002; Burns, Butterworth, Luszcz, & Anstey, 2013), while women report higher levels of depression and anxiety across most of their adult lifespan (Burns, Butterworth, et al., 2012; Korten & Henderson, 2000). Hence, it is likely that there will be sex differences in mental health trajectories; as such, sex stratification will also be a critical component of this research that will add significantly to the literature.

Given the inadequate examination of mental health in the successful ageing literature, it is necessary to look to other areas of research to investigate how and why the mental health of older people changes. A number of longitudinal studies of older people have included mental health as a variable, but the reporting of the associated trajectories and predictors requires closer inspection. The methodologies and analyses used also require critiquing. The most comprehensive research from other disciplines can then be used to illuminate the neglected area of mental health in a successful ageing context. The systematic review reported in Chapter 3 in this thesis was designed to fulfil this purpose.

1.5 Rationale

It is imperative to develop an evidence base on the quality of life in older age to identify the components, predictors and interventions that promote successful ageing (Depp et al., 2010). This research is necessary to create effective policy and practice designed to increase the “health span” or “healthy life expectancy” (HALE) of older people (Depp & Jeste, 2006; Fries, 2002), and thus reduce the potential economic impact of an ageing population.

Peel, McClure, & Bartlett (2005) argued that while many nations produce and implement healthy ageing policy, such policy assumes the existence of a sound evidence base. This assumption is frequently false given the over-abundance of research based on negative aspects of ageing such as mortality and morbidity, and the lack of research regarding ageing in positive terms, such as well-being.

Indeed, the majority of existing research on ageing tends to focus on prevention and management of chronic disease and disability (Peel et al., 2004). An impairment and disease-free older age is unlikely with the current gains in life expectancy associated with increased years with a disability (Australian Bureau of Statistics, 2009; Australian Institute of Health and Welfare, 2006). However, there are many older people who are physically and/or mentally well despite such chronic disabilities. Dichotomising people as either “diseased” or “normal” does not recognise the heterogeneity of the ageing experience within both these groups (Bowling & Dieppe, 2005).

Currently there is an over-emphasis in existing research on physical functioning and disability, with comparatively little research into the mental health components of successful ageing (Depp et al., 2010). There is also discrepancy between the definitions of successful ageing offered by researchers and those adopted lay people (Bowling & Dieppe, 2005; Depp et al., 2010). Along with such theoretical issues, the empirical literature is plagued with methodological flaws that limit the conclusions that can be drawn about successful ageing as a concept. It is not possible to produce effective and informed policy and practice when the concept of ageing well is poorly defined (Depp & Jeste, 2006; Peel et al., 2004).

This research has a focus on the mental health of older people, in the context of the successful ageing literature. It explores how mental health changes over time and what indicators have been found to predict different trajectories of mental health. The important relationship between mental health and physical health is examined in detail. This research contributes to the evidence-base and theoretical discourse around successful ageing by distilling and integrating work across disciplines, in addition to providing empirical evidence that has the potential to enhance the mental health of older people. This thesis concentrates on mental

health and successful ageing and the translation of the thesis findings to current practice and policy in Australia.

1.6 Scope

This thesis addresses the following questions: i) how and why does mental health change over time for older people, ii) does the MHI-5 function homogenously across groups, iii) how does physical health influence mental health over time, iv) how does mental health influence physical health over time, and v) how does physical health influence depression over time. To do so, this research focuses on the health of people aged 65 years and older. This was investigated using both a systematic review and integrative data analytic methodology. The quantitative research explores older people in Australia specifically. This thesis takes an exploratory approach rather than specifying specific hypotheses. This research incorporates interdisciplinary perspectives, presenting literature and insights from various fields of study including gerontology, epidemiology, public health, psychology, sociology and medicine. Other areas of health that are potential components of successful ageing, such as genetic factors, physiological, and cognitive health are not central to this research.

1.7 Research framework

The research undertaken for this thesis consists of two broad exploratory studies. Both the first research theme (i.e. how and why does the mental health of older people change over time?) and the second (i.e. what is the relationship between physical and mental health?) were addressed by the two studies using different approaches.

Study 1 comprised a systematic review of existing literature documenting trajectories of mental health in older people. This study aimed to distil the outcomes of past research from across disciplines and ultimately provide unique insight into mental health pathways in an ageing context. The methodology applied was taken from the PRISMA (Preferred Reporting Items for Systematic reviews and MetaAnalyses) guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009). Explicit processes were used to identify, select and critically evaluate the relevant research articles.

Study 2 consisted of the analysis of a large longitudinal harmonised dataset of older adults. Specifically, this study modelled the trajectories of the physical and mental health of participants over time. This study was performed within an integrative data analysis framework, that is, the statistical analysis of a single data set that consists of two or more separate datasets that have been pooled into one (Curran & Hussong, 2009, p. 82). Trajectory analysis was conducted using statistical modelling to examine mental and physical health. This modelling enabled the study of participants' health over time and the patterns of change experienced.

1.8 Structure of the thesis

This thesis consists of ten chapters. The first chapter has presented an introduction to the overall thesis topic, the theoretical and empirical bases for the research and a brief overview of the aims and methods that drove the research. Chapter 2 provides a comprehensive description of the successful ageing literature in the form of a narrative review. The third chapter entails the systematic review of the literature investigating trajectories of mental health in older people, including a detailed description of the methodological protocol adhered to (Study 1). Chapter 4 details the methodology applied in the longitudinal analyses. Chapter 5 involves an invariance analysis (Study 2.1) of the assessment tool that is used in the longitudinal analyses and the results of these analyses (Studies 2.2, 2.3, 2.4) are presented in Chapters 6-8. The ninth chapter involves a discussion of the findings, followed by a conclusion in Chapter 10.

Chapter 2

NARRATIVE REVIEW OF THE SUCCESSFUL AGEING LITERATURE

2.1 Introduction

This chapter provides a comprehensive description and critique of the theoretical and empirical literature on successful ageing. Successful ageing is the theoretical framework that has been selected to inform the current thesis. To begin, a history of the prominent theories of ageing is presented, as they are an important precursor in the understanding of the development of the successful ageing literature. A summary of concepts similar to successful ageing is then provided for contextual and comparative purposes. This is followed by detailed explanation and review of the major theories of successful ageing and the associated empirical research designed to evaluate the theories.

2.2 Theories of ageing

Prior to discussing successful ageing as a concept, its important theoretical predecessors must be described. This is to provide the historical context from which successful ageing emerged. Described below are arguably the three major psychological theories that aim to depict socioemotional development in older people: disengagement, activity and continuity theory. These theories aim to describe the process of ageing. The explanatory power of the theories will be discussed.

2.2.1 Disengagement Theory

In their seminal book *Growing Old* (1961), Cumming, a sociologist, and Henry, a psychologist, proposed a theoretical description of the psychosocial aspects of ageing termed disengagement theory. In the forward of Cumming and Henry's book, their work was described by Parsons as:

an impressively detailed empirical study of a sample of older people and made what is probably the most serious attempt so far to put forward a general theoretical interpretation of the social and psychological nature of the aging process in American society. (Parsons in Cumming & Henry, 1961, p. v)

The theory was based on the authors' empirical observation of older Americans' withdrawal from social roles and activities. They proposed that the purpose of this withdrawal was to facilitate the process of dying by minimising the societal impact of death; the major objective being to maintain the normal functioning of society (Fry, 1992).

The authors defined disengagement as:

an inevitable process in which many of the relationships between an aging person and other members of society are severed, and those remaining are altered in quality.

(Cumming & Henry, 1961, p. 211)

Cumming and Henry constructed nine explicit postulates to explain the underlying processes of their disengagement theory. These are documented in Table 2.1.

Table 2.1. Postulates of the Disengagement Theory of Aging (from Cumming & Henry, 1961, pp. 211-218).

1. Although individuals differ, the expectation of death is universal, and decrement of ability is probable. Therefore a mutual severing of ties will take place between a person and others in his society.
2. Because interactions create and reaffirm norms, a reduction in the number or variety of interactions leads to an increased freedom from the control of the norms governing everyday behaviour. Consequently, once begun, disengagement becomes a circular, or self-perpetuating, process.
3. Because the central role of men in American society is instrumental, and the central role of women is socio-emotional, the process of disengagement will differ between men and women.
4. The life cycle of the individual is punctuated by ego changes — for example, aging is usually accompanied by decrements in knowledge and skill. At the same time, success in an industrialized society is based on knowledge and skill, and age-grading is a mechanism used to ensure that the young are sufficiently well trained to assume authority and the old are retired before they lose skill. Disengagement in America may be initiated by either the individual because of ego changes, or by the society because of organizational imperatives, or by both simultaneously.
5. When both the individual and society are ready for disengagement, complete disengagement results. When neither is ready, continuing disengagement results. When the individual is ready and society is not, a disjunction between the expectations of the individual and of the members of his social systems results, but usually engagement continues. When society is ready and the individual is not, the result of the disjunction is usually disengagement.
6. Because the abandonment of life's central roles — work for men, marriage and family for women — results in a dramatically reduced social life space, it will result in crisis and loss of morale unless different roles, appropriate to the disengaged state, are available.
7. If the individual becomes sharply aware of the shortness of life and the scarcity of the time remaining to him, and if he perceives his life space as decreasing, and if his available ego energy is lessened, then readiness for disengagement has begun.
8. The reduction in interaction and the loss of central roles result in a shift in the quality of relationship in the remaining roles. There is a wider choice of relational rewards, and a shift from vertical solidarities to horizontal ones.
9. Disengagement is a culture-free concept, but the form it takes will always be culture-bound.

At the time, their work was perceived as an original, contentious and perhaps the first attempt at defining a theory of normal ageing (Achenbaum & Bengtson, 1994). It has been noted to be one of the few theories of ageing produced for, and by, gerontologists (Achenbaum, 2009). The prediction made by Parsons was correct, and disengagement theory stimulated a great deal of research and discussion regarding the ageing process (Youmans, 1969). This was a positive advancement in furthering ageing discourse and an important step away from a pathological view of ageing, despite being a model of decline.

However, disengagement theory was criticised by many, for various reasons (Dowd, 1975; Hochschild, 1975; Kutner, 1962; Maddox, 1964). The primary criticism of disengagement theory is that it is not supported by the vast majority of empirical research (Achenbaum & Bengtson, 1994; Kapnick, Goodman, & Cornwell, 1968; Prasad, 1964; Shanas, 1968; Youmans, 1968; Zborowski, 1962). Indeed, research has often shown the opposite to disengagement to be true, with participation increasing with age, and engaged and social older people tending to have higher life satisfaction (Glanz, 1984; Glenn & Grimes, 1968; Rose, 1964).

Other criticisms included that it was ethnocentric, and not applicable to cultures other than the reasonably homogenous sample of the observed older American people that the theory arose from (Rose, 1964). However, even in culturally similar populations the theory is not supported (Tallmer & Kutner, 1970; Youmans, 1969). Brehm (1968) and Kutner (1962) criticise the over-generality of the theory, suggesting that the process of disengagement is applicable only to certain older people. Others have suggested that the implication that older people should disengage is ageist (Wilmoth & Ferraro, 2007), “wasteful” and detrimental for individuals and society, given the many valuable contributions older people make (Fry, 1992, p. 255).

Disengagement theory does not adequately account for the effects of gender, socioeconomic status, or education on ageing. Although gender is mentioned, it involves unrealistic stereotyping. The theory also fails to allow for the effects on ageing of differences in personality (Havighurst, 1968). That is, the theory suggests that ageing is a universal,

homogenous, context free and biologically determined process, and to achieve life satisfaction *all* older people *must* disengage (Fry, 1992; Maddox, 1965, 1987). Maddox (1987) described this as an implausible generalisation given the heterogeneity of older people and the ageing process, and stated:

Evidence, experience, and theory led me to reject totally such reductionists theorizing about psychosocial processes of aging. (Maddox, 1987, p. 559)

The rejection of disengagement theory appears almost universal. The authors of the theory themselves distanced themselves almost immediately from the theory (Achenbaum & Bengtson, 1994). The empirical data indicates that disengagement theory has fundamental limitations that prevent its acceptance as an explanation of psychosocial ageing or as a guide for researchers and practitioners (Youmans, 1969). However, the theory presented a novel way of describing the ageing process, and represents a notable attempt at providing a comprehensive and explicitly stated explanation of ageing.

2.2.2 Activity Theory

In response to the inadequacies of disengagement theory, during the 1960s and 1970s activity theory became a prominent framework to describe the ageing process. In direct contrast to disengagement theory, activity theory proposes that sustaining existing social roles and involvement in meaningful activities increases well-being and life-satisfaction (Kleemeier, 1951; Zborowski, 1962).

The theory was supported by many, a main proponent being Robert J. Havighurst, a professor of education interested in human development, who stated:

that people should maintain the activities and attitudes of middle age as long as possible and then find substitutes for the activities which they must give up—substitutes for work when they are forced to retire; substitutes for clubs and associations which they must give up; substitutes for friends and loved ones whom they lose by death. (Havighurst, 1961, p. 8)

This was based on the premise that reduction in physical, mental and social activity is the primary cause of psychological ill health in older people (Maddox, 1968); an overly simplistic hypothesis, not supported by the current evidence base, as will be discussed below. The theory claims that the maintenance and substitution of previous activity levels maintains a positive sense of self (Schroots, 1996). Commentators have criticised these claims, as needs can be harder or impossible to fulfil in the context of ageing, as they are determined by social norms such as enforced retirement or cognitive decline (see, for example Knapp, 1977).

Activity theory was reformulated by Lemon, Bengtson, and Peterson (1972) to state that quality is more important than quantity when assessing outcomes of social roles. Lemon and colleagues (1972) created four explicit postulates of the reframed activity theory:

The greater the role loss, the less the activity one is likely to engage in.

The greater the activity, the more role support one is likely to receive.

The more role support one receives, the more positive one's self-concept is likely to be.

The more positive one's self-concept, the greater one's life-satisfaction is likely to be.
(Lemon et al., 1972, p. 515)

That is, “perceived positive outcomes of role investment is more important than the number of roles older adults play” (Lefrancois, Leclerc, & Poulin, 1997, p. 16). This contention continues to find support in the empirical literature (Litwin & Shiovitz-Ezra, 2006).

However, the empirical evidence for activity theory is equivocal. Whilst there is evidence for an association between activity engagement and life satisfaction (Kahana et al., 1995; Matz-Costa, Besen, Boone James, & Pitt-Catsoupes, 2014; C. Peterson, Park, & Seligman, 2005), others have found no empirical evidence for the association of activity with increased life satisfaction. Fry (1992) summarises the overall literature:

Research findings...show that the general activity level of elderly groups is not uniformly and positively associated with life satisfaction (Lemon et al., 1972; Maddox, 1970). Therefore, one of the manifest problems of the activity approach is

evidence contradicting its major proposition, that maintenance of a relatively high level of activity leads to adjustment with concomitant high morale. (Fry, 1992, p. 265)

This problem may be explained by the observation that, similarly to disengagement theory, activity theory promotes a single, socially active way of life for all older people. That is, the theory does not acknowledge the empirically established heterogeneity of older people and their life preferences. Interestingly, older people experiencing health or social problems report disengagement as preferable (Fry, 1992). Again, the theory ignores important mediating effects of health, social, economic and personality factors that may reduce older people's desire, ability and opportunity to take part in activities and perform particular roles (Achenbaum, 2009; Healthpact Research Centre for Health Promotion and Wellbeing, 2006; Walker, 2002). Thus the theory has been described as too idealistic, Walker (2002) arguing that it:

placed an unrealistic expectation on ageing individuals themselves to maintain the levels of activity associated with middle age through to advanced old age. (Walker, 2002, pp. 122-123)

Both disengagement and activity theory have been criticised for being overly broad (Covey, 1981). The theories have been presented as an over-simplification of the extremely complex process of ageing (Covey, 1981), in which many factors could be said to play a part, including personality, culture, socioeconomic status, and genetics. Both theories underplay the reciprocity of interactions between the individual and the environment (see, for example, Lawton, 1983). It seems unlikely that one broad variable could explain the intricacies of the ageing process, which these theories have attempted to do (Quadagno & Street, 1996; Utz, Carr, Nesse, & Wortman, 2002). Achenbaum (2009) summarises this criticism of the two theories:

Neither end of the dualism captures the range of potentials and pitfalls common to late life or the circumstances that affect widening and or withdrawing social bonds and meaningful endeavours that people engage in as they grow older. (Achenbaum, 2009, p. 32)

However, both theories have played an important part in contributing to our understanding of ageing, and how it is conceptualised (Covey, 1981).ⁱ

2.2.3 Continuity Theory

Given the limitations associated with both disengagement and activity theory, continuity theory was put forward in the 1960s as an alternative perspective on ageing (Rosow, 1963). Gerontologist Robert Atchley was a major and vocal proponent for decades (1971, 1989) along with other commentators such as Fox (1981) and Rosow (1963). Continuity theory can be presented as a modified, fluid version of activity theory. Atchley (1989) described the central premise of continuity theory:

In making adaptive choices, middle-aged and older adults attempt to preserve and maintain existing internal and external structures and that they prefer to accomplish this objective by using continuity... (Atchley, 1989, p. 183)

The theory was developed to explain the observation that despite changes in health, functioning and social circumstances, many older people maintain consistent patterns of personality, ideas, beliefs, thinking, activity, living arrangements and social roles (Atchley, 1989). This consistency allows the individual to sustain a stable concept of self, and make decisions based on these internal foundations, formed from past experience. The use of the term “adaptive choices” was an important conceptual milestone, taking the opposite approach to the former passive acceptance of the “perils” of ageing. Although not a prescription for successful ageing, Atchley (1989) argued that continuity theory is an explanatory framework that can be used to understand why many older people experience ageing as a positive process, despite ageism and decreasing physical and mental health.

ⁱ These two theories also allowed for the emergence of the related Socioemotional Selectivity Theory (Carstensen, 1995). This theory has been described as the “logical extension” of disengagement theory (DeLiema & Bengtson, 2017, p. 18). Rather than universal disengagement, Carstensen (1995) argued that as the goals of older people change, their social behaviour is selected accordingly to optimise achieving these goals.

The internal continuity structures that Atchley (1989) refers to above are defined by the individual and consist of remembered ideas, temperament, affect, experiences, preferences, dispositions, and skills (p. 184). External continuity is the remembered structure of physical and social environments, role relationships, and activities (p. 185). Therefore, external continuity is achieved through performing familiar activities and roles in familiar environments. Continuity is then achieved through the individual validating these experiences through internal structures. Broadly speaking, the continuity theory suggests that an individual's characteristic qualities and behaviours remain stable over time (Fry, 1992).

The primary criticism of the continuity theory is that it does not have a clear succinct definition with a set of explicit testable postulates or propositions (Fry, 1992). Therefore, it cannot be confirmed or refuted through empirical research studies. Fry (1992) argues that the only conclusion that can be drawn from much of the research into continuity theory is that older people have the same psychosocial needs as middle-aged people. Like both activity and disengagement theories, continuity theory has been described as overly broad, with many also broad variables included in its conceptualisation, such as personality, lifestyle, beliefs and preferences (Covey, 1981; Fry, 1992). Covey (1981) also described it as being potentially too complex to be of use in understanding the ageing process and older people.

Continuity theory has also been criticised for its focus on “normal” ageing, as it does not encompass older people with chronic illness or disabilities. Again, continuity theory was criticised for minimising the impact of external social factors on the process of ageing (Achenbaum, 2009), Utz and colleagues (2002) suggesting:

continuity of lifestyle and role stability is nearly impossible considering the inevitability of role loss through events such as retirement, death of loved ones, and the emptying of the familial nest. (Utz et al., 2002, p. 523)

In summary, although there is evidence that suggests that older people behave similarly to their younger selves (Fry, 1992), continuity theory is a problematic description of the ageing process that is also difficult to operationalise and assess.

Taken together, the disengagement, activity and continuity theories of ageing are unable to encapsulate the ageing process adequately (Utz et al., 2002), despite their contributions to productive debate. They lack consistent empirical support and attract similar and considerable criticisms towards their propositions.

2.3 Successful ageing and other similar concepts

The three theories described above attempted to both describe the psychosocial aspects of ageing and implicitly dictate a particular prescription of how to age well. This is a more specific contention to make than simply describing the ageing process. This prescription is what many researchers take interest in, as the promotion of ageing well carries many potential individual and societal benefits. Many researchers have gone on to specifically focus on the task of investigating the process and outcomes of ageing well, with the goal of creating a universally accepted definition.

In the process of trying to achieve this goal, researchers have used various terms to conceptualise the optimisation of well-being as we age. These terms include:

- Active ageing
- Healthy ageing
- Positive ageing
- Productive ageing
- Successful ageing
- Ageing well

These terms are not interchangeable: they have differing aetiologies, purposes, and interpretations of the conceptualisation of optimised well-being in later life. The following sections will discuss in detail these concepts and the associated research literature. The origin, definition, purpose, content, limitations and empirical evidence for these concepts will be considered. Those concepts with associated theory will be discussed in more detail.

2.3.1 Active ageing

The concept of active ageing stemmed from the activity theory contention that well-being in older age is reliant on the maintenance of the activities of middle age. Active ageing is a concept that attempts to acknowledge the complexities of and many influences upon the ageing process, and forms the basis for the worldwide approach to the management of ageing populations (Mayhew, 2005; Perek-Bialas, Ruzlk, & Vidovicova, 2006; Piekkola, 2006; Poscia, Landi, & Collamati, 2015; Stenner, McFarquar, & Bowling, 2011; World Health Organization, 2002). Preserving functional independence, reducing health care costs and enhancing quality of life are key tenets of active ageing (Bauman, Merom, Bull, Buchner, & Fiatarone Singh, 2016). Although not uncriticised, the proposed conceptualisations thus far appear well-meaning, with an emphasis on approaching ageing in positive terms that acknowledge the contributions that older people make to society.

As discussed above, activity theory was criticised for the generalisations inferred about ageing and older people. The theory was also criticised for creating an unrealistic expectation on older people to maintain the activity levels of middle age in the face of biological, social challenges associated with ageing (Walker, 2002).

Despite these acknowledged issues, there is an important empirical link between activity and well-being in older people (Walker, 2002). The World Health Organization recognised this link by creating a new conceptual model of active ageing which included previously ignored factors such as health and social inclusion (Healthpact Research Centre for Health Promotion and Wellbeing, 2006), encapsulated by the World Health Organization's familiar pronouncement of good health adding "life to years" (2012a). This is contrary to a pure focus on longevity, adding years to life, which is an inadequate description of good health in ageing. Longevity is important, but quality of life must be optimised throughout the life-span.

Although having a much longer history, given its association with activity theory, active ageing became a popular policy concept in the early 2000s (Walker, 2002). This was largely

due to the work of the World Health Organization, a major proponent of active ageing. In the World Health Organization's 2002 policy framework active ageing is expressed as:

The process of optimising opportunities for health, participation and security in order to enhance quality of life as people age.

The word 'active' refers to continuing participation in social, economic, cultural, spiritual and civic affairs, not just the ability to be physically active or to participate in the labour force. (World Health Organization, 2002, p. 6)

The policy framework was designed to inform and strongly encourage the creation of future policies and programmes to promote active ageing. In doing so, the World Health Organization wanted to emphasise that active ageing is a social responsibility in addition to an individual's responsibility (Walker, 2006).

Aside from being a practical policy prescription, the active ageing concept was also designed with an agenda to:

change our views, perspectives, understandings, stereotypes and prejudices about ageing in order to reconstruct the practical societal reality of the ageing process...(Stenner et al., 2011, p. 2)

Although not overtly stated, this is an important function of the concept. The concept represents a substantial paradigm shift from the somewhat ageist "decline and loss paradigm" of the ageing process (Holstein & Minkler, 2007). Instead, active ageing portrays older people as active and contributing members of society, which is a reality and an important message to send for the benefit of individuals and society in general (Stenner et al., 2011). Foster and Walker (2015) argue that active ageing represents a more holistic, life-course perspective concept when compared to successful ageing. The authors also believe that both societal and organisational responses are integral to the concept of active ageing, rather than relying on, and emphasising the actions of individuals (Foster & Walker, 2015).

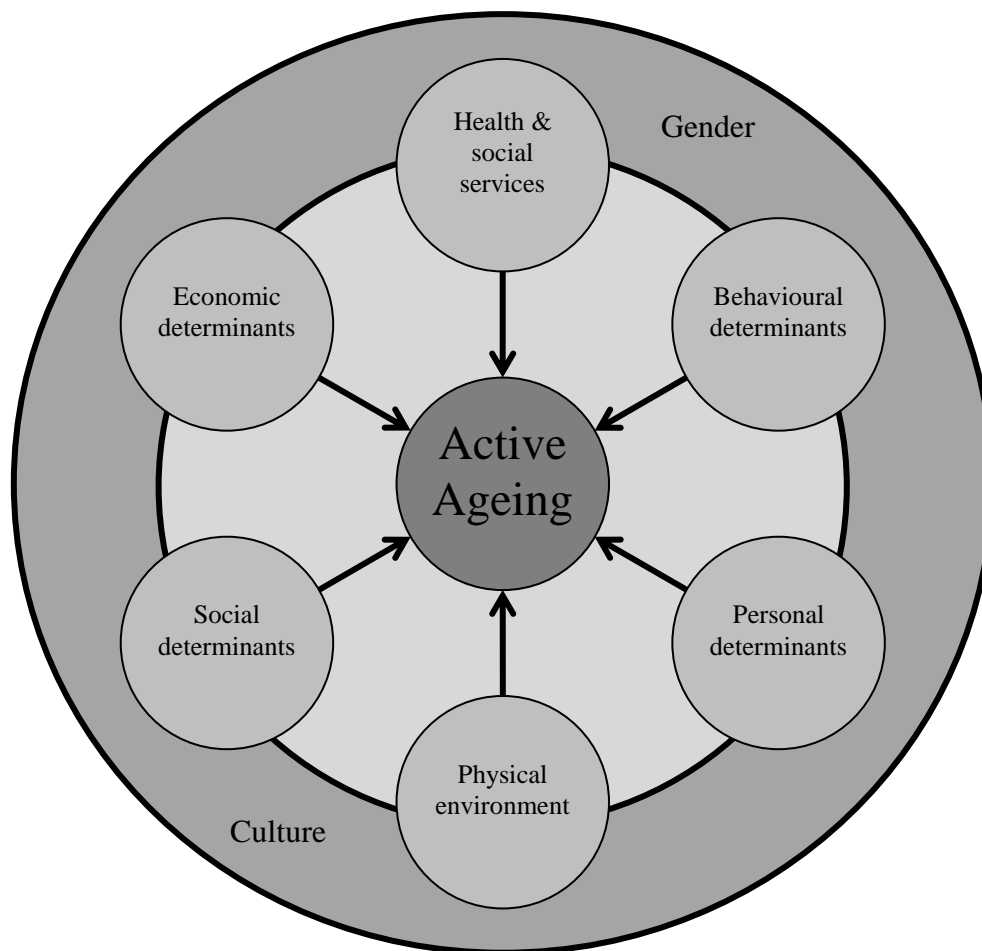
In the World Health Organization's conceptualisation, active ageing aims to increase life expectancy and quality of life. This definition is applicable to individuals and population

groups, and includes frail and disabled people. The World Health Organization adopted the term to provide a broader, more inclusive concept than “healthy ageing” to aspire to; a concept in use prior to active ageing and discussed in more detail below. The authors of the Active Ageing Framework suggest that “healthy ageing” is too narrow a definition, as it does not acknowledge factors not associated with health care that influence how people age. The World Health Organization recommends a “rights-based” strategic planning approach where older people are recognised as deserving equal opportunity and treatment. This is opposed to a “needs-based” approach, where older people are seen as taking a passive role. The World Health Organization recommends a life course approach to active ageing. That is, interventions that promote active ageing should be provided throughout life.

There are three general components of active ageing which constitute quality of life: health, participation, and security. “Health” encompasses physical, social and mental well-being; “participation” is involvement in society, and; “security” is the provision of adequate protection and care when necessary. This definition focuses on the importance of participation in many fields of life, including social, economic, cultural, spiritual, civic, and work. Maintaining independence and autonomy are important factors in active ageing. Additionally, as ageing occurs in a social context, the World Health Organization Active Ageing Framework also emphasises interdependencies and intergenerational solidarity. That is, mutual giving and receiving between individuals and generations. The definition of active ageing offered by the World Health Organization is based on the acknowledgement of the “human rights of older people and the United Nations Principles of independence, participation, dignity, care and self-fulfilment” (World Health Organization, 2002, p. 7).

As shown in Figure 2.1, the influences upon active ageing are economic, behavioural, personal and social determinants, in addition to physical environment and health and social services. Culture and gender are defined as “cross cutting determinants”, influencing all other determinants of active ageing. For example, in some contexts women are prohibited from undertaking paid employment, which influences economic and personal determinants.

Figure 2.1. The determinants of active ageing (World Health Organization, 2002, p. 10).



Whilst active ageing is a much more inclusive and comprehensive concept than activity theory, this model was created for policy, rather than research, purposes. In the research literature, there is no accepted definition of active ageing and little research around the concept. In her analysis of the conceptual area, Bowling (2009) states:

Despite policy emphasis on promoting active ageing...and the large psycho-social literature aiming to test ‘activity theory’, there is a dearth of conceptual literature on ‘active ageing’ per se, in contrast to related concepts...(Bowling, 2009, p. 1)

Bowling agrees with both the World Health Organization and Walker that active ageing is a multidimensional concept and acknowledges empirical support exists for different constituents of the active ageing models. For example, it is well-established that physical activity enhances quality of life for the majority of people (Rejeski & Mihalko, 2001; Sims, Hill, Hunt, & Haralambous, 2010). However, research into the model as a whole is sparse.

Bowling also addresses the issue of the lack of clear conceptual delineation between the constituents of optimal quality of life (Bowling's proposed end point of active ageing) and the associated influencing variables of active ageing. A definition based on a sound model is necessary to develop appropriate measures to evaluate the efficacy of policy and interventions designed to promote active ageing (Bowling, 2009).

There are commentators that go further than these criticisms of the active ageing concept. Ranzijn (2010) argues that active ageing as a conceptual paradigm and policy framework is a form of doublespeak:

While active ageing on the face of it appears to reflect a positive view of ageing, it has been argued that it is underpinned by an economic imperative—reducing the ‘burden’ on society of supporting increasing hordes of non-productive retirees...which paradoxically reinforces negative stereotypes of older people as non-productive drains on society's resources. (Ranzijn, 2010, p. 717)

Ranzijn (2010) also argues that the concept further stigmatises and excludes certain marginalised older people by establishing unrealistic and culturally inappropriate expectations. Ranzijn specifically references disadvantaged and diverse non-dominant cultural groups, such as Australian Aboriginal Elders.

Similarly, other authors have raised concerns that active ageing policy primarily benefits individuals with higher education only (König, Hess, & Hofäcker, 2016). This contention is mirrored by Holstein and Minkler (2007) who argue that the excessive focus on the positive aspects of ageing risks ignoring certain groups of older people. The idealisation and imposition of an active lifestyle may be counterproductive and oppressive, ultimately reducing individual self-worth (Stenner et al., 2011). Maintaining independence is simply not a realistic outcome for many older people. For example, individuals with physical disabilities may be further marginalised by the theory as it does not correspond to their beliefs around optimal well-being (Molton & Yorkston, 2017). Walker (2002), an active ageing supporter, also refers to this, warning against overly coercing older people into a certain way of life, and the need to recognise diversity and different conceptualisations of “activity” that might not be

adequately represented by policy which may have an economic productivity focus (Stenner et al., 2011).

Whilst active ageing is a well-established and utilised policy catchphrase (Healthpact Research Centre for Health Promotion and Wellbeing, 2006), Walker (2006) has argued that the concept of active ageing has not been supported by a “coherent strategy” and is sometimes applied as an overly broad “political slogan” (p. 84), a sentiment reflected elsewhere (Healthpact Research Centre for Health Promotion and Wellbeing, 2006). Indeed, the World Health Organization appears to have ceased publishing substantial works in this area in 2007. A conceptual testable model of active ageing informed by lay and theoretical perspectives is yet to be established. Such a model needs to be inclusive of older people who may be frail, have chronic illnesses or disabilities (Stenner et al., 2011). This will enable the testing of markers of active ageing, to assess the utility of the concept in practice.

In summary, active ageing currently remains a blanket health and well-being policy term (Healthpact Research Centre for Health Promotion and Wellbeing, 2006), lacking a clear conceptual model and empirical support.

2.3.2 Positive ageing

Positive ageing is a concept that appears to have developed from the positive psychology movement in the late 1990s (Fernandez-Ballesteros, Kruse, Zamarron, & Caprara, 2007). Positive psychology itself has been described as:

A science of positive subjective experience, positive individual traits, and positive institutions promises to improve quality of life and prevent the pathologies that arise when life is barren and meaningless. (Seligman & Csikszentmihalyi, 2000, p. 5)

Both the concepts of positive psychology and positive ageing arose from the observation that research into human experience was dominated by a focus on pathology, or negative outcomes. Seligman and Csikszentmihalyi (2000) argued that this is problematic as it results in:

a model of the human being lacking the positive features that make life worth living.
(Seligman & Csikszentmihalyi, 2000, p. 5)

Positive psychology is now an established discipline, with associated research and practice (Fredrickson, 2003; Gable & Haidt, 2005; Joseph, 2015; V. Mitchell & Helson, 2016; Seligman & Csikszentmihalyi, 2000; Seligman, Steen, Park, & Peterson, 2005; Sheldon & King, 2001; Snyder & Lopez, 2009). However, the concept of positive ageing does not often appear in the research literature. When it is discussed, it is nearly always used interchangeably with successful ageing or other similar concepts (Asquith, 2009; Bowling, 1993; Fernandez-Ballesteros et al., 2007; Hays, Bright, & Minichiello, 2002; Laliberte Rudman, 2015; Vaillant, 2015, 2004; Woods et al., 2012).

Two of the few commentators that treat positive ageing as a unique concept are social psychologists Mary and Kenneth Gergen (E. Cole & Gergen, 2016; Gergen & Gergen, 2001, 2003, 2006). Applying the same contention of positive psychology, Gergen and Gergen argue that social gerontology has depicted ageing in terms of “decline, degeneration, and decrepitude” (Gergen & Gergen, 2001, p. 3). As a consequence of this depiction, minimal consideration has been given to “the possibility of growth, generativity, and development in the last decades of life” (Gergen & Gergen, 2001, p. 3). These authors called for research to reconstruct ageing in positive terms, arguing that this shift is necessitated by increasing numbers of older people experiencing enhanced social, political and economic power and being less willing to accept what they describe as “the Dark Ages” of aging (Gergen & Gergen, 2001, p. 3).

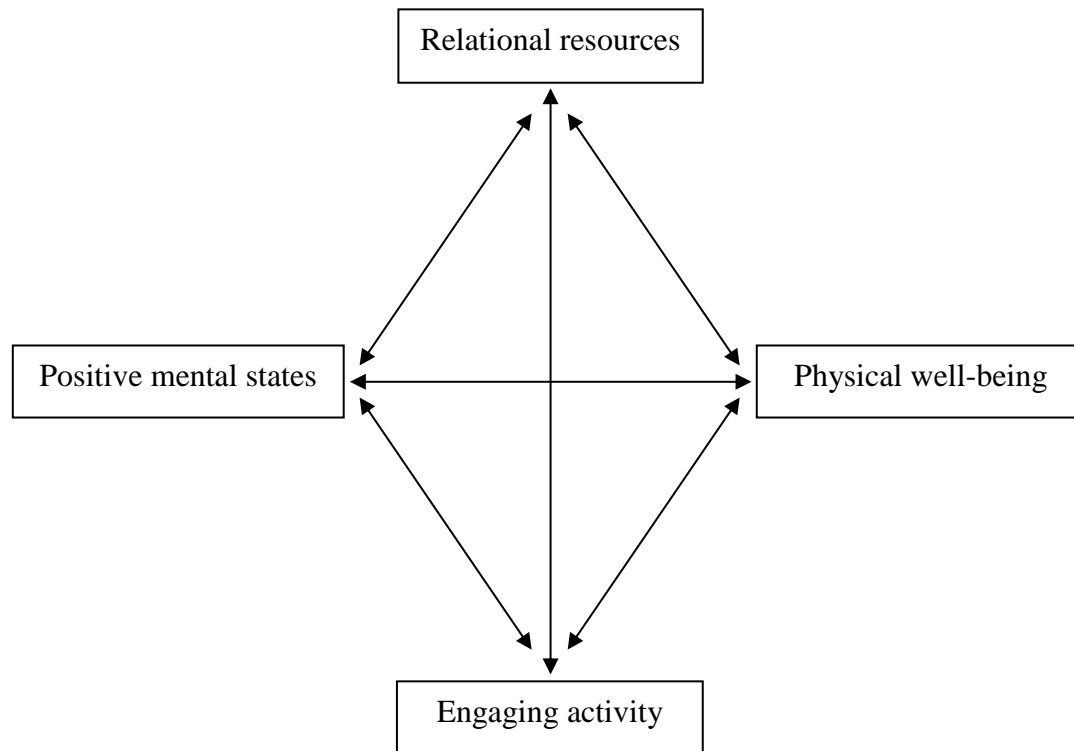
In their description of the concept, Gergen and Gergen presented research focusing on work that shows how older people avoid decline and improve their lives:

We fasten on research that does not close the door to a good life, but demonstrates ways in which the door may be opened wider...and embrace inquiry that opens new paths to well-being. (Gergen & Gergen, 2001, p. 9)

Gergen and Gergen described the importance of the research potential of positive ageing. The authors depicted the patterns of results observed in the research literature, calling this pattern

the “life-span diamond”, (see Figure 2.2 and Box 2.1). The authors present the diamond as a model of positive functioning, where all four points influence each other and are both origins and outcomes of positive ageing.

Figure 2.2. The life-span diamond (Gergen & Gergen, 2001, p. 10).



Box 2.1. Explanation of the Components of the Life-Span Diamond (Gergen & Gergen, 2006, p. 418).

Relational Resources: Supportive family and friends, conversational partners, and mediated connections, such as with chat room members and imaginal others – that is, those with whom we imagine interactions such as celebrities, fictional characters, or people who have died of who are no longer a part of our lives.

Physical Well-Being: Optimal functioning of brain and body as determined by medical tests, as well as through self-reports of health.

Positive Mental States: Well-being, happiness, optimism, and satisfaction with life.

Engaging Activity: Active participation in mental and physical activity.

Gergen and Gergen are self-described constructionists, arguing that positive ageing is constructionist in orientation, while successful ageing is empiricist. This is a key and damning difference in the authors' eyes. Successful ageing researchers are described as:

primarily concerned to get the facts straight regarding correlates or predictors of selected criteria of "success." (Gergen & Gergen, 2001, p. 19)

The authors suggest that research be used as a resource that people can choose to use if they wish. Gergen and Gergen argue that such resources will be useful to some and perhaps not to others, such as people with chronic disease and disability, who may be oppressed by the messages in the findings. They emphasise that the purpose of positive ageing is not to define a set "truth" about ageing, but to acknowledge the many different outcomes possible in the ageing process. Gergen and Gergen briefly address what they term: "the seeming optimism of our approach and its failure to take account of the existing hardships" (Gergen & Gergen, 2001, p. 20). The hardships they refer to are older people subject to poverty, loneliness, disease and disability. The authors defer this criticism by stating that their work is a counterbalance for the amount of attention that is focused on the negative issues of ageing. They even go as far with this argument to state:

this emphasis on decline may reflect the needs of those professions--scientific, medical, social service--that depend on aging as a problem to remain viable. To emphasize the positive would be to lose their *raison d'être*. (Gergen & Gergen, 2001, p. 20)

In keeping with their criticism of an empiricist view of science, the authors do not offer an evidence base to support their positive ageing model. The model does not appear to have been reproduced or discussed extensively in the research literature. The arguments presented by Gergen and Gergen represent quite an extreme viewpoint. The same criticism they level at other researchers focusing on disease and disability can perhaps be reversed and directed back at their focus on the positive aspects of ageing. Instead of appearing overly pessimistic, as they categorise the majority of ageing research, they appear overly optimistic about the outcomes of ageing to the point of losing sight of reality. There are serious issues associated with not acknowledging death and potential decline as part of the human ageing experience.

Ageing is a heterogeneous experience, one that is unlikely to be all positive or all negative experiences.

Although not prominent or a clarified concept in the research literature, the term positive ageing is ubiquitous in Australian policy documents, at localⁱⁱ, state and federal government levels (Bass Coast Shire Council, 2010; Seniors Bureau Department of Premier and Cabinet, 2007; Swan & Butler, 2012). Again, in policy the term is used interchangeably with other concepts, as explicitly stated in the following definition:

Positive Ageing is a term that is very much related to the creation of an age-friendly community that is, creating a community which facilitates older people's participation and involvement. It recognises the vital roles ageing people play in our community as family members, carers, volunteers, neighbours, workers and consumers. Other terms used interchangeably with positive ageing are 'ageing well', 'successful ageing', 'productive ageing' or 'active ageing'. (Byron Shire Council, 2010, p. 5)

In their policy analysis of the area, Davey and Glasgow offer the following warning, which is also pertinent to research:

some aspects of the underlying concepts of active, productive and positive ageing remain questionable. Without a broadening of these concepts there is a risk that the frail old may be further marginalised. It may be only the active old who benefit. (Davey & Glasgow, 2006, p. 26)

In summary, although not a concept used extensively in policy and practice, like positive psychology, the role of the positive ageing movement does have a place as it promotes awareness of the often negative view of ageing and associated ageism in research and Western society in general.

ⁱⁱA full list of Victorian Council's positive ageing strategies is available at www.mav.asn.au

2.3.3 Healthy ageing

Like active ageing, the term healthy ageing is liberally applied in the grey literature. However, it is in the research literature that the term is ubiquitous. Again, there is no universally accepted definition of healthy ageing. Health itself is a reasonably complex multidimensional construct, summarised by the often quoted definition provided by the World Health Organization:

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. (World Health Organization, 1946b, p. 1)

Healthy ageing as a concept also has to incorporate this conceptualisation of health, in that the concept is not merely the opposite of ageing with illness and disability (Peel et al., 2004). The following grey literature definitions have attempted to capture this:

A lifelong process of optimizing opportunities for improving and preserving health and physical, social and mental wellness, independence, quality of life and enhancing successful life-course transitions. (Health Canada, 2002, p. 5)

Healthy ageing is the process of optimising opportunities for physical, social and mental health to enable older people to take an active part in society without discrimination and to enjoy an independent and good quality of life. (The Swedish National Institute of Public Health, 2007, p. 8)

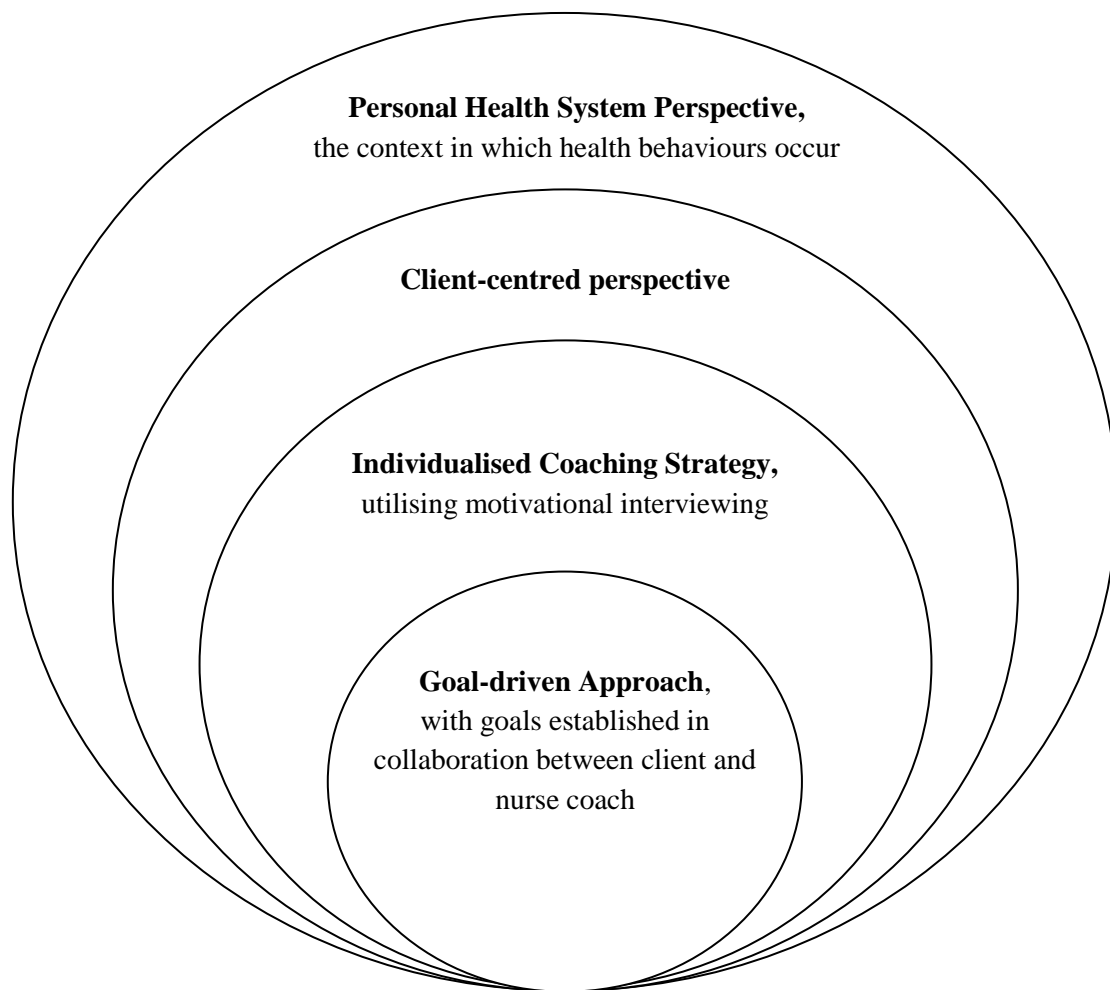
The World Health Organization has recently embraced the term healthy ageing in their health policy documents (Beard et al., 2016; World Health Organization, 2012b, 2015, 2016). In their 2015 World Report on Ageing and Health, the definition of healthy ageing focusses on the development and maintenance of functional ability that enables well-being in older age (World Health Organization, 2015, p. 28) while still acknowledging that there is:

surprisingly little consensus on what this might comprise or how it might be defined or measured. (World Health Organization, 2015, p. 28)

The authors do elaborate on the definition they provide, stating that functional ability is reliant on intrinsic capacity (physical and mental) and environmental characteristics.

Although these definitions have been offered, healthy ageing does not appear to be a theory driven concept. Potempa, Butterworth, Flaherty-Robb, and Gaynor (2010) recognised the lack of formal theory and established the Healthy Ageing Model (see Figure 2.3). The Model was developed to guide research and practice in regards to health promotion for an ageing population (Potempa et al., 2010). As Figure 2.3 shows the model is focussed on the promotion of positive health behaviour changes in older people by clinical practitioners, including important contextual elements that have been shown to impact efficacy of behaviour change. This is a practical model, addressing the process of how to effectively change health behaviours, but does not address what healthy ageing actually entails. This is one of the few identified attempts at providing a model of healthy ageing.

Figure 2.3. The Healthy Ageing Model (adapted from Potempa et al., 2010, p. 53).



Coming from a similar clinical perspective, nurse researcher Hansen-Kyle (2005) performed a concept analysis of healthy ageing, integrating the definitions and perspectives from multiple disciplines, including medicine, gerontology, psychology, sociology and nursing. Following this integration, Hansen-Kyle (2005) offered the following attributes of healthy ageing shown in Box 2.2.

Box 2.2. Attributes of healthy ageing (Hansen-Kyle, 2005, p. 48).

Continuous process of change and adaptation.

Self-defined and individualistic.

Slowing down of body processes.

Acceptance and movement towards death.

Desire to continue to actively participate in life processes.

Ability to function physically, cognitively, and socially.

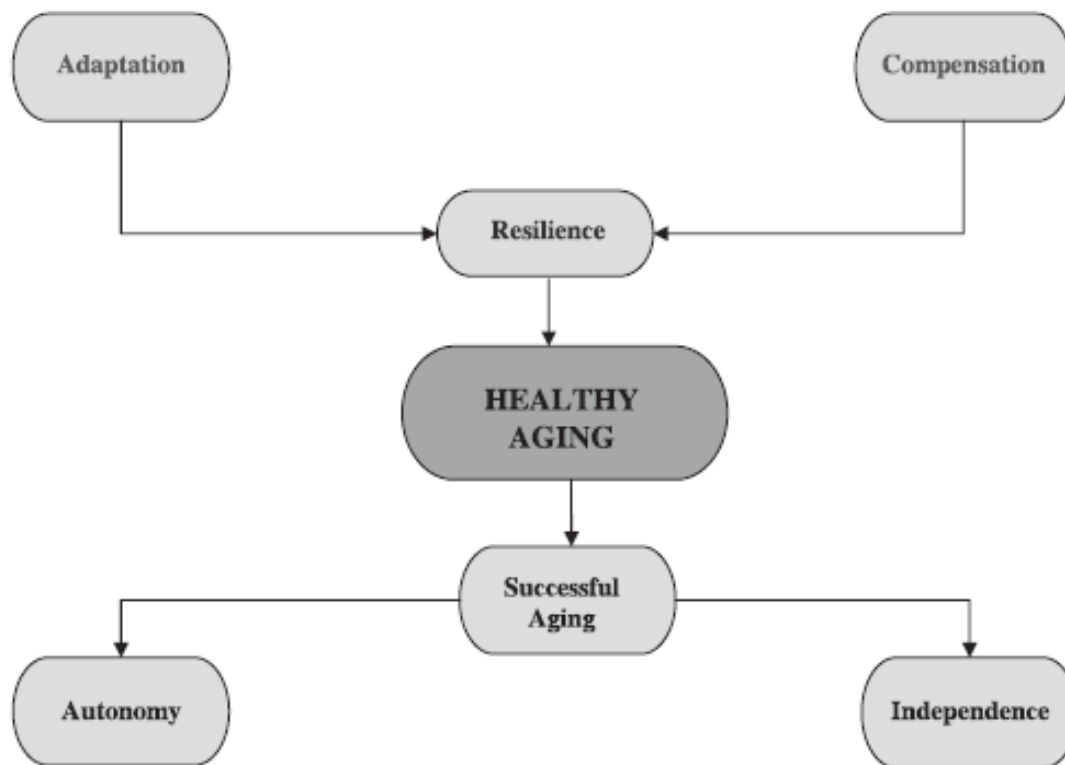
Continual modification, self-assessment, and redefinition of self and abilities.

Hansen-Kyle (2005) presents an interesting and multidimensional definition, informed by research into the lay perspective of healthy ageing. However, it appears contradictory to argue that healthy ageing should be self-defined and individualistic using a list of attributes that prescribes certain requirements to ageing well. She goes on to offer the following definition:

Healthy aging is the process of slowing down, physically and cognitively, while resiliently adapting and compensating in order to optimally function and participate in all areas of one's life (physical, cognitive, social, and spiritual). (Hansen-Kyle, 2005, p. 52)

The purpose of this definition was to allow nurses to promote activities to maintain the health of older people. Hansen-Kyle also reviewed the research and theoretical literature to describe the antecedents, consequences, and produced the following model of healthy ageing (Figure 2.4):

Figure 2.4. A model of healthy ageing (Hansen-Kyle, 2005, p. 50).



Hansen-Kyle (2005) has thus attempted to capture the multidimensional nature of healthy ageing in an extensive and explicit theory. However, the work is problematic in that the different components that Hansen-Kyle has proposed do not seem to interconnect into a cohesive concept of healthy ageing.

An important progression from defining any of these concepts of ageing is the empirical validation of the concept. This creates an evidence base that effective practice and policy can be created from, implemented and tested. To do so, the concept must be addressed in terms of measurable outcomes (Peel et al., 2004). As the concept of healthy ageing is itself not well defined, there are no established standard criteria for measuring healthy ageing (Willcox, Willcox, & Ferrucci, 2008). Indeed, as indicated, the conceptualisations of healthy ageing applied in the empirical literature vary considerably. The term is used across many different

disciplines for various purposes with many different definitions. Often, the full multidimensional nature of healthy ageing is not captured.

The empirical research on healthy ageing generally tends to focus on the negative aspects of the concept, usually the lack of physical health, assessing mortality, morbidity and disability (Peel et al., 2004). Applying these “pathology” or “deficit” models, rather than encompassing good health, is not an adequate depiction of healthy ageing (Peel et al., 2004; Willcox et al., 2008). Policy, on the other hand, tends to conceive healthy ageing in positive terms, as with active ageing (Health Canada, 2002). This is one example of the confusion and inconsistencies around the concept of healthy ageing (Peel et al., 2004).

To look at the research in more detail, in the biomedical literature healthy ageing is used to describe a population group that does not develop certain prevalent chronic diseases or conditions. There is a focus on observed physiological changes over time (Hansen-Kyle, 2005). “Healthy agers” are often used as a control group for comparative purposes against those that do develop the particular condition in both humans (McDowd et al., 2011; Zhu et al., 2011) and animals (Dubeau et al., 2011). This comparison is made to determine the difference between the two populations, investigating the aetiology of particular illnesses with the ultimate goal being to develop preventative and treatment techniques.

Similarly in the public health literature, healthy ageing is a term used to describe individuals who remain free of major clinical diseases and in good physical health or functioning (Benfante, Reed, & Brody, 1985; D. Reed et al., 1998; Swindell et al., 2010). Physical health is often framed in terms of the absence of disability, most often measured using activities of daily living (ADLs) (Guralnik & Kaplan, 1989; Willcox et al., 2008). Longevity is also often a component of the concept in this context (Swindell et al., 2010; Willcox et al., 2008). The other component most often considered is cognitive function, often the only concession to healthy ageing over and above physical health and longevity (D. Reed et al., 1998; Thompson, Sierpina, & Sierpina, 2001). Categorising individuals according to physical, and occasionally cognitive, health is most often done to find the prevalence of healthy agers in the population, and the demographic predictors of remaining physically healthy (Guralnik &

Kaplan, 1989). Again, if the antecedents of good health are known, policy and practice can potentially be developed to promote physical health and prevent decline. Interventions can be designed, informed from such research, implemented and tested for efficacy.

In summary, although often appearing in the literature, healthy ageing is problematic concept for a number of reasons. Firstly, the concept lacks a theoretical basis and is consequently used differently, not only between disciplines but also within disciplines. There is major overlap among these many definitions but little agreement about a meaningful approach to the study of healthy aging. Although the World Health Organization definition of health and subsequent definitions of healthy ageing stress the multidimensional structure of the concept, this is rarely applied in empirical research. The literature depicts a bias towards “healthy ageing” to mean not having physical health issues, through a focus on disease rather than health (Kapnick et al., 1968). Peel and colleagues (2004) summarises these issues:

There appears to be no agreed standard by which healthy ageing can be measured, nor clear contextual discourse establishing the parameters of the entity. (Peel et al., 2004, p. 115)

There are times when the term healthy ageing is used interchangeably with successful ageing, which does have associated theories, as will be discussed in detail below (S. J. McLaughlin et al., 2012). Arguably, these terms should not be used interchangeably as although there are conceptual overlaps, they have different connotations and proponents. Primarily, the key difference between the concepts is healthy ageing is often referring to a one-dimensional concept of physical health only, while successful ageing tends to have broader multidimensional conceptualisations inclusive of mental and social well-being, which will now be discussed.

2.3.4 Successful ageing

As noted above, the concept of successful ageing has significant conceptual overlap with healthy ageing, and the two terms are often used interchangeably in the literature. However, the concept of successful ageing has developed differently to that of healthy ageing.

Successful ageing has well established and empirically investigated associated theories. Perhaps as a consequence of being a more theory-driven concept, successful ageing has also been a more controversial concept than healthy ageing. Indeed, an entire issue of the prominent journal *The Gerontologist* was devoted to debate and discussion of the concept (Volume 55, Issue 1, 2015).

The prominent theories of successful ageing will now be discussed, including the seminal works of Havighurst (1961), Rowe and Kahn (1987), and Baltes and Baltes (1990b).

Havighurst's contribution

Successful ageing was first described in the biomedical literature by Havighurst (1961), in the first issue of the journal *Gerontologist*. Havighurst made it clear that successful ageing is more than simply maximising longevity and preventing disease and disability, an observation generally accepted in the contemporary literature (Depp & Jeste, 2006; T. A. Glass, 2003). Havighurst recognised the complexity of the concept and the multidimensionality of successful ageing, noting that both physical and psychological health factors should be taken into account:

A theory of successful aging is a statement of the conditions of individual and social life under which the individual person gets a maximum of satisfaction and happiness and society maintains an appropriate balance among satisfactions for the various groups which make it up—old, middleaged, and young, men and women, etc.
(Havighurst, 1961, p. 8)

Havighurst called for an observable operationalised definition of successful ageing. He proposed that the following components required measurement as indicators of successful ageing:

1. A way of life that is socially desirable for this age group.
2. Maintenance of middle-age activity.

3. A feeling of satisfaction with one's present status and activities.
4. A feeling of happiness and satisfaction with one's life. (Havighurst, 1961, pp. 9-10)

Havighurst's attempt at defining the components of successful ageing was a notable shift away from a more biomedical view of ageing, focusing on disease and disability. His work created an important framework for further study in the area.

Psychological theories

Following on from the work of Havighurst, a number of other theories and components of successful ageing have been proposed. Many of these theories have a focus on similar psychological components proposed by Havighurst (1961). These psychological theories of successful ageing focus on factors such as life satisfaction and psychological resources, such as personal growth. Following is a description of the conceptually significant psychological theories of successful ageing.

Ryff's work

Carol Ryff (1982, 1989), a psychologist, provided important input into the conceptualisation of successful ageing. She drew attention to issues in the literature, many still relevant today, and proposed her own model of successful ageing. The four primary criticisms of the literature Ryff discussed were:

1. The absence of theoretical frameworks surrounding the many dimensions of well-being.
2. An implicit negativism in many previous approaches to successful ageing...much research has been conducted with measures of illness rather than measures of wellness...Such research tends to equate well-being with the absence of illness.
3. Previous studies have paid little attention to the unique resources and challenges of old age, or to possibilities of continued growth and development in the later years. Most indicators, such as happiness, well-being, or affect balance, are better measures

of successful living, regardless of age, than they are indices of successful ageing...A related tendency has been to equate positive functioning with maintenance of previous attitudes and behaviours rather than successful negotiation of new challenges and developmental tasks...there is a pervasive stability bias in the well-being literature, which excludes the individual's potential for further development, self-realisation, and growth.

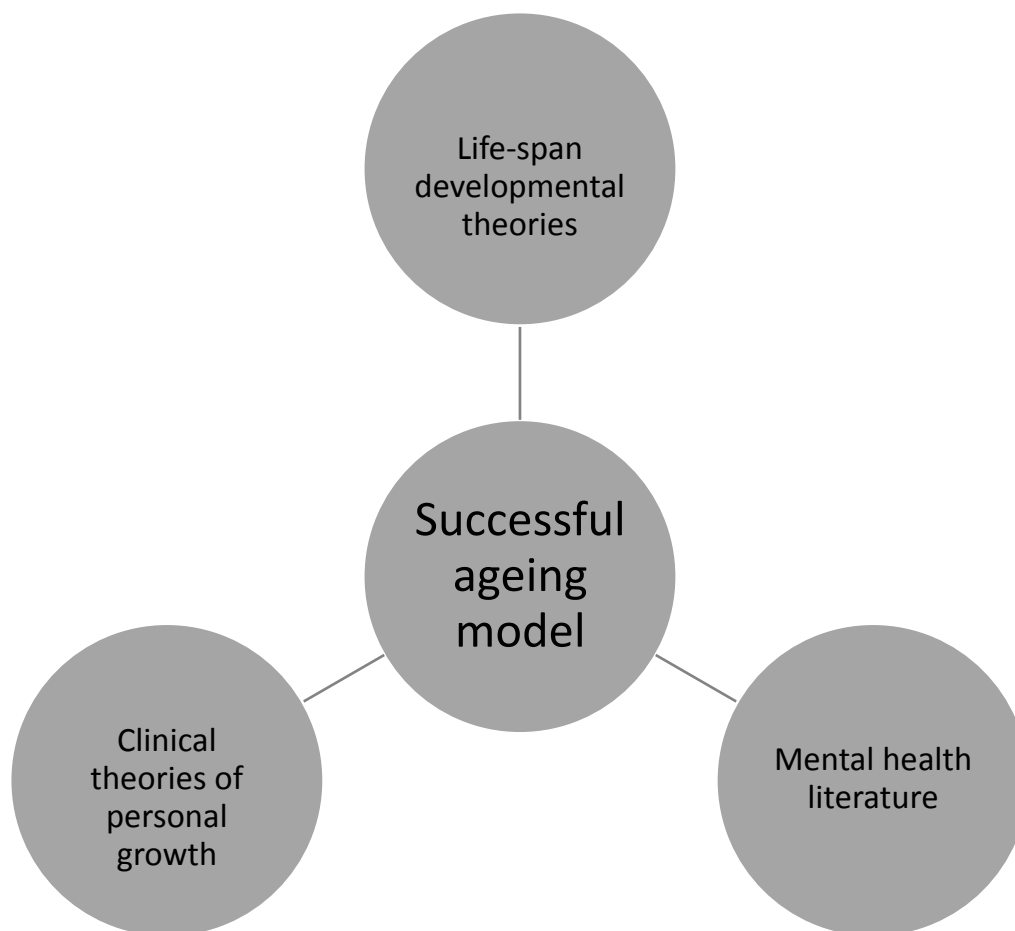
4. There has been insufficient recognition that conceptions of well-being are human constructions, and thereby, open to diverse and competing definitions as well as to cultural variation and historical change. The question of what we define as positive functioning in the later years inevitably leads to value discussions, which can never be fully resolved on scientific grounds. While scientific psychology cannot settle the values people should live by (Smith, 1974), it can help us identify the values that underlie our theories and the values that are endorsed by those we study. Such an orientation reminds us that the criteria of well-being need constant re-evaluation and refinement, as new cohorts of aged individuals bring different standards and ideals by which to evaluate themselves and others. (Ryff, 1989, pp. 37-39)

These criticisms made by Ryff remain highly pertinent to current discourse around successful ageing, and should be acknowledged and considered by those working in the area.

Ryff's primary criticism of work into successful ageing was the lack of theory used to guide research. To address this issue, she identified and incorporated relevant established psychological theories of development to create a new model of successful ageing, see Figure 2.5. Ryff argued that no one established theory was adequate to describe the process but the synthesis of different theoretical perspectives could be used to define well-being in later years. The first group of theories she drew from were life-span developmental theories: Erikson's psycho-social stage model (Erikson, 1959), Bühler's basic life tendencies (Bühler, 1935; Bühler & Massarik, 1968), and Neugarten's work on personality. These theories differentiate between how positive functioning is formulated in different life stages of development. The second group of theories Ryff integrated were clinical theories of personal growth, which she used to provide more information on the meaning of positive functioning in later life. She uses Maslow's view of self-actualisation (1968), Roger's fully functioning person (1961), Jung's process of individuation (1933), and Allport's conception of maturity

(1961). The final discipline she applied to fully describe positive functioning is the mental health literature, in particular Jahoda's criteria of mental health (1958): positive self-attitudes, growth and self-actualisation, integration of the personality, autonomy, reality perception and environmental mastery.

Figure 2.5. Theories integrated by Ryff to create a successful ageing model.



Through integration of these established theories, Ryff proposed a new set of criteria for successful ageing. The six dimensions she proposed were positive functioning, self acceptance, positive relations with others, autonomy, control over one's environment, purpose in life and personal growth. This model was an important contribution, as Ryff was one of the first researchers to emphasise the idea of growth where ageing is a process of ongoing development over the life course (Ouweland, de Ridder, & Bensing, 2007). Fisher found support for the model in his work analysing themes from interviews with older people about successful ageing. (Fisher, 1992, 1995; Fisher & Specht, 1999).

Ryff's model of successful ageing is very much a psychosocial theory, a reflection of her discipline. There is little acknowledgement of cognitive or physical health in her model, or the interaction of these dimensions with psychosocial functioning. The model has also been criticised for not adequately defining the role that environment plays in development (Wahl, Iwarsson, & Oswald, 2012). However, Ryff provided important insight into the issues associated with research into successful ageing. Her work is also commendable for the examination and inclusion of past, established theories. Ryff's contribution thoroughly examines the psychosocial aspects of successful ageing but ultimately lacks other important dimensions, which are arguably necessary for practical purposes.

Selection, optimisation and compensation theory

Not long after Ryff's work emerged, in the early 1990s, Baltes and Baltes (1990a) developed an extensive and well-reported psychological theory of successful ageing: selective optimization with compensation (SOC). Successful ageing is conceptualised as maintaining a level of functioning that allows personal goal attainment and preservation of personal standards (Freund, 2008). This occurs through a dynamic system of adaptive change based on the coordination of three sub processes: selection, optimisation and compensation (P. B. Baltes, 1997).

1. Selection refers to the ability to choose specific functional life domains to focus resourcesⁱⁱⁱ on. These domains are those most important and meaningful to an individual. In older age, where there is often a decline in resources and changes in needs, the selection of attainable goals that meet new needs with the resources available is important for positive functioning^{iv}.
2. Optimisation is the process of maximising the utility of the available resources to facilitate success in the selected domains. With older age comes the loss of certain

ⁱⁱⁱ Freund (2008) broadly defines resources as the means for achieving personal goals:

what constitutes a resource must be defined with regard to a specific goal and can be biological, genetic, socio-cultural, or psychological in nature. (Freund, 2008, p. 95)

^{iv} This is a similar concept to the second postulate of the disengagement theory of ageing.

resources, and it is necessary to utilise new resources for personal growth through achievement of new goals.

3. Compensation is the management of losses to facilitate adaptation to biological, psychological, and environmental changes. Compensation ultimately results in maintenance of functioning – an important aspect of successful ageing.

SOC processes can occur consciously or unconsciously, actively or passively (P. B. Baltes, Staudinger, & Lindenberger, 1999). When the processes are applied in unison, successful ageing is attained by individuals selecting realistic goals that account for their own capacity (selection); allocating resources such as time and energy to realising selected goals (optimisation); and increasing efforts, changing strategies and/or requesting assistance to offset potential losses (compensation) (Urry & Gross, 2010).

The SOC theory conceptualises ageing as a dynamic equilibrium of gains and losses. Individuals who are goal-driven, working to maximise gains and minimise and compensate for losses, retain life satisfaction (Freund, Li, & Baltes, 1999; Ouwehand et al., 2007). This compensation involves older people actively developing new strategies and abilities, rather than “just coping with decline” (Ouwehand et al., 2007, p. 874). The authors described the *process* of successful ageing, rather than the end point, which previous theories had focussed on.

The SOC theory is framed as a lifespan model of development (Freund, 2008). That is, that successful ageing does not only occur in older age but throughout the entire lifespan, through the optimal use of the SOC processes (Freund, 2008). Successful ageing is:

characterised by a level of functioning that allows one to strive to fulfil personal goals and maintain personal standards and is, to a substantial degree, a result of one’s having successfully managed internal and external resources throughout one’s life span. (Freund, 2008, pp. 94-95)

The use of these processes does, however, become increasingly salient in older age, especially amongst the old-old in the face of significant biological challenges (P. B. Baltes & Smith, 2003). Hence Baltes and Baltes (1990a) argue that the SOC theory is especially relevant to later life. This is a time in life when losses are likely to outweigh gains, so to maintain the equilibrium individuals must reorganise their goal hierarchy, relinquish past goals, and concentrate on achieving the most important goals (Ouwehand et al., 2007).

The authors describe the SOC model as a “metatheory of development” (P. B. Baltes, 1997, p. 372), meaning that it is a highly general description of processes:

operating on different levels of analysis (e.g., society, individual, cell) and applicable to different domains of functioning (e.g., cognition, emotion, motivation). (Freund, 2008, p. 95)

Although SOC is a universally experienced process, how it is experienced depends on the individual and their environment (Ouwehand et al., 2007). Personal goals are informed by culture and experience, and vary between individuals (M. M. Baltes & Carstensen, 1996). The theory has been praised by commentators (Ouwehand et al., 2007) for this flexibility, as it characterises the ageing process as heterogeneous, with many different trajectories and outcomes. Hence, the SOC theory provides a flexible framework that allows for indefinite, non-normative individualised trajectories of achieving goals which lead to successful ageing (Ouwehand et al., 2007). This is an achievement that the previous theories of ageing, discussed above, did not accomplish.

The Baltes and their colleagues have published extensively on the SOC theory. The researchers have also conducted many research studies designed to test the SOC model empirically, often using participant data from the Berlin Aging Study (Ebner, Freund, & Baltes, 2006; Freund & Baltes, 1998, 1999). One such cross-sectional study involved older people completing a self-published SOC-questionnaire created by the researchers (P. B. Baltes, Baltes, Freund, & Lang, 1999). The questionnaire is a 12-item self-report measure that claims to operationalise and assess the processes of adaptive development involved in the SOC model (P. B. Baltes, Baltes, et al., 1999). Use of SOC strategies was reported to be associated with the following selected outcome indicators of successful ageing: subjective

well-being, positive emotions, and absence of loneliness. There is a notable lack of objective measures of physical and cognitive health as indicators of successful ageing. Despite this issue, the authors concluded that participants:

reporting SOC-related behaviors also reported higher levels of well-being and aging well. (Freund & Baltes, 1999, p. 700)

Comparable cross-sectional studies have also been reported with similar results, some using data from studies other than the Berlin Ageing Study (Freund & Baltes, 1998, 1999, 2002; Gignac, Cott, & Badley, 2002; Li, Lindenberger, Freund, & Baltes, 2001). The use of cross-sectional design seems unusual given the theory's emphasis on life-span development. Longitudinal studies are necessary to investigate the causal relationship between SOC use and successful ageing (Ouwehand et al., 2007), such as the study conducted by Lang, Rieckmann, and Baltes (2002) attempted to do. The researchers investigated the use of SOC strategies in 206 community dwelling participants of the Berlin Aging Study aged between 70 and 103. They did so by asking about participation in certain activities, such as leisure and household chores, and classing them as indicators of selection, optimisation or compensation. For example, compensation was indicated by an increase in sleeping during the daytime. However, the researchers did not monitor SOC use over time, they examined whether indicators of SOC at baseline predicted survival at follow-up four years later. In spite of these methodological issues, the authors presented the results as supportive of the SOC theory.

Indeed, the SOC theory appears regularly in empirical research, and support is nearly universally reported for the theory (Abraham & Hansson, 1995; Freund, 2008; Gignac et al., 2002; Hutchinson & Nimrod, 2012; Lang et al., 2002; Li et al., 2001; Ziegelmann & Lippke, 2007). Discussions of the limitations and balanced critiques of the theory are not easily found in the literature (see, for example, Freund, 2008; Riediger, Li, & Lindenberger, 2006). This is perhaps because the most prolific publishers in the area are those that created the theory, or their colleagues.

It is difficult to critique the SOC theory, as it is extremely flexible. While this elasticity is a positive quality as it allows for the heterogeneity of ageing, it also makes it difficult to operationalise and test the theory empirically. The theory is so accommodating that it is able to be used as a framework to explain a variety of observations, some appearing to be reasonably common sense (see, for example, Gignac et al., 2002; Li et al., 2001). The authors of the SOC theory have attempted to test the theory empirically by encapsulating it in the SOC questionnaire above. However, the questionnaire does not appear to be used regularly in longitudinal studies of ageing, of which there are many. In fact, the questionnaire does not seem to be used and tested extensively by researchers outside the theory development group. In addition, it could be argued that independent to the theory, there are no common proxies existing that can test its propositions. Proponents of the theory, Ouwehand and colleagues (2007) acknowledge the difficulty with operationalising such complex processes, suggesting that future research develop new measures that do not rely on self-report.

In summary, the SOC theory is commonly assumed to be valid in the literature. It is used as a framework to design studies and explain observations, rather than a theory to be conceptually questioned and empirically evaluated (see, for example, Hutchinson & Nimrod, 2012). The theory may be a true depiction of the ageing process, however as it is arguably not easily testable, its' practical application is called into question. The utility of a concept has to be considered in addition to its veracity. The theory appears to have had few practical impacts on policy and practice to date.

Rowe and Kahn's work

In keeping with Havighurst's (1961) proposition that successful ageing goes beyond extended life expectancy, Rowe and Kahn (1987) provided what is currently the prevailing (Depp & Jeste, 2006; Stowe & Cooney, 2015), although not uncriticised (see for example Masoro, 2001), model of successful ageing. Their influential work has been referenced in thousands of scientific articles, and continues to be cited (Stowe & Cooney, 2015; Thomson Reuters, 2017). Rowe and Kahn (1987) initially conceptualised successful ageing as: i) low risk of experiencing disease and disability, and ii) high cognitive, physical and social functioning. They went on to further refine this model to include three principal components: i) low risk of disease and disease related disability, ii) high cognitive and physical function, and iii) active engagement with life (Rowe & Kahn, 1998, 2015). Rowe and Kahn's theory of successful ageing has been operationalised and debated at length.

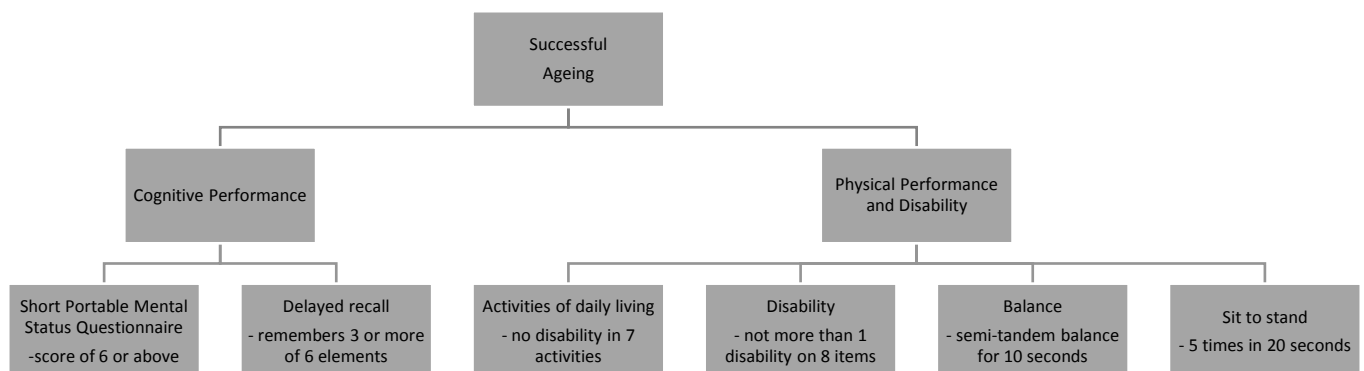
Prior to the work of Rowe and Kahn (1987), many researchers were attributing decreased health to the ageing process and any heterogeneity was assumed to be the result of genetic factors. In contrast, Rowe and Kahn argued against an overemphasis on age-related declines in mental and physical health, while emphasising the beneficial effects of lifestyle behaviours, such as diet and exercise. Rowe and Kahn argued that declines in health could also be explained by extrinsic, modifiable factors such as lifestyle behaviours and psychosocial factors. Rowe and Kahn thus split the "normal" ageing category (people who do not experience disease) into two conceptual divisions: "usual" and "successful" ageing. People who experience a non-pathological age-characteristic decline in physical, mental and/or cognitive function are categorised as "usual" agers, while those who do not are categorised as "successful" agers.

Rowe and Kahn's theory was famously empirically investigated by the MacArthur Foundation Research Network on Successful Aging. The Network commenced a study in the early 1990s led by Rowe of 1354 community-dwelling older Americans to investigate the distinction between usual and successful ageing (Berkman et al., 1993). This was done to better understand the factors that influence functional change in later life. Successful ageing was operationalised in terms of high physical and cognitive functioning, as depicted in Figure

2.6. No mental health components were included in the operationalisation. Based on this definition of successful ageing, approximately one-third (32.6%) of participants met the criteria of successful ageing.

Successfully ageing participants were then compared to lower functioning participants across a range of psychosocial and physiological measures. The participants who were high functioning performed better on many assessments, including having greater pulmonary function, self-rated health, engagement in productive and physical activities, self-efficacy, mastery and life satisfaction. Successful agers were also less likely to report feelings of anxiety and depression.

Figure 2.6. Operationalisation of successful ageing used by the MacArthur studies of successful ageing (Berkman et al., 1993).



The research was conducted on a relatively small sample, comparing high-functioning participants with only 82 low-functioning, and 80 medium-functioning participants. This study, like the majority of research of operationalised models of successful ageing is limited by the use of cross-sectional, rather than longitudinal, data. That is, the direction of potential determinant effects and patterns of change in successful ageing cannot be ascertained.

Although longitudinal analyses have been reported by the Network, they tend to focus on predicting physical health and disease (Seeman et al., 1995; Seeman et al., 1994) without addressing other potential components of successful ageing, such as mental health and social well-being.

In subsequent literature following on from the seminal work of Rowe and Kahn (1987) and the MacArthur studies, many researchers have gone on to similarly operationalise theories, definitions and models of successful ageing using measurable variables as indicators of components of successful ageing. The majority of operationalised models have been based on the theory of successful ageing proposed by Rowe and Kahn (1987) and have also focussed on measures of physical health (for example S. J. McLaughlin et al., 2012). When operationalised, Rowe and Kahn's (1987) research theory categorises only a minority of older people as ageing successfully, given that most do experience chronic disease or disability (Minkler & Fadem, 2002; Montross et al., 2006; Strawbridge et al., 2002).

Rowe and Kahn's theory of successful ageing has been extensively referenced, employed and evaluated (Stowe & Cooney, 2015). The majority of the formerly mentioned issue of *The Gerontologist* (Volume 55, Issue 1, 2015) devoted to successful ageing focused on their work. However, it has been criticised for a number of reasons. The theory implies that numerous people will experience a disease and physiological deterioration-free older age, a sentiment that has been questioned (Bowling & Dieppe, 2005; Masoro, 2001). Although individual rate of decline is highly variable, it seems unlikely, if not impossible, to not experience noticeable physiological deterioration in older age.

In his commentary, gerontologist Edward J. Masaro's most salient criticism of the theory is that it instils the false hope of a guaranteed healthy older age if particular lifestyle behaviours are adhered to. That is, the role of genetics and physiological deterioration associated with ageing is misleadingly underemphasised. Masaro goes on to strongly state that the concept of successful ageing is detrimental and should be referred to as only a slowing of the ageing process. Masaro's interpretation of the theory is relatively extreme and, it could be argued, unconstructive in its attempt to negate the importance of the study of successful ageing.

There are people who can be described as ageing more successfully than others and insight into this process could improve the quality of life of many. Whether successful ageing is only for a limited time period and inevitably everyone becomes “unsuccessful” agers is important information, but it is not the salient component of Rowe and Kahn’s theory. While partaking in healthy lifestyle behaviours will not guarantee successful ageing, it will maximise the potential for time experienced in a healthy state. Rowe and Kahn argue that the role of genetics has been overemphasised to the detriment of the effects of lifestyle behaviours, but the authors do not discount genetics entirely. However, to be beneficial perhaps models of successful ageing need to be accompanied with the caveat that there are no guarantees. This stipulation may seem fundamental, but according to Masaro, is not intuitive to all and should be spelled out to avoid misinterpretation to the detriment of the individual.

A number of other commentators have offered further criticisms of Rowe and Kahn’s work. One of the primary and consistent criticisms offered is that the criteria set by Rowe and Kahn are concrete and objective fixed end points, rather than depicting successful ageing as a subjective process of personal goal attainment. The theory does not allow for multiple patterns of successful ageing, that is, it is a homogenous account (Ouwehand et al., 2007). Another common criticism is that their work is heavily influenced by Western norms, success being a cultural ideal and often associated with “economic achievement, employment status, income and assets” (Peel et al., 2004, p. 116). Ouwehand and colleagues (2007) state that the criteria are “culturally and historically specific” (p. 875). S. Lamb (2014) extends these criticisms, describing the successful ageing concept as normative and tied to individualist cultural traditions of independence, productivity, and self-maintenance. She states that as a society we would benefit by accepting “the normal human conditions of dependence, decline, and death” (p. 41) which are not incompatible with an enjoyable ageing experience.

Scheidt, Humpherys, and Yorgason (1999) write an entire discussion critiquing the concept, making similar criticisms as those directed towards active ageing. Namely, that there will be many older people who do not have the resources to achieve the criteria of success:

The danger of this successful aging perspective, as with all resource perspectives, is that it places primary responsibility for change on the individual...The individual is

responsible for successes, when they occur, and also responsible for her own failures. (Scheidt et al., 1999, p. 280)

Stowe and Cooney (2015) also critique Rowe and Kahn's concept of successful ageing, suggesting that the theory could be enhanced by including the "life course perspective's emphasis on ageing as a lifelong process" (Stowe & Cooney, 2015, p. 48). Additionally the authors recommend that context is also important when theorising development, citing place (including culture), time, socio-environmental forces and heterogeneity as factors that should be considered. In the same journal issue, Martin and colleagues (2015) discuss the concept also, suggesting that Rowe and Kahn's model is missing a subjective component, a successful dying component and other socio-environmental factors. The authors appear to be recommending an entirely separate and process-orientated conceptualisation of ageing which would arguably fit a different purpose for that proposed by the work of Rowe and Kahn.

For some commentators, the cost of creating labels such as successful ageing is too high, as they devalue individuals who do not fulfil the criteria and achieve success (Holstein & Minkler, 2003; Stenner et al., 2011). Kahn (2003) argues that this criticism is based on a cultural tendency for wanting no one to 'fail', while the importance of the model is that it describes what individuals can do to improve their own well-being. In their linguistic discussion of this issue, N. M. Peterson and Martin (2015) suggest that interpreting success as only having positive connotations ignores the more ambiguous origins of the term.

Since it was first proposed, Rowe and Kahn's theory has stimulated extensive gerontological research across disciplines, and will continue to do so (Katz & Calasanti, 2015; P. Martin et al., 2015). Despite the proposed limitations of Rowe and Kahn's work, given its extensive use, psychosocial focus, empirical underpinning and alignment to the health context, their theory is deemed to be best suited to act as the theoretical framework for this thesis.

2.4 Conclusion

A number of tested theories of ageing have been introduced, critiqued and evolved over time to produce what is currently the prevailing research model of optimal ageing, Rowe and Kahn's theory of successful ageing (Bosnes et al., 2016; Rowe & Kahn, 1987). Given the conceptual and higher order nature of the theory, it does not explicitly feature mental health as a component. This model will be used as the theoretical framework underlying the analyses conducted in the current thesis, as the proposed analyses will be addressing a number of key issues identified in the empirical research literature. The next chapter will investigate mental health ageing, a neglected area of the successful ageing literature.

Chapter 3

STUDY 1: SYSTEMATIC REVIEW OF THE USE OF THE SF-36 MHI-5 TO MEASURE MENTAL HEALTH IN OLDER POPULATIONS

3.1 Introduction

This chapter presents the results of Study 1, a systematic review of existing literature documenting the use of the Short Form Health Survey-36 (SF-36) Mental Health Index (MHI-5) in older populations. The associated predictors or determinants of mental health outcomes and change in mental health status are also presented. The methodology applied was taken from the PRISMA (Preferred Reporting Items for Systematic reviews and MetaAnalyses) guidelines (Moher et al., 2009). The processes that were used to identify, select and critically evaluate the relevant research articles are explicitly detailed. This study aimed to distil the outcomes of past research from across disciplines and ultimately provide unique insight into mental health pathways in an ageing context. The existing research literature is methodically critiqued and gaps in the literature are identified and considered. Before presenting the systematic review methodology and results of the review, the next section will provide an overview of the common measures of mental health. The chapter concludes with a discussion of recommended future research, and a rationale for the predictors of mental health in older people chosen for the modelling used in this thesis.

3.2 Mental health

Mental health is a broad concept, generically defined as the absence of mental illness (e.g. not having depression or anxiety) or in terms of experiencing subjective well-being (e.g. happiness). Regardless of how mental health is represented, many researchers argue that good mental health is an important component of ageing successfully (Depp et al., 2010).

Much research suggests that older people (except the oldest old) are less likely to experience mental illness than younger adults (Korten & Henderson, 2000; Westerhof & Keyes, 2010). Research has shown evidence for declining prevalence of mental disorders with increasing age (Korten & Henderson, 2000). However in his review of the literature, Jorm (2000) reported no consistent pattern across studies for age differences in the occurrence of anxiety, depression or distress. There is also evidence for significant gender differences, with men at

greater risk of depression as they age and in the years preceding death (Anstey & Luszcz, 2002; Burns, Butterworth, et al., 2013); results in keeping with the high rates of male suicide occurring in older men (Australian Bureau of Statistics, 2012; Centers for Disease Control and Prevention, 2013). These findings occur in the context of women reporting higher levels of depression and anxiety than men across most of the adult lifespan (Burns, Butterworth, et al., 2012; Korten & Henderson, 2000), demonstrating the complexity of the development of mental health.

There is a need to understand the development of mental health in older people and the associated correlates of change, using a reliable assessment tool. Thus, the current study aimed to systematically identify and review all articles reporting on the Mental Health Index (MHI-5), a sub-scale of the Short Form Health Survey-36 (SF-36) (Ware & Gandek, 1998; Ware & Sherbourne, 1992) in longitudinal cohort studies of older people. Where reported, factors associated with change in mental health were identified for consideration.

There are currently many different assessment tools available to evaluate mental health, which complicates the task of understanding and conceptualising mental health. In the current review, the MHI-5 was chosen to conceptualise mental health. The SF-36 is perhaps the most commonly used measure of health-related quality of life (Friedman, Heisel, & Delavan, 2005; Halvorsrud & Kalfoss, 2007) in both clinical and epidemiological studies. The SF-36 has been positively evaluated for use with older people and has satisfactory internal consistency, test-retest reliability, construct validity, concurrent validity, and responsiveness (Haywood, Garratt, & Fitzpatrick, 2005). The SF-36 is validated for use in the Australian population (McCallum, 1995).

3.2.1 MHI-5

The MHI-5 is the mental health subscale of the SF-36 and consists of the five items that best reproduced the total score for the 38-item Mental Health Inventory (Ware & Sherbourne, 1992). Four mental health dimensions were identified in factor analyses of the Mental Health Inventory: anxiety, depression, loss of behavioural or emotional control and psychological

well-being (Veit & Ware, 1983). The MHI-5 includes one or more items from each of these dimensions (Ware & Sherbourne, 1992).

The MHI-5 consists of the following instructions and items (Ware, Kosinski, & Keller, 1994):

These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks:

Have you been a very nervous person?

Have you felt so down in the dumps that nothing could cheer you up?

Have you felt calm and peaceful?

Have you felt downhearted and blue?

Have you been a happy person?

The possible responses are:

All of the time (1 point)

Most of the time (2 points)

A good bit of the time (3 points)

Some of the time (4 points)

A little of the time (5 points)

None of the time (6 points)

Each response has a particular number of associated points as listed above. The responses to the third and fifth questions are reversed when scoring. The MHI-5 raw score is calculated by adding the item points, and can range from 5 to 30. This raw score is then transformed into a variable ranging from 0 (poor mental health) to 100 (good mental health) using a standard

linear transformation (Ware et al., 1993). Different cut-off scores have been recommended for dividing respondents into high and low risk groups. Thorsen, Rugulies, Hjarsbech, and Bjorner (2013) report that the most commonly used cut-off point is 52 (Bültmann et al., 2006; Kelly, Dunstan, Lloyd, & Fone, 2008), but there are various others reported in the literature including 54, 74 (Cuijpers, Smits, Donker, Ten Have, & de Graaf, 2009), 60, 68, 76 (Kelly et al., 2008; Thorsen et al., 2013).

The MHI-5 is a well-validated and reliable measure of mental health status (Ware & Gandek, 1998), and has been found to have sound psychometric properties in older populations. For example, Friedman and colleagues (2005) examined the criterion and construct validity of the MHI-5 in relation to the presence of major depression in 1,444 functionally impaired, community-dwelling elderly patients. The researchers reported evidence that the MHI-5 has sufficient criterion and construct validity in this population. Similarly, Beusterien, Steinwald, and Ware (1996) reported that the MHI-5 was a valid measure of differences in mental health and was responsive to changes over time in the severity of depression in older people. They also reported that the MHI-5 showed construct validity, demonstrated by significant associations with the Hamilton Depression Rating HAM-D, the Clinician's Global Impression of Depression Severity measure, and the Geriatric Depression Scale. In more general populations that include older people, such as data from the Medical Outcomes Study (MOS), McHorney, Ware, and Raczek (1993) reported similar results on the validity of the MHI-5. The researchers found that the MHI-5 distinguished adult patient groups differing in the presence and severity of psychiatric disorders.

However, the use of a mental health measure that has only five items could be perceived as limiting due to its brevity and potential lack of depth (discussed in more detail in Section 10.6). Additionally, the MHI-5 has not consistently been found to have good screening properties: Rumpf, Meyer, Hapke, and John (2001) investigated this in their study of the validity of the MHI-5, analysing its performance in different diagnostic groups. Here, 4036 German respondents completed the MHI-5 and were assessed for DSM-IV diagnoses using the Munich Composite International Diagnostic Interview (M-CIDI). The authors reported that the MHI-5 performed best for screening mood and anxiety disorders, but had poor sensitivity and specificity for somatoform and substance use disorders. Similarly, Cuijpers

and colleagues (2009) validated the MHI-5 as a screening measure for depression and anxiety using clinical interviews as the gold standard. The authors reported that the measure was a suitable screening tool for depression and some anxiety disorders (generalised anxiety disorder; panic disorder; obsessive compulsive disorder), but not others, including phobias (agoraphobia; social phobia; simple phobia).

There are many assessment tools designed to evaluate mental health, however the MHI-5 was chosen in the current study, as in addition to having clinical validity, it is a more general measure of mental health, rather than assessing the presence or absence of depression, as many studies do. This is potentially problematic as depression is only one aspect of mental health and does not provide information on other components, including the positive aspects of mental health. In comparison, the MHI-5 includes two items for psychological well-being, and one each for depression, emotional control, and anxiety (Ware & Sherbourne, 1992) and is thus a more multi-dimensional representation of mental health. Focussing on the MHI-5 allowed for meaningful comparisons between articles and provided a necessary narrowing down of the vast mental health assessment literature available, described in more detail below in the protocol section. The MHI-5 was chosen to investigate in detail due to its established psychometric properties in older community samples, which is the population of interest in the current study. The MHI-5 is one of the mental health measures available in the DYNOPTA study. The results of this review form part of a larger study and will be discussed and compared to the quantitative analyses of the MHI-5 collected from the DYNOPTA population, a community sample.

The alternative mental health measure of the SF-36 is the Mental Component Summary score (MCS), an aggregate measure of mental health based on the mental health factor of the SF-36 (McHorney et al., 1993). The MCS incorporates data from all eight subscales of the SF-36, whereas the MHI-5 is calculated from the responses to five questions only. The MHI-5 was selected as the assessment of interest in this review due to its brevity, and as it is a well established and often used indicator of mental health, with only items concerning mental health contributing to its scoring.

3.2.2 Aims of systematic review

Given the predominant focus in the successful ageing literature on cross-sectional data and physical health (Cosco et al., 2014), this current review aims to balance this bias by reviewing articles that analyse how general mental health changes over time for older people. This will provide a necessary overview of the literature and an overall picture of the trajectories of mental health in older age. Importantly, this review will also detail the correlates of improvements and declines in mental health. Correlates can include time-invariant factors, usually unchanging personal characteristics such as education or sex, or time-varying factors, such as diet or partner status. Understanding how and why mental health changes over time is integral to our understanding of how to develop and create effective, data-driven public health policy and practice to improve the ageing experience.

3.3 Method

3.3.1 Protocol

The search strategy's inclusion criteria and methodological analyses were specified in advance and documented (protocol available on request). The initial protocol was modified, given the overwhelming number of articles reporting on trajectories of mental health using a variety of assessment tools. The large number of articles identified for inclusion indicated that the criteria were overly broad and therefore impractical. The large number of different assessment tools used in the articles to assess mental health made the task of synthesising data in a meaningful way difficult. The protocol was modified so that the analysis would focus on those studies that use the MHI-5 (Berwick et al., 1991; Ware & Sherbourne, 1992). To create a comprehensive review, no date restriction was included. The age of participants was lowered to 45 years and over (as opposed to 65 years and over) to allow the inclusion of studies that have participants younger than 65 years, but report specifically on changes in older age (Burns, Byles, Mitchell, & Anstey, 2012; Fine et al., 1999; Jokela et al., 2010; Olesen, Butterworth, & Rodgers, 2012). These modifications allowed for a more meaningful, practical, and detailed analyses.

3.3.2 Search methods for identification of studies

A systematic literature search was conducted to identify articles that documented change in mental health in older people over time using the SF-36 MHI-5 (Berwick et al., 1991; Ware & Sherbourne, 1992). The methodology applied was taken from the PRISMA (Preferred Reporting Items for Systematic reviews and MetaAnalyses) guidelines (Moher et al., 2009). The search procedure comprised the following strategies:

1) Electronic Searches

The electronic databases searched were Medline, CINAHL, EMBASE, EBM reviews, PsychINFO, Web of Knowledge, Scopus, ProQuest, and the Cochrane Library database.

2) Hand searches

The following journals were hand searched to identify potentially relevant articles that were not indexed in any of the included databases. These journals were chosen as quality examples of the most specifically relevant journals to ageing and mental health:

- Aging & Mental Health
- Psychology and Aging
- International Psychogeriatrics

3) Reference list searches

The reference lists and bibliographies of all included articles were examined for additional relevant articles.

The search terms used were a combination of MeSH terms and keywords with wildcards. The terms were grouped broadly into three areas: SF-36 and MHI-5 (e.g. short form 36, mental health index) ageing (e.g. older people, gerontology) and longitudinal studies (e.g. repeated measures). These phrases were used with both American and British English spelling conventions, put in quotations, and linked via the Boolean operator “OR” within groups and “AND” between groups. Where possible, a wild-card operator, e.g. “*” was used as a suffix to collect all variations of a phrase. Filters were applied for papers on human subjects published in the English language without date restriction. The references of included articles were hand-searched for additional relevant articles. A detailed description of the search strategy can be found in Appendix 1. Searches were initially conducted on 30 April 2013 and then updated on 30 March 2017.

3.3.3 Inclusion/exclusion criteria

The Inclusion Criteria were identified as (1) Studies reporting the MHI-5 as an outcome variable (2) Participants were aged 45 years and over at the time of outcome assessments (3) Participants were community dwelling (4) Longitudinal cohort or follow-up studies, including at least two data collection time points occurring. Exclusion Criteria were: (1) Review articles (2) Participants were clinical populations (3) Cross-sectional studies.

3.3.4 Data extraction

The titles and abstracts of the identified articles were assessed for relevance to the topic and full-text extraction (SH). Full text was obtained and assessed for relevance if the abstracts were not available or did not contain enough information to determine eligibility. Multiple articles using data from the same study were identified and grouped with the primary publication, namely the article that was published first. Secondary publications were read for relevant information not reported in the primary publication. If the same outcomes were reported from the same study, only the article that reported the most comprehensive information was included in this review. If unique information was available in the secondary publications, they were also included. Data were extracted from papers on the sample studied, country, sample size, age of participants, follow up period and how the MHI-5 was reported. Results and limitations were further extracted for each included study.

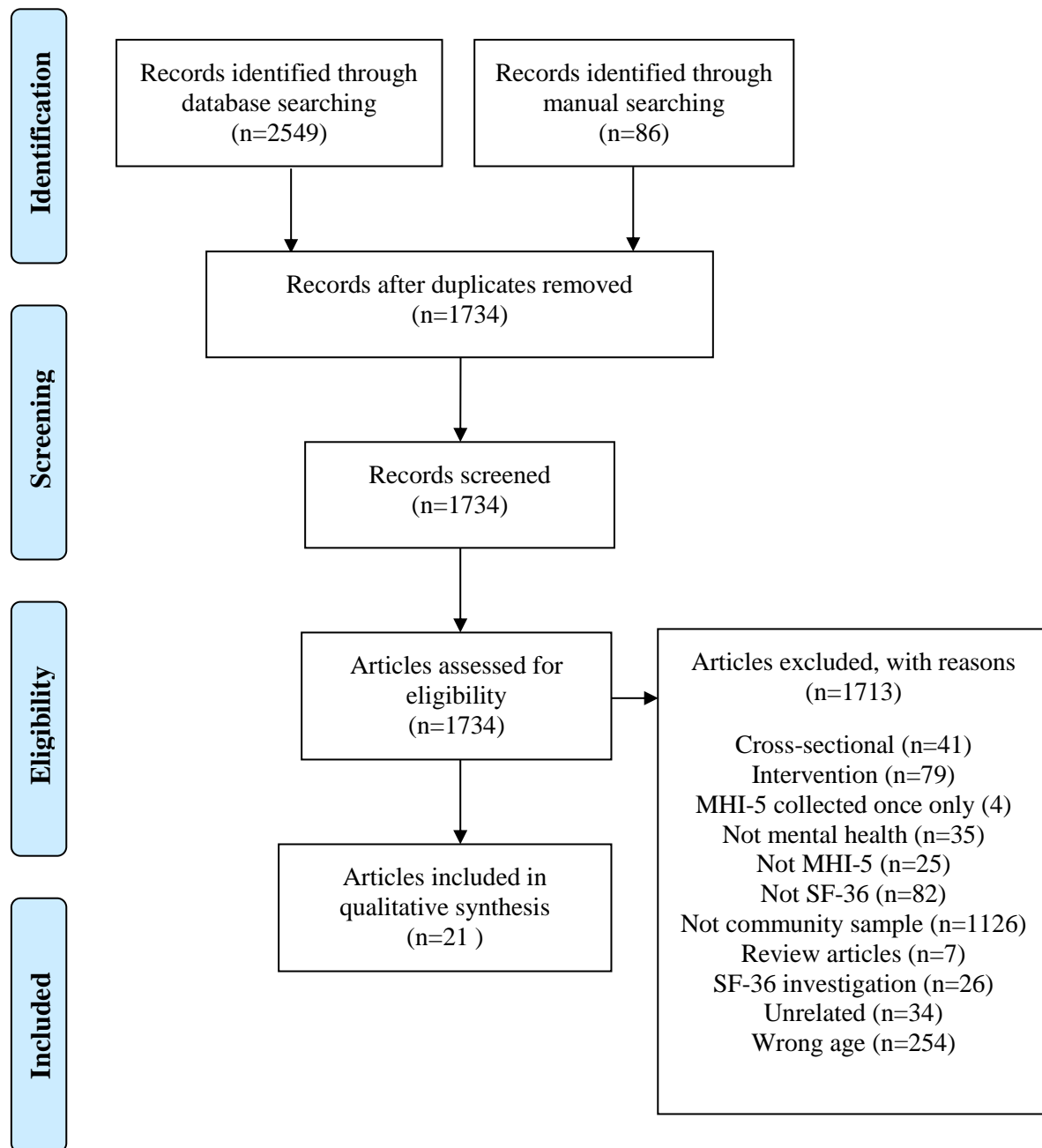
3.4 Results

3.4.1 Included studies

The search strategy identified 2,635 articles in total, which left 1,734 articles when duplicates were removed. The number of papers screened and the filtering process is shown in Figure 3.1. Title and abstract screening eliminated 1,660 articles and full-text screening eliminated 53 articles, 21 studies met inclusion criteria and were ultimately identified for inclusion in this systematic review.

The majority of studies that were excluded assessed mental health in clinical, non-community populations ($n=1126$). The clinical samples investigated included participants with chronic pain, arthritis, depression, and many other conditions. Seventy-nine articles were trials assessing interventions on participants' mental health. These trials included weight loss or physical activity interventions for overweight participants. Forty-one articles reported cross-sectional rather than longitudinal data. Twenty-six articles collected SF-36 data but did not report on the MHI-5 specifically.

Figure 3.1. Flow diagram of search results.



3.4.2 Study characteristics

Characteristics of the 21 included articles are presented in Table 3.1. The sample size of each study ranged from 50 to 12,432, with a mean of 6,975 (SD 3,916; median 7,692). Fifteen articles reported on studies with large sample sizes (over 5,000 participants).

Table 3.1. Characteristics of studies.

Reference	Study	Summary	Country	Sample size (n)	Age range	Measurement times	Reporting of MHI-5
Burns, Byles, et al. (2012)	DYNOPTA	Neither between- person nor within-person change in mental health was associated with the likelihood of reporting a fall.	Australia	11,340 women	55–95	Four waves over 13 years	Raw baseline scores reported according to fallers and non-fallers. Graphs also split according to mental health status (low, average, high).
Byles, Mishra, and Harris (2005)	ALSWH	Sleep disturbance was associated with a greater negative change in mental health.	Australia	1,011 women	70-75 73-78 74-80	1996 1999 2000	Beta coefficients
Byles, Powers, Chojenta, and Warner-Smith (2006)	ALSWH	Mental health remained constant over time.	Australia	8,397 women	70-75 73-78 76-81	1996 1999 2002	Raw scores
Byles, Young, Furuya, and Parkinson (2006)	ALSWH	Non-drinkers scored lower on the MHI-5. The covariates of smoking and having a chronic condition were associated with lower scores on MHI-5. Being overweight was associated with poorer scores on all subscales except MHI-5. Women with higher education had higher mean scores on MHI-5. There was a more significant decline in scores over the second 3-year period than the first.	Australia	11,878 women	70-81	1996 1999 2002	Graph only – split according to alcohol intake.
Byles, Mishra, Harris, and Nair (2003)	ALSWH	Sleeping difficulty and use of sleep medication at baseline was negatively associated with MHI-5 at follow up.	Australia	10,430 women	70-78	1996 1999	Graph only – split according to sleeping difficulty and medication use.
Faubel et al. (2009)	Not specified	Sleep duration did not predict MHI-5 at two-year follow up.	Spain	2,311 (992 men, 1319 women)	(70.2 ± 6.8 years)	2001 2003	Beta coefficients
Fine et al. (1999)	Nurses' Health Study	Weight gain was not associated with change in mental health in older women.	USA	40,098 women 10,024 were 65+	46-71 10024 were 65+	1992 1996	Baseline raw scores and graphs of score change reported according to BMI groups.

Reference	Study	Summary	Country	Sample size (n)	Age range	Measurement times	Reporting of MHI-5
		Weight loss was associated with decreased mental health among the leanest women (BMI <25.0 kg/m ²)					
		Weight change was more strongly associated with the physical than the mental components of health-related quality of life.					
Goodman (2012)	Not specified	Relationships at baseline with grandchildren and their sons or daughters influenced gains in life satisfaction later, but not mental health. Development of greater closeness in the grandmother–grandchild relationship was associated with improvement in the grandmother's mental health.	USA	50 women	58.6 (6.5) 67.26 (6.43)	1998–1999 2008	Standardized regression coefficients
Heesch, van Uffelen, van Gellecum, and Brown (2012)	ALSWH	Curvilinear trends observed between physical activity and walking with MHI-5 scores. HRQL scores increased with increasing physical activity and walking, in both cohorts, with increases less marked above sufficient activity levels. Associations attenuated prospectively.	Australia	7,646 women	76-81 79-84 82-87	2002 2005 2008	Raw scores
Hopman et al. (2006)	Canadian Multicentre Osteoporosis Study (CaMos)	For women, the mean change in mental health was positive for the 65-74 age group. Those in the 75+ year group show a mean decline. For men in both age groups declines in mental health mean change was observed.	Canada	2,134 women 802 men 1,771 women 625 men 1,169 women 443 men 743 women 232 men	65-74 75+	1996-7 2001-2 1996-7 2001-2	Mean change only

Reference	Study	Summary	Country	Sample size (n)	Age range	Measurement times	Reporting of MHI-5
Ice, Yogo, Heh, and Juma (2010)	The Kenyan Grandparents Study	Caregiving predicted mental health and caregivers experienced a significantly decline in mental health, whereas non-caregivers do not have a significant decline.	Kenya	287 (139 men, 148 women) 396 (189 men, 207 women) 389 (179 men, 210 women)	60+ 73.03±7.55	2005 2006 2007	Beta coefficients
Jokela et al. (2010)	Whitehall II cohort study	High cognitive performance was associated with better mental health. Mental health differences associated with cognitive performance widened with age from 39 to 76 years of age. SES explained part of the widening differences in mental health functioning before age 60. Cognitive performance was more strongly associated with mental health in retired than non-retired participants, which contributed to the widening differences after 60 years of age.	England	7,692 (5,414 men, 2,278 women)	39–64 50–76	1991–1993 1995–1996 1997–1999 2001 2003–2004 2006	Beta coefficients
C. Lee and Russell (2003)	ALSWH	Women who had made a transition from some physical activity to none showed more negative changes in mental health than those who had always been sedentary, while those who maintained or adopted physical activity tended to have better outcomes. When these means were adjusted for baseline values of covariates, only those who adopted exercise showed a significant increase.	Australia	6472 women	70-75 73-78	1996 1999	Split according to categories of physical activity amounts. Change scores reported.
Leigh, Byles, Chojenta, and Pachana (2016)	ALSWH	Most women showed little change in mental health scores. Small decline for those with poorer scores. Deceased women had lower mental health scores in each category (good, excellent, poor). Remote	Australia	7,061 women survivors 2,622 deceased women	73-78 76-81 79-84 82-87	1999 2002 2005 2008	Split according to mental health status (good, excellent, poor) and survivors or deceased.

Reference	Study	Summary	Country	Sample size (n)	Age range	Measurement times	Reporting of MHI-5
		living, higher education, having higher BMI and falls were associated with mental health in survivors. Education, BMI and falls were associated with mental health in the deceased. Stroke, arthritis, diabetes, heart disease, bronchitis/emphysema, osteoporosis associated with worse mental health. Asthma also for survivors.					Graphs of means and tables of odds ratios reported.
Lucke et al. (2010)	ALSWH	Women in the older cohort had the best mental health but it declined as women aged from 79–84 to 82–87 years.	Australia	12,432 women 10,434 women 8,647 women 7,158 women 5,561 women	70-75 73-78 76-81 79-84 82-87	1996 1999 2002 2005 2008	Graph only
D. McLaughlin, Adams, Vagenas, and Dobson (2011)	ALSWH	Good mental health was associated with larger social networks over time. Poor mental health was associated with smaller networks.	Australia	9,233 women 8,294 women 6,833 women	73–78 76–81 79–84	1999 2002 2005	Raw scores
Mishra, Ball, Dobson, and Byles (2004)	ALSWH	No significant relationships between SES and change in MHI-5 scores in either the crude analysis or after adjustment for covariates.	Australia	10,430 women	70-75 73-78	1996 1999	Raw scores
Olesen et al. (2012)	HILDA	Poor mental health was associated with higher rates of retirement in men, and workforce exit more generally in women. These associations varied with the timing of retirement and were driven by early retirees specifically. The association between mental health and retirement is greatest in the youngest cohort of men, and progressively decreases throughout older cohorts.	Australia	2803 (1,516 men, 1,287 women)	45+	2001-2 2002-3 2003-4 2004-5 2005-6	Reversed scores

Reference	Study	Summary	Country	Sample size (n)	Age range	Measurement times	Reporting of MHI-5
Pachana, Ford, Andrew, and Dobson (2005)	ALSWH	Companion animal status was not associated with differences in mental health scores.	Australia	7,952 women 7,952 women	73-78 76-81	1999 2002	Split according to pet ownership
Pachana, Smith, Watson, McLaughlin, and Dobson (2008)	ALSWH	An increase in social network was associated with improved mental health. Most women became less satisfied with their social support, with the largest decreases associated with being born overseas, vision problems and a reduction in mental well-being. A reduction in social network was associated with being born overseas and poor mental health.	Australia	6,373 women 6,373 women	70-75 73-78	1996 1999	Split according to above or below 53 to indicate the presence of probable psychiatric disorder
Parkinson, Warburton, Sibbritt, and Byles (2010)	ALSWH	Mental health was relatively stable for continuing, new and never volunteers. Never volunteers had poorer mental health than the other two groups. Intermittent volunteers started with a similar level of mental health as continuing and new volunteers, but decreased significantly to approach the levels of never volunteers.	Australia	7088 women 7088 women 7088 women	73-78 76-81 79-84	1999 2002 2005	

Overall, nine different longitudinal studies provided data in the 21 articles. Sixteen articles examined the mental health of women only. This was largely due to the women-only Australian Longitudinal Study on Women's Health (ALSWH) representing 13 of the 21 articles. There were no articles that examined the mental health of men only.

The majority of the populations studied were from majority-white, English-speaking developed countries with more individualistic culturesⁱ: Australia, USA, Canada, and England. The only exceptions to this were Kenya, a less-developed country with a majority-native African population and a more collectivist culture, and Spain, a non-English-speaking developed country.

Nine articles used two waves of data to look at changes in mental health. Seven articles used three waves of data, two used four, two used five, and one used six waves. The waves all occurred between 1991 and 2008.

Three articles focused solely on mental health trajectories and did not refer to associated predictors or outcomes. The remaining 18 articles reported correlates of mental health

ⁱ Individualism and collectivism are culturally related psychological constructs that are used to categorise people by their cultural attributes (Shulruf, Hattie, & Dixon, 2011). Broadly speaking, this cultural theory divides western (individualist) and non-western (collectivist) cultures.

According to Oyserman, Coon, and Kemmelmeier (2002) the key feature of individualism is the assumption that individuals are independent. This perspective centralises the personal—personal objectives, personal uniqueness, and personal control—and peripheralises the social group (Oyserman et al., 2002).

The key feature of collectivism is the assumption that groups are bound through the mutual obligation of individuals (Oyserman et al., 2002). Schwartz (1990) defines collectivist cultures as communal societies characterised by broad mutual obligations and expectations founded on assigned statuses. Social units that share common objectives, values and futures are centralised, while individuals are just an element of these units (Oyserman et al., 2002).

trajectories. See Table 3.2 for a summary of the correlates of improved and decreased mental health.

One of the identified correlates of improved mental health was education, most likely in this older population to be a time-invariant or unchanging personal characteristic (Byles, Young, et al., 2006). The majority of other correlates were modifiable lifestyle behaviours, such as increased physical activity (Heesch et al., 2012; C. Lee & Russell, 2003), larger social networks (D. McLaughlin et al., 2011; Pachana et al., 2008), and developing family relationships (Goodman, 2012). High cognitive performance was also found to be a correlate of improved mental health (Jokela et al., 2010). It is of interest to note that neither good physical health nor diet were identified as a correlates of improved mental health. This is perhaps unusual as both physical health and diet are commonly reported and well-established characteristics associated with good and improved mental health (Caligiuri, Lengyel, & Tate, 2012).

The correlates of decreased mental health were all time-varying, that is, personal characteristics that can change over time. A number were modifiable lifestyle behaviours that were associated with decreased mental health, such as not drinking alcohol or smoking (Byles, Young, et al., 2006), and being physically inactive when previously active (C. Lee & Russell, 2003). Other correlates of decreased mental health included difficulty sleeping (Byles et al., 2005; Byles et al., 2003), caregiving (Ice et al., 2010) and having poorer mental health (Leigh et al., 2016). Chronic illness (Byles, Young, et al., 2006; Leigh et al., 2016) and falls (Leigh et al., 2016) were also identified as correlates of poorer mental health. Interestingly, disability (often assessed through instrumental activities of daily living) and diet were not identified as factors associated with lower mental health. This is of interest as previous literature has reported disability and less nutritious diets to be associated with declines in mental health (Conwell et al., 2010; Kvamme, Gronli, Florholmen, & Jacobsen, 2011; Meltzer et al., 2012).

Table 3.2. Identified correlates of improved and decreased mental health.

Study	Correlates
Improved	
Byles, Young, et al. (2006)	Higher education
Goodman (2012)	Development of greater closeness in the grandmother–grandchild relationship
Heesch et al. (2012)	Increased physical activity and walking
Jokela et al. (2010)	High cognitive performance
C. Lee and Russell (2003)	Adopting exercise
D. McLaughlin et al. (2011)	Larger social networks
Pachana et al. (2008)	Increased social network size
Decreased	
Byles et al. (2005)	Sleep disturbance
Byles, Young, et al. (2006)	Not drinking alcohol, smoking, chronic illness
Byles et al. (2003)	Sleeping difficulty, sleep medication
Fine et al. (1999)	Weight loss among women with lower BMIs
Ice et al. (2010)	Caregiving
C. Lee and Russell (2003)	Transition from some physical activity to no physical activity
D. McLaughlin et al. (2011)	Smaller social networks
Parkinson et al. (2010)	Never volunteering or only intermittently
Leigh et al. (2016)	Chronic illness, falls, having poorer mental health

3.4.3 Critical appraisal

The articles' quality was assessed using the Critical Appraisal Skills Programme (CASP) checklist for cohort studies (Public Health Resource Unit, 2006); see Box 3.1 for the checklist and Table 3.3 for results. The majority of articles were of high quality. No articles were excluded due to methodological, ethical or reporting reasons. This is largely due to the majority of articles coming from the ALSWH, which is an example of a high quality cohort study. All articles were clear in identifying and addressing a focussed issue and the use of a cohort study to address the issue was appropriate.

Box 3.1. Critical Appraisal Skills Programme (CASP) checklist for cohort studies (Public Health Resource Unit, 2006).

1. Did the study address a clearly focused issue?
2. Did the authors use an appropriate method to answer their question?
3. Was the cohort recruited in an acceptable way?
4. Was the exposure accurately measured to minimize bias?
5. Was the outcome accurately measured to minimize bias?
6. A) Have the authors identified all important confounding factors?
B) Have they taken account of the confounding factors in the design and/or analysis?
7. A) Was the follow up of subjects complete enough?
B) Was the follow up of subjects long enough?
8. What are the results of this study?
9. How precise are the results?
10. Do you believe the results?
11. Can the results be applied to the local population?
12. Do the results of this study fit with other available evidence?

Table 3.3. CASP evaluations of included articles.

Reference	1.	2.	3.	4.	5.	6A.	6B.	7A.	7B.	8.	9.	10.	11.	12.
1. Burns, Byles, et al. (2012)	✓	✓	✓	✓	✓	Gender, age, smoking, alcohol, physical health, self-rated health.	✓	✓	✓	See Table 3.1	Good CIs	✓	✓ but women only	✓
2. Byles et al. (2005)	✓	✓	✓	✓	✓	Depression scores, life events, use of sleeping medications area of residence, smoking, body mass index, exercise, age.	✓	✓	✓	See Table 3.1	Good SEs	✓	✓ but women only	✓
3. Byles, Powers, et al. (2006)	✓	✓	✓	✓	✓	Area of residence (urban, rural, remote).	×	✓	✓	See Table 3.1	Good CIs	✓	✓ but women only	✓
4. Byles, Young, et al. (2006)	✓	✓	✓	✓	✓	Time, smoking, comorbidity, education, BMI, area of residence.	✓	✓	✓	See Table 3.1	Good CIs but graphs only	✓	✓ but women only	✓
5. Byles et al. (2003)	✓	✓	✓	✓	✓	Prior SF-36 scores, symptoms, co-morbidity, life events and age at baseline.	✓	×	✓	See Table 3.1	Good CIs but graphs only	✓	✓ but women only	✓
6. Faubel et al. (2009)	✓	✓	✓	✓	✓	Gender, age, physical activity, BMI, tobacco use, alcohol, coffee, education, social ties, chronic disease, depression, cognitive impairment, arousal from sleep, anxiolytics	✓	×	✓	See Table 3.1	×	×	✓	×
7. Fine et al. (1999)	✓	✓	✓	✓	✓	Age, cigarette smoking, physical activity, alcohol, comorbid conditions.	✓	×	✓	See Table 3.1	Graphs only – no CIs	×	✓ but women only	✓

Reference	1.	2.	3.	4.	5.	6A.	6B.	7A.	7B.	8.	9.	10.	11.	12.
8. Goodman (2012)	×	✓	×	✓	✓	Baseline Physical health, income, ethnicity	✓	×	✓	See Table 3.1	Not reported	✓	✓ but women only	✓
9. Heesch et al. (2012)	✓	✓	✓	✓	✓	Socio-demographic and health variables	✓	✓	✓	See Table 3.1	Not reported	✓	✓ but women only	✓
10. Hopman et al. (2006)	✓	✓	✓	✓	✓	List many variables considered in the models but it is unclear which are.	✓	×	✓	See Table 3.1	Credible intervals reported – seem reasonable	✓	✓	✓
11. Ice et al. (2010)	✓	✓	✓	✓	✓	Gender, SES, Age, Stress, Intensity, Burden	✓	✓	✓	See Table 3.1	Not reported	✓	No as low-income country. However, caregivers seem to have universally worse mental health.	✓
12. Jokela et al. (2010)	✓	✓	✓	✓	✓	SES and retirement	✓	✓	✓	See Table 3.1	Good SEs	✓	✓	✓
13. C. Lee and Russell (2003)	✓	✓	✓	✓	✓	Age, marital status, BMI, PCS, life events	✓	×	✓	See Table 3.1	Not reported	✓	✓ but women only	✓
14. Leigh et al. (2016)	✓	✓	✓	✓	✓	Age, physical function, marital status, geographical location, BMI, education, physical activity, living alone, falls and whether or not the survey had been filled out by proxy	✓	✓	✓	See Table 3.1	Good CIs	✓	✓ but women only	✓
15. Lucke et al. (2010)	✓	✓	✓	✓	✓	None reported	×	✓	✓	See Table 3.1	Good CIs but graphs only	✓	✓ but women only	✓
16. D. McLaughlin et al. (2011)	✓	✓	✓	✓	✓	None reported	×	✓	✓	See Table 3.1	Good CIs	✓	✓ but women only	✓

Reference	1.	2.	3.	4.	5.	6A.	6B.	7A.	7B.	8.	9.	10.	11.	12.
17. Mishra et al. (2004)	✓	✓	✓	✓	✓	Baseline scores, menopausal status, smoking, physical activity, life events, marital status, language spoken at home, age.	✓	✓	✓	See Table 3.1	SEs	✓	✓ but women only	×
18. Olesen et al. (2012)	✓	✓	✓	✓	✓	Age, physical health, functioning, income, financial hardship, spousal status, social support, social activity, workplace conditions, job satisfaction.	✓	✓	✓	See Table 3.1	Good CIs	✓	✓	✓
19. Pachana et al. (2005)	✓	✓	✓	✓	✓	Physical activity, ability to manage on available income, area of residence, living arrangements, housing, moved house in last 3 years.	✓	×	✓	See Table 3.1	Good CIs but seem to be unlabelled	✓	✓ but women only	✓
20. Pachana et al. (2008)	✓	✓	✓	✓	✓	Unsure	?	×	✓	See Table 3.1		✓	✓ but women only	✓
21. Parkinson et al. (2010)	✓	✓	✓	✓	✓	Unsure	?	✓	✓	See Table 3.1	Good CIs -	✓	✓ but women only	✓

The information about recruitment strategies varied from a brief summary of the number, age, and sex of participants recruited, with no detail on how recruitment occurred (Jokela et al., 2010) to detailed descriptions of randomisation and oversampling to improve the representativeness of the population (Byles, Powers, et al., 2006). Overall, there were no issues were identified regarding how participants were recruited, although some methods appeared less biased and resulted in a more representative sample than others.

For example, Ice and colleagues (2010) used rolling recruitment and were assisted by chiefs of the 18 villages that participated. This was likely to produce a biased sample, given there was no mention of randomisation when selecting the villages or participants. Goodman (2012) recruited participants through announcements distributed in 223 of 792 schools in a particular School District, as well as media announcements. Again, the lack of randomisation is likely to introduce bias. In comparison, the researchers involved in the ALSWH were able to access to the Australian national health insurance database (Medicare). This database theoretically involves all women in Australia, including non-residents (Byles et al., 2003). Samples of each cohort were randomly drawn from the database, with women from rural and remote areas intentionally over-sampled to ensure adequate representation (Heesch et al., 2012). Given these methods used to minimise bias, it could be assumed the ALSWH is a highly representative sample of women in Australia. Faubel and colleagues (2009) selected participants using probabilistic sampling by multistage clusters. Census sections and households were randomly chosen within each geographical cluster, and subjects were selected in age and sex strata. Again, the methods described would suggest the dataset used would be representative.

The MHI-5 was used to measure the outcome variable mental health, and as discussed above, is a psychometrically sound and appropriate tool to use to minimise bias. The factors identified as being associated with change in MHI-5 were generally measured appropriately using valid tools; however, the article by Byles and colleagues (2003) may have benefited from using more established and validated measures of sleep quality.

A number of studies did not report controlling for confounding variables. This is problematic given that in articles that did control, relationships decreased or disappeared when confounding variables such as education or chronic illness were included in analyses (see, for example, Faubel et al., 2009).

The primary limitation identified by the CASP checklist was the number of times data was collected. As mentioned above, nine articles used two time points to assess change in mental health. This has implications for any conclusions made about longitudinal associations, as two time points are insufficient to determine the direction of effects between outcome and predictor variables (Rogosa, Brandt, & Zimowski, 1982, p. 729; Singer & Willett, 2003, p. 10), as will be discussed in more detail below.

In general, the results concerning predictors of mental health change were consistent with other literature and made intuitive sense. That is, correlates that are well-established negative health behaviours, such as smoking, were associated with a decline in mental health, while traditionally positive characteristics such as having a larger social network size were associated with increased mental health. There were two exceptions to this. Firstly, Faubel and colleagues (2009) found that mental health was not associated with sleep duration, which is not in keeping with previous literature including articles in this review (Byles et al., 2005; Byles et al., 2003). Secondly, Mishra and colleagues (2004) did not find an association with mental health and socioeconomic status, which is not consistent with the majority of research literature in this area, which links lower socioeconomic status with declines in mental health. There was an inconsistency between the trajectories reported by Byles, Powers and colleagues (2006) and Hopman et al. (2006). Byles, Powers and colleagues (2006) reported that mental health remained constant for women aged 70-81, while Hopman et al. (2006) found that the mental health of women aged 65-74 improved, whereas those aged 75 years and above had a decline in mental health. The decline in mental health in older age is consistent with the findings of Lucke and colleagues (2010), who reported that mental health began to decline from the aged of 79 to 87 years for the same population used by Byles, Powers and colleagues (2006). The two articles were looking at different age groups, 70-81 year olds vs. 65-74 year olds, which makes it likely that the trajectories would be different and potentially not comparable. The discrepancy could also be due to cross-national

differences, as Hopman's conclusions were based on a Canadian sample while Byles' used an Australian sample. Additionally, Hopman et al. (2006) were making conclusions from two time points of data collection while Byles, Powers and colleagues (2006) were using three time points.

Also mentioned above is that the majority of articles reported on data from women only, which make the results ungeneralisable to the general population as there is evidence that men have significantly different mental health outcomes to women (Hopman et al., 2006; Rosenfield & Mouzon, 2013; Rosenfield & Smith, 2010). In addition, the findings of Ice and colleagues (2010) would not be considered generalisable to the local population given the population studied was in Kenya, an economically developing relatively unindustrialised country. However, the results reported by Ice and colleagues (2010) are consistent with the majority of research that reports caregivers seem to have universally worse mental health than non-caregivers (Ho, Chan, Woo, Chong, & Sham, 2009; Mausbach, Chattillion, Roepke, Patterson, & Grant, 2013).

3.4.4 Trajectories of mental health only

Three articles described the trajectories of mental health over time without looking at associated predictors (Byles, Powers, et al., 2006; Hopman et al., 2006; Lucke et al., 2010). Byles, Powers, et al. (2006) reported that mental health did not change over time for women with baseline ages of 70-75 years, likely due to a survival effect. Using data from the same study, Lucke et al. (2010) reported that older women had the best mental health overall compared to younger adult women, but that health began to decline from the age of 79 to 87 years. Hopman et al. (2006) reported different trajectories, finding that the mental health of women aged 65-74 improved while those aged 75 and above showed a decline in mental health. The dataset also included men, who showed a decline in mental health over time in both age groups (65-74 years, 75 years and above).

3.4.5 Excluded study characteristics

The majority of studies that were excluded were assessing trajectories of mental health in samples that were non-community populations ($n=1108$). The clinical samples investigated included participants with chronic pain, arthritis, and depression as well as many other conditions. There were also a small number of articles investigating different non-community populations, such as women who had experienced domestic violence or abuse. Seventy-nine articles were trials involving the assessment of the impact of particular interventions on participants' mental health. For example, these trials included weight loss or physical activity interventions for overweight participants.

Thirty-nine articles reported cross-sectional rather than longitudinal data, and four articles that collected MHI-5 data on one occasion only and were therefore effectively cross-sectional in terms of the outcome variable of interest.

Twenty-five articles collected SF-36 data but did not report the MHI-5 specifically. Often, the authors chose to report the alternative mental health score of the SF-36, the Mental Component Summary score (MCS). The studies using the MCS reported similar findings to those using the MHI-5, such as higher scores being associated with meaningful activity (Grundy et al., 2012; Mein, Martikainen, Hemingway, Stansfeld, & Marmot, 2003).

3.5 Discussion

Many previous conclusions about successful ageing in older people are based predominantly on cross-sectional studies that do not include mental health as an important outcome variable. The current study comprised a systematic review of longitudinal cohort studies and provided unique evidence indicating how mental health changes over time in community dwelling older people. Results generally indicated that the studies reported mental health scores within the normal range. It should be noted that this is not a surprising finding given that the majority of the cohort studies used were based in economically developed countries. Most of the studies used community samples that often carry a potential bias, as they are less likely to include people with mental health conditions such as depression and anxiety and are therefore

not representative of the general population. Additionally, participants who remain in longitudinal studies and contribute data at each time point are likely to be biased towards better physical and mental health when compared to other participants of the same age (Byles, Powers, et al., 2006; C. Lee et al., 2005).

Results generally indicated that mental health remains relatively stable over time, with evidence for a decrease associated with older age, modifiable lifestyle behaviours and potentially non-modifiable factors such as chronic illness. Increased physical and social activity, in addition to demographic factors, were associated with improved mental health.

The current results indicate that there are readily modifiable lifestyle behaviours that can be varied to improve mental health outcomes in older people. This has clear implications for healthcare providers, policy makers and older people themselves. Interventions can be designed to increase uptake of, for example, physical activity, which has the potential to significantly improve mental health outcomes in older people. The current results also identify populations at risk of decreased mental health, who can be targeted with interventions designed to reduce their risk of declining mental health. For example, people with lower BMIs need to not lose weight, as weight loss in this population is associated with declines in mental health. Many of these factors also have strong associations with physical health, such as reducing smoking and increasing physical activity. Thus, a strong argument can be made to introduce interventions to target these factors, as they would have substantial real world outcomes, reducing both the individual, societal and economic burden of decreased physical and mental health.

The primary methodological limitation of the articles reported was the inclusion of longitudinal studies with two time points only. As mentioned above, the use of only two time points does not allow for definitive conclusions to be made about trajectories of mental health, or predictors associated with change. Two waves of data provide only a limited amount of information about individual change. In their seminal work, Rogosa et al. (1982) argue strongly that behavioural scientists need to recognise that:

two waves of data poorly define the individual time paths and often are not sufficiently rich to yield satisfactory answers to important questions about change and growth. (Rogosa et al., 1982, p. 729)

This is further described by Singer and Willett (2003) who state:

two wave studies cannot describe individual trajectories of change and they confound true change with measurement error. (Singer & Willett, 2003, p. 10)

An additional limitation of the articles is the potential for bias towards participants with better mental health to participate in such studies which could skew the results, however given the majority of the samples included were very large samples (the majority over 5,000 participants), the risk of this bias is significantly reduced. In addition, the majority of studies reported data from women only, in particular from the Australian Longitudinal Study on Women's Health. Equivalent studies in men, such as the Florey Adelaide Male Ageing Study, have a focus on physical health (aside from depression), endocrinology and utilisation of health services (S. Martin, Haren, Middleton, Wittert, & Study, 2007). This indicates that further research is needed into trajectories of mental health in men and associated predictors of change. Comparing such research with women would provide valuable information about gender differences, and help inform the design of effective interventions for mental health improvement ensuring that factors that are important to both genders are included. In addition, these results are not globally generalisable as most of the samples are from industrialised economically developed countries where the majority of the population are Caucasian and individualist in culture. Other cultures will potentially have different trajectories of mental health, and most likely different predictors of change, given differences in how mental health (Jimenez, Bartels, Cardenas, Dhaliwal, & Alegría, 2012) and ageing (Hung, Kempen, & De Vries, 2010) are perceived between cultures.

The limitations affecting this current review include the inclusion of only a single indication of general mental health, the MHI-5. However, given the overwhelming number of longitudinal studies that have assessed mental health over time using a wide variety of measurement tools, a synthesis of these articles would potentially produce meaningless

results, the heterogeneity of studies making it impossible to compare results across studies. Mental health is a broad concept, with many different indicators are possible for use.

Overall, this review has provided an important and systematic overview of mental health in ageing relevant to individuals, researchers, practitioners and policy makers. Whilst a number of factors that negatively affect mental health cannot be modified, there is the potential to improve mental health for at risk populations through encouraging lifestyle behaviours associated with increased mental health. These correlates of change in mental health that were identified in this review will be tested in further quantitative analyses of the DYNOPTA data to assess if the same patterns are observed in a much larger dataset. The next chapter describes the overall methodology for the dataset applied in this thesis.

Chapter 4

METHODOLOGY

4.1 Introduction

This chapter systematically describes the methodology related to the quantitative analysis of the DYNOPTA data. It includes a discussion of integrative data analysis as an analytic framework. The DYNOPTA dataset is also fully described, in addition to the data cleaning that was performed on the dataset. These analyses are performed to answer the question of how mental and physical health influence each other over time in older people. This thesis addresses the following questions: i) how and why does mental health change over time for older people, ii) does the MHI-5 function homogenously across groups, iii) how does physical health influence mental health over time, iv) how does mental health influence physical health over time, and v) how does physical health influence depression over time.

4.2 Integrative data analysis

The procedures adopted in this dissertation were based on an Integrative Data Analysis (IDA) framework. IDA is the statistical analysis of a single data set that consists of two or more separate datasets that have been pooled into one (Curran & Hussong, 2009, p. 82). Data pooling is an important and cost-effective technique for increasing sample size (Noale et al., 2005).

IDA, like meta-analysis, is performed in an attempt to add to the cumulative knowledge base of empirical science by imparting important information that may contribute to theories and methodologies (Curran & Hussong, 2009). The techniques differ in that meta-analysis is the integration of results from multiple studies (G. V. Glass, 1976), whereas IDA involves the synthesis of original raw data from multiple studies. IDA is also called individual patient/participant data meta-analysis or mega-analysis (Cooper & Patall, 2009; L. A. Stewart, 1995).

Given the time and financial cost associated with participant recruitment and data collection, IDA offers an attractive opportunity for secondary analysis with potentially better results and more external validity, than the original individual studies (Curran, 2009).

Proponents of IDA Curran and Hussong (2009, pp. 86-91) outline the major advantages associated with IDA. Firstly, IDA can offer considerably larger statistical power for testing hypotheses. Often in the field of psychological research, it can be difficult to provide a large enough sample to provide adequate power. This means that if the effect of interest exists in the population, there is an insufficiently low probability that it will be observed in the sample. IDA can solve this issue due to multiple samples are being combined resulting in a larger sample size.

Given the larger sample sizes involved in IDA, there will also be increased sample heterogeneity. It is likely that there will be increased frequencies of low prevalence or rare attributes and behaviours. For example, the oldest old, people who do many hours of exercise per day, or people with rare diseases. Hence, the sample will most likely become more representative of the population that it is drawn from, thus increasing the external validity of the findings and improving the stability of model estimation.

Group comparisons may be performed in IDA that could not in the individual studies due to too few group members. In addition, it is possible by combining longitudinal studies to include a greater age range to investigate a larger developmental period. In addition, IDA enables testing whether results consistently replicate across independent studies.

Before continuing this discussion of what the procedures involved in IDA are, a specific example of IDA, the Dynamic Analyses to Optimise Ageing (DYNOPTA) dataset, will now be presented.

4.3 Dynamic Analyses to Optimise Ageing dataset

The secondary analyses conducted as part of the current thesis were drawn from the DYNOPTA data set. DYNOPTA is the product of integrating raw data from nine Australian longitudinal studies. See Table 4.1 for details of the studies.

Table 4.1. Studies contributing to the DYNOPTA dataset (from Anstey et al. (2009)).

Study	Location	Wave	Year	N	Age	Deceased at wave
Australian Longitudinal Study of Ageing (ALSA)	Adelaide	1	1992-1993	2087	65-103	0
		2	1993-1994	1779	65-104	131
		3	1994-1995	1679	66-105	250
		4	1995-1996	1504	68-106	630
		5	1998	1171	70-100	723
		6	2000-2001	791	72-101	1248
		7	2003-2004	487	75-102	1264
Australian Longitudinal Study of Women's Health Mid Cohort (ALSWH-mid), Old Cohort (ALSWH-old)	National (Mid)	1	1996	13 706	45-51	0
		2	1998	12 329	46-53	50
		3	2001	11 185	49-56	116
		4	2004	10 897	52-59	204
	National (Old)	1	1996	12 431	68-76	0
		2	1999-2000	10 434	71-79	529
		3	2002-2003	8629	74-82	1098
		4	2005-2006	7152	77-85	1867
Australian Diabetes and Obesity and Lifestyle Study (AUSDIAB)	National	1	1999-2001	7296	45-95	0
		2	2004-2005	4380	49-93	*
Blue Mountains Eye Study (BMES)	Blue Mountains	1	1992-1993	3654	45-100	0
		2	1997-2000	2334	50-98	*
		3	2001-2004	1952	55-99	*
Canberra Longitudinal Study (CLS)	Canberra, Queanbeyan	1	1990-1991	1134	70-103	0
		2	1994-1995	637	74-102	306
		3	1998	380	78-101	552
		4	2002	213	82-105	744
Household, Income and Labour Dynamics of Australia (HILDA)	National	1	2001-2002	6164	45-90+	0
		2	2002-2003	5454	45-90+	*
		3	2003-2004	5089	46-90+	*
		4	2004-2005	4769	47-90+	*
		5	2005-2006	4658	48-90+	*
Melbourne Longitudinal of Study Healthy Ageing (MELSHA)	Melbourne	1	1994	1000	65-94	0
		2	1995	979	66-95	35
		3	1996	796	67-96	74
		4	1997	718	68-97	91
		5	1998	649	69-98	113
		6	1999	648	70-99	128
		7	2000	542	71-96	143
		8	2002-2003	372	73-98	170
		9	2003	347	74-99	193
		10	2004-2005	326	75-96	193
		11	2005-2006	242	76-97	415
Personality and Total Health through life (PATH)	Canberra, Queanbeyan	1	2001-2002	2550	60-66	0
		2	2005-2006	2222	64-70	70
Sydney Older Person's Study (SOPS)	Sydney	1	1991-1993	630	75-97	0
		2	1994-1996	449	78-99	123
		3	1996-1997	367	78-100	163
		4	1997-1999	299	80-101	226
		5	2001-2003	62	84-106	318

*Death data not available

There are 50 652 participants that comprise the DYNOPTA sample at wave 1. There are 39,085 (77.20%) participants who are female, while 11 567 (22.80%) participants are male.ⁱ

The current dissertation will focus on the older cohort of participants, that is people aged 65 years and above. This reflects the majority of the research literature and the Australian Government's definition of older people, which will enable comparisons to be made with previous findings.

There are 24,016 participants aged 65 years and over at wave 1. The mean age of these participants at wave 1 is 73.40 years (SD=5.08) with a range of 65 to 103 years. 18 627 (77.60%) participants are female and 5389 (22.40%) participants are male.

Studies have a mean of 4.4 waves of data collection over a mean period of 9.4 years (SD=2.99). Each participant engaged in an average of 3.1 waves of data collection (SD=1.51) with a mode of 4 and a median of 3 waves per participant (Anstey et al., 2009).

Participants are from all over Australia. Three of the contributing studies are nationally representative – ALSWH (51.80%), AusDiab (9.90%), HILDA (8.50%). Two studies were conducted in Canberra and Queanbeyan in the Australian Capital Territory - CLS (4.70%) and PATH (1.30%). Two studies were conducted in NSW – SOPS in Sydney (2.60%) and BMES in the Blue Mountains (8.30%) One study was conducted in Melbourne, Victoria - MELSHA (4.20%); and the final study was conducted in Adelaide, South Australia - ALSA (8.70%). It should be noted that at wave 1, the majority of the DYNOPTA sample (93.00%) resided in either highly accessible or accessible areas according to the Australian Standard Geographical Classification system.

ⁱ This difference is due to the inclusion of the all-female ALSWH.

The majority of participants were born in Oceania (72.00%), according to the Standard Australian Classification of Countries. The next largest group of participants were born in North-West Europe (15.70%).

4.3.1 Ethical approval

All studies contributing to the DYNOPTA dataset were approved by the appropriate home institution's ethics committee. DYNOPTA was approved by the Australian National University's Human Research Ethics Committee (reference number: Protocol 2006/218). The current thesis analyses de-identified data files.

4.4 Procedural overview

IDA typically consists of three main stages: (1) selection of studies; and (2) integration and harmonisation; and (3) data analysis. These stages will now be discussed in detail in relation to the DYNOPTA dataset.

4.4.1 Selection of studies

The goal of the analyses for the current research is to fit a series of models to a single pooled sample that consists of data drawn from multiple separate longitudinal studies to examine individual variability in trajectories of mental and physical health (Curran et al., 2008). To accomplish this, appropriate measures need to be identified. The measures need to be valid, reliable and have the same underlying metric, regardless of which study the data were drawn from (Curran et al., 2008). Hence, it is necessary to select studies that are most appropriate for integration into a single data set. The specific studies used in the current analyses were thus selected on the basis of providing comparable measures of mental and physical health.

Identification of studies

Data was considered from four longitudinal studies of ageing that had included the SF-36: ALSWHold (C. Lee et al., 2005), AusDiab (Dunstan et al., 2002), BMES (P. Mitchell, Smith, & Chang, 1996), and HILDA (Watson & Wooden, 2002; Wooden, Freidin, & Watson, 2002).

ALSWHold

The ALSWHold consists of older women born between 1921 and 1926. Participants were selected from the database of the Health Insurance Commission (HIC) that runs the national health insurance scheme, Medicare. This database includes all Australian citizens and permanent residents. Sampling was randomised, but participants living in rural and remote geographical areas were sampled at twice the rate of participants living in urban areas. The baseline assessment (Wave 1) occurred in 1996 when these participants were aged 70-75 years of age. Information packs and surveys were mailed from the HIC to approximately 31000 women. Approximately 40% of women responded to the first survey. Surveys have been mailed to participants every three years after the initial survey; see Table 4.1.

Included in the surveys were validated for mailed data collection assessment tools, in addition to standard questions about demographic and health behaviours from the Australian census or other national surveys. For a full description of the study methodology and cohort profile see C. Lee et al. (2005).

AusDiab

The AusDiab study consists of non-institutionalised English speaking adults living in private accommodation who were aged over 25 years in 1999. Participants were from the six states and the Northern Territory of Australia (all states and territories except the Australian Capital Territory).

A stratified cluster sampling method was used. Census collector districts (CDs—the smallest geographic unit defined by the Australian Bureau of Statistics at each census, with an average of 225 dwellings each) were used as clusters in the states and territory. Six CDs were randomly selected within each state and territory, with a selection probability proportional to the population size (aged over 25 years).

A sample size of 10500 was selected and baseline data collection occurred over a 21-month period between May 1999 and December 2001.

Data collection was divided into two phases: household interview and biomedical examination. Every eligible adult member of participating households was interviewed about demographic information and diabetes history. Participants were then invited to attend a biomedical examination and given the self-administered SF-36 questionnaire.

Of the 25984 households approached, 11479 (44.17%) were interviewed after ineligibility and refusal were taken into account. 20347 participants took part in the household interview, while 11247 (55.28%) of these took part in the biomedical examination.

For a full description of the study methodology and cohort profile see Dunstan et al. (2002) and Barr et al. (2006).

BMES

The BMES study consisted of participants sampled from an urban population in two postcode areas in the Blue Mountains region, west of Sydney. This area is considered representative of Australia for income and socioeconomic status, but is older compared with the NSW state average. All permanent non-institutionalised residents born prior to 1943 were invited to participate. There were 4433 people eligible to participate, 3654 agreed to take part in the study (82.40%). Baseline data collection ran from January 1992 to January 1994.

Interviewers initially administered a short questionnaire to participants at their dwellings collecting information on self-reported health, medical conditions and health service use. Participants then attended a clinic to provide a detailed medical history and have an eye examination,

2335 (63.90%) participants took part in follow up examinations five years later in 1997-1999. 1952 participants (53.40% of the original cohort) took part another five years later in 2002-2004. 2564 participants were followed up at least once after baseline examination. For a full description of the study, see Attebo, Mitchell, and Smith (1996).

HILDA

HILDA is a nationally representative household panel survey that targeted all members of private dwellings in Australia. A sample of 488 CDs were selected from across Australia, with 22-34 private dwellings selected within each CD. From the 11693 households identified, interviews were completed with all eligible individuals aged over 15 years in 6872 households. A further 810 households had at least one eligible member take part, resulting in an average of 2.6 individuals participating per household.

Participants completed a face-to-face interview and a self-completion questionnaire. The first wave was administered in 2001, and participants were followed up annually. For a full description of the study methodology and cohort profile see (Wooden et al., 2002).

4.4.2 Outcome measures

The three main outcome variables used in the analyses were mental health, depression and physical health. As such, the Short Form Health Survey-36 (SF-36) was identified as an appropriate measure in the DYNOPTA dataset to represent these variables. Throughout this thesis, mental health is defined as the absence of psychological distress and the presence of well-being. Depression is defined according to the Diagnostic and Statistical Manual of Mental Disorders (DSM) and International Classification of Disease (ICD) (Burns,

Butterworth, et al., 2012). Physical health is defined in terms of physical function, role-physical, bodily pain, and general health (defined in more detail below).

All variables were time-varying and collected at each measurement occasion, with the exception of age at baseline, sex, and education.

SF-36

The SF-36 is perhaps the most commonly used measure of health-related quality of life in both clinical and epidemiological studies (Friedman et al., 2005; Garratt, Ruta, Abdalla, Buckingham, & Russell, 1993; Halvorsrud & Kalfoss, 2007). The measure was developed in the USA to evaluate population health characteristics, make group comparisons and quantify disease burden with high psychometric standards (Ware & Gandek, 1998).

The SF-36 has been adapted for use in 120 different languages and used around the world to assess population health (Burholt & Nash, 2011). The SF-36 was adapted for use in Australia in 1992 and is validated for use in the Australian population (McCallum, 1995; Sanson-Fisher & Perkins, 1998). The SF-36 has been positively evaluated for use with older people and has satisfactory internal consistency, test-retest reliability, construct validity, concurrent validity, and responsiveness (Haywood et al., 2005).

The SF-36 consists of 36 questions that are summarised to eight health scales: physical function, role physical, bodily pain, general health, vitality, social functioning, role emotional and mental health. See Appendix 2 for the Australian version of the SF-36 (Sanson-Fisher & Perkins, 1998) and the scale to which each question belongs.

The SF-36 data were collected at each wave through self-report questionnaires using the Australian adaptation of the SF-36 version 1. The SF-36 was administered and scored in accordance with the standard International Quality of Life Assessment (IQOLA) procedure (Sanson-Fisher & Perkins, 1998).

Responses to 35 questions (question 2 that measures health transitions is excluded) are recoded, summed and standardised to provide eight scales. Scores for each scale vary between 0-100 with higher scores indicating positive health status (Ware, Kosinski, Dewey, & Gandek, 2000). If valid responses were available for at least half of the items comprising each scale, missing values were replaced with scale means. As per standard SF-36 scoring procedures, the scores were calculated using US norms (Ware et al., 1994).

Table 4.2 presents information about the SF-36 health scales and the interpretation of scores. See Table 4.3 for the SF-36 questions grouped according to the scales they contribute to.

Mental health

The MHI-5 is the mental health subscale of the SF-36 and consists of the five items that best reproduced the total score for the 38-item Mental Health Inventory (Ware & Sherbourne, 1992). Four mental health dimensions were identified in factor analyses of the Mental Health Inventory: anxiety, depression, loss of behavioural or emotional control and psychological well-being (Veit & Ware, 1983). See Table 4.2 for a description of the scoring and interpretation of the MHI-5 (SF-36 general mental health domain).

As noted in Chapter 3, the MHI-5 is a well-validated and reliable measure of mental health status (Ware & Gandek, 1998), and has been found to have sound psychometric properties in older populations (Beusterien et al., 1996; Friedman et al., 2005). It has been used extensively to assess mental health (Rumpf et al., 2001).

Depression

Depression was assessed at each wave using the SF-36 MHI-5, described above and in Table 4.2. The SF-36 MHI-5 is frequently used to assess depression in epidemiological studies and has sound validity, clinical utility and psychometric properties (Burns, Butterworth, et al., 2012; Gill et al., 2006; Rumpf et al., 2001; Skapinakis, Lewis, Araya, Jones, & Williams, 2005).

A binary variable that reflects that a participant is likely to have depression, or “probable depression” was created by using the recommended cut-off scores for the MHI-5 validated to reflect depression, as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM) and International Classification of Disease (ICD) (this process is fully reported on in Burns, Butterworth, et al., 2012).

To create the binary depression variable, MHI-5 scores were reversed so higher scores reflected lower mental health. Cut-off scores of 60, 55, and 50 (also reversed) equated to 1.0, 1.2 and 1.6 standard deviations above the mean respectively on the variable (Gill et al., 2006; Rumpf et al., 2001; Skapinakis et al., 2005). A cut-off of 1.5 standard deviations above the mean on the score was then used as an indicator of likely or probable depression. The resulting prevalence was validated against national Australian data (Burns, Butterworth, et al., 2012).

Change in depression status

Change in depression status was assessed by creating a lagged depression variable that was then compared to participant’s depression status at the subsequent wave. Participants were grouped into four categories:

- i) remained depressed – participants who were depressed previously and were also depressed at the subsequent wave.
- ii) became depressed – participants who were not depressed previously and became depressed at the subsequent wave.
- iii) became not depressed – participants who were depressed previously and did not have depression at the subsequent wave.
- iv) remained not depressed – participants who were not depressed previously and were also not depressed at the subsequent wave.

Physical health

Physical health was assessed using the four SF-36 physical health domain scores: physical function, role-physical, bodily pain, and general health. These were selected to provide specific detail on each physical health domain rather than use the Physical Component Summary Score. See Table 4.2 for a description of the SF-36. Applying the SF-36 scoring procedure, each domain score was standardised to have a range of 0 to 100, with higher scores reflecting positive health status (Ware et al., 2000). Scores were then mean centred and transformed into z-scores.

Physical function

This scale indicates whether on a typical day, an individual is limited by their health in performing certain physical activities. Ten items assess physical function in the SF-36, as the authors argue for the importance of detecting the range of distinct physical limitations. See Table 4.3 for the questions relating to physical functioning (3a-j).

Role physical

The role physical scale indicates whether physical health affects an individual's ability to perform work or other daily activities. Four items assess role physical; see Table 4.3 (items 4a-d).

Bodily pain

The bodily pain scale indicates the amount of pain experienced and the extent to which it interferes with an individual's ability to perform daily activities. Two items assess bodily pain; see Table 4.3 (items 7-8).

General health

This scale integrates self-reported health beliefs with measures of expectations and assessments of health relative to other individuals. Five items assess general health; see Table 4.3 (items 1, 11a-d).

4.4.3 Covariates

Sociodemographics

These included sex, age, partner status and education. Age at baseline was centred at 65 years as the reference for the youngest participant. To do so, a new variable was created by subtracting the youngest baseline age in years (65 years) from participants' baseline chronological age (range: 65-98 years). The new variable, age at baseline, ranged from 0 to 33.

Partner status was coded as partnered (married or de facto) or not partnered (never married, separated and widowed). Education was assessed in terms of the highest level of completed education according to three categories: secondary school or less, non-tertiary study (i.e. apprenticeship/trade, certificate, undergraduate diploma) and tertiary study (bachelor degree, postgraduate diploma, higher degree).

Lifestyle behaviours

These included alcohol intake and smoking status. Following the guidelines of the National Health and Medical Research Council (Australia) (NHMRC) (2001), participants' quantity and frequency of alcohol consumption was categorised as low risk, risky/high-risk, and non-drinker. All of the contributing studies included questions on the frequency and quantity of alcohol participants typically consumed. From this data, low risk for long-term health risk for men was determined to be up to four standard drinks per day, while for women it was two standard drinks. Risky and high risk for long-term health risk for men was determined to be five or more standard drinks per day, while for women it was three or more standard drinks (National Health and Medical Research Council (Australia), 2001). Smoking consumption

was assessed in terms of never-smoked, former-smoker, or current smoker. These lifestyle behaviours were selected to be included as they have shown to be two salient factors that influence health outcomes, as noted in Chapter 3.

Table 4.2. Information about SF-36 health domains and the interpretation of low and high scores. Adapted from (Ware & Sherbourne, 1992).

SF-36 health domains	Number of items	Item and response overview	Meaning of scores	
			Low score	High score
Physical functioning	10	Does the respondent health limit such activities as lifting or carrying groceries and bathing or dressing with a response format of <i>limited a lot</i> to <i>not limited at all</i> .	Limited a lot in performing all physical activities including bathing or dressing.	Performs all types of physical activities including the most vigorous without limitations due to health.
Role limitations due to physical problem	4	Does the respondent have problems, such as cutting down the amount of time they spent on activities and accomplishing less than they would like, as a result of physical health with a <i>yes–no</i> response format.	Problems with work or other daily activities as a result of physical health.	No problems with work or other daily activities as a result of physical health, past four weeks.
Social Functioning	2	Does the respondent experience interference in social activities caused by physical health or emotional problems (<i>not at all</i> to <i>extremely</i>) and the amount of time this occurs (<i>all of the time</i> to <i>none of the time</i>).	Extreme and frequent interference with normal social activities due to physical and emotional problem.	Performs normal social activities without interference due to physical or emotional problems, past four weeks.
Bodily pain	2	How much pain did the respondent have during the past 4 weeks (<i>none</i> to <i>very severe</i>) and the extent of interference in activities caused by pain (<i>not at all</i> to <i>extremely</i>).	Very severe and extremely limiting pain.	No pain or limitations due to pain, past four weeks.
Mental health, MHI-5	5	How much of the time has the respondent experienced particular emotional states during the past 4 weeks, such as calm and peaceful or nervous, with a response format ranging from <i>all of the time</i> to <i>none of the time</i> .	Feelings of nervousness and depression all of the time.	Feels peaceful, happy, and calm all of the time, past four weeks.
Role limitations due to emotional problem	3	Does the respondent have problems, such as cutting down the amount of time they spent on activities and accomplishing less than they would like, as a result of emotional problems (e.g. feeling depressed or anxious) with a <i>yes–no</i> response format.	Problems with work or other daily activities as a result of emotional problems.	No problems with work or other daily activities as a result of emotional problems, past four weeks.
Vitality	4	How much of the time has the respondent felt full of life, had a lot of energy, felt worn out, and felt tired during the past 4 weeks with a response format ranging from <i>all of the time</i> to <i>none of the time</i> .	Feels tired and worn out all of the time.	Feels full of pep and energy all of the time, past four weeks.
General health perceptions	5	Includes a single item of self-rating of health with a response format ranging from <i>excellent</i> to <i>poor</i> and four additional items (e.g. “I seem to get sick a little easier than other people”) with a response format ranging from <i>definitely true</i> to <i>definitely false</i> .	Believes personal health is poor and likely to get worse.	Believes personal health is excellent.

Table 4.3. SF-36 questions grouped according to scales.

Question	Scale
3a. Vigorous activities 3b. Moderate activities 3c. Lift, carry groceries 3d. Climb several flights 3e. Climb one flight 3f. Bend, kneel, stoop 3g. Walk more than one kilometre 3h. Walk half kilometre 3i. Walk 100 metres 3j. Bathe, dress	Physical function
4a. Cut down time 4b. Accomplished less 4c. Limited in kind 4d. Had difficulty	Role physical
7. Pain interfere 8. Pain magnitude	Bodily pain
1. Health rating 11a. Sick easier 11b. As healthy 11c. Health to get worse 11d. Health excellent	General health
9a. Life 9e. Energy 9g. Worn out 9i. Tired	Vitality
6. Social extent 10. Social time	Social functioning
5a. Cut down time 5b. Accomplished less 5c. Not careful	Role emotional
9b. Nervous 9c. Down in the dumps 9d. Calm 9f. Downhearted 9h. Happy	Mental health

Notes: Highlighted questions and scales are those relevant to this thesis

4.4.4 Integration and harmonisation

Variables from the different studies were harmonised using the “by fiat” method (van Buuren, Eyres, Tennant, & Hopman-Rock, 2001, 2003, 2005). This method assumes a common scoring system across studies and involves collapsing response categories for comparable variables (from the different studies) to create a single harmonised variable (Bartsch et al., 2011). The “by fiat” method is recommended for use when: i) the possibility of dispute is small, ii) the number of categories is reasonably consistent across studies, and iii) a clear authority can endorse the system (Anstey et al., 2009).

The harmonised variables in the DYNOPTA dataset are organised under ten main categories: demographics, risk factors, mobility, psychological constructs, mental health, cognition and dementia, sensory functioning, service use, carers.

Final integrated dataset

The final dataset used to complete all analyses in this study consisted of the four studies harmonised into one dataset. Participants aged 65 years and above were selected.

Additionally, individuals living in institutional care were excluded from the analysis. The current sample includes community dwelling participants only (private residence) and does not include those living in residential care (e.g., hostels, nursing homes, hospitals, or boarding houses) (Andresen, Gravitt, Aydelotte, & Podgorski, 1999). Table 4.4 shows a description of the sample used for all analyses in this thesis.

Table 4.4. Description of the studies included in the analysis according to wave, including number, age range and sex of participants, and the year and type of data collection.

Study	Wave	<i>n</i>	Age range	% female	Year	Collection method	Sampling unit	Sampling	Exclusion
ALSWH-old	1	10828	68-76	100	1996	Postal survey	Person	Random sample from Australian Medicare database. Rural and remote areas were sampled at twice the rate of urban areas.	None
	2	9196	71-79	100	1999-2000				
	3	7954	74-82	100	2002-2003				
	4	6549	77-85	100	2005-2006				
AusDiab	1	2254	65-91	53.8	1999-2001	Personal interview	Household	Stratified cluster sampling based on census collector district (smallest geographic unit defined by the Australian Bureau of Statistics at each census, with an average of 225 dwellings each)	Census collector districts that: 1.contained fewer than 100 persons aged 25 years and over 2. formed part of a statistical local area that was classified as 100% rural according to 1996 census data 3. contained more than 10% Indigenous population. Institutionalised persons. Households within the Australian Capital Territory.
	2	1060	69-93	51.7	2004-2005				
BMES	2	1034	69-98	58.5%	1997-2000	Clinical and personal interview	Household	Door-to-door census	Non-permanent residents

	3	543	74-96	62.1%	2001-2004				
HILDA	1	1860	65-92	54.9%	2001-2002	Personal interview and self-completion questionnaire	Household	Stratified cluster sampling based on CDs	1. Certain diplomatic personnel of overseas governments. 2. Overseas residents in Australia (that is, persons who had stayed or intended to stay in Australia for less than one year). 3. Members of non-Australian defence forces (and their dependants) stationed in Australia. 4. Remote and sparsely populated areas. 5. Dwellings that were not primary places of residence (for example, holiday homes).
	2	1630	65-92	54.8%	2002-2003				
	3	1506	66-92	55.7%	2003-2004				
	4	1378	67-92	56.0%	2004-2005				
	5	1302	68-92	55.1%	2005-2006				

4.4.5 Data analysis

This section outlines the statistical methods adopted in the current study. These procedures were organised under three broad stages of analysis that can be used to characterise the integrative analysis of longitudinal data (see, for example, Hussong, Huang, Curran, Chassin, and Zucker (2010)). These stages comprise: (1) preparation of the integrative dataset; (2) invariance testing; and (3) longitudinal analyses.

Organisation of the data set

The DYNOPTA data is available in nine separate SPSS data files (organised according to variable topic). Data files containing the variables of interest were identified (i.e., “administration and demographics” and “mental health” data files). These files were sorted by wave and DYNOPTA unique case number (participant ID), and were then merged into a single data file. The studies that included the mental health variable of interest (MHI-5) were identified, while the remaining unselected studies were excluded.

Data screening

All data screening was conducted using IBM SPSS Statistics 22, and were conducted on data from each individual study. These preliminary analyses mainly comprised procedures for checking each study for data entry or administration errors and out-of-range values.

Missing data analyses

A series of analyses were conducted to examine the likely influence of missing data on the current study. Overall, less than 5% of cases had missing observations on MHI-5 data, the key outcome variable. Consequently, as DYNOPTA is a large dataset the common procedure of listwise deletion was proposed (Graham, 2009). To investigate this as a valid method, a dummy variable was created to indicate missingness of MHI-5 data for individuals at each wave. Generalized Estimating Equations (GEE) were used to evaluate the relationship between missingness and key variables to determine if participants with missing data were significantly different to those who provided MHI-5 data. The GEE Model was conducted in

IBM SPSS Statistics 22 and specified an unstructured working correlation matrix. As the outcome variable was binary, the analysis of missing data utilised a logistic distribution with a logit link function. Odds-ratios effect size indices were calculated to index the likely magnitude of any systematic differences between those that provided MHI-5 data and those that did not. There were no significant differences to report between the two groups on the key variables of age, sex, partner status and education tested. As such, listwise deletion is recommended, as it is likely to produce unbiased estimates (Graham, 2009). In accordance with the standard SF-36 scoring procedures discussed in Section 4.4.2, participants who missed answering three, four or five items did not get an MHI-5 score and were excluded from the analyses.

To further accommodate any other issues associated with missing data that are likely to occur in large longitudinal studies, the multilevel modelling procedures used were selected to minimise effects of sample attrition.

Statistical analyses

Chapters 5, 6, 7 and 8 contain the specific details of the statistical analyses used in each study.

Significance

The criterion for statistical significance was set at $p < .05$. However, consideration will be given to what the data really mean in application, and how substantive the effects are despite statistical significance. That is, whether the effects would likely have a clear and noticeable impact on the quality of life in older people. Interpretations of data were informed by prior benchmarking literature relating to the meaningfulness of change in SF-36 scores (Bjorner, Lyng Wolden, Gundgaard, & Miller; Ware et al., 1995).

Modelling of time

All subsequent results index time over a “years in study” metric. This approach has been shown to provide a better description of longitudinal change than using an “age” metric in past research and is recommended as the optimal scaling of time in longitudinal analyses (Kiely, Gopinath, Mitchell, Luszcz, & Anstey, 2012; Morrell, Brant, & Ferrucci, 2009).

4.4.6 Participants

The sample comprised the older cohort (65 years of age and older) of the DYNOPTA project. Results presented here relate to up to five waves of data from 65- to 98-year olds. The data was collected between 1996 and 2006.

Data collection relevant to the aims of the current study occurred within ALSWHold at wave 1 (1996), wave 2 (1999-2000), wave 3 (2002-2003) and wave 4 (2005-2006). Data collection relevant to the aims of this study occurred within AusDiab at wave 1 (1999-2000) and wave 2 (2004-2005). Data collection relevant to the aims of this study occurred within BMES at wave 2 (1997-2000) and wave 3 (2002-2004). Data collection relevant to the aims of this study occurred within HILDA at wave 1 (2001), wave 2 (2002), wave 3 (2003), wave 4 (2004) and wave 5 (2005-2006).

The baseline sample in the current study is defined as pooled data from wave 2 of BMES and wave 1 of the other three studies.

The current sample includes community dwelling participants only (private residence) and does not include those living in residential care (e.g., hostels, nursing homes, hospitals, or boarding houses) (Andresen et al., 1999).

4.4.7 Description of sample characteristics

Descriptive statistics were expressed as means and standard deviations for continuous variables, and as percentages for categorical variables. The baseline sample profile is described in Table 4.5. The pooled sample comprised 15,976 participants (85.55% women) with a mean age of 72.63 years ($SD = 3.70$, range = 65 to 98 years).

Table 4.5. Baseline descriptive statistics.

	Men ($N=2,309$)	Women ($N=13,667$)
Age (years) (mean \pm SD)	73.41 \pm 5.79	72.50 \pm 3.19
Partner Status (n (%))		
Partnered	1837 (79.56)	7615 (55.72)
Not Partnered	471 (20.40)	6030 (44.12)
Education (n (%))		
Secondary school or less	961 (41.62)	10489 (76.75)
Non-Tertiary Study	1082 (46.86)	2127 (15.56)
Tertiary Study	238 (10.31)	503 (3.68)
Alcohol (n (%))		
Non-Drinker	252 (10.91)	4113 (30.09)
Low-risk Drinkers	1672 (72.41)	8310 (60.80)
Risk/High Drinkers	146 (6.32)	453 (3.31)
Smoking Status (n (%))		
Never	829 (35.90)	8327 (60.93)
Former	1274 (55.18)	3730 (27.29)
Current	190 (8.23)	925 (6.77)
Mental health, MHI-5 (mean \pm SD)	78.59 \pm 16.75	77.25 \pm 16.76
Physical function (mean \pm SD)	66.96 \pm 26.06	63.43 \pm 25.83
Role physical (mean \pm SD)	61.42 \pm 42.16	58.69 \pm 42.53
Bodily pain (mean \pm SD)	68.47 \pm 25.84	65.71 \pm 26.58
General health (mean \pm SD)	63.03 \pm 21.73	65.63 \pm 21.54
Depression (n (%))		
Not depressed	2,153 (93.24)	12,658 (92.62)
Probable depression	156 (6.76)	1,009 (7.38)

In summary, this large sample is drawn from four large longitudinal studies, three of them national. One study is comprised of women only and as such, there are substantially more women than men in the final sample, which will be, discussed in more detail in relevant analyses chapters. The next chapter will examine the invariance properties of the MHI-5 in detail for assurance that it is appropriate for use in further analysis.

Chapter 5

STUDY 2.1: INVARIANCE PROPERTIES OF THE MHI-5

5.1 Introduction

This chapter presents the results of Study 2.1. The chapter examines in detail the invariance properties of the Short Form 36 (SF-36) Mental Health Index (MHI-5) using a large representative Australian sample of older people. Firstly, a description of invariance is provided. This is followed by the details of the analyses performed to determine invariance of the MHI-5. The results are then discussed in relation to their implications for the next stages of analyses.

5.1.1 What is invariance?

When performing multi-group comparisons in research studies, it is assumed that the instrument of measurement being used, in the present study the SF-36 MHI-5, is functioning the same way for all participants regardless of group (e.g. gender). In addition, it is also assumed that the underlying construct that the instrument is measuring has the same theoretical structure for each group (Byrne, 2004). However, these are significant assumptions, and need to be tested statistically, which does not occur often in the research literature (Byrne, 2004). These statistical tests of equivalence are described as invariance analyses, and involve testing for the invariance of both the measurement items and the factorial structure across groups. The primary aim of invariance analyses is to test the assumption that the measurement scale measures the same construct in different groups of people (Cieciuch & Davidov, 2012).

This assumption needs to be tested to establish invariance, which should occur prior to further analyses so as to interpret any between-group differences unambiguously (Ingles et al., 2011). That is, in the current study, between-group differences could either be due to actual differences in mental health, or merely be an artefact of different psychometric properties of the MHI-5 items (T. Brown, 2006). Invariance testing is carried out to ensure that scores across groups are actually comparable (Saban, Bryant, Reda, Stroupe, & Hynes, 2010). If constructs have different meanings for different groups, any mean score comparisons between groups would not be valid.

Violations of invariance assumptions have been described by Vandenberg and Lance (2000): “as threatening to substantive interpretations as is an inability to demonstrate reliability and validity” (p. 6). Horn and McArdle (1992) also stress the importance of invariance to empirical research in their seminal article:

evidence of invariance of measurement is necessary for drawing clear inference from results. Such clear inferences must be at the foundation of valid scientific explanation. Evidence of measurement invariance is fundamentally important to the process of building a science. (p. 118)

Byrne, Shavelson, and Muthén (1989) divided these tests into measurement or structural invariance tests. Measurement invariance involves relationships between indicators and their latent constructs that is the invariance of “regression intercepts, factor loadings (regression slopes), and error/uniqueness variances” (p. 456). Structural invariance involves latent variables only, that is the invariance of “factor mean and factor variance-covariance structures” (p. 456).

Byrne et al. (1989) and Vandenberg and Lance (2000) recommend that five types of measurement invariance and two types of structural invariance be tested, described in Table 5.1 below.

Table 5.1. Types of invariance.

Equivalent across groups	
Measurement invariance	
Invariant covariance	Sample variances and covariances
Configural invariance	Factor loadings
Metric invariance	Factor coefficients
Scalar invariance	Intercepts of the regressions of like items on the same latent variable
Invariant uniqueness	Measurement errors (residuals or error variances)
Structural invariance	
Invariant factor variances and covariances	Factor variances and covariances
Equal factor means	Factor means

For meaningful group comparisons to be made in subsequent analyses, Widaman and Reise (1997) recommend that at the least, the relationships between indicators and their latent constructs should be equivalent across groups.

5.1.2 How is invariance testing performed?

The most commonly applied method used to evaluate measurement invariance is multigroup confirmatory factor analysis (CFA) (Cieciuch & Davidov, 2012; Milfont & Fischer, 2010; Steenkamp & Baumgartner, 1998). CFA is a particular type of structural equation modelling (Tabachnick & Fidell, 2013): a model testing technique where a theoretical model is evaluated against the observed structure in a sample (Milfont & Fischer, 2010). In multigroup CFA, a theoretical model is evaluated against two or more samples (Milfont & Fischer, 2010).

The literature consistently recommends that the method of establishing invariance should follow a hierarchical series of progressively restrictive hypotheses concerning equality across

groups (Saban et al., 2010). A sequence of models are tested that increasingly constrain parameters (Meredith, 1993). Measurement invariance is tested first, followed by structural invariance. More constrained models are nested in previously estimated less constrained models. Widaman and Reise (1997) provide an explanation of nested models:

If one model can be obtained by placing restrictions on parameter estimates in a second model (restrictions such as fixing parameters to zero), and the first model introduces no parameter estimates not contained in the second model, then the first model is nested within the second. (p. 303)

5.1.3 The current study

The measurement tool of interest in the current study is the Short Form 36 (SF-36) Mental Health Index (MHI-5) (Berwick et al., 1991). The MHI-5 is a measure that is frequently used in longitudinal studies to assess overall mental health and is used to compare self-reported mental health status across groups (Balboa-Castillo, León-Muñoz, Graciani, Rodríguez-Artalejo, & Guallar-Castillón, 2011; Burns, Byles, et al., 2012; Parkinson et al., 2010; Rumpf et al., 2001). Implicit in the use of the tool is the assumption that the hypothesised structure of the MHI-5 is equivalent across groups. However, there is currently no evidence to support this assumption, and there is some evidence that the SF-36 and potentially the MHI-5, may not be invariant across groups.

P. J. Reed (1998) reported that the physical function scale of the SF-36 was variant in different age and education groups. From these results, the author suggested that perception of physical health varies in its impact on physical function between these groups. P. J. Reed (1998) also found variance between racial and education groups in the path from mental health to the general mental health score. The author recommended that direct comparison of mean scale scores and use of the scores to create summary scores would therefore not be meaningful. McHorney, Ware, Lu, and Sherbourne (1994) found similar results, reporting that older, African American, lower SES participants had less reliable SF-36 responses. Different cultural groups may also interpret items differently in the SF-36 (Coulton, Hyduk, & Chow, 1989; Deyo, 1984).

Older adulthood has been found to be associated with certain changes in emotional experience. Specifically, there is extensive evidence that the amount of positive emotions experienced remains relatively stable, while negative emotions decrease with age (Scheibe & Carstensen, 2010). This pattern is reported to occur at least up until young-old adulthood, at least until after adults reach 70 or 80 years of age. For example, in their study of affect in the DYNOPTA population, Windsor, Burns, and Byles (2013) reported that older adults have lower levels of negative emotions in comparison to midlife adults. The researchers differentiated emotional experiences on both the dimension of valence (positive or negative) and arousal (the energy associated with emotional experience). The researchers used items of the SF-36 to assess discrete emotions. For example, endorsing feeling calm and peaceful was used as an indicator of low-arousal positive emotion, while endorsing being a nervous person was used as an indicator of a high-arousal negative emotion. Windsor and colleagues (2013) found that older adults were more likely to endorse low-arousal positive affect, and less likely to endorse negative affect (both high and low arousal) compared to midlife adults. This finding is supported by previous studies where older age has been shown to be associated with lower levels of negative affect (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Charles, Reynolds, & Gatz, 2001). In other previous studies, positive affect remains relatively stable or decreases slightly with age (Charles et al., 2001). Pinquart (2001), who performed a meta-analysis synthesising 125 studies in this area, reported a small age-associated decline of positive affect and increase of negative affect. Additionally, he found an age-associated decline of both positive and negative high arousal emotions and increase in low arousal emotions. Older adults have also been shown to report fewer symptoms of depression (Kobau, Safran, Zack, Moriarty, & Chapman, 2004).

Similarly, there are also reported differences in emotional experience according to gender (Fischer, Rodriguez Mosquera, van Vianen, & Manstead, 2004). For example, Birditt and Fingerman (2003) found that women report experiencing emotions more intensely than men, a finding supported elsewhere (Fujita, Diener, & Sandvik, 1991). Carstensen et al. (2000) also found that women endorsed more intense negative affect than men did. Additionally, researchers have also found that women reported experiencing negative emotions for a longer duration than men did (Birditt & Fingerman, 2003).

Considering the finding that adults have varying emotional experiences according to age and gender, adults of different ages and genders will potentially respond to the MHI-5 items differently. Hence, it is important to test the invariance of the individual items of the MHI-5. The invariance of the MHI-5 has not been previously investigated. The purpose of this study was to therefore establish the invariance properties of the MHI-5 to ensure that any subsequent group mean comparisons and interpretations are valid and meaningful (McHorney, 1996). That is, the MHI-5 was tested to ensure that it functions homogeneously across gender and age groups, and that the mental health construct has the same theoretical structure across these respective groups.

5.2 Method

Please see Chapter 4 for the general methodology for the DYNOPTA dataset. The following sections entail a description of the specific statistical analyses for this study.

5.2.1 Measures

Outcome measure

Mental Health

The main outcome for this study, mental health, was assessed at each wave using the SF-36 MHI-5. See Chapter 4 for more details.

Age

Age was divided into two groups where 65 to 79 year olds were categorised as “young-old” and participants 80 and above categorised as “old-old”.

5.2.2 Statistical analyses

To test for invariance a set of models were estimated, following the sequencing of tests recommended by Vandenberg and Lance (2000). The first five tests are referred to as tests of

measurement invariance as they assess relationships between measured variables and latent constructs (Byrne et al., 1989; Vandenberg & Lance, 2000). The final two tests are termed tests of structural invariance as they assess the latent variables (Byrne et al., 1989; Vandenberg & Lance, 2000). Confirmatory Factor Analysis (CFA) tested for gender and age invariance using the Multi-Groups Function in the IBM SPSS Amos 20 software package applying Maximum Likelihood Estimation (MLE).

Tests of measurement invariance

Test 0. Invariant covariance

This tests whether the sample variances and covariances for each group come from the same population. That is, it is a test of the null hypothesis of invariant covariance matrices. An unconstrained model of variances and covariances of the measured variables is compared to a constrained model where the variances and covariances are set as equal across groups (male and female; young-old and old-old).

If this test is not significant, it is accepted that the variance-covariance matrices are equal across groups. This indicates that the model has measurement and structural invariance for all parameter estimates. No further tests need to be performed. If this test is significant, this indicates that the variance-covariance matrices are not equal across groups and further tests need to be performed to determine measurement and structural invariance.

Test 1. Configural invariance

This tests whether the factor loadings are equivalent across groups, which indicates that different groups conceptualise the constructs in the same way (Milfont & Fischer, 2010). It is a test of a null hypothesis where the same pattern of fixed and free factor loadings is specified for each group.

Initially, separate CFAs are computed for each group (young-old, old-old, male and female). A CFA is then estimated simultaneously for the groups to test for configural invariance (young-old vs old-old; male vs female). This is a test of weak configural invariance, and is termed the baseline model, or in Amos, the unconstrained model.

If the fit statistics indicate inadequate fit of the model this suggests that the factor model is not invariant across groups and measurement invariance has not been established. If the fit statistics indicate good fit of the model this suggests that the factor model is invariant across groups and configural invariance has been established. Additional tests are required to further test for strong factorial invariance.

Test 2. Metric invariance

This tests whether the factor coefficients are equivalent across groups, which indicates that different groups respond to the items in the same way (Milfont & Fischer, 2010). It is a test of the null hypothesis that factor loadings for like items are the same across groups; that is, whether the strengths of the relations between items and their respective underlying construct are invariant across groups (Milfont & Fischer, 2010). The fit statistics of a model where the factor loadings are constrained across groups are compared to the fit statistics of the previous unconstrained model described in Test 1 above. This is a test of strong factorial invariance, and is termed the measurement weights model in Amos.

If the fit statistics indicate inadequate fit of the model this suggests that the factor coefficients are not invariant across groups and metric invariance has not been established. If the fit statistics indicate good fit of the model this suggests that the factor coefficients are equal across groups and metric invariance has been established. Additional tests are required to further test for invariance.

Test 3. Scalar invariance

This tests the null hypothesis that the intercepts of the regressions of like items on the same latent variable are invariant across groups. This indicates that participants with the same score on the latent construct would obtain the same score on the observed variable, regardless of which group they belong to (Milfont & Fischer, 2010). The fit statistics of a model where the intercepts are constrained across groups are compared to the fit statistics of the previous measurement intercepts model in Test 2 above. This is a test of strict factorial invariance and is termed the measurement intercepts model in Amos.

If the fit statistics indicate inadequate fit of the model this suggests that the intercepts are not equal across groups and scalar invariance has not been established. Therefore mean comparisons between groups should not be performed. If the fit statistics indicate good fit of the model this suggests that the intercepts are equal across groups and scalar invariance has been established. This is the last test necessary to proceed with performing mean comparisons between groups (Milfont & Fischer, 2010). Further tests of invariance can be performed.

Test 4. Invariant uniqueness

This tests whether the measurement errors (residuals or error variances) are invariant across groups. This is a test of the null hypothesis that like items unique variances are equivalent across groups. The fit statistics of a model where the residuals are constrained across groups are compared to the fit statistics of the previous measurement intercepts model in Test 3 above. This is termed the measurement residuals model in Amos.

If the fit statistics indicate inadequate fit of the model this suggests that the measurement errors are not equal across groups and invariant uniqueness has not been established. If the fit statistics indicate good fit of the model this suggests that the measurement errors are equal across groups and invariant uniqueness has been established. This indicates that full measurement invariance has been established and structural invariance can now be assessed.

Tests of structural invariance

Test 5. Invariant factor variances and covariances

This is a test of the null hypothesis that factor variances and covariances are equivalent across groups. This is termed the structural covariances model in Amos.

If the fit statistics indicate inadequate fit of the model this suggests that the factor variances and covariances are not equal across groups and structural invariance has not been established. If the fit statistics indicate good fit of the model this suggests that the factor variances and covariances are equal across groups and structural invariance has been established.

Test 6. Equal factor means

This tests the null hypothesis of equivalent factor means across groups. This model is tested by constraining the means to be the same across groups (Milfont & Fischer, 2010).

Partial Measurement Invariance

The tests above are examples of full measurement invariance, where all examples of a certain parameter are tested to establish if they are equal across groups. However Byrne et al. (1989) argued that this was unlikely to hold in practice, and was an unrealistic and overly restrictive objective. Byrne et al. (1989) introduced the concept of partial measurement invariance, where not all the examples of a certain parameter are equal across groups, only a subset are. Meaningful analyses can still be performed if only partial measurement invariance is achieved (Steenkamp & Baumgartner, 1998).

Assessing model fit

Several Goodness of Fit Indices (GFI) can be used to assess model fit: the chi-square statistic, the Adjusted Goodness of Fit Index (AGFI), the comparative fit index (CFI), the root mean

square error of approximation (RMSEA), and the Akaike Information Criterion (AIC). The chi-square statistic is the most commonly used test of model fit. It is however, sensitive to sample size. That is, the chi-square statistic can reject acceptable models if the sample size is large (van de Schoot, Lugtig, & Hox, 2012), as very negligible differences can produce a significant test result (Milfont & Fischer, 2010). Due to the very large sample size of DYNOPTA, the chi-square test is not an appropriate statistic for model evaluation (Bartsch et al., 2011; Ullman & Bentler, 2004). Therefore, other GFI were considered, as summarised below.

The AGFI is a corrected measure of fit between the hypothesised model and the observed covariance matrix. The AGFI ranges between 0 and 1, with .90 to indicate good fit relative to the baseline model (Schermelleh-Engel, Moosbrugger, & Müller, 2003).

The CFI is a comparative index that compares the fit of the model of interest with the fit of the baseline model. The CFI is less sensitive to sample size than the chi-square statistic. Adequate fit is reflected by CFI values greater than .90, and better if greater than .95 (Hu & Bentler, 1999; van de Schoot et al., 2012). Changes in CFI values of .01 between models are indicative of significant differences in model fit (Chen, 2007).

The RMSEA is an absolute index that assesses whether a model reasonably fits the population covariance matrix while accounting for the degrees of freedom and sample size (T. Brown, 2006). Fit is considered adequate with an RMSEA less than .08 but better if less than .05 (Hu & Bentler, 1999; van de Schoot et al., 2012). Changes in RMSEA values larger than 0.015 between models are indicative of significant differences in model fit (Chen, 2007). Ninety percent Confidence Intervals for RMSEA are also reported.

An information theoretic index, the AIC, is used to compare competing models and reflects a trade-off between model fit and complexity (Akaike, 1987). The AIC adjusts the chi-square statistic according to the number of parameters estimated in the model (Schermelleh-Engel et

al., 2003). The model with the lowest AIC value is considered to be the best fitting model (Schermelele-Engel et al., 2003).

Unlike the chi-square statistic, these additional indices are less sensitive to sample size and are particularly important in this study given the large sample size of DYNOPTA. Meade, Johnson, and Braddy (2006) suggest that the two options for researchers who are using large samples are to either use a smaller subset of the sample to minimise power of rejecting the null hypothesis of no differences between groups or to use these additional indices to examine fit. The authors note that “Seeking out smaller samples is unlikely to ever be the preferred course of action under basic sampling theory” (Meade et al., 2006, p. 5). Hence, in the analyses below more weight was given to the indices that are not influenced by sample size.

As well as assessing the chi-square statistic for each model, the difference in chi-square (also known as the likelihood ratio test) was also evaluated. As mentioned above, in invariance testing the models are nested, and hence the difference in chi-square values between two models is distributed as chi-square, with degrees of freedom equal to the difference in degrees of freedom between models (Byrne, 2004). A cut off of $<.01$ was used to test the statistical significance of the difference in fit of two models. If the difference in chi-square test is statistically significant, the less constrained model is accepted as providing a significantly better fit to the data than the more restricted model. If the difference in chi-square test is not statistically significant, the more restricted model is accepted as the more parsimonious model compared to the previous model (Widaman & Reise, 1997). However, like chi-square test, the difference in chi-square test has been shown to be sensitive to sample size (Meade et al., 2006). Therefore, as recommended by Milfont and Fischer (2010), the difference test was only used to indicate significant improvements in model fit. The critical ratios produced by AMOS will be examined to compare the regression coefficients between models. A critical ratio above 1.96 suggest that the difference between two regression coefficients is significant at a 0.05 level (Byrne, 2016). However, the critical ratio is also sensitive to sample size and will be interpreted in this context.

5.3 Results

5.3.1 Description of sample response

Table 5.2 gives details of the participants' responses to the MHI-5 items.

Table 5.2. Percent participant response for the MHI-5.

Item	Question	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
1	Have you been a very nervous person?	1.80	3.10	4.60	16.70	26.30	47.40
2	Have you felt so down in the dumps that nothing could cheer you up?	0.70	1.40	2.60	10.40	18.10	66.80
3	Have you felt calm and peaceful?	12.40	42.10	16.00	17.20	7.50	4.80
4	Have you felt down?	0.8	2.00	4.20	21.20	33.10	38.70
5	Have you been a happy person?	19.30	51.50	13.20	10.30	3.30	2.40

5.3.2 Initial model using full data

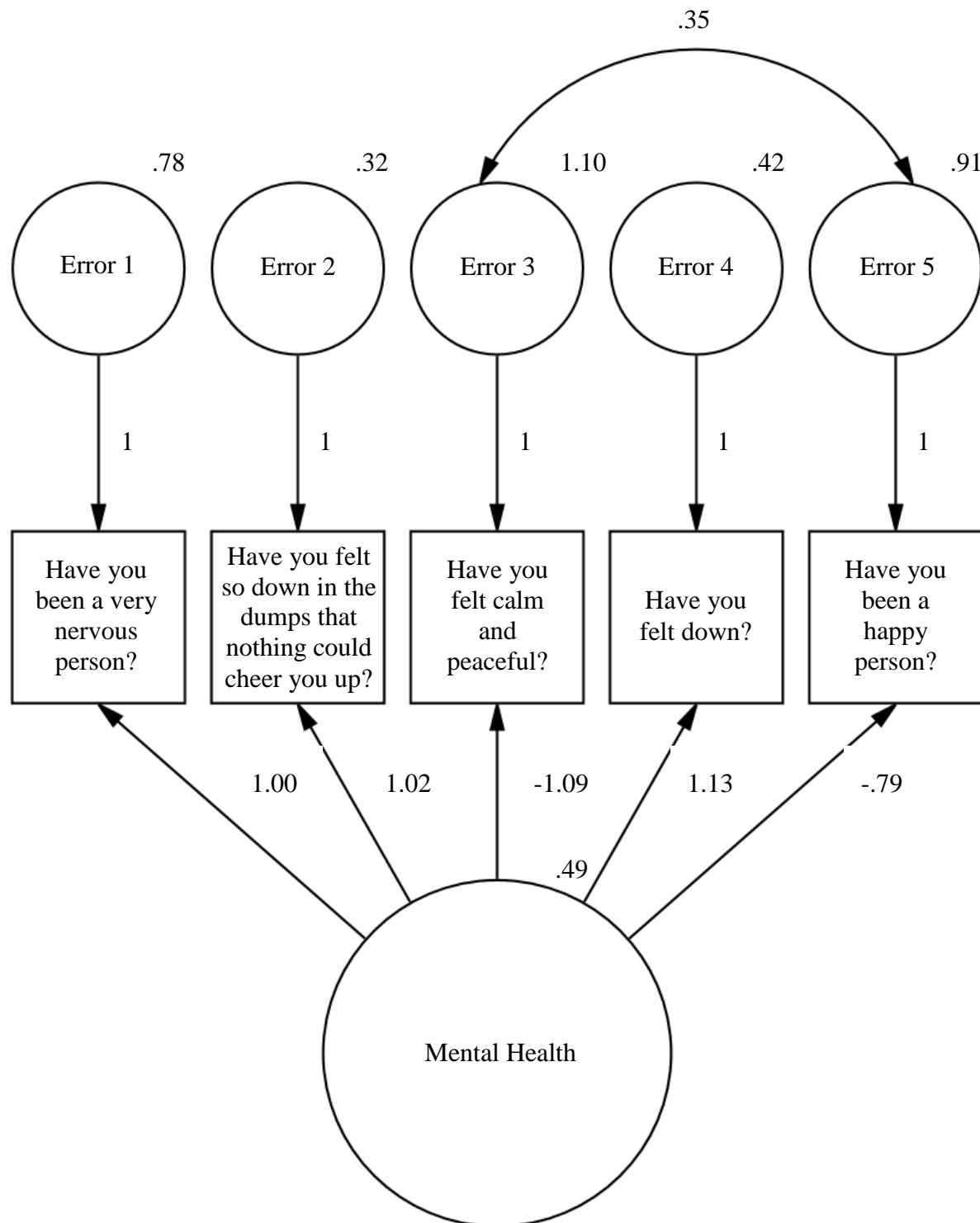
The single factor model of responses to the five item MHI-5 was examined in separate CFA models to establish the hypothesised model structure.

The chi-square statistic was significant, and the remaining indices did not indicate good fit of the model to the data $\chi^2(5) = 5193.741$, $p < .000$, AGFI = .869, CFI = .927, RMSEA=.148 (.145<RMSEA CI₉₀<.152).

Inspection of the modification indices indicated exceptionally large correlated errors between the items (items 3 and 5). Scrutiny of the content for each of these items revealed they were the two “positively” worded items of the MHI-5. These error terms were subsequently specified as free parameters in the model for each group. Therefore, the model was re-estimated to include the covariance between MHI-5 items 3 and 5 that was allowed to be freely estimated.

Although the chi-square statistic was statistically significant, the remaining indices now indicated good fit $\chi^2(4) = 359.295$, $p < .000$, AGFI = .989, CFI = .995, RMSEA = .043 ($.040 < \text{RMSEA CI}_{90} < .047$). As the chi-square statistic is dependent on sample size it is assumed that here it is rejecting a reasonable model, as the DYNOPTA sample is so large (Cieciuch & Davidov, 2012; Saris, Satorra, & Van der Veld, 2009; van de Schoot et al., 2012). Hence, this was accepted as the hypothesised model structure; see Figure 5.1.

Figure 5.1. The best fitting model, with unstandardized estimates, based on results of Confirmatory Factor Analysis of the five items in the MHI-5. This modified one-factor model (correlation between item 3 and 5) was used for all further analyses.



Note: The large circle represents the latent unobserved variables. The smaller circle represents the errors or residuals. The squares represent the manifest, observed variables.

Lines indicate a relationship between variables. The single headed arrow indicates a direct relationship; the variable being pointed to is the dependent variable. The double-headed arrow indicates an association or correlation.

5.3.3 Age group invariance

Tests of measurement and structural invariance

Test 0. Invariant covariance

The data does not support the structural covariances model, ($\chi^2(15) = 58.379$, $p < .000$). The chi-square difference test between the unconstrained model and the nested structural covariance model is also significant ($\Delta\chi^2(15) = 58.379$, $p < .000$). This indicates that at least some of the covariance structure parameters are different between young-old and old-old participants. Hence, it cannot be assumed that this data was drawn from the same population. Further tests are needed to establish invariance.

Test 1 – 6

Separate CFA analyses in each sample indicated that the model fit the data well in both the young-old sample ($\chi^2(4) = 284.296$, $p < .000$, AGFI = .989, CFI = .995, RMSEA=.043 (.039<RMSEA CI₉₀ <.047) and the old-old sample ($\chi^2(4) = 81.253$, $p < .000$, AGFI=.987, CFI = .994, RMSEA=.047 (.038<RMSEA CI₉₀ <.056). This indicates that the single factor model of mental health is supported in both groups.

Two group analyses were then performed to assess measurement invariance across the young-old and old-old groups. The invariance of this uni-dimensional model was estimated by assessing the measurement and structural invariance between the younger and older age groups. See Table 5.3 for the Goodness of Fit Indices.

Table 5.3. Goodness of Fit Indices for the Two-Group CFA across young-old and old-old groups with the MHI-5.

	χ^2	df	<i>p</i>	CFI	RMSEA	AIC	$\Delta\chi^2$	Δ df	<i>p</i>
1. Unconstrained model	365.550	8	.000	.995	.031 (.028-.034)	429.550	-	-	-
2. Constrained measurement weights model	377.164	12	.000	.995	.025 (.023-.028)	433.164	11.614	4	.020
3. Measurement intercepts model	438.636	17	.000	.994	.023 (.021-.025)	484.636	61.472	5	.000
4. Constrained structural co-variances model	447.582	18	.000	.994	.022 (.021-.024)	491.582	8.946	1	.003
5. Measurement residuals model	477.868	24	.000	.994	.020 (.018-.022)	509.868	30.286	6	.000

Note: CFI = comparative fit index; RMSEA = root mean square error of approximation; AIC = Akaike Information Criterion; $\Delta\chi^2$ = difference in chi-square values; Δ df = difference in degrees of freedom.

Table 5.4. Unstandardised and standardised factor coefficients (item loadings) for the full sample, young-old and old-old samples – unconstrained model.

MHI-5 items	Unstandardised			Standardised		
	Full sample	Young-old	Old-old	Full sample	Young-old	Old-old
Item 1	1.000	1.000	1.000	0.620	0.623	0.605
Item 2	1.017	1.009	1.052	0.780	0.780	0.780
Item 3	-1.091	-1.080	-1.145	-0.587	-0.590	-0.577
Item 4	1.126	1.117	1.170	0.769	0.773	0.753
Item 5	-0.792	-0.778	-0.860	-0.502	-0.500	-0.509

As can be seen from Table 5.3, the unconstrained model provided good fit to the data, indicating that the factorial structure of the construct is equal across age groups. As above, the chi-square statistic is disregarded as it is dependent on sample size it is assumed that here it is rejecting a reasonable model as the DYNOPTA sample is so large. Hence, configural invariance was supported with all factor loadings equivalent between age groups; see Table 5.4.

The second model also has good fit indices, indicating support for metric invariance. The third and fourth models also appear to provide good fit to the data, supporting scalar invariance and invariant uniqueness. Despite the models differing based on their chi-square tests and chi-square difference tests, the similar RMSEA and 90% CI, and CFI values across models indicated invariance across age groups.

On inspection of the critical ratios there was a significant difference between how the different samples answered item 1, as the ratio was 5.994. However, on inspection of the estimates intercepts they are very similar when equality is removed for item 1: 5.150 vs. 5.164. This apparent difference seems to be an artefact of the sample size.

Overall, these analyses indicate models to be comparable across age and suggests that this model is invariant.

5.3.4 Gender invariance

Tests of measurement and structural invariance

Test 0. Invariant covariance

The data does not support the structural covariances model, ($\chi^2(15) = 154.375$, $p < .000$). The chi-square difference test between the unconstrained model and the nested structural covariance model is also significant ($\Delta\chi^2(15) = 154.375$, $p < .000$). Hence, it cannot be

assumed that this data was drawn from the same population. Further tests are needed to establish invariance.

Test 1 – 6

Separate CFA analyses in each sample indicated that the model fit the data well in both the male sample ($\chi^2(4) = 62.022$, $p < .000$, AGFI = .984, CFI = .994, RMSEA=.051 (.040<RMSEA CI₉₀ <.063) and the female sample ($\chi^2(4) = 293.713$, $p < .000$, AGFI = .990, CFI = .995, RMSEA=.042 (.038<RMSEA CI₉₀ <.046).

Two group analyses were then performed to assess measurement invariance across the male and female groups. The invariance of this uni-dimensional model was estimated by assessing the measurement and structural invariance between the male and female groups. See Table 5.5 for the global fit measures.

Table 5.5. Global Fit Measures for the Two-Group CFA across male and female groups with the MHI-5.

	χ^2	df	<i>p</i>	CFI	RMSEA	AIC	$\Delta\chi^2$	Δ df	<i>p</i>
1. Unconstrained model	355.738	8	.000	.995	.030 (.028-.033)	419.738	-	-	-
2. Constrained measurement weights model	374.220	12	.000	.995	.025 (.023-.028)	430.220	18.483	4	.001
3. Measurement intercepts model	689.612	17	.000	.991	.029 (.027-.031)	735.612	315.392	5	.000
4. Constrained structural co-variances model	692.599	18	.000	.991	.028 (.026-.030)	736.599	2.986	1	.0084
5. Measurement residuals model	790.602	24	.000	.989	.026 (.024-.028)	822.602	98.003	6	.000

Note: CFI = comparative fit index; RMSEA = root mean square error of approximation; AIC = Akaike Information Criterion; $\Delta\chi^2$ = difference in chi-square values; Δ df = difference in degrees of freedom

Table 5.6. Unstandardised and standardised factor coefficients for the full sample, young-old and old-old samples – unconstrained model. Item loadings from a CFA analysis of the MHI-5 items.

MHI-5 items	Unstandardised			Standardised		
	Full sample	Male	Female	Full sample	Male	Female
Item 1	1.000	1.000	1.000	0.620	0.618	0.621
Item 2	1.017	1.089	1.007	0.780	0.787	0.779
Item 3	-1.091	-1.128	-1.087	-0.587	-0.608	-0.585
Item 4	1.126	1.211	1.114	0.769	0.801	0.765
Item 5	-0.792	-0.865	-0.782	-0.502	-0.543	-0.496

As can be seen from Table 5.5, the unconstrained model provided good fit to the data, indicating that the factorial structure of the construct is equal across genders. As above, the chi-square statistic is disregarded as it is dependent on sample size it is assumed that here it is rejecting a reasonable model as the DYNOPTA sample is so large. Hence, configural invariance was supported with all factor loadings equivalent between genders; see Table 5.6.

The second model also has good fit indices, indicating support for metric invariance. The third and fourth models also appear to provide good fit to the data, supporting scalar invariance and invariant uniqueness.

Despite these models differing based on their chi-square tests and chi-square difference tests, the similar RMSEA and 90% CI, and CFI values across models indicated invariance across genders.

On inspection of the critical ratios there was a significant difference between how the different samples answered item 2, as the ratio was 4.544. On inspection of the estimates intercepts, they are very similar when equality is removed for item 2: 5.507 vs. 5.447. This was also observed for item 3, which had a large ratio of 9.303. The estimates intercepts were also very similar when equality was removed for item 3: 2.790 vs 2.605. Again, for item 5, the ratio was 3.943; however, the estimate intercepts were also very similar when equality was removed: 2.326 vs 2.425. These apparent differences seem to be an artefact of the sample size.

Overall, these analyses indicate models to be comparable across gender and suggests that this model is invariant.

5.4 Discussion

This chapter examined the measurement invariance of the unidimensional model of the MHI-5 across two gender groups and two age groups. The establishment of multigroup invariance across these groups is necessary to determine whether the MHI-5 measures the construct of mental health similarly across males and females, and young-old and old-old participants. The measure demonstrated invariance of the factor structure, factor loadings, intercepts and item uniqueness. Therefore, the MHI-5 measured the construct of mental health similarly for participants regardless of group membership.

This study extended previous research, as while the invariance of both the SF-36 and its mental component summary score have been investigated (P. J. Reed, 1998), this is the first study to examine the invariance properties of the MHI-5. A limitation was the inability to use all standard fit indices to interpret results. As with previous studies, the chi-square statistic and chi-square difference test proved to be an unsuitable indication of model fit due to the large sample size of DYNOPTA. However, the alternative indices used provided adequate information.

A number of studies have examined the differences in mental health across genders and ages. In those studies, older people generally report fewer high arousal emotions and women tend to report more negative emotions (Carstensen et al., 2000; Scheibe & Carstensen, 2010; Windsor et al., 2013). However, these differences clearly do not translate to the answering of the MHI-5 differently for the two different groups examined.

The analyses above support the measurement invariance of the single factor model across age groups and genders. That is, the MHI-5 is functioning the same way for all participants regardless of group. These data support the general equivalence of the MHI-5 as a tool for measuring mental health in young-old and old-old people, and males and females. Hence, further analyses, such as a comparison of mean scores across groups can be interpreted according to a change in the underlying construct (mental health). The MHI-5 is a robust measurement tool, and is recommended as appropriate for use in analyses of age and gender

differences in mental health. The next chapter will report results of an analysis of the impact of physical health on mental health over time.

Chapter 6

STUDY 2.2: INVESTIGATION INTO THE IMPACT OF PHYSICAL HEALTH ON MENTAL HEALTH

6.1 Introduction

Similar to The World Health Organization's conceptualisation of health (1946a), successful ageing is a multidimensional construct composed of physical, social, and mental components (Jeste & Depp, 2010). Nevertheless, the successful ageing literature has largely overlooked the area of mental health, despite older people emphasising its significance to them when discussing the topic (Phelan et al., 2004; Reichstadt et al., 2007). Given the importance of good mental health to quality of life, this neglect is surprising. Additionally, the growing ageing population are experiencing increased longevity and a subsequent increase in prevalence rates of mental disorders, with substantial associated societal and individual costs (Jokela, Batty, & Kivimäki, 2013; Karel, Gatz, & Smyer, 2012; Langa, Valenstein, Fendrick, Kabeto, & Vijan, 2004; Prince et al.; R. Stewart & Lindesay, 2011; Volkert, Schulz, Härter, Włodarczyk, & Andreas, 2013).

The World Health Organization constitution states: "health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (World Health Organization, 1946a, p. 1). This definition indicates that mental health is more than just the absence of mental illness, such as depression. Rather, there is also a positive dimension to mental health. Thus, the current study has chosen to focus on a generic indicator of mental health, the SF-36 MHI-5 (Ware & Sherbourne, 1992). The SF-36 is a self-assessment tool that is widely used to evaluate eight dimensions of health: physical functioning, role functioning related to physical health problems, bodily pain, general health perceptions, vitality, social functioning, role functioning related to emotional problems, and mental health (MHI-5). The psychometric properties of the SF-36 have shown it to be a suitable instrument for exploring the influence of ageing on health (Bartsch et al., 2011). Four mental health dimensions were identified in factor analyses of the Mental Health Inventory: anxiety, depression, loss of behavioural or emotional control and psychological well-being (Veit & Ware, 1983).

The systematic review discussed in Chapter 3 identified that past research on the MHI-5 has shown that there is little documented research on the trajectories of older men's MHI-5 scores, with the majority of studies focussing on women. Chapter 8 discusses sex differences in mental health in more detail; but, to summarise, men and women have been shown to have different mental health outcomes in past research. Men are at greater risk of depression as they age and in the years preceding death (Anstey & Luszcz, 2002; Burns, Butterworth, et al., 2013), while women report higher levels of depression and anxiety across most of their adult lifespan (Burns, Butterworth, et al., 2012; Korten & Henderson, 2000). Hence, it is likely that there will be sex differences in MHI-5 trajectories (Afifi, 2007; Piccinelli & Wilkinson, 2000). Therefore, analyses will be stratified by sex to examine whether associations are consistent between men and women.

The systematic review also identified that the influence of physical health on MHI-5 scores has not been examined in detail. More generally, the association between physical and mental health has been explored to varying degrees. People in poor physical health are more likely to experience mental illness, and the reverse is also true. Many studies have examined the relationship between mental health and chronic illnesses such as respiratory problems, cancer and arthritis (Dealberto, Pajot, Courbon, & Alperovitch, 1996; Husaini & Moore, 1990; Wilkinson & Kitzinger, 2000).

While it is generally accepted in the literature that physical health influences mental health, there are some inconsistent findings. In their cross sectional study of successful ageing in Taiwan, Wang and Lin (2012) did not find an association between physical and mental health. Alternatively, the Berlin Ageing Study data showed that physical health status had a direct effect on mental health over time (Kunzmann, Little, & Smith, 2000). However, comprehensive longitudinal analyses are yet to thoroughly examine this complex relationship. The role of physical health on general mental health trajectories remains to be explored. For example, is prior physical health pertinent to future mental health? Or, does physical health influence the extent to which an individual's mental health changes?

This study has two substantive aims. First, it describes mental health progression in old age in a representative sample of adults aged 65 years and above. This will contribute to the literature on mental health development in older age, as it reports data collected on up to five occasions. The second aim is to determine whether physical health factors are associated with mental health in older age. Further, the analyses take into account a wide range of covariates that have previously been shown to be associated with mental and/or physical health and have been hypothesised to be explanatory of the relationship. These covariates include sociodemographics and lifestyle behaviours.

Specifically, this study explores:

- i) How mental health changes over time.
- ii) How baseline physical health factors are associated with mental health over time.
- iii) How time-varying physical health factors are associated with mental health over time.
- iv) How time-varying physical health factors influence future mental health.
- v) How time-varying physical health factors predict change in mental health.
- vi) How change in physical health predicts change in mental health.

To examine whether these effects are consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. To address the methodological challenges of longitudinal research in this field, the effects of sample attrition and missing data were minimised using multilevel modelling techniques.

6.2 Method

Please see Chapter 4 for the general methodology for the DYNOPTA dataset. The following sections entail a description of the specific statistical analyses for this study.

6.2.1 Statistical analyses

Linear mixed models using maximum likelihood estimation were used to examine change in MHI-5 scores over time (Singer & Willett, 2003). Linear mixed models were chosen to analyse this data as they have the advantage of using all available observations so that cases where the participant did not complete all waves of measurement are retained in the models. Additionally, the random effects included account for the clustered observations in DYNOPTA (Xu, 2003). To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women. Men and women were compared on predictor variables using independent t tests. Analyses were conducted in IBM SPSS™ Statistics 22. Significance levels at $p < .05$ (*), $p < .01$ (**), and $p < .001$ (***) are reported. All analyses included random effect variance components for the intercept with an unstructured covariance matrix.

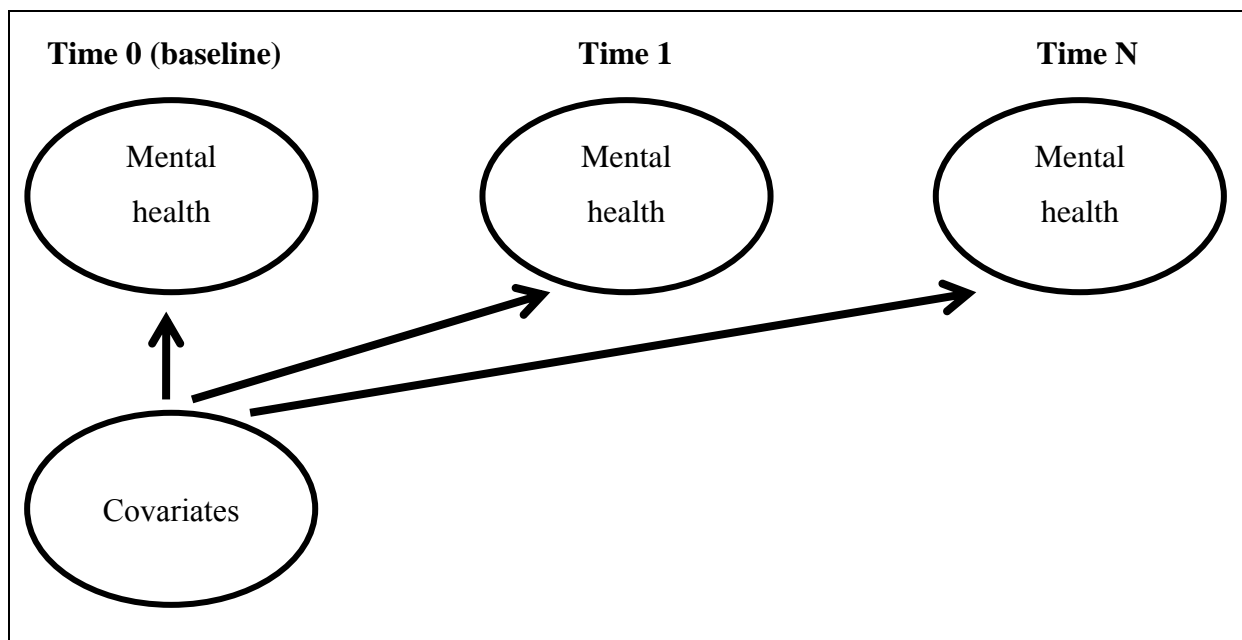
To address the study's objectives eight models were assessed. Models 1 – 4 focussed on baseline predictors of mental health. Model 5 assessed concurrent associations. Model 6 examined the relationship of prior physical health to mental health. Model 7 investigated how prior physical health impacts change in mental health. Model 8 assessed the relationship between change in physical health and the change in mental health.

Models 1-4. Testing baseline predictors of MHI-5 score

To investigate mental health over time, linear mixed models with random effects for intercept were evaluated for MHI-5 score collected at each wave (Model 1). To evaluate the effect of baseline sociodemographic predictors on mental health over time, a second model adjusted for sex, baseline partner status, education and age (centred at 65 years) (Model 2). To evaluate lifestyle behaviour predictors of mental health, a third model (Model 3) added fixed effects of baseline drinking and smoking status. The fourth model also added fixed effects of

baseline physical health variables: physical function, role-physical, bodily pain, and general health scores (Model 4). Twelve additional variations of Model 4 were conducted to test between-person differences in mental health trajectories using interaction terms between baseline predictors and their impact over time (Models 4.1-12). These were conducted to investigate if the impact of baseline predictors varies as time progresses. See Figure 6.1 for a graphical representation of Models 1-4.

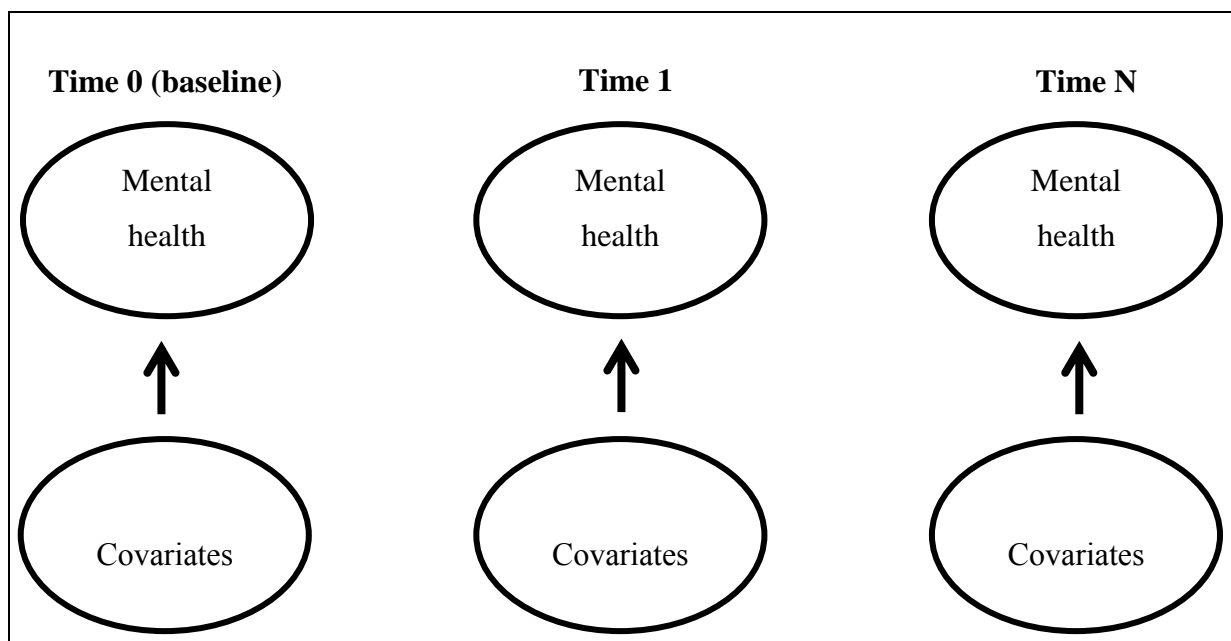
Figure 6.1. Models 1-4. Which baseline sociodemographic, lifestyle behaviour and physical health factors are associated with mental health over time?



Model 5 – Testing time-varying predictors of MHI-5 score

A fifth model evaluated how covariates influence concurrent mental health by including the following time-varying predictors: partner, drinking, and smoking status, physical function, role-physical, bodily pain, and general health. Baseline covariates included were sex, education and age. See Figure 6.2 for a graphical representation of Model 5.

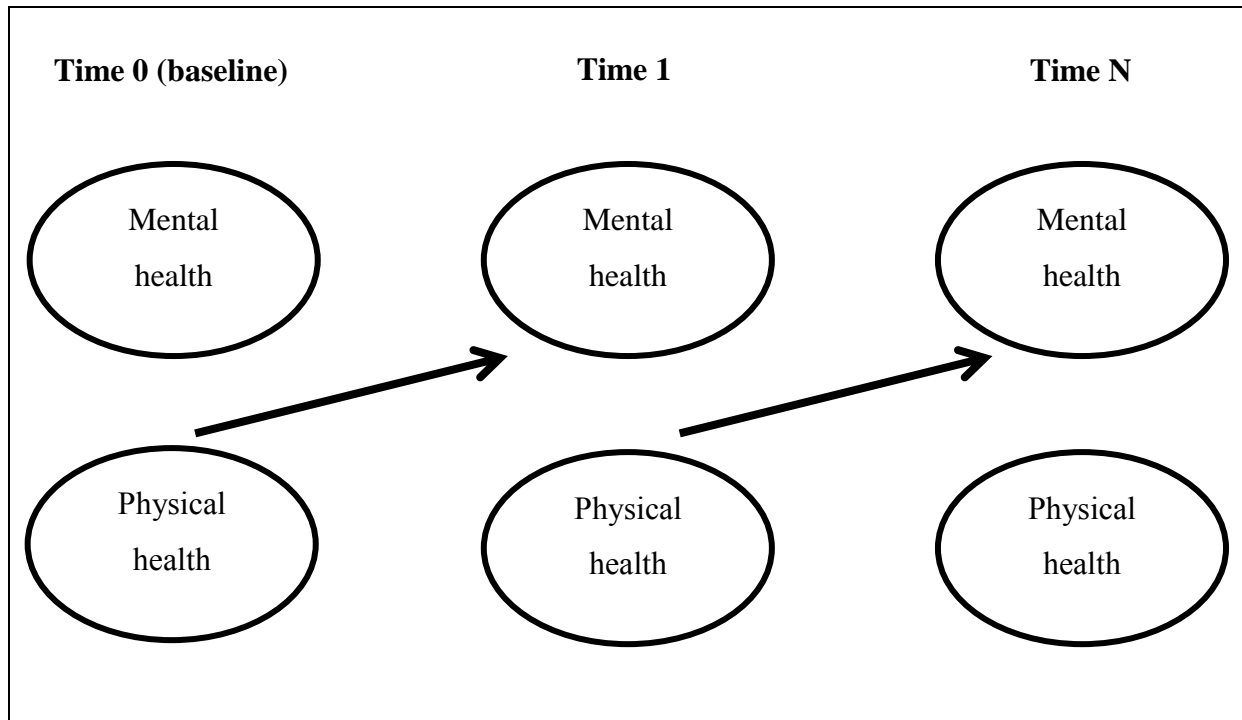
Figure 6.2. Model 5. Which time-varying sociodemographic, lifestyle behaviour and physical health factors are associated with mental health over time?



Model 6 – Testing lagged physical health predictors of MHI-5 score

As the literature indicates, physical health is strongly related to mental health in later life, prior physical health was tested specifically. Model 6 documented how prior physical health influences future mental health by including lagged physical health predictors: physical function, role-physical, bodily pain, and general health. The model was adjusted using time-varying covariates (partner, drinking, and smoking status) and baseline covariates (sex, education and age). See Figure 6.3 for a graphical representation of Model 6.

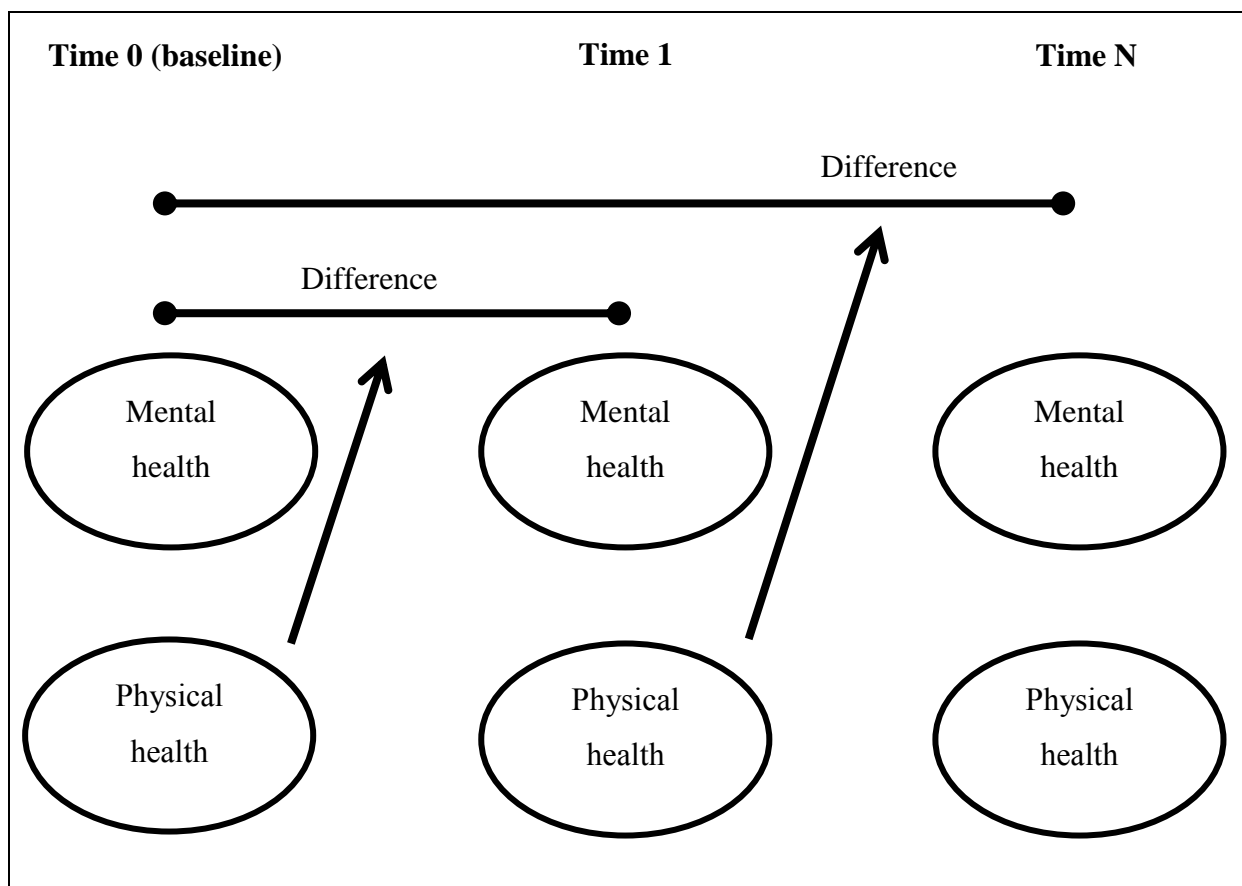
Figure 6.3. Model 6. How prior physical health influences future mental health.



Model 7 – Testing lagged physical health predictors of change in MHI-5 score

As the literature indicates, physical health is strongly related to mental health in later life, prior physical health was tested specifically. A seventh model evaluated change in mental health and included the following lagged physical health predictors: physical function, role-physical, bodily pain, and general health. The model was adjusted using time-varying covariates (partner, drinking, and smoking status) and baseline covariates (sex, education and age). Within-person change in mental health scores was calculated by subtracting baseline scores from the score at the relevant wave (Singer & Willett, 2003). See Figure 6.4 for a graphical representation of Model 7.

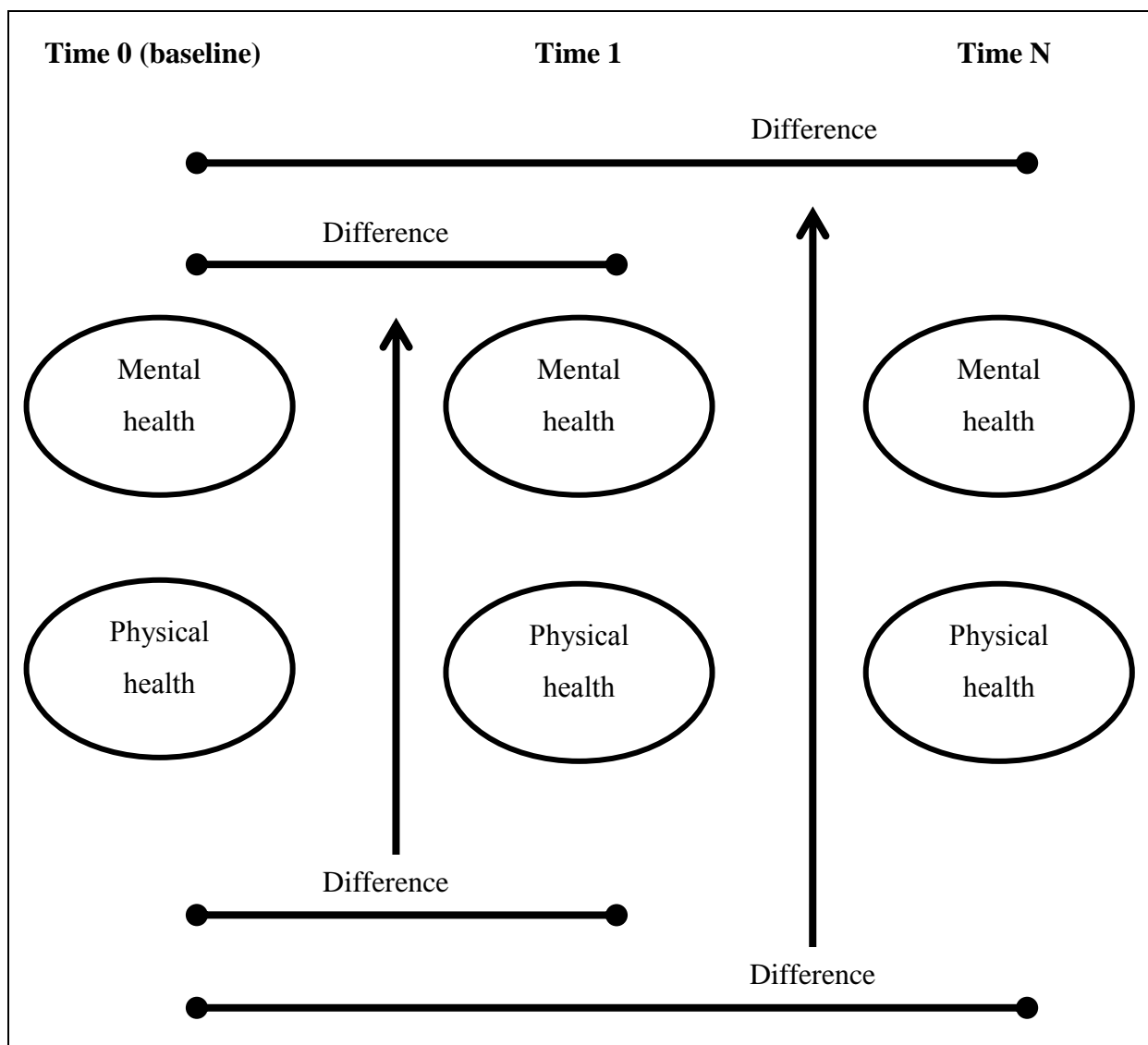
Figure 6.4. Model 7. How prior physical health influences change in mental health.



Model 8 – Testing change in physical health predictors of change in MHI-5 score

As the literature indicates, physical health is strongly related to mental health in later life, prior physical health was tested specifically. Model 8 evaluated how change in physical health influences change in mental health by including change in physical function, role-physical, bodily pain, and general health. The model was adjusted using time-varying covariates: partner, drinking, and smoking status. Baseline covariates included were sex, education and age. Within-person change in mental and physical health scores was calculated by subtracting baseline scores from the score at the relevant wave. See Figure 6.5 for a graphical representation of Model 8.

Figure 6.5. Model 8. How change in physical health predicts change in mental health.



6.2.2 Amendments to models

Including random effects for time was considered, to allow for variation in within-person change over time; but, when specified, only 0.25% of the variance was accounted for by time. Hence, there were greater between-person differences; that is, if there was any change, participants were changing in the same way. As so little variance was accounted for by time, the time in study variable was removed as a random effect.

6.3 Results

6.3.1 Modelling results

The following sections present the results from the eight models. Firstly, the results from Models 1-4 are presented, followed by the results of the investigation of interaction effects (Models 4.1-12) for the total sample. These models (Models 4-4.12) are then repeated, stratified by sex. Models 5 to 8 are then reported for the total sample, alongside the results for men and women separately.

Models 1-4 - Testing baseline predictors of MHI-5 score

Table 6.1 shows the results from the series of time and multivariate adjusted linear mixed models for MHI-5 score for the overall sample ($N=15,976$). Baseline covariates included were sex, education, age, partner, drinking, and smoking status, and physical health scores. The outcome variable was mental health score.

Table 6.1. Parameter estimates from linear-mixed models testing baseline predictors of MHI-5 score (Models 1-4).

	Model 1	Model 2	Model 3	Model 4
	β (SE)	β (SE)	β (SE)	β (SE)
Fixed Effects				
Intercept	77.53 (0.12)***	77.67 (0.30)***	79.56 (0.34)***	77.12 (0.31)***
Time (years)	0.01 (0.02)	0.01 (0.02)	-0.01 (0.02)	-0.05 (0.02)**
Men	-	-0.22 (0.36)	0.22 (0.38)	1.10 (0.34)***
Not Partnered baseline	-	0.33 (0.24)	0.61 (0.25)*	0.72 (0.22)***
Non-Tertiary Study baseline	-	2.59 (0.30)***	2.42 (0.31)***	1.65 (0.27)***
Tertiary Study baseline	-	3.84 (0.54)***	3.62 (0.55)***	2.16 (0.48)***
Age (years) baseline ^a	-	-0.12 (0.03)***	-0.16 (0.04)***	0.04 (0.03)
Non-Drinker baseline	-	-	-1.55 (0.27)***	0.23 (0.24)
Risk/High Drinker baseline	-	-	-0.05 (0.61)	-0.72 (0.54)
Former Smoker baseline	-	-	-2.20 (0.27)***	-0.98 (0.24)***
Current Smoker baseline	-	-	-5.00 (0.48)***	-3.63 (0.43)***
Physical function baseline	-	-	-	0.12 (0.16)
Role physical baseline	-	-	-	1.33 (0.15)***
Bodily pain baseline	-	-	-	1.76 (0.15)***
General health baseline	-	-	-	5.52 (0.14)***
Random Effects				
Intercept	163.63 (2.36)***	160.95 (2.40)***	157.28 (2.46)***	103.00 (1.84)***
Residual	107.10 (.88)***	106.87 (.90)***	106.45 (.93)***	104.95 (0.94)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

* $p < .05$; ** $p < .01$; *** $p < .001$

Model 1 examined the unadjusted MHI-5 scores over time. The mean estimated initial score was 77.53, and the random effects for the intercept suggested that there were significant differences between individuals. The effect of time was non-significant, indicating that MHI-5 scores were constant over time. Most of the variance (60.44%) was accounted for at the intercept, suggesting that just over half of the variance between participants was in their baseline scores while the remainder of the variance changed from one wave to the next.

After adjusting for baseline sociodemographic variables (Model 2), there were no sex or partner status differences in mental health but higher education was associated with better mental health (higher MHI-5 scores) and increasing age was associated with poorer mental health. Participants with tertiary education scored 3.84 points higher on the MHI-5, and those with non-tertiary education were 2.59 points higher than those who completed secondary school or less education. The results suggest that a one-year increase in baseline age results in a decrease of 0.12 points.

After adjusting for baseline lifestyle behaviours in Model 3, baseline age and education remained significant. Former smokers at baseline were 2.20 points lower on the MHI-5, and current smokers were 5.00 points lower than people who had never smoked. Non-drinkers at baseline were 1.55 points lower than low risk drinkers. Un-partnered participants at baseline were 0.61 points higher on the MHI-5 than partnered participants. This is likely a suppression effect, driven by the inclusion of the smoking and alcohol covariates that are increasing the relationship between being un-partnered and MHI-5 score (MacKinnon, Krull, & Lockwood, 2000). As this is a very small effect in comparison with the other effects, it will not be focussed on.

Model 4 included baseline physical health variables; the standardised coefficients are reported. Baseline partner status, education and smoking were again significant, but drinking status was no longer significant. Sex differences in MHI-5 score emerged, with men 1.10 points higher than women. There was a small but significant time effect, with MHI-5 score decreasing by 0.05 points per annum, showing there is very little change over time.

For each one standard deviation increase, MHI-5 score was predicted to increase by 1.33 points for baseline role physical score, 1.76 points for baseline bodily pain scoreⁱ, and 5.52 points for baseline general health score.

Table 6.2 shows the results of twelve additional models that were conducted to test between-person differences in mental health trajectories using interaction terms between baseline predictors and their impact over time (Models 4.1-12). The interactions were tested individually.

Table 6.2. Parameter estimates from linear-mixed models testing interaction effects between baseline predictors of MHI-5 score and time (Models 4.1-12).

	β (SE)
Not Partnered baseline*Time	0.30 (0.04)***
Non-Tertiary Study baseline*Time	-0.07 (0.05)
Tertiary Study baseline*Time	-0.07 (0.08)
Baseline Age*Time	-0.02 (0.01)*
Non-Drinker baseline*Time	0.07 (0.04)
Risk/High Drinker baseline*Time	-0.10 (0.10)
Former Smoker baseline*Time	-0.04 (0.04)
Current Smoker baseline*Time	0.01 (0.08)
Physical function baseline*Time	-0.11 (0.02)***
Role physical baseline*Time	-0.14 (0.02)***
Bodily pain baseline*Time	-0.15 (0.02)***
General health baseline*Time	-0.21 (0.02)***

Notes: Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

Age (years) baseline is centred to 65 years.

* $p < .05$; ** $p < .01$; *** $p < .001$

Significant interactions between baseline partner status and time (Table 6.2) indicated that being un-partnered was associated with MHI-5 score increase. Conversely, the interaction

ⁱ Please note that the higher the pain score, the less likely that the participant was to have experienced recent pain or associated limitations. Higher scores in this variable indicate experiencing less pain.

between baseline age and time indicated that older age was associated with greater decline. Although this interaction is significant, the change in MHI-5 score is minimal. Similarly, participants with higher physical health scores at baseline also experience greater decline in MHI-5 scores over time.

Although these were statistically significant interactions, the size of these interactions was not substantive. For example, if a participant is one standard deviation higher in general health, they will be 5.52 points higher on the mental health scale but they will only drop one MHI-5 point every five years at a rate of 0.21 standard deviations a year. Someone with high general health at baseline would therefore only reach average mental health after 28 years (i.e. they experience a slow decline). That is, a participant with a high general health score at 65 will only reach the intercept of the MHI-5 score at age 93. Therefore, these effects should not be over emphasised.

To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences in the structural relationships between the predictor and dependent variables. The next table (Table 6.3) presents the results from Model 4 for men and women separately to explore sex differences in MHI-5 trajectories.

Table 6.3 shows the results from the series of time and multivariate adjusted linear mixed models for MHI-5 score for men and women. Men and women were compared on predictor variables using independent *t* tests, the results of which are reported in Table 6.3.

Table 6.3. Parameter estimates from linear-mixed models testing baseline predictors of MHI-5 score according to sex, and t test of each predictor variable from the model (Model 4).

	Men (N=2309)	Women (N=13667)	
	β (SE)	β (SE)	<i>t</i> (df=2308)
Fixed Effects			
Intercept	78.03 (0.76)***	77.07 (0.36)***	1.14
Time (years)	-0.20 (0.08)*	-0.04 (0.02)*	1.94
Not Partnered baseline	-1.16 (0.73)	0.90 (0.23)***	2.69**
Non-Tertiary Study baseline	1.23 (0.60)*	1.77 (0.31)***	0.80
Tertiary Study baseline	2.49 (0.95)**	1.96 (0.56)***	0.48
Age (years) baseline ^a	0.08 (0.05)	0.04 (0.04)	0.62
Non-Drinker baseline	-0.78 (0.89)	0.28 (0.25)	1.15
Risk/High Drinker baseline	0.19 (1.13)	-0.86 (0.61)	0.82
Former Smoker baseline	-0.19 (0.61)	-1.07 (0.26)***	1.33
Current Smoker baseline	-1.28 (1.11)	-3.98 (0.46)***	2.25*
Physical function baseline	0.50 (0.41)	0.07 (0.17)	0.97
Role physical baseline	1.14 (0.41)**	1.36 (0.16)***	0.50
Bodily pain baseline	2.17 (0.39)***	1.70 (0.16)***	1.11
General health baseline	5.47 (0.39)***	5.52 (0.16)***	0.12
Random Effects			
Intercept	99.79 (4.99)***	103.31 (1.97)***	0.66
Residual	100.62 (2.65)***	105.52 (1.01)***	1.73

Notes: Reference group for each variable: Partnered, secondary school or less, low risk drinker, never smoker.

Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

* $p < .05$; ** $p < .01$; *** $p < .001$

The mean estimated initial score was 78.03 for men and 77.07 for women. The random effects for the intercept suggested variability between individuals. The statistically significant predictors of MHI-5 score for both men and women were time and baseline education. Baseline partner status was also a significant predictor for women, but not for men. Women who were not partnered at baseline were 0.90 points higher than women who were partnered at baseline. This sex difference was significant ($t = 2.69$; $df = 2308$; $P = 0.007$).

Smoking was significant for women only, with baseline former and current smokers having lower mental health. The effect of being a current smoker at baseline was also significantly different between men and women ($t = 2.25$; $df = 2308$; $P = 0.02$).

Table 6.4 shows the results of twelve additional models that were conducted to test between-person differences in mental health trajectories using interaction terms between baseline predictors and their impact over time (Models 4.1-12) along with t tests. The interactions were tested individually.

Table 6.4. Parameter estimates from linear-mixed models testing interaction effects between baseline predictors of MHI-5 score and time according to sex, and t test of each interaction effect (Models 4.1-12).

	Men	Women	
	β (SE)	β (SE)	t ($df=2,308$)
Interactions			
Not Partnered baseline*Time	0.12 (.23)	0.29 (0.04)***	0.73
Non-Tertiary Study baseline*Time	0.17 (0.18)	-0.08 (0.05)	1.34
Tertiary Study baseline*Time	0.34 (0.27)	-0.09 (0.09)	1.51
Baseline Age*Time	-0.01 (0.02)	-0.02 (0.01)*	0.45
Non-Drinker baseline*Time	-0.03 (0.28)	0.06 (0.04)	0.32
Risk/High Drinker baseline*Time	-0.22 (0.33)	-0.07 (0.10)	0.44
Former Smoker baseline*Time	0.37 (0.18)*	-0.05 (0.04)	2.28*
Current Smoker baseline*Time	-0.30 (0.34)	0.06 (0.08)	1.03
Physical function baseline*Time	-0.33 (0.09)***	-0.10 (0.02)***	2.49*
Role physical baseline*Time	-0.46 (0.09)***	-0.12 (0.02)***	3.69***
Bodily pain baseline*Time	-0.50 (0.09)***	-0.13 (0.02)***	4.01***
General health baseline*Time	-0.64 (0.09)***	-0.19 (0.02)***	4.88***

Notes: Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

Age (years) baseline is centred to 65 years.

* $p < .05$; ** $p < .01$; *** $p < .001$

For men only, there was a significant interaction between being a former smoker at baseline with time, indicating that being a former smoker was associated with small mental health

improvements. This interaction effect was significantly different between men and women ($t = 2.28$; $df = 2308$; $P = 0.02$).

For women only, there was a significant interaction between baseline partner status and time indicating that being un-partnered was associated with an MHI-5 score increase over time; again, the effect was quite small. The interaction between baseline age and time amongst women indicated that older age was associated with greater decline. Although this interaction is significant, the change in MHI-5 score is minimal and would be considered clinically non-significant.

The following interaction effects were all significantly different between men and women: physical function ($t = 2.49$; $df = 2308$; $P = 0.01$); role physical ($t = 3.69$; $df = 2308$; $P < 0.001$); bodily pain ($t = 4.01$; $df = 2308$; $P < 0.001$); general health ($t = 4.88$; $df = 2308$; $P < 0.001$). These differences indicate that men with higher physical health scores at baseline experience greater decline in MHI-5 scores over time, again, the size of these interactions are not substantive. A summary of these findings is provided below in Box 6.1.

Box 6.1. Key substantive findings from Models 1-4.

- Baseline general health was associated with better mental health in both men and women.
- The physical health interaction effects were significantly different between men and women indicating men with higher physical health scores at baseline experienced greater decline in MHI-5 scores over time.

Model 5 - Testing time-varying predictors of MHI-5 score

Time-varying predictors included in this model were partner, drinking, and smoking status, along with the physical health variables. Time invariant predictors were sex, education and age at baseline. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 6.5. Men and women were compared on predictor variables using independent *t* tests, the results of which are reported in the text.

Table 6.5. Parameter estimates from linear-mixed models testing time-varying predictors of SF-36 MHI-5 score for the total sample and according to sex (Model 5).

	Total Sample (N=15976)	Men (N=2,309)	Women (N=13,667)
	β (SE)	β (SE)	β (SE)
Fixed Effects			
Intercept	77.19 (0.30)***	78.24 (0.71)***	76.94 (0.35)***
Time (years)	0.23 (0.04)***	-0.29 (0.10)**	0.35 (0.05)***
Men	0.53 (0.33)	-	-
Not Partnered time-varying	-0.70 (0.21)***	-1.88 (0.63)**	-0.61 (0.22)**
Baseline Non-Tertiary Study	1.67 (0.27)***	1.29 (0.58)*	1.78 (0.31)***
Baseline Tertiary Study	2.15 (0.49)***	1.99 (0.94)*	2.16 (0.58)***
Baseline Age (years) ^a	0.12 (0.03)***	0.14 (0.05)**	0.12 (0.04)**
Non-Drinker time-varying	0.00 (0.22)	-1.48 (0.68)*	0.16 (0.23)
Risk/High Drinker time-varying	-0.23 (0.45)	1.72 (0.87)*	-0.88 (0.52)
Former Smoker time-varying	-0.83 (0.23)***	-0.58 (0.53)	-0.81 (0.26)***
Current Smoker time-varying	-3.22 (0.41)***	-1.89 (0.95)*	-3.44 (0.45)***
Physical function time-varying	0.22 (0.13)	0.64 (0.29)*	0.16 (0.14)
Role physical time-varying	1.52 (0.11)***	1.02 (0.26)***	1.63 (0.12)***
Bodily pain time-varying	1.61 (0.12)***	2.49 (0.27)***	1.43 (0.13)***
General health time-varying	5.81 (0.12)***	5.68 (0.28)***	5.84 (0.13)***
Random Effects			
Intercept	98.62 (2.07)***	93.07 (4.89)***	99.35 (2.28)***
Residual	96.00 (1.27)***	90.39 (2.62)***	96.87 (1.45)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

p* < .05; *p* < .01; ****p* < .001

The average mental health trajectory increased at a rate of 0.23 points per annum. The results also suggest that a one year increase in baseline age results in an increase of 0.12 points. There were no significant sex differences, though partner status was associated with MHI-5 outcomes: un-partnered participants were 0.70 points lower than partnered participants were. Higher education was again associated with better mental health and smoking with poorer mental health. Three of the physical health variables were significantly associated with mental health: role physical, bodily pain and general health.

For men, the average mental health trajectory decreased at a rate of 0.29 points per annum, while conversely for women, it increased at 0.35 points per annum. This was a small but significant difference ($t = 5.72$; $df = 2308$; $P < 0.001$). Drinking status was significant for men but not for women. Interestingly, men who were non-drinkers showed decreased mental health score, while risky drinkers exhibited an increased mental health score. Both these effects were significantly different between men and women (non-drinkers ($t = 2.28$; $df = 2308$; $P = 0.02$); risky drinkers ($t = 2.57$; $df = 2308$; $P = 0.01$)).

Being a current smoker was negatively associated with mental health for both men and women, and for women being a former smoker was also negatively associated with mental health. Both sexes showed significant positive associations for role physical, general health and bodily pain. The effect for bodily pain was significantly larger for men ($t = 3.54$; $df = 2308$; $P < 0.001$). Physical function also had a small, significant association with mental health for men. A summary of these findings is provided in Box 6.2.

Box 6.2. Key substantive findings from Model 5.

- Good general health was associated with better mental health in both men and women.

Model 6 – Testing lagged physical health predictors of MHI-5 score

Time-varying predictors included in this model were partner, drinking, and smoking status. Time invariant predictors were sex, education and age at baseline. Lagged predictors were physical function, role-physical, bodily pain, and general health. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 6.6. Men and women were compared on predictor variables using independent *t* tests, the results of which are reported in the text.

Table 6.6 Parameter estimates from linear-mixed models testing lagged physical health predictors of SF-36 MHI-5 score (Model 6).

	Total Sample (<i>N</i> =15,976)	Men (<i>N</i> =2,309)	Women (<i>N</i> =13,667)
	β (<i>SE</i>)	β (<i>SE</i>)	β (<i>SE</i>)
Fixed Effects			
Intercept	79.76 (0.55)***	79.51 (1.20)***	79.26 (0.68)***
Time (years)	-0.27 (0.11)*	-0.38 (0.17)*	-0.16 (0.15)
Men	-0.12 (0.48)	-	-
Not Partnered time-varying	-0.37 (0.30)	-1.30 (0.93)	-0.28 (0.32)
Baseline Non-Tertiary Study	1.70 (0.38)***	2.16 (0.93)*	1.66 (0.42)***
Baseline Tertiary Study	2.20 (0.66)***	3.20 (1.46)*	1.96 (0.75)**
Baseline Age (years) ^a	0.01 (0.05)	-0.02 (0.08)	0.02 (0.06)
Non-Drinker time-varying	-0.46 (0.31)	-2.99 (0.92)***	-0.12 (0.33)
Risk/High Drinker time-varying	-1.15 (0.65)	1.34 (1.27)	-1.99 (0.75)**
Former Smoker time-varying	-1.15 (0.32)***	-0.47 (0.80)	-1.19 (0.35)***
Current Smoker time-varying	-4.71 (0.62)***	-2.57 (1.45)	-5.10 (0.69)***
Physical function lagged	0.27 (0.19)	0.37 (0.41)	0.20 (0.22)
Role physical lagged	0.58 (0.17)***	0.13 (0.35)	0.72 (0.19)***
Bodily pain lagged	1.43 (0.18)***	1.32 (0.39)***	1.41 (0.20)***
General health lagged	4.23 (0.18)***	2.76 (0.41)***	4.56 (0.20)***
Random Effects			
Intercept	108.99 (3.42)***	121.59 (8.54)***	108.31 (4.02)***
Residual	93.60 (2.28)***	91.02 (3.44)***	92.78 (3.01)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

p* < .05; *p* < .01; ****p* < .001

The statistically significant predictors of mental health score were time, education, smoking status, and prior role physical, bodily pain and general health scores. Higher mental health was observed for more educated, non-smokers with better prior role physical, bodily pain and general health scores. The impact of prior physical health on mental health was smaller than in previous (non-lagged) models. The average mental health trajectory decreased at a rate of 0.27 points per annum.

Average mental health decreased at an annual rate of 0.38 for men. Being a non-drinker for men was associated with decreased mental health, while being a risky drinker showed the same effect for women. These were both significant differences (non-drinker ($t = 2.94$; $df = 2308$; $P = 0.003$); risky drinker ($t = 2.26$; $df = 2308$; $P = 0.02$).

Higher prior general health and bodily pain scores were associated with better mental health for both men and women. For each one standard deviation increase, men's MHI-5 score was predicted to increase 1.32 points for bodily pain score, and 2.76 points for general health score. For women, MHI-5 score was predicted to increase 1.41 points for bodily pain score, and 4.56 points for general health score. The effect for general health was substantially larger for women ($t = 3.95$; $df = 2308$; $P < 0.001$). For women alone, MHI-5 score was predicted to increase 0.72 points for increased role physical score. A summary of these findings is provided below in Box 6.3.

Box 6.3. Key substantive findings from Model 6.

- Higher prior general health was associated with better mental health in both men and women.
- Having higher prior general health was associated with better mental health in women compared to men.

Model 7 – Testing lagged physical health predictors of change in MHI-5 score

Time-varying predictors included in this model were partner, drinking, and smoking status. The lagged predictors were physical function, role-physical, bodily pain, and general health. Baseline covariates included were sex, education and age. The outcome variable was within-person change in mental health score. The study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 6.7.

Table 6.7. Parameter estimates from linear-mixed models testing time-varying predictors of change in MHI-5 score (Model 7).

	Total Sample (N=15,976)	Men (N=2,309)	Women (N=13,667)
	β (SE)	β (SE)	β (SE)
Fixed Effects			
Intercept	2.18 (0.56)***	0.44 (1.28)	2.33 (0.69)***
Time (years)	-0.22 (0.11)	-0.25 (0.18)	-0.19 (0.15)
Men	-1.24 (0.50)**	-	-
Not Partnered time-varying	0.72 (0.31)*	-0.18 (0.99)	0.79 (0.32)*
Baseline Non-Tertiary Study	-0.13 (0.40)	0.66 (1.01)	-0.32 (0.44)
Baseline Tertiary Study	0.12 (0.68)	0.87 (1.58)	-0.05 (0.77)
Baseline Age (years) ^a	-0.15 (0.05)**	-0.01 (0.09)	-0.19 (0.06)***
Non-Drinker time-varying	-0.57 (0.32)	-3.11 (0.96)***	-0.27 (0.34)
Risk/High Drinker time-varying	-0.72 (0.66)	2.28 (1.30)	-1.82 (0.76)*
Former Smoker time-varying	-0.46 (0.33)	-0.79 (0.84)	-0.36 (0.36)
Current Smoker time-varying	-1.76 (0.64)**	-2.17 (1.53)	-1.58 (0.71)*
Physical function lagged	0.15 (0.19)	-0.27 (0.42)	0.29 (0.22)
Role physical lagged	-0.45 (0.17)**	0.08 (0.35)	-0.62 (0.19)***
Bodily pain lagged	-0.36 (0.18)	-0.41 (0.40)	-0.33 (0.21)
General health lagged	-0.75 (0.19)***	-0.51 (0.42)	-0.81 (0.21)***
Random Effects			
Intercept	125.90 (3.60)***	150.95 (10.19)***	122.93 (4.12)***
Residual	88.47 (2.20)***	89.82 (3.43)***	87.11 (2.88)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

*p < .05; **p < .01; ***p < .001

The mean estimated initial change score was 2.18 (an improvement in MHI-5 score from baseline to time 1), and was significantly different between individuals. . The effect of time was non-significant, indicating that change in mental health scores were constant over time.

The statistically significant predictors of mental health change were sex, partner status, baseline age, smoking, role physical, and general health score. Less improvement in mental health score was observed for older adults, men, current smokers, and those with higher role physical and general health scores. Greater increases in mental health score were observed for un-partnered participants.

The only statistically significant predictor of mental health change for men was drinking status, where non-drinkers showed a greater decrease in mental health score. This was not the case for men who were risky drinkers. In contrast, for women, significantly less improvement in mental health score was observed for risky drinkers. These were significant differences between men and women (non-drinkers ($t = 2.79$; $df = 2308$; $P = 0.005$); risky drinkers ($t = 2.72$; $df = 2308$; $P = 0.007$)).

Greater increases in mental health score were observed for un-partnered women. For women also, significantly less improvement in mental health score were observed in older ages, risky drinkers, current smokers and those with higher role physical and general health scores. A summary of these findings is provided below in Box 6.4.

Box 6.4. Key substantive findings from Model 7.

- Having higher prior general health was associated with lower improvements in mental health in both men and women.

Model 8 – Testing change in physical health predictors of change in MHI-5 score

Model 8 evaluated how change in physical health influences change in mental health by including change in physical function, role-physical, bodily pain, and general health. The model was adjusted using time-varying covariates: partner, drinking, and smoking status. Baseline covariates included were sex, education and age. The outcome variable was within-person change in mental health score. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 6.8. Men and women were compared on predictor variables using independent *t* tests, the results of which are reported in the text.

Table 6.8. Parameter estimates from linear-mixed models testing change in physical health predictors of change in MHI-5 score (Model 8).

	Total Sample (N=15,976)	Men (N=2,309)	Women (N=13,667)
	β (SE)	β (SE)	β (SE)
Fixed Effects			
Intercept	0.32 (0.19)	-0.15 (0.48)	0.38 (0.22)
Time (years)	0.13 (0.04)***	-0.38 (0.09)***	0.23 (0.04)***
Men	-0.68 (0.20)***	-	-
Not Partnered time-varying	0.27 (0.13)*	0.12 (0.42)	0.29 (0.14)*
Baseline Non-Tertiary Study	-0.10 (0.17)	0.36 (0.38)	-0.24 (0.19)
Baseline Tertiary Study	0.01 (0.29)	0.24 (0.60)	0.01 (0.34)
Baseline Age (years) ^a	-0.03 (0.02)	0.03 (0.03)	-0.06 (0.02)*
Non-Drinker time-varying	-0.02 (0.15)	-0.72 (0.49)	0.04 (0.15)
Risk/High Drinker time-varying	-0.22 (0.31)	1.14 (0.65)	-0.61 (0.36)
Former Smoker time-varying	-0.01 (0.15)	-0.23 (0.37)	0.03 (0.16)
Current Smoker time-varying	-0.58 (0.27)*	-1.16 (0.66)	-0.39 (0.29)
Physical function within-person change	0.86 (0.13)***	1.34 (0.29)***	0.78 (0.15)***
Role physical within-person change	1.48 (0.10)***	1.21 (0.24)***	1.54 (0.12)***
Bodily pain within-person change	1.14 (0.12)***	1.83 (0.27)***	0.97 (0.13)***
General health within-person change	4.07 (0.13)***	4.45 (0.29)***	3.98 (0.15)***
Physical function baseline	-0.03 (0.10)	0.09 (0.27)	-0.05 (0.11)
Role physical baseline	0.05 (0.10)	0.03 (0.27)	0.05 (0.10)
Bodily pain baseline	-0.10 (0.10)	-0.18 (0.25)	-0.08 (0.10)
General health baseline	0.18 (0.10)	0.46 (0.25)	0.12 (0.10)
Random Effects			
Intercept	13.66 (0.61)***	20.54 (1.46)***	11.54 (0.68)***
Residual	75.48 (0.84)***	70.27 (1.78)***	76.86 (0.95)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

p* < .05; *p* < .01; ****p* < .001

Men reported decreases in mental health scores, which also decreased by a further 0.38 points per annum. Women reported increases in mental health scores and showed improvement over time. The time effect was significantly different between men and women ($t = 6.19$; $df = 2308$; $P < 0.001$). Greater increases in mental health were observed for un-partnered women. A small, non-substantive but significant age effect was shown for women, with older women improving less in MHI-5 score. This was significantly different between men and women ($t = 2.50$; $df = 2308$; $P = 0.01$). The effect of being a risky drinker was also significantly different between men and women ($t = 2.36$; $df = 2308$; $P < 0.02$).

All physical health change scores were associated with greater increases in mental health score for both sexes. The effect for bodily pain was significantly greater for men ($t = 2.87$; $df = 2308$; $P = 0.004$). The within- and between-person effects indicated that it was not the between-person differences that are driving change in mental health, but rather change in physical health that is having the greatest effect on change in mental health. This was the focus of this model and potentially the most important finding of these analyses. A summary of these findings is provided below in Box 6.5.

Box 6.5. Key substantive findings from Model 8.

- Experiencing greater change in general health was associated with greater improvements in mental health in both men and women.
- Change in physical health had the greatest effect on change in mental health in both men and women.

6.3.2 Summary of results

When looking at the substantive baseline physical health predictors, general health was associated with better mental health. Time-varying predictors showed similar results. Similarly, for lagged predictors, prior general health status was associated with better mental health, particularly amongst women. Additionally, men's mental health worsened over time, while women's improved.

Looking at change in mental health, having higher prior general health was associated with lower improvements in mental health. Experiencing greater change in general health was associated with greater improvements in mental health. Men reported decreases in mental health score while women's scores increased. A full discussion of these results is presented in Chapter 9. The following chapter will report on the results of the investigation into the impact of mental health on physical health.

Chapter 7

STUDY 2.3: INVESTIGATION INTO THE IMPACT OF MENTAL HEALTH ON PHYSICAL HEALTH

7.1 Introduction

As discussed in Chapter 6, while the broad association of physical and mental health is well established in the literature, the details of this complex relationship have not been fully explored and documented. The previous chapter investigated the effect of physical health on mental health, while this chapter will aim to look at the inverse relationship: how mental health influences physical health. This chapter will focus on testing changes in physical health scores, as in the previous chapter these change relationships appeared to be the most influential and of interest.

Since the start of the century, the World Health Organization has conceptualised mental health as more than the absence of mental illness:

a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community. (World Health Organization, 2001, p. 1)

In 2005, the World Health Organization published an extensive and notable report on mental health promotion which drew attention to the understudied relationship between physical and mental health, stating:

While common sense would suggest these domains interact and overlap, this has not been well tested empirically. (World Health Organization, 2005, p. 135)

The relationship of physical health influencing mental health is perhaps easier to comprehend, as it is reasonably intuitive. The reverse is less so.

In 1969, Palmore reported that poor mental health is linked to increased mortality, arguably an outcome measure of physical health, even after excluding death by suicide and accident (Palmore, 1969a). Palmore discovered that in a group of 268 volunteers aged 60 to 94 years

old, longevity was predicted most strongly by work satisfaction and global happiness, after controlling for age, physical functioning and tobacco use. He advised:

These findings suggest that, in general, the most important ways to increase longevity are: 1. maintain a useful and satisfying role in society, 2. maintain a positive view of life, 3. maintain good physical functioning, and 4. avoid smoking. (Palmore, 1969b, p. 250)

Moving on from using mortality as an outcome measure, in his seminal work in this area Vaillant (1979) followed 188 men longitudinally in the Grant Study of Adult Development. The men were assessed three times at ages 42, 48 and 53. Vaillant (1979) used physical examination data to represent physical health, which included routine laboratory studies, electrocardiography, and x-ray films of the chest. He also used self-reports of participants' physical health. Mental health was assessed using a scale of global mental health that measured adult adjustment. Vaillant (1979) reported that:

The relation between previous mental health and subsequent physical health remained statistically significant when the effects on health of alcohol, tobacco use, obesity, and longevity of ancestors were excluded by multiple regression analysis. The data suggest that good mental health retards midlife deterioration in physical health. (Vaillant, 1979, p. 1249)

Although an interesting finding, the authors acknowledged that their participant population of white, college educated men was not a representative sample and experienced substantially better health than the general population. This research was also conducted on a younger age group than the population that the current thesis is focussing on and used different data analytic techniques. However, the results are still relevant to this research.

7.1.1 Mechanisms and protective effects

Assessing disease as an indicator of physical health, Hemingway and Marmot (1999) conducted a review of the literature investigating whether psychosocial factors cause coronary heart disease or affect survival among patients with coronary heart disease. The authors reported that:

prospective cohort studies provide strong evidence that psychosocial factors, particularly depression and social support, are independent aetiological and prognostic factors for coronary heart disease. (Hemingway & Marmot, 1999, p. 1460)

This has been supported by other research (Bunker et al., 2003), and there is some evidence to suggest that similar conclusions could apply to the prognosis of other diseases, including stroke (Hackett Maree, Anderson Craig, House, & Halteh, 2008), diabetes (Snoek & Skinner, 2002), and asthma (Devine, 1996).

Hemingway and Marmot (1999) cautiously note that their conclusions should take into account the possibility of publication bias. The authors discuss three pathways by which psychosocial factors may affect physical health:

- i) By influencing health related behaviours such as smoking, diet, drinking or physical activity.
- ii) Through causing direct acute or chronic pathophysiological changes.
- iii) By influencing access to and quality of medical care.

7.1.2 Positive psychological states

Also discussing what is driving the effect of mental health on physical health, Edwards and Cooper (1988) argued that while much research has focused on the impact of poor mental health on physical health, positive psychological states have not received the same attention. The authors thus proposed a theoretical framework to describe the influence of positive psychological states, or good mental health, on physical health (Edwards & Cooper, 1988). They suggested a framework of two pathways. Firstly, that positive psychological states have a direct effect on physical health in that an individual has improved coping ability. The authors go on to suggest that that positive psychological states reverse the development of disease. Edwards and Cooper (1988) acknowledge that the pathways they hypothesise are speculative. The authors do attempt to support their arguments using empirical evidence; however, they call for further longitudinal research to investigate the relationship of positive

psychological states and physical health. As such, it is recommended that their proposed frameworks be considered theoretical.

Alternatively, Post (2005) proposes that the pathway between positive mental states and physical health is preceded by altruistic behaviour:

The essential conclusion of this article is that a strong correlation exists between the well-being, happiness, health, and longevity of people who are emotionally kind and compassionate in their charitable helping activities...(Post, 2005, p. 73)

Other research has not always agreed with the proposed pathways of Edwards and Cooper (1988) and Post (2005). Perneger, Hudelson, and Bovier (2004) found no statistically significant association between happiness and physical health in cross-sectional research. Similarly, R. A. Martin (2001) found little evidence to suggest that humour and laughter is associated with physical health or longevity. However, Simmons and Nelson (2001) did report that hope (the belief that one can and will accomplish goals) was significantly positively associated with perceptions of health.

7.1.3 Summary and aims

Best practice for research in this area dictates that both mental and physical health must be reliably assessed over an extended period of time (Vaillant, 1979). Also, it must be considered that while poor mental health may make individuals more susceptible to physical ill health, good mental health may be a protective factor in coping with disease onset. Hence, a general indicator of health is more useful in this area, rather than a clinical diagnosis of mental illness only (Lamers, Westerhof, Bohlmeijer, & Keyes, 2013). Additionally, the effects of social and lifestyle behaviours, such as partner status, education, and smoking, need to be controlled for.

This study has two primary aims. First, it describes physical health progression in old age in a representative sample of adults aged 65 years and above. This will contribute to the literature

on physical health development in older age, as it reports data collected on up to five occasions using four different measures. The second aim is to determine whether mental health is associated with change in physical health in older age. As mentioned earlier, unlike Chapter 6, this study will focus only on change in physical health scores as the area of interest. Further, the analyses take into account a wide range of covariates that have previously been shown to be associated with mental and/or physical health and have been hypothesised to be explanatory of the relationship. These covariates include sociodemographics and lifestyle behaviours.

Specifically, this study aims to identify:

- i) How physical health changes over time.
- ii) How prior mental health predicts change in physical health.
- iii) How change in mental health factors predict change in physical health.

To examine whether these effects are consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. To address the methodological challenges of longitudinal research in this field, the effects of sample attrition and missing data were minimised using multilevel modelling techniques.

7.2 Method

Please see Chapter 4 for the general methodology for the DYNOPTA dataset. The following sections entail a description of the specific statistical analyses for this study.

7.2.1 Statistical analyses

Linear mixed models using maximum likelihood estimation were used to examine change in physical health summary scores over time (Singer & Willett, 2003). Linear mixed models were chosen to analyse this data as they have the advantage of using all available observations so that cases where the participant did not complete all waves of measurement are retained in the models. Additionally, the random effects included account for the

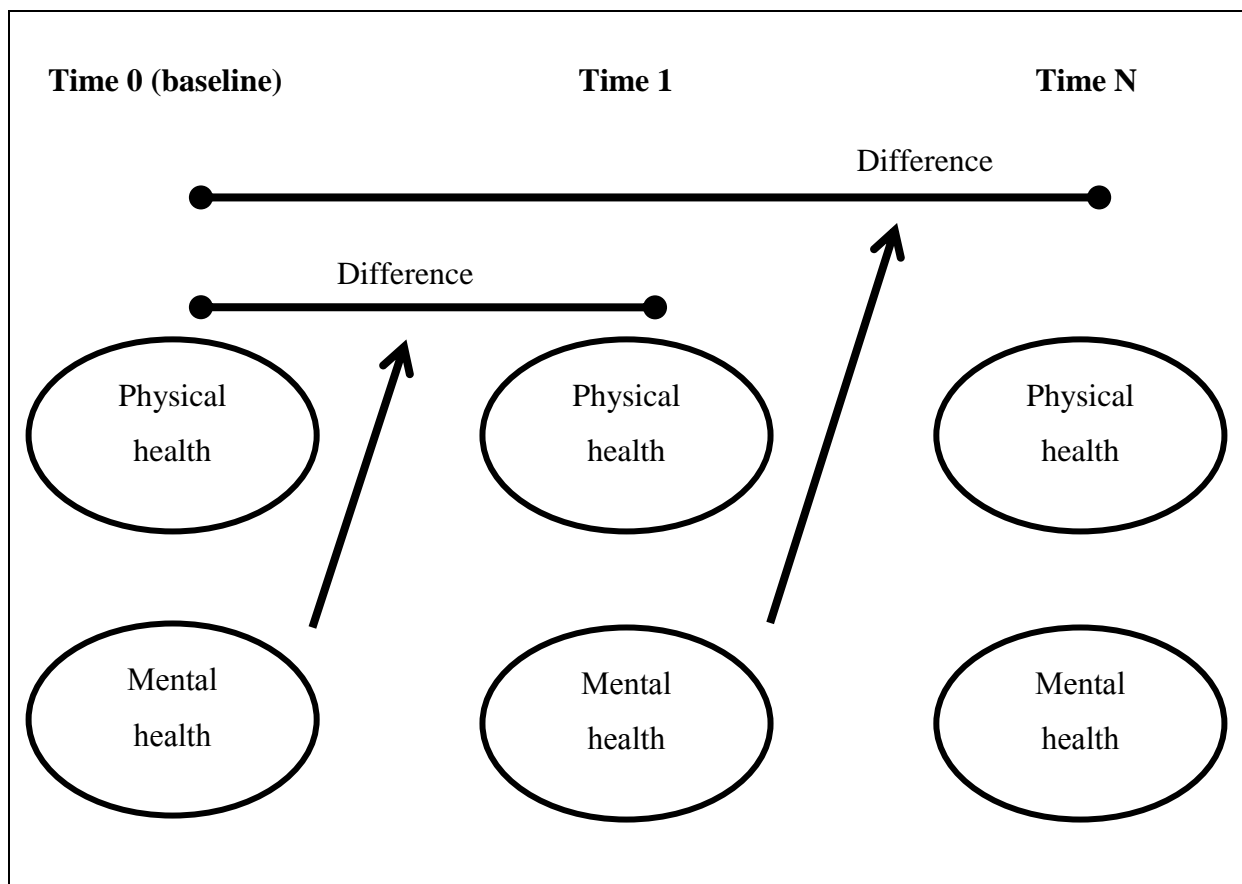
clustered observations in DYNOPTA (Xu, 2003). To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women. Men and women were compared on predictor variables using independent *t* tests. Analyses were conducted in IBM SPSS™ Statistics 22. Significance levels at $p < .05$ (*), $p < .01$ (**), and $p < .001$ (***) are reported. All analyses included random effect variance components for the intercept with an unstructured covariance matrix.

To address the study's objectives two models were assessed. Model 1 investigated how prior mental health impacts change in physical health. Model 2 assessed the relationship between change in mental health and the change in physical health. Each model was applied in turn to the four physical health measures physical function, role-physical, bodily pain, and general health.

Model 1 – Testing lagged MHI-5 scores as a predictor of change in physical health summary scores

As the literature indicates mental health is strongly related to physical health in later life, prior mental health was tested specifically. Model 1 evaluated change in the four physical health outcome measures (physical function (Model 1.1), role-physical (Model 1.2), bodily pain (Model 1.3), and general health (Model 1.4)) and included lagged MHI-5 score. The model was adjusted using time-varying covariates (partner, drinking, and smoking status) and baseline covariates (sex, education and age). Within-person change in physical health scores was calculated by subtracting baseline scores from the score at the relevant wave (Singer & Willett, 2003). See Figure 7.1 for a graphical representation of Model 1.

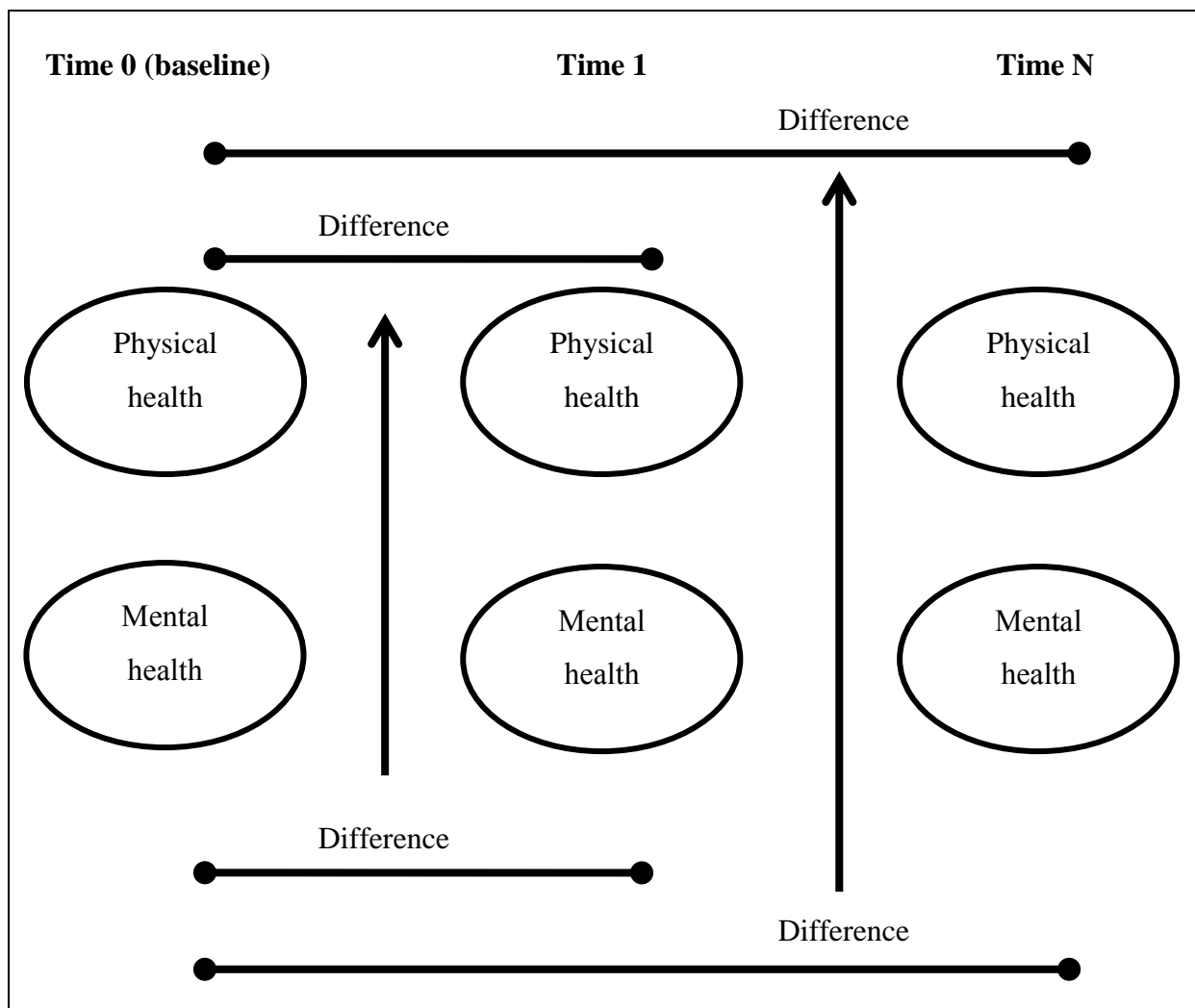
Figure 7.1. Model 1. How prior mental health influences change in physical health.



Model 2 – Testing change in MHI-5 scores as a predictor of change in physical health summary scores

As the literature indicates mental health is strongly related to physical health in later life, prior mental health was tested specifically. Model 2 evaluated how change in mental health influences change in the four physical health outcome measures: physical function (Model 2.1), role-physical (Model 2.2), bodily pain (Model 2.3), and general health (Model 2.4). The model was adjusted using time-varying covariates: partner, drinking, and smoking status. Baseline covariates included were sex, education and age. Within-person change in mental and physical health scores was calculated by subtracting baseline scores from the score at the relevant wave. See Figure 7.2 for a graphical representation of Model 2.

Figure 7.2. Model 2. How change in mental health predicts change in physical health.



7.3 Results

7.3.1 Modelling results

The following sections present the results from the two models. Firstly, the results from Model 1 are reported for the total sample alongside the results for men and women separately for each of the four physical health outcome measures: physical function, role-physical, bodily pain, and general health. This process is then repeated for Model 2.

Model 1.1 – Testing lagged MHI-5 scores as a predictor of change in physical function

Time-varying predictors included in this model were partner, drinking, and smoking status. The lagged predictor was mental health. Baseline covariates included were sex, education and age. The outcome variable was within-person change in physical function score. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 7.1. Men and women were compared on predictor variables using independent t tests, the results of which are reported in the text.

Table 7.1. Parameter estimates from linear-mixed models testing lagged MHI-5 score as a predictor of change in physical function score (Model 1.1).

	Total Sample (N=15,976)	Men (N=2,309)	Women (N=13,667)
	β (SE)	β (SE)	β (SE)
Fixed Effects			
Intercept	2.07 (0.78)**	6.04 (2.01)**	2.40 (0.94)*
Time (years)	-0.92 (0.16)***	-0.95 (0.24)***	-1.12 (0.21)***
Men	0.99 (0.69)	-	-
Not Partnered time-varying	0.43 (0.42)	1.34 (1.54)	0.37 (0.43)
Baseline Non-Tertiary Study	0.28 (0.54)	-2.48 (1.64)	0.79 (0.58)
Baseline Tertiary Study	0.30 (0.94)	-1.58 (2.58)	0.36 (1.03)
Baseline Age (years) ^a	-0.37 (0.07)***	-0.43 (0.15)**	-0.36 (0.08)***
Non-Drinker time-varying	-0.61 (0.44)	-3.36 (1.42)*	-0.33 (0.45)
Risk/High Drinker time-varying	-1.33 (0.90)	-1.98 (1.85)	-0.98 (1.03)
Former Smoker time-varying	0.10 (0.45)	-0.25 (1.27)	-0.05 (0.48)
Current Smoker time-varying	-2.28 (0.88)**	-4.39 (2.29)	-1.41 (0.96)
Mental health lagged	-0.71 (0.20)***	-1.01 (0.49)*	-0.57 (0.21)**
Random Effects			
Intercept	232.65 (6.66)***	431.52 (26.71)***	195.99 (7.50)***
Residual	179.50 (4.22)***	167.93 (6.28)***	190.10 (5.81)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Mental health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

*p < .05; **p < .01; ***p < .001

The mean estimated initial change score was 2.07 (an improvement in physical function score from baseline to time 1), and was significantly different between individuals.

The statistically significant predictors of change were time, baseline age, smoking, and prior mental health. Less improvement in physical function score was observed for older adults, current smokers, and those with higher prior mental health scores. The average change in physical function was a decrease of 0.92 points per annum.

For men, the mean estimated initial change score was 6.04, and was significantly different between individuals. The statistically significant predictors of change for men were time,

baseline age, drinking status and prior mental health. The average change in physical function was a decrease of 0.95 points per annum for men. Less improvement in physical function score was observed for older men, non-drinkers and those with higher prior mental health scores.

For women, the mean estimated initial change score was 2.40, and was significantly different between individuals. Similar to men, the statistically significant predictors of change for women were time, baseline age, and prior mental health. The average change in physical function was a decrease of 1.12 points per annum. Less improvement in physical function score was observed for older women and those with higher prior mental health scores.

There was a significant difference between men and women regarding the effect of being a non-drinker ($t = 2.03$; $df = 2,308$; $P = 0.04$). A summary of these findings is provided below in Box 7.1

Box 7.1. Key substantive findings from Model 1.1.

- Having higher prior mental health was associated with lower improvements in physical function for both men and women.

Model 1.2 – Testing lagged MHI-5 scores as a predictor of change in role physical

Time-varying predictors included in this model were partner, drinking, and smoking status. The lagged predictor was mental health. Baseline covariates included were sex, education and age. The outcome variable was within-person change in role physical score. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 7.2. Men and women were compared on predictor variables using independent *t* tests, the results of which are reported in the text.

Table 7.2. Parameter estimates from linear-mixed models testing lagged MHI-5 score as a predictor of change in role physical score (Model 1.2).

	Total Sample (<i>N</i> =15,976)	Men (<i>N</i> =2,309)	Women (<i>N</i> =13,667)
	β (<i>SE</i>)	β (<i>SE</i>)	β (<i>SE</i>)
Fixed Effects			
Intercept	2.31 (1.68)	6.63 (3.77)	2.60 (2.07)
Time (years)	-1.49 (0.35)***	-1.39 (0.54)**	-1.57 (0.46)***
Men	3.01 (1.46)*	-	-
Not Partnered time-varying	1.71 (0.90)	0.13 (2.94)	1.98 (0.95)*
Baseline Non-Tertiary Study	-1.86 (1.16)	-2.82 (2.92)	-1.63 (1.28)
Baseline Tertiary Study	-0.87 (1.99)	-2.07 (4.56)	-0.76 (2.25)
Baseline Age (years) ^a	-0.40 (0.14)**	-0.22 (0.26)	-0.48 (0.17)**
Non-Drinker time-varying	-0.61 (0.94)	-6.03 (2.91)*	0.15 (0.99)
Risk/High Drinker time-varying	-3.26 (1.96)	-7.88 (4.08)	-1.64 (2.24)
Former Smoker time-varying	-0.82 (0.96)	-2.31 (2.51)	-0.56 (1.05)
Current Smoker time-varying	-4.58 (1.89)*	-1.67 (4.56)	-5.46 (2.09)**
Mental health lagged	-3.71 (0.43)***	-3.72 (1.05)***	-3.70 (0.47)***
Random Effects			
Intercept	988.25 (31.14)***	1161.09 (81.46)***	957.68 (36.90)***
Residual	881.61 (21.09)***	899.58 (33.45)***	878.69 (28.15)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Mental health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

p* < .05; *p* < .01; ****p* < .001

The mean estimated initial change score was 2.31 (an improvement in role physical score from baseline to time 1). The statistically significant predictors of change were time, sex, baseline age, smoking, and prior mental health. Less improvement in role physical score was observed for older adults, current smokers, and those with higher prior mental health scores. Men experienced more improvement than women did. The average change in role physical was a decrease of 1.49 points per annum.

For men, the mean estimated initial change score was 6.63. The statistically significant predictors of change for men were time, drinking status and prior mental health. The average change in role physical score for men was a decrease of 1.39 points per annum. Less improvement in role physical score was observed for non-drinkers and those with higher prior mental health scores. There was a significant difference between men and women regarding the effect of being a non-drinker ($t = 2.01$; $df = 2,308$; $P = 0.04$).

For women, the mean estimated initial change score was 2.60. The statistically significant predictors of change for women were time, partner status, baseline age, smoking and prior mental health. Less improvement in role physical score was observed for older women, current smokers and those with higher prior mental health scores. Greater increases in role physical score were observed for un-partnered women. The average change in role physical score for women was a decrease of 1.57 points per annum. A summary of these findings is provided below in Box 7.2.

Box 7.2. Key substantive findings from Model 1.2.

- Having higher prior mental health was associated with lower improvements in the role physical score for both men and women.

Model 1.3 – Testing lagged MHI-5 scores as a predictor of change in bodily pain

Time-varying predictors included in this model were partner, drinking, and smoking status. The lagged predictor was mental health. Baseline covariates included were sex, education and age. The outcome variable was within-person change in bodily pain score. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 7.3. Men and women were compared on predictor variables using independent *t* tests, the results of which are reported in the text.

Table 7.3. Parameter estimates from linear-mixed models testing lagged MHI-5 score as a predictor of change in bodily pain score (Model 1.3).

	Total Sample (<i>N</i> =15,976)	Men (<i>N</i> =2,309)	Women (<i>N</i> =13,667)
	β (<i>SE</i>)	β (<i>SE</i>)	β (<i>SE</i>)
Fixed Effects			
Intercept	1.76 (0.91)	-0.75 (2.09)	2.94 (1.11)**
Time (years)	-0.75 (0.18)***	-0.65 (0.28)*	-0.85 (0.24)***
Men	-0.83 (0.81)	-	-
Not Partnered time-varying	0.21 (0.50)	1.60 (1.62)	0.15 (0.52)
Baseline Non-Tertiary Study	0.17 (0.65)	-0.38 (1.66)	0.40 (0.71)
Baseline Tertiary Study	0.06 (1.12)	2.26 (2.64)	-0.59 (1.26)
Baseline Age (years) ^a	-0.07 (0.08)	0.17 (0.15)	-0.19 (0.10)*
Non-Drinker time-varying	-0.90 (0.51)	0.31 (1.54)	-1.04 (0.54)
Risk/High Drinker time-varying	-1.30 (1.05)	-3.10 (2.09)	-0.56 (1.22)
Former Smoker time-varying	-1.14 (0.53)*	-2.41 (1.36)	-0.94 (0.58)
Current Smoker time-varying	-0.62 (1.03)	0.53 (2.47)	-1.10 (1.15)
Mental health lagged	-1.94 (0.23)***	-1.48 (0.54)**	-2.04 (0.25)***
Random Effects			
Intercept	347.48 (9.61)***	428.62 (27.34)***	331.92 (11.24)***
Residual	238.65 (5.72)***	237.57 (8.62)***	241.46 (7.84)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Mental health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

p* < .05; *p* < .01; ****p* < .001

The mean estimated initial change score was 1.76 (an improvement in bodily pain score from baseline to time 1). The statistically significant predictors of change were time, smoking, and prior mental health. Less improvement in bodily pain score was observed for former smokers, and those with higher prior mental health scores. The average change in bodily pain was a decrease of 0.75 points per annum.

For men, the mean estimated initial change score was -0.75 (a decrease in bodily pain score from baseline to time 1). The statistically significant predictors of change for men were time and prior mental health. The average change in bodily pain score for men was a decrease of 0.65 points per annum. Less improvement in bodily pain score was observed for men with higher prior mental health scores.

For women, the mean estimated initial change score was 2.94 and was significantly different between individuals. The statistically significant predictors of change for women were time, baseline age, and prior mental health. Less improvement in bodily pain score was observed for older women and those with higher prior mental health scores. There was a significant difference between men and women regarding the effect of baseline age ($t = 2.00$; $df = 2,308$; $P = 0.046$). The average change in bodily pain score for women was a decrease of 0.85 points per annum. A summary of these findings is provided below in Box 7.3.

Box 7.3. Key substantive findings from Model 1.3.

- Having higher prior mental health was associated with lower improvements in bodily pain for both men and women.

Model 1.4 – Testing lagged MHI-5 scores as a predictor of change in general health

Time-varying predictors included in this model were partner, drinking, and smoking status. The lagged predictor was mental health. Baseline covariates included were sex, education and age. The outcome variable was within-person change in general health score. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 7.4. Men and women were compared on predictor variables using independent *t* tests, the results of which are reported in the text.

Table 7.4. Parameter estimates from linear-mixed models testing lagged MHI-5 score as a predictor of change in general health score (Model 1.4).

	Total Sample (<i>N</i> =15,976)	Men (<i>N</i> =2,309)	Women (<i>N</i> =13,667)
	β (<i>SE</i>)	β (<i>SE</i>)	β (<i>SE</i>)
Fixed Effects			
Intercept	1.35 (0.64)*	1.05 (1.62)	1.94 (0.78)*
Time (years)	-0.64 (0.13)***	-0.51 (0.20)**	-0.81 (0.16)**
Men	0.01 (0.58)	-	-
Not Partnered time-varying	0.94 (0.35)**	1.63 (1.24)	0.88 (0.37)*
Baseline Non-Tertiary Study	-0.28 (0.46)	-0.75 (1.32)	-0.17 (0.50)
Baseline Tertiary Study	-0.05 (0.79)	0.06 (2.07)	-0.12 (0.87)
Baseline Age (years) ^a	-0.10 (0.06)	-0.05 (0.12)	-0.12 (0.07)
Non-Drinker time-varying	-0.24 (0.36)	-3.43 (1.14)**	0.16 (0.38)
Risk/High Drinker time-varying	-0.62 (0.74)	0.48 (1.50)	-0.94 (0.85)
Former Smoker time-varying	-0.62 (0.37)	-0.45 (1.03)	-0.60 (0.40)
Current Smoker time-varying	-1.25 (0.73)	1.36 (1.88)	-1.72 (0.80)*
Mental health lagged	-1.25 (0.16)***	-1.28 (0.40)**	-1.22 (0.18)***
Random Effects			
Intercept	176.00 (4.79)***	277.23 (17.60)***	164.06 (5.34)***
Residual	110.55 (2.73)***	113.87 (4.29)***	107.90 (3.60)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Mental health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

p* < .05; *p* < .01; ****p* < .001

The mean estimated initial change score was 1.35 (an improvement in general health score from baseline to time 1) and was significantly different between individuals. The statistically significant predictors of change were time, partner status, and prior mental health. Less improvement in general health score was observed for those with higher prior mental health scores. Greater increases in general health score were observed for un-partnered participants. The average change in general health was a decrease of 0.64 points per annum.

For men, the mean estimated initial change score was 1.05. The statistically significant predictors of change for men were time, drinking status and prior mental health. The average change in general health score for men was a decrease of 0.51 points per annum. Less improvement in general health score was observed for men with higher prior mental health scores and non-drinkers. There was a significant difference between men and women regarding the effect of being a non-drinker ($t = 2.99$; $df = 2,308$; $P = 0.00$).

For women, the mean estimated initial change score was 1.94 and was significantly different between individuals. The statistically significant predictors of change for women were time, partner status, smoking, and prior mental health. Less improvement in general health score was observed for current smokers and those with higher prior mental health scores. Greater increases in general health score were observed for un-partnered women. The average change in general health score for women was a decrease of 0.81 points per annum. A summary of these findings is provided below in Box 7.4.

Box 7.4. Key substantive findings from Model 1.4.

- Having higher prior mental health was associated with lower improvements in general health for both men and women.

Model 2.1 – Testing change in MHI-5 score as a predictor of change in physical function

Model 2.1 evaluated how change in mental health influences change in physical function score by including change in MHI-5 score. The model was adjusted using time-varying covariates: partner, drinking, and smoking status. Baseline covariates included were sex, education, age and MHI-5 score. The outcome variable was within-person change in physical function score. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 7.5. Men and women were compared on predictor variables using independent *t* tests, the results of which are reported in the text.

Table 7.5. Parameter estimates from linear-mixed models testing change in MHI-5 score as a predictor of change in physical function score (Model 2.1).

	Total Sample (<i>N</i> =15,976)	Men (<i>N</i> =2,309)	Women (<i>N</i> =13,667)
	β (<i>SE</i>)	β (<i>SE</i>)	β (<i>SE</i>)
Fixed Effects			
Intercept	0.92 (0.26)***	1.54 (0.77)*	0.95 (0.29)***
Time (years)	-0.94 (0.05)***	-0.43 (0.13)***	-1.06 (0.06)***
Men	0.26 (0.28)	-	-
Not Partnered time-varying	0.12 (0.19)	0.33 (0.70)	0.11 (0.20)
Baseline Non-Tertiary Study	0.05 (0.24)	-0.67 (0.63)	0.23 (0.26)
Baseline Tertiary Study	0.09 (0.43)	-0.23 (1.00)	0.00 (0.48)
Baseline Age (years) ^a	-0.14 (0.03)***	-0.15 (0.06)**	-0.14 (0.03)***
Non-Drinker time-varying	-0.32 (0.21)	-1.70 (0.79)*	-0.16 (0.21)
Risk/High Drinker time-varying	-0.68 (0.45)	-2.06 (1.05)*	-0.25 (0.49)
Former Smoker time-varying	0.03 (0.21)	0.23 (0.60)	-0.12 (0.22)
Current Smoker time-varying	-0.70 (0.38)	-3.04 (1.08)**	-0.15 (0.40)
Mental health within-person change	4.16 (0.15)***	5.71 (0.38)***	3.77 (0.16)***
Mental health baseline	0.18 (0.10)	-0.53 (0.32)	0.30 (0.10)**
Random Effects			
Intercept	32.93 (1.19)***	71.82 (4.23)***	23.40 (1.21)***
Residual	153.98 (1.64)***	178.09 (4.42)***	149.54 (1.77)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Mental health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

p* < .05; *p* < .01; ****p* < .001

The mean estimated initial change in physical function score was 0.92 (an improvement from baseline to time 1), and was significantly different between individuals. There was a significant time effect with physical function scores decreasing over time. The statistically significant predictors of change were baseline age and mental health within-person change score. Less improvement in physical function score was observed for older adults. Greater increases in physical function score were observed for participants who experience greater change in their mental health score. For example, a one standard deviation increase in mental health score is associated with a 4.16 increase in physical function score.

Men reported initial increase of 1.54 in physical function scores, which decreased by 0.43 points per annum. Women also reported an initial increase of 0.95 in physical function scores, and decreased by 1.06 points per annum. The time effect was significantly different between men and women ($t = 4.40$; $df = 2,308$; $P < 0.000$). A small, non-substantive but significant age effect was shown for both sexes, with older men and women improving less in physical function score.

For men, being a non-drinker, a risky drinker or a current smoker was associated with less improvement in physical function score. The effect of being a current smoker was significantly different between men and women ($t = 2.51$; $df = 2,308$; $P < 0.01$).

Mental health change scores were associated with greater increases in physical function score for both sexes. The effect for mental health was significantly greater for men ($t = 4.71$; $df = 2,308$; $P < 0.000$). A summary of these findings is provided below in Box 7.5.

Box 7.5. Key substantive findings from Model 2.1.

- Experiencing greater positive change in mental health was associated with greater improvements in physical function for both men and women. This effect was greater for men.

Model 2.2 – Testing change in MHI-5 scores as a predictor of change in role physical

Model 2.2 evaluated how change in mental health influences change in role physical score by including change in MHI-5 score. The model was adjusted using time-varying covariates: partner, drinking, and smoking status. Baseline covariates included were sex, education, age and MHI-5 score. The outcome variable was within-person change in role physical score. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 7.6. Men and women were compared on predictor variables using independent *t* tests, the results of which are reported in the text.

Table 7.6. Parameter estimates from linear-mixed models testing change in MHI-5 score as a predictor of change in role physical score (Model 2.2).

	Total Sample (<i>N</i> =15,976)	Men (<i>N</i> =2,309)	Women (<i>N</i> =13,667)
	β (<i>SE</i>)	β (<i>SE</i>)	β (<i>SE</i>)
Fixed Effects			
Intercept	0.93 (0.56)	2.24 (1.49)	1.11 (0.64)
Time (years)	-1.49 (0.11)***	-0.79 (0.27)**	-1.64 (0.12)***
Men	1.22 (0.60)*	-	-
Not Partnered time-varying	0.54 (0.41)	-0.12 (1.37)	0.71 (0.42)
Baseline Non-Tertiary Study	-1.03 (0.51)*	-1.68 (1.21)	-0.81 (0.56)
Baseline Tertiary Study	-0.73 (0.89)	-1.29 (1.92)	-0.76 (1.03)
Baseline Age (years) ^a	-0.12 (0.06)*	-0.06 (0.11)	-0.16 (0.07)*
Non-Drinker time-varying	-0.34 (0.44)	-3.75 (1.55)*	0.13 (0.45)
Risk/High Drinker time-varying	-1.52 (0.95)	-5.95 (2.08)**	0.08 (1.07)
Former Smoker time-varying	-0.16 (0.44)	-0.10 (1.17)	-0.26 (0.47)
Current Smoker time-varying	-1.64 (0.81)*	-0.60 (2.11)	-1.94 (0.87)*
Mental health within-person change	10.02 (0.32)***	12.25 (0.77)***	9.46 (0.35)***
Mental health baseline	-0.25 (0.21)	-0.86 (0.61)	-0.17 (0.22)
Random Effects			
Intercept	134.43 (5.29)***	230.88 (14.95)***	106.82 (5.73)***
Residual	700.20 (7.48)***	725.90 (17.88)***	700.23 (8.36)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Mental health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

p* < .05; *p* < .01; ****p* < .001

The mean estimated initial change in role physical score was 0.93 (an improvement from baseline to time 1), and there was a significant time effect with role physical scores decreasing over time.

The statistically significant predictors of change were sex, education, baseline age, smoking status and mental health within-person change score.

Less improvement in role physical score was observed for older adults, current smokers and those who had completed non-tertiary study.

Greater increases in role physical score were observed for men and participants who experience greater change in their mental health score. For example, a one standard deviation increase in mental health score is associated with a 10.02 increase in role physical score.

Men reported initial increases in role physical scores, which decreased by 0.79 points per annum. Women also reported initial increases in role physical scores, and decreased by 1.64 points per annum. The time effect was significantly different between men and women ($t = 2.88$; $df = 2,308$; $P = 0.004$).

For men, being a non-drinker or a risky drinker was associated with less improvement in role physical score. For women, being a current smoker was associated with less improvement in role physical score. A small, non-substantive but significant age effect was shown for women, with older women improving less in role physical score.

The effect of drinking status was significantly different between men and women: non-drinker ($t = 2.40$; $df = 2,308$; $P = 0.016$); risky-drinker ($t = 2.58$; $df = 2,308$; $P = 0.01$).

Mental health change scores were associated with greater increases in role physical score for both sexes. The effect for mental health was significantly greater for men ($t = 3.30$; $df = 2,308$; $P = 0.001$). A summary of these findings is provided below in Box 7.6.

Box 7.6. Key substantive findings from Model 2.2.

- Experiencing greater positive change in mental health was associated with greater improvements in role physical score for both men and women. This effect was greater for men.

Model 2.3 – Testing change in MHI-5 scores as a predictor of change in bodily pain

Model 2.3 evaluated how change in mental health influences change in bodily pain score by including change in MHI-5 score. The model was adjusted using time-varying covariates: partner, drinking, and smoking status. Baseline covariates included were sex, education, age and MHI-5 score. The outcome variable was within-person change in bodily pain score. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 7.7. Men and women were compared on predictor variables using independent *t* tests, the results of which are reported in the text.

Table 7.7. Parameter estimates from linear-mixed models testing change in MHI-5 score as a predictor of change in bodily pain score (Model 2.3).

	Total Sample (<i>N</i> =15,976)	Men (<i>N</i> =2,309)	Women (<i>N</i> =13,667)
	β (<i>SE</i>)	β (<i>SE</i>)	β (<i>SE</i>)
Fixed Effects			
Intercept	0.24 (0.31)	-0.18 (0.81)	0.61 (0.35)
Time (years)	-0.50 (0.06)***	-0.59 (0.14)***	-0.48 (0.07)***
Men	-0.24 (0.33)	-	-
Not Partnered time-varying	0.08 (0.23)	0.77 (0.74)	0.06 (0.23)
Baseline Non-Tertiary Study	0.02 (0.28)	-0.12 (0.66)	0.08 (0.31)
Baseline Tertiary Study	-0.17 (0.50)	0.58 (1.07)	-0.52 (0.57)
Baseline Age (years) ^a	0.00 (0.03)	0.06 (0.06)	-0.06 (0.04)
Non-Drinker time-varying	-0.24 (0.24)	1.01 (0.83)	-0.32 (0.25)
Risk/High Drinker time-varying	-0.72 (0.52)	-2.69 (1.12)*	-0.03 (0.59)
Former Smoker time-varying	-0.31 (0.24)	-0.68 (0.64)	-0.27 (0.26)
Current Smoker time-varying	-0.13 (0.45)	0.31 (1.15)	-0.28 (0.48)
Mental health within-person change	5.34 (0.17)***	7.78 (0.41)***	4.71 (0.19)***
Mental health baseline	-0.20 (0.12)	-0.35 (0.34)	-0.20 (0.12)
Random Effects			
Intercept	42.79 (1.66)***	76.86 (4.68)***	32.71 (1.80)***
Residual	217.37 (2.30)***	213.83 (5.20)***	219.88 (2.60)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Mental health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

p* < .05; *p* < .01; ****p* < .001

The mean estimated initial change in bodily pain score was 0.24 (an improvement from baseline to time 1), and there was a significant time effect with bodily pain scores decreasing over time.

The only statistically significant predictor of change was mental health within-person change score. Greater increases in bodily pain score were observed for participants who experience greater change in their mental health score. For example, a one standard deviation increase in mental health score is associated with a 5.34 increase in bodily pain score, an improvement.

Men reported decreases in bodily pain scores, which further decreased by 0.59 points per annum. Women reported increases in bodily pain scores, and decreased by 0.48 points per annum. For men, being a risky drinker was associated with less improvement in bodily pain score. The effect of being a risky drinker was significantly different between men and women ($t = 2.10$; $df = 2,308$; $P = 0.04$).

Mental health change scores were associated with greater increases in bodily pain scores for both sexes. The effect for mental health was significantly greater for men ($t = 6.79$; $df = 2,308$; $P < 0.00$). A summary of these findings is provided below in Box 7.7.

Box 7.7. Key substantive findings from Model 2.3.

- Experiencing greater change in mental health was associated with greater improvements in bodily pain score for both men and women. This effect was greater for men.

Model 2.4 – Testing change in MHI-5 scores as a predictor of change in general health

Model 2.4 evaluated how change in mental health influences change in general health score by including change in MHI-5 score. The model was adjusted using time-varying covariates: partner, drinking, and smoking status. Baseline covariates included were sex, education, age and MHI-5 score. The outcome variable was within-person change in general health score. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences. The results are illustrated in Table 7.8. Men and women were compared on predictor variables using independent *t* tests, the results of which are reported in the text.

Table 7.8. Parameter estimates from linear-mixed models testing change in MHI-5 score as a predictor of change in general health score (Model 2.4).

	Total Sample (<i>N</i> =15,976)	Men (<i>N</i> =2,309)	Women (<i>N</i> =13,667)
	β (<i>SE</i>)	β (<i>SE</i>)	β (<i>SE</i>)
Fixed Effects			
Intercept	0.13 (0.21)	0.20 (0.59)	0.11 (0.24)
Time (years)	-0.35 (0.04)***	-0.20 (0.11)	-0.37 (0.05)***
Men	-0.04 (0.23)	-	-
Not Partnered time-varying	0.34 (0.15)*	0.68 (0.54)	0.30 (0.16)
Baseline Non-Tertiary Study	-0.20 (0.19)	-0.35 (0.48)	-0.16 (0.21)
Baseline Tertiary Study	-0.30 (0.34)	-0.23 (0.77)	-0.35 (0.39)
Baseline Age (years) ^a	-0.02 (0.02)	-0.02 (0.04)	-0.01 (0.03)
Non-Drinker time-varying	-0.13 (0.17)	-1.61 (0.61)**	0.04 (0.17)
Risk/High Drinker time-varying	-0.46 (0.36)	-0.86 (0.81)	-0.35 (0.40)
Former Smoker time-varying	-0.18 (0.17)	-0.02 (0.46)	-0.21 (0.18)
Current Smoker time-varying	-0.28 (0.30)	0.33 (0.84)	-0.38 (0.32)
Mental health within-person change	5.37 (0.12)***	6.97 (0.30)***	4.96 (0.13)***
Mental health baseline	0.12 (0.08)	-0.28 (0.24)	0.17 (0.08)*
Random Effects			
Intercept	19.83 (0.78)***	38.63 (2.48)***	15.10 (0.82)***
Residual	100.49 (1.08)***	110.87 (2.75)***	98.74 (1.18)***

Notes: Reference group for each variable: Women, partnered, secondary school or less, low risk drinker, never smoker.

Mental health scores were mean centred and transformed into z-scores to ease interpretation of results.

^aAge (years) baseline is centred to 65 years.

p* < .05; *p* < .01; ****p* < .001

The mean estimated initial change in general health score was 0.13 (an improvement from baseline to time 1), and there was a significant time effect with general health scores decreasing over time.

The statistically significant predictors of change were partner status and mental health within-person change score.

Greater increases in general health score were observed for non-partnered participants and those who experience greater change in their mental health score. For example, a one standard deviation increase in mental health score is associated with a 5.37 increase in general health score.

Men reported increases in general health scores. Women also reported increases in general health scores, and decreased by 0.37 points per annum.

For men, being a non-drinker was associated with less improvement in general health score. This effect was significantly different between men and women ($t = 2.61$; $df = 2,308$; $P = 0.009$).

Mental health change scores were associated with greater increases in general health score for both sexes. The effect for mental health was significantly greater for men ($t = 6.15$; $df = 2,308$; $P < 0.000$). A summary of these findings is provided in Box 7.8.

Box 7.8. Key substantive findings from Model 2.4.

- Experiencing greater change in mental health was associated with greater improvements in general health score for both men and women. This effect was greater for men.

7.3.2 Summary of results

Having higher prior mental health were consistently associated with lower improvements in physical health. Experiencing greater change in mental health was also consistently associated with greater improvements in physical health scores. This effect was greater for men. The effect of time was also more pronounced for women on physical function and role physical outcomes, with scores decreasing more for women per year in the study. A full discussion of these results is presented in Chapter 9. The next chapter will report on the results of the analysis of the impact of physical health on depression.

Chapter 8

STUDY 2.4: INVESTIGATION INTO THE IMPACT OF PHYSICAL HEALTH ON DEPRESSION

8.1 Introduction

Physical health status is an integral component of successful ageing, and is often used as the only component in representations of successful ageing. The influence of mental health status is a less researched, but important part of ageing well. The relationship between mental and physical health is complex. This chapter will further investigate how mental health relates to physical health in the context of influencing ageing well. This chapter will use depression as an indicator of mental health. The chapter will firstly discuss depression, focussing on a discussion of sex differences and past research. The data analysis will examine the association between physical health and depression in community dwelling older adults, including looking in detail at the differences between men and women. The chapter concludes with a full discussion of the results in the context of the current research literature.

Across the lifespan, depression is a major public health problem and makes a sizable contribution to the burden of disease. The World Health Organization reported depression to be the third leading cause of global disease burden, after lower respiratory infections and diarrhoeal diseases (World Health Organization, 2008). Depression is projected to be the leading cause of global burden of disease by 2030 (World Health Organization, 2008). Major depressive disorder was among the top ten causes of years lived with disability (YLDs) in all of the 188 countries investigated between 1990 and 2013 by the Global Burden of Disease Study (Global Burden of Disease Study 2013 Collaborators, 2015).

The total global disease burden for lower respiratory infections and diarrhoeal diseases is similar in magnitude for both men and women. However, there is a substantial sex difference for depression. Depression is the leading cause of burden for women in all countries, regardless of economic status. Additionally, while depression is the leading cause for both men and women in middle- and high-income countries, the burden of depression is 50% higher for women than men (World Health Organization, 2008). Other gender differences in

neuropsychiatric disorders include women having higher burden of disease from anxiety disorders, dementia and migraines. Additionally, the male burden for substance and alcohol use disorders is approximately seven times higher than that for women. These disorders will not be explored in the current research.

The research literature shows that women report higher levels of depression throughout most of adulthood. However, the research into depression prevalence in older age is inconsistent. Some researchers have reported that there are no sex differences in older age (D. R. Brown, Milburn, & Gary, 1992; Pachana, McLaughlin, Leung, Byrne, & Dobson, 2012; Pirkis et al., 2009; Segal, Coolidge, Cahill, & O'Riley, 2008; Van't Veer-Tazelaar et al., 2008), while others found that women continue to have higher prevalence in older adulthood (Anstey, von Sanden, Sargent-Cox, & Luszcz, 2007; Katsumata et al., 2005; Osborn et al., 2002; Regan, Kearney, Savva, Cronin, & Kenny, 2013; Suen & Morris, 2006; Trollor, Anderson, Sachdev, Brodaty, & Andrews, 2007; Zunzunegui et al., 2007). Girgus and Yang (2015) suggest that it is not possible to infer what is responsible for this inconsistency in the research literature, but they suggest it may be due to “sample sizes, demographic characteristics, countries of origin, and measures of depression varied from study to study” (p. 54). However, in their systematic review and meta-analysis of the prevalence of depression in older people, Luppá et al. (2012) conclusively reported that across the literature, women were more at risk of depression than men were.

Burns and colleagues (2012) reported on cross-sectional prevalence estimates for probable depressionⁱ in older people in the DYNOPTA dataset. The authors also compared their findings to those reported in the 1997 and 2007 National Surveys of Mental Health and Wellbeing (NSMHWB) (Australian Bureau of Statistics, 1997, 2007). The authors suggest that the use of the DYNOPTA dataset eliminates a number of previous criticisms related to methodological weaknesses in the NSHWB data. Specifically:

ⁱProbable depression is a measure used to identify respondents who are likely to have depression. How the measure was created is discussed in detail in Chapter 4.

the greater number of DYNOPTA participants, which increases the representation of older participants and which includes participants in age groups that are not sampled in the national surveys. (Burns, Butterworth, et al., 2012, p. 508)

For example, the NSMHWB did not sample adults aged 84 years of age and over. Whereas the 2007 survey reported prevalence across separate age groups, the 1997 survey aggregated the results from all participants aged over 74. Consequently, there are differences in the results, with DYNOPTA reporting substantially higher prevalence of depression.

Burns, Butterworth, et al. (2012) found that, overall, women were more likely to report higher levels of probable depression. However, in men aged 85 years and older, proportions of probable prevalence appeared substantially higher than in their female peers but the difference did not reach statistical significance. The 1997 NSMHWB survey indicated women were more likely to report depression; however, this was not statistically significant. The 2007 survey did not show sex differences. Burns and colleagues (2012) recommended further longitudinal analytic research be conducted to fully explore sex differences in depression in older adults. The researchers also found no evidence for change in the likelihood of depression with increasing age in either DYNOPTA or the 1997 NSMHWB data. However, in the 2007 NSMHWB data there was a significant quadratic effect indicating a greater decline in the rate of change in likelihood of depression with increasing age.

There is significant debate around the association of age with depression in older adults (Burns, Butterworth, et al., 2012; Street, O'Connor, & Robinson, 2007). While past research has suggested the prevalence of depression decreases with age, Jorm's (2000) review of the literature concluded that "there is no clear answer" (p. 20) as to whether older age is associated with reduced risk of depression. When particular risk factors were controlled for, age was associated with less depression, but Jorm argued that there was insufficient evidence to say whether this was due to age or cohort effects. Burns, Butterworth, et al. (2013) reason that while the larger epidemiological studies show similar results, there are a number of methodological issues. For example, a number of estimates are from cross-sectional studies, or only sample a small number of older people. Burns, Butterworth, et al. (2012) also argue that "inconsistency in the reports of late-life depression prevalence in previous

epidemiological studies may be explained by either the exclusion and/or limited sampling of the oldest old” (p. 503).

Additionally, in all studies lower prevalence of depression in older study participants could be due to selection and survival effects. In a study that addressed these limitations by using a large longitudinal dataset, Anstey et al. (2007) found older participants had a greater increase over time in depressive symptoms relative to younger participants in both community and residential care populations. Similarly, in their study of trajectories of late-life depression over a 13- year period, Burns, Butterworth, et al. (2013) found that older adults reported lower likelihood of probable depression, but this occurred in the context of reporting increasing levels of depressive symptomology as they aged. Luppá et al. (2012) reported inconsistent results across the literature. Studies showed:

an increase or decrease of prevalence rates with increasing age, whereas, however, the majority of studies showed an increase beyond the age of 85 years for women. (Luppá et al., 2012, p. 218)

Studies report a wide range of variation in the prevalence of depression in older people. Luppá et al. (2012), reported that the prevalence of major depression in people aged 75 years and older ranged from 4.6% to 9.3%, and that of depressive disorders from 4.5% to 37.4%. Pooled prevalence was 7.2% (95% CI 4.4–10.6%) for major depression and 17.1% (95% CI 9.7–26.1%) for depressive disorders. Pirkis et al. (2009) reported approximately 8% of their large older Australian sample experienced depression, which is a similar proportion to amongst middle-aged Australians (Burns, Butterworth, et al., 2012). Regardless of the variability in reported prevalence rates, the overall evidence suggests that a substantial proportion of older people experience clinically significant depression, making it a major public health problem.

Depression has been associated with decreased quality of life, increased risk of morbidity, mortality and suicide, and impairment in role functioning (Adamson, Price, Breeze, Bulpitt, & Fletcher, 2005; Blazer, 2003; Blazer & Hybels, 2005; Blazer, Hybels, & Pieper, 2001;

Braam et al., 2005; Grek, 2007). The prognosis of depression in older people is poor, with a meta-analysis of outcomes at 24 months estimating that 33% of subjects were well, 33% were depressed, and 21% had died (M. G. Cole, Bellavance, & Mansour, 1999).

Depression appears to exacerbate comorbid health conditions commonly experienced in older age, which leads to increased healthcare expenditure (Choi, Lee, Matejkowski, & Baek, 2014). The majority of research tends to focus on the association of depression with chronic diseases, such as lung disease, arthritis, cancer and cardiac disease (Bisschop, Kriegsman, Deeg, Beekman, & van Tilburg, 2004; Shen et al., 2011), stroke and heart attack (Mojtabai & Olfson, 2004) and hospital inpatients generally (McCusker et al., 2007) and post-injury patients (Thombs et al., 2007). These samples do not reflect the general older population, and assess physical health simply in terms of “diseased” or “not diseased”. The current study instead uses four separate validated summary scales that capture a range of dimensions of physical health. Similarly, Street et al. (2007), in a small convenience sample of 187 older adults, found that poorer SF-12 physical health scores were cross-sectionally associated with higher depression scores. The conclusions that can be drawn from these studies are limited by methodological issues including small sample sizes, large age ranges, and the use of cross-sectional data (see, for example, Di Benedetto et al. (2013)).

8.1.1 Longitudinal research

While there is much research into depression in samples of older clinical patient populations of those with chronic physical illnesses, fewer studies longitudinally investigate large, representative samples of community living older people. Longitudinal research with measurements taken at multiple points in time is an essential tool to aid a greater understanding of depression and ageing in general. Longitudinal research allows researchers to control for initial levels of depression, and therefore determine the variables associated with change in depressive status. In cross-sectional research, it is only possible to determine which factors occur concurrently with depression.

There are a small number of longitudinal studies that have investigated the association between physical health and depression in community populations. Koster et al. (2006) reporting results from the Longitudinal Aging Study Amsterdam (LASA) found that low socioeconomic status predicted the incidence of depression (measured with the CES-D), and 7% of this association was explained by physical health status (chronic illness and physical function). This study was longitudinal (three waves over nine years) and had a reasonably large sample size of 2593 participants. Geerlings, Beekman, Deeg, and Van Tilburg (2000) studied a smaller sample of 652 LASA participants for eight waves over three years and found that chronic depression was predicted by physical health. Physical health was measured using number of chronic diseases (pathology), functional limitations and limited activities due to health problems.

Achat and colleagues (2000) investigated how prior depression and optimism predicted future physical health functioning in 659 men. The authors reported that while prior optimism was not associated with the preservation of physical functioning or completing work or other daily activities as a result of physical health, it was associated with general health perceptions and bodily pain scores, which they argued are more measures of psychological well-being. Prior depression was associated with reduced functioning across all SF-36 domains.

Again, in a reasonably small and homogenous sample of 351 older veterans and their families, Cho et al. (2010) found that prior depression was associated with adverse effects on physical health. The study involved psychiatric interviews and assessment of depressive symptom severity, sleep quality, chronic medical illness and health functioning at baseline and three follow-up visits over two years. The authors measured both objective and subjective physical health, both of which deteriorated more rapidly for participants with a history of depression, regardless of current depressive symptoms. The authors reported these participants experienced a clinically meaningful deterioration in physical health functioning. They argue that although their findings support the notion of depression leading to physical health decline, they do not discount a bidirectional relationship:

although the relationship between depression and physical health is likely to be bidirectional, our study supports the notion of depression leading to physical health

decline rather than the inverse directionality in community-dwelling older adults.
(Cho et al., 2010, p. 8)

Although older people are more likely to experience poorer physical health, and physical health issues are associated with depression, it should also be noted that there is also evidence showing that older people experiencing poor physical health do not necessarily become depressed (Street et al., 2007). A number of these researchers call for more research to explain the complex interplay between depression and physical health (Burns, Butterworth, et al., 2013). Given that not all older people develop depression, it is important to further understand risk and protective factors to inform interventions for those facing physical health decline and other challenges associated with ageing. In their systematic review and meta-analyses, M. G. Cole and Dendukuri (2003) documented risk factors for depression among elderly community subjects. The authors identified the significant risk factors were bereavement, sleep disturbance, disability, prior depression, and female gender. However, it should be noted that while the authors did review longitudinal studies, they only looked at two time points of data, baseline and follow-up.

As highlighted in Chapters 1 and 3, a significant proportion of older people experience depression. Good mental health is an important component of successful ageing, but is somewhat neglected in the literature. In order to address some of the limitations of the previous literature, not only on successful ageing, but also on the impact of physical health (and other factors – sociodemographic, lifestyle behaviours) on depression, the current study examines findings from a large representative study of older Australians aged 65 years and older at baseline who were observed longitudinally.

Therefore, the primary aim of this study is to describe the association between physical health and depression in a representative sample of adults aged 65 years and above. This will contribute meaningfully to the literature on depression, as unlike previous studies, this work will report longitudinal data collected on up to five occasions. Further, the analyses will adjust for a wide range of control variables that have previously been shown to be associated with depression and/or physical health and have been hypothesised to be explanatory of the

relationship. These control variables include sociodemographics and lifestyle behaviours. Importantly, the outcomes for men and women will be examined separately as previous research has identified different gender trajectories in mental health in older people (Burns, Luszcz, et al., 2013).

Specifically, this study aims to identify:

- i) Which baseline physical health factors are associated with depression over time.
- ii) Which time-varying physical health factors are associated with depression over time.
- iii) How prior physical health influences future depression.
- iv) Which prior physical health factors predict change in depression status.
- v) How change in physical health predicts change in depression status.

This study will measure depression using a binary outcome variable, and change in depression status as a categorical outcome variable, rather than using the continuous general mental health variable, the MHI-5, studied in the previous chapters. This is done with the purpose of investigating only depression, rather than general mental health, as an outcome. Depression is a common and highly costly condition that is deserving of focus and thorough investigation. The work applies a different modelling technique to investigate depression in older people. To examine whether these effects are consistent between men and women, the study analyses will be conducted separately for men and women to identify any significant sex differences. To address the methodological challenges of longitudinal research in this field, the effects of sample attrition and missing data will be minimised using generalized modelling techniques.

8.2 Method

The general methodology for the DYNOPTA dataset was presented in Chapter 4 (p. 105). The following sections entail a description of the specific statistical analyses for the current study.

8.2.1 Statistical analyses

Generalized Estimating Equations (GEE) were used to evaluate the relationship between physical health predictors and probable depression as the outcome variable in this case is multinomial. The GEE Models 1-3 were conducted in IBM SPSS Statistics 22 and specified an unstructured working correlation matrix. As the outcome variable for the first three models was binary, analysis of probable depression utilised a logistic distribution with a logit link function. For Models 4 and 5 the outcome variable was categorical, hence analysis of probable depression utilised multinomial logistic regression and was conducted using Stata version 11 (Stata Corp., College Station, TX, USA) with clustered standard errors owing to repeated observations.

To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women. Significance levels at $p < .05$ (*), $p < .01$ (**), and $p < .001$ (***) are reported.

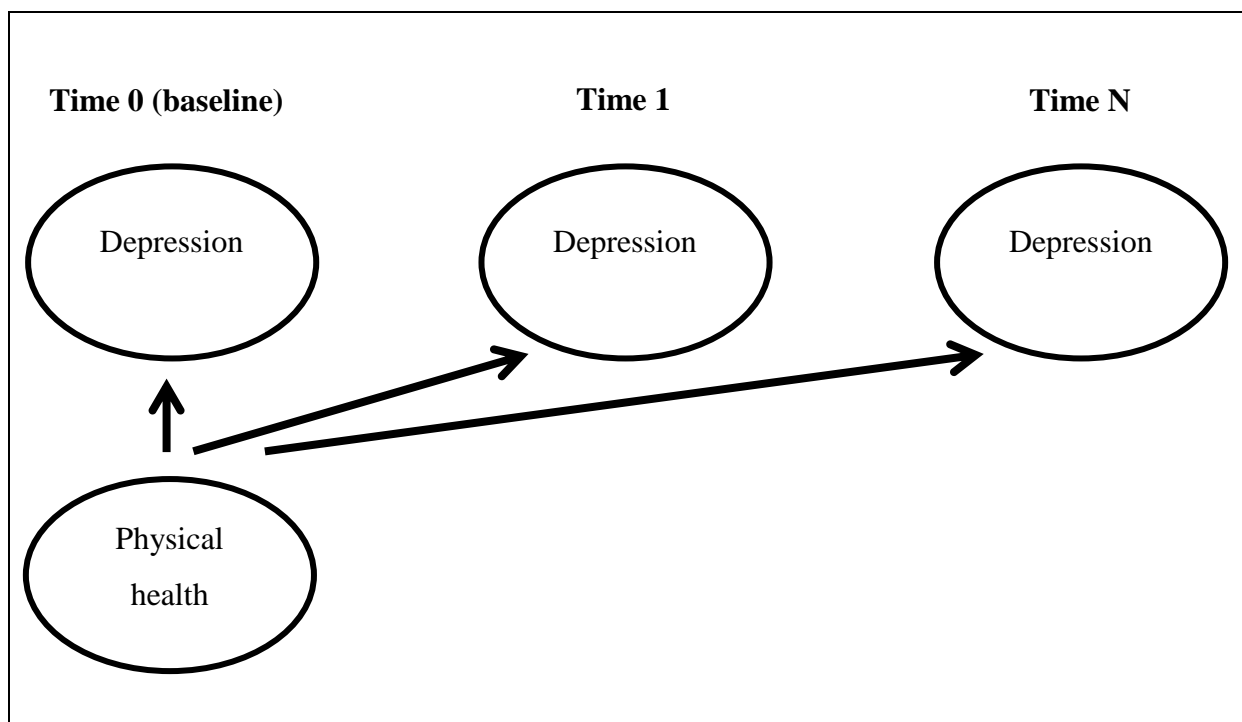
To address the study's objectives five models were assessed. The first three models were built in the sequence: Model 1) baseline physical health variables; Model 2) time-varying physical health variables; and Model 3) lagged physical health variables. Analyses were stratified by sex. Outcomes are reported as odds ratios (OR) with 95% confidence intervals (CI).

Models 4 and 5 investigated change in depression status. Model 4 included lagged physical health variables. Model 5 included change in physical health. This process was followed for men and women separately. Outcomes are reported as relative risk ratios (RRR) with 95% confidence intervals (CI).

Model 1. Testing baseline physical health predictors of probable depression

To evaluate the baseline physical health predictors of probable depression over time, Model 1 was adjusted for baseline sociodemographics factors: sex, baseline partner status, education, age (centred at 65 years). Baseline life-style behaviours were drinking and smoking status. The baseline physical health variables included were physical function, role-physical, bodily pain, and general health scores. See Figure 8.1 for a graphical representation of Model 1.

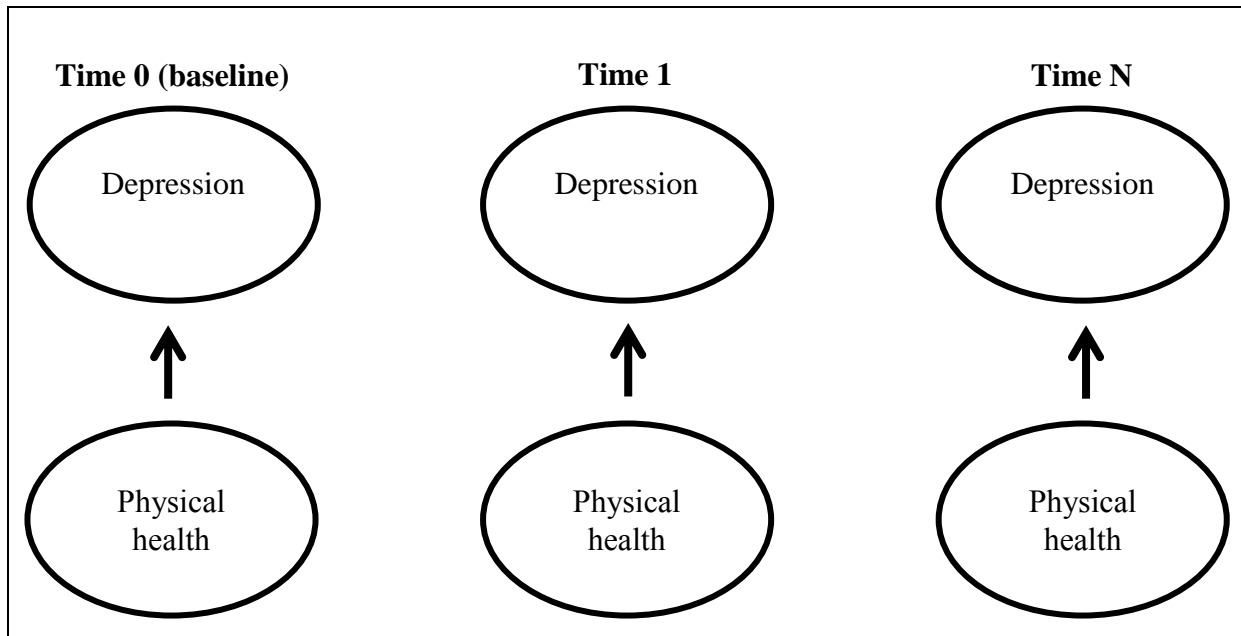
Figure 8.1. Model 1. Which physical health factors are associated with depression over time?



Model 2. Testing time-varying physical health predictors of probable depression

To evaluate the time-varying physical health predictors of probable depression, Model 2 included time-varying physical function, role-physical, bodily pain, and general health scores. The model was adjusted for time-varying partner, drinking, and smoking status and fixed control variables, namely baseline sex, education and age. See Figure 8.2 for a graphical representation of Model 2.

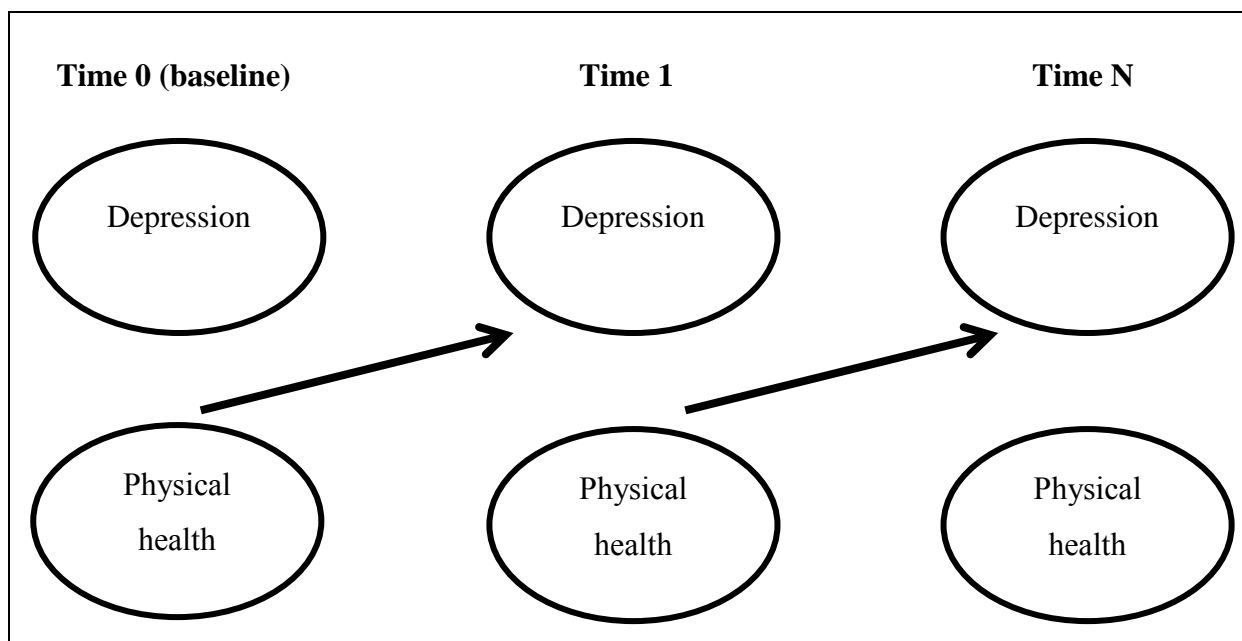
Figure 8.2. Model 2. Which time-varying physical health factors are associated with depression over time?



Model 3. Testing lagged physical health predictors of probable depression

Model 3 documented how prior physical health influences future probable depression by including lagged physical health predictors: physical function, role-physical, bodily pain, and general health. The model was adjusted using time-varying control variables (partner, drinking, and smoking status) and fixed control variables (sex, education and age at baseline). See Figure 8.3 for a graphical representation of Model 3.

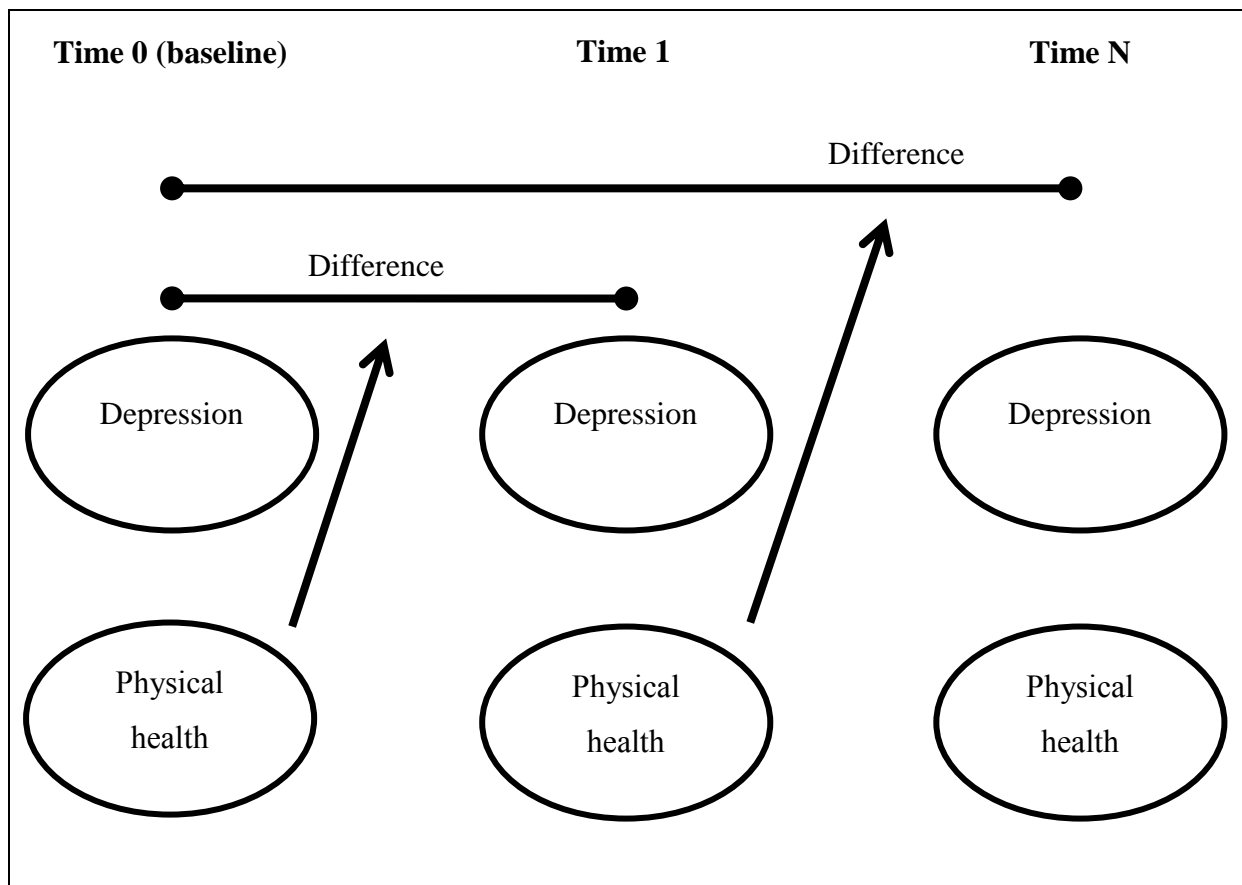
Figure 8.3. Model 3. Does prior physical health influence future depression?



Model 4. Testing lagged physical health predictors of change in probable depression status

A fourth model evaluated change in probable depression status and included the following lagged physical health predictors: physical function, role-physical, bodily pain, and general health. The model was adjusted using time-varying control variables (partner, drinking, and smoking status) and baseline control variables (sex, education and age). Within-person change in depression status was calculated by comparing participants' depressive status to their depressive status at the previous wave. See Figure 8.4 for a graphical representation of Model 4.

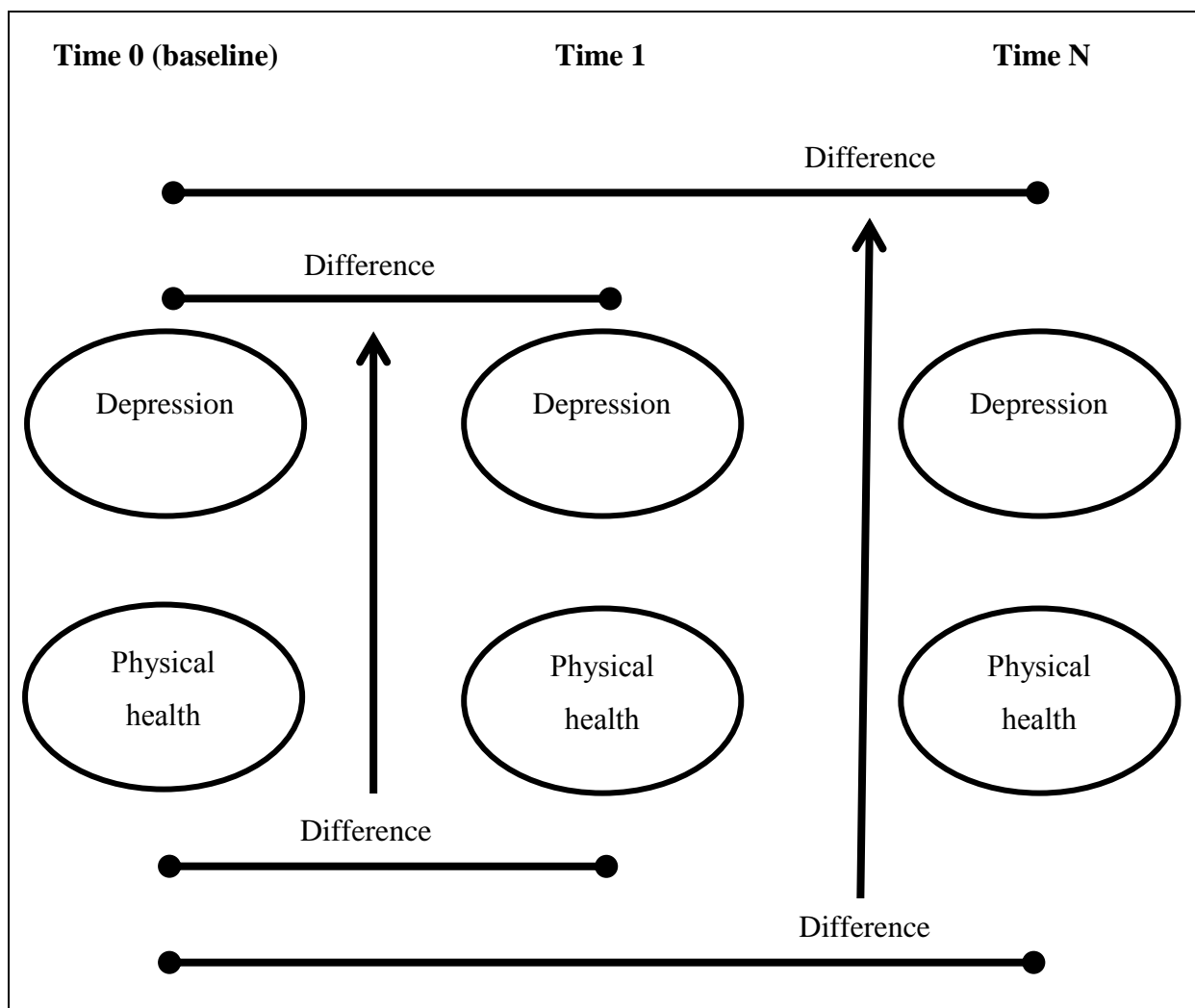
Figure 8.4 Model 4. How prior physical health influences change in depression status.



Model 5. Testing change in physical health predictors of change in probable depression status

Model 5 evaluated how change in physical health influences change in depression status by including change in physical function, role-physical, bodily pain, and general health. The model was adjusted using time-varying control variables: partner, drinking, and smoking status. Baseline covariates included were sex, education and age. Within-person change in depression status was calculated by comparing participants' depressive status to their depressive status at the previous wave. Within-person change in physical health scores were calculated by subtracting baseline scores from the score at the relevant wave. See Figure 8.5 for a graphical representation of Model 5.

Figure 8.5. Model 5. How change in physical health influences onset of depression.



8.3 Results

8.3.1 Modelling results

The following sections present the results from the five models. The results are presented for the whole sample and then repeated, split according to sex. For ease of interpretation sociodemographic and lifestyle behaviour effects will not be reported, as in this modelling they were used as control variables only; rather, this analyses will focus on physical health effects. Standardised results for the physical health variables will be reported in the text.

Model 1. Testing baseline physical health predictors of probable depression

Table 8.1 shows the results of time and multivariate adjusted generalized estimating equations for probable depression ($N=15,976$). Baseline covariates included were physical health scores. The model was adjusted for baseline sex, education, age, partner, drinking, and smoking status. The outcome variable was depression. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences in depression.

Table 8.1. Generalized estimating equation (GEE) results for baseline physical health predictors of probable depression according to sex (Model 1).

Variable	Whole sample				Men				Women			
	OR	<i>p</i>	95% Confidence Interval		OR	<i>p</i>	95% Confidence Interval		OR	<i>p</i>	95% Confidence Interval	
Time (years)	1.00	0.96	0.99	1.01	0.97	0.33	0.90	1.04	1.00	0.99	0.99	1.01
Age (years) baseline	0.98*	0.02	0.96	0.99	0.96*	0.02	0.93	0.99	0.98	0.11	0.96	1.00
SF-36 physical health scales baseline ^a												
Physical function	1.02	0.69	0.94	1.10	1.06	0.59	0.85	1.33	1.01	0.80	0.93	1.10
Role physical	1.24***	0.00	1.15	1.34	1.09	0.48	0.86	1.38	1.26***	0.00	1.16	1.37
Bodily pain	1.21***	0.00	1.12	1.31	1.34*	0.01	1.08	1.67	1.20***	0.00	1.10	1.31
General health	1.99***	0.00	1.85	2.13	2.18***	0.00	1.70	2.78	1.97***	0.00	1.83	2.12

^a Items are reverse scored so higher scores indicated poorer physical health. Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 8.1 shows the results for the whole sample and men and women separately. Increasing age at baseline was associated with decreased odds of probable depression. Participants with

higher baselineⁱⁱ role physical (OR=1.24), bodily pain (OR=1.21) and general health scores (OR=1.99) had increased odds of having probable depression.

For male participants increasing age at baseline was also associated with decreased odds (OR=0.96), while poorer baseline bodily pain (OR=1.34) and general health (OR=2.18) scores were associated with increased odds of probable depression.

For female participants having poorer baseline scores for role physical (OR=1.26), bodily pain (OR = 1.20) and general health (OR = 1.97) increased the odds of having depression.

Role physical was associated with depression for women, but not for men. The effects of bodily pain and general health were larger for men than for women. Additionally, women did not experience an age effect, while the likelihood of having depression for men decreased with age.

Box 8.1. Key substantive findings from Model 1.

- Having poorer role physical, bodily pain and general health at baseline was associated with increased likelihood of depression for both men and women.
- For men, poorer general health at baseline increased odds of depression.
- For women, poorer role physical, bodily pain and general health at baseline increased odds of depression.

ⁱⁱ Reversed so higher scores indicate poorer physical health.

Model 2. Testing time-varying physical health predictors of probable depression

Table 8.2 shows the results of time and multivariate adjusted generalized estimating equations for probable depression ($N=15,976$). Time-varying predictors included in this model were the physical health variables. The model was adjusted for time-varying partner, drinking, and smoking status, and baseline sex, education and age. The outcome variable was depression. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences in depression.

Table 8.2. Generalized estimating equation (GEE) results for time-varying predictors of probable depression (Model 2).

Variable	Whole sample				Men				Women			
	OR	<i>p</i>	95% Confidence Interval		OR	<i>P</i>	95% Confidence Interval		OR	<i>p</i>	95% Confidence Interval	
Time (years)	0.94***	0.00	0.91	0.98	0.99	0.84	0.91	1.08	0.93***	0.00	0.90	0.97
Age (years) baseline	0.96***	0.00	0.95	0.98	0.96*	0.01	0.93	0.99	0.97*	0.01	0.94	0.99
SF-36 physical health scales ^a												
Physical function	1.09*	0.04	1.01	1.18	1.24*	0.02	1.03	1.48	1.07	0.18	0.97	1.17
Role physical	1.25***	0.00	1.16	1.35	1.13	0.24	0.93	1.37	1.27***	0.00	1.17	1.39
Bodily pain	1.22***	0.00	1.13	1.32	1.32*	0.01	1.07	1.63	1.20***	0.00	1.10	1.31
General health	2.16***	0.00	2.00	2.32	2.02***	0.00	1.65	2.48	2.19***	0.00	2.02	2.37

^a Items are reverse scored so higher scores indicated poorer physical health. Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

* $p < .05$; ** $p < .01$; *** $p < .001$

In the overall sample, higher scoresⁱⁱⁱ for all the physical health variables increased the odds of depression (physical function OR = 1.09; role physical= 1.25; bodily pain OR = 1.22), with general health having the greatest impact (OR=2.16). The odds of having depression decreased with baseline age. The model also showed the odds of having depression declined by 6% for each year post baseline.

For men and women, the odds of having depression decreased similarly with baseline age (4% and 3% respectively). Among men, those with higher scores of physical function (OR=1.24), bodily pain (OR=1.32) and general health (OR=2.02) had increased likelihood of

ⁱⁱⁱ Reversed so higher scores indicate poorer physical health.

depression. Similarly, women with higher scores on role physical (OR=1.27), bodily pain (OR=1.20) and general health (OR=2.19) had increased odds of probable depression. The model showed decreased odds of depression for women with increasing time in the study (OR=0.93).

While men showed no effects for role physical, women showed no effects for physical function. The effect of bodily pain was more pronounced for men, and similarly the effect of general health was more pronounced for women. While age and time effects were observed for women, only a small age effect was observed for men.

Box 8.2. Key substantive findings from Model 2.

- Having poorer role physical, bodily pain and general health scores was associated with increased likelihood of depression for both men and women.
- For men, poorer physical function, bodily pain and general health increased odds of depression.
- For women, poorer role physical, bodily pain and general health increased odds of depression.

Model 3. Testing lagged physical health predictors of probable depression

Table 8.3 shows the results of time and multivariate adjusted generalized estimating equations for probable depression ($N=15,976$). Lagged predictors were physical function, role-physical, bodily pain, and general health. The model was adjusted for time-varying partner, drinking, and smoking status and baseline sex, education and age. The outcome variable was depression. To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences in depression.

Table 8.3. Generalized estimating equation (GEE) results for lagged physical health predictors of probable depression (Model 3).

Variable	Whole sample				Men				Women			
	OR	<i>p</i>	95% Confidence Interval		OR	<i>p</i>	95% Confidence Interval		OR	<i>p</i>	95% Confidence Interval	
Time (years)	1.05	0.25	0.97	1.14	1.06	0.37	0.94	1.18	1.04	0.52	0.93	1.16
Age (years) baseline	0.97	0.05	0.95	1.00	0.99	0.58	0.95	1.03	0.97	0.05	0.93	1.00
SF-36 physical health scales lagged ^a												
Physical function	1.00	1.00	0.88	1.13	1.08	0.59	0.82	1.41	0.99	0.86	0.86	1.13
Role physical	1.14*	0.03	1.01	1.28	0.94	0.62	0.73	1.21	1.19*	0.01	1.05	1.36
Bodily pain	1.14*	0.03	1.01	1.29	1.39*	0.02	1.06	1.81	1.09	0.19	0.96	1.25
General health	1.89***	0.00	1.70	2.11	1.61***	0.00	1.20	2.16	1.97***	0.00	1.75	2.21

^a Items are reverse scored so higher scores indicated poorer physical health. Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 8.3 shows the results for the whole sample and split according to sex. Higher prior role physical (OR=1.14), bodily pain (OR=1.14) and general health (OR=1.89) scores^{iv} were also associated with increased likelihood.

For men, only higher prior bodily pain (OR=1.39) and general health (OR=1.61) scores increased the odds of probable depression. Lagged higher general health scores (OR=1.97) also increased the likelihood for women, along with lagged higher role physical scores (OR=1.19).

^{iv} Reversed so higher scores indicate poorer physical health.

While men showed no effects for prior role physical, women showed no effects for prior bodily pain. The effect of prior general health was also more pronounced for women.

Box 8.3. Key substantive findings from Model 3.

- Having poorer prior general health scores was associated with increased likelihood of depression in both men and women.

Model 4. Testing lagged physical health predictors of change in probable depression status

Table 8.4 shows the results of time and multivariate adjusted generalized estimating equations for change in probable depression status for the overall sample ($N=15,976$). Lagged predictors were physical function, role-physical, bodily pain, and general health. The model was adjusted for time-varying partner, drinking, and smoking status and baseline sex, education and age. The outcome variable was within-person change in depression status. The reference category of the outcome variable was “remained not depressed”. Hence, the table presents the likelihood of remaining depressed, becoming depressed or becoming not depressed, compared to the reference category, remaining not depressed.

Table 8.4. Generalized estimating equation (GEE) results for lagged physical health predictors of change in probable depression status (Model 4).

Variable	Remained depressed ^b				Became depressed				Became not depressed			
	RRR	<i>p</i>	95% Confidence Interval		RRR	<i>p</i>	95% Confidence Interval		RRR	<i>p</i>	95% Confidence Interval	
Time (years)	0.93	0.28	0.82	1.06	1.13*	0.04	1.01	1.26	1.18***	0.00	1.06	1.30
Age (years) baseline	0.93***	0.00	0.89	0.97	0.99	0.47	0.96	1.02	0.97	0.06	0.95	1.00
SF-36 physical health scales lagged ^a												
Physical function	0.98	0.88	0.80	1.21	0.95	0.53	0.82	1.11	1.05	0.55	0.90	1.22
Role physical	1.13	0.18	0.94	1.36	1.17*	0.03	1.01	1.36	1.36***	0.00	1.18	1.57
Bodily pain	1.38***	0.00	1.12	1.70	1.14	0.08	0.98	1.33	1.29***	0.00	1.11	1.49
General health	2.75***	0.00	2.30	3.30	1.78***	0.00	1.55	2.04	1.92***	0.00	1.68	2.19

^a Items are reverse scored so higher scores indicated poorer physical health. Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

^b The reference category for this analysis was remaining not depressed, so all comparisons are made to this category.

* $p < .05$; ** $p < .01$; *** $p < .001$

To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences in change in depression. Table 8.5 presents the results of time and multivariate adjusted generalized estimating equations for change in probable depression status for men and women (Model 4).

Table 8.5. Generalized estimating equation (GEE) results for lagged physical health predictors of change in probable depression status according to sex (Model 4).

Variable	Remained depressed ^b								Became depressed								Became not depressed							
	Men				Women				Men				Women				Men				Women			
	RRR	<i>p</i>	95% Confidence Interval		RRR	<i>P</i>	95% Confidence Interval		RRR	<i>p</i>	95% Confidence Interval		RRR	<i>p</i>	95% Confidence Interval		RRR	<i>p</i>	95% Confidence Interval		RRR	<i>p</i>	95% Confidence Interval	
Time (years)	0.92	0.43	0.76	1.12	0.93	0.40	0.79	1.10	1.17	0.05	1.00	1.36	1.10	0.25	0.94	1.28	1.26*	0.01	1.07	1.49	1.14	0.07	0.99	1.30
Age (years) baseline	0.97	0.40	0.90	1.04	0.91***	0.00	0.86	0.96	0.99	0.61	0.95	1.03	0.99	0.54	0.95	1.03	0.97	0.19	0.92	1.02	0.97	0.13	0.94	1.01
SF-36 physical health scales lagged ^a																								
Physical function	1.07	0.76	0.71	1.61	0.97	0.80	0.77	1.23	0.88	0.45	0.63	1.23	0.98	0.81	0.83	1.16	1.11	0.57	0.78	1.58	1.04	0.66	0.88	1.23
Role physical	0.68	0.09	0.44	1.06	1.28*	0.02	1.05	1.57	1.17	0.40	0.81	1.70	1.18*	0.04	1.00	1.38	1.64*	0.01	1.12	2.39	1.33***	0.00	1.14	1.55
Bodily pain	1.95*	0.01	1.17	3.26	1.27*	0.03	1.02	1.59	1.57*	0.01	1.10	2.24	1.05	0.55	0.89	1.24	1.65***	0.00	1.19	2.29	1.22*	0.02	1.03	1.44
General health	2.98***	0.00	1.77	5.01	2.73***	0.00	2.26	3.30	1.46*	0.04	1.02	2.09	1.87***	0.00	1.62	2.16	1.47*	0.04	1.01	2.14	2.03***	0.00	1.77	2.33

^a Items are reverse scored so higher scores indicated poorer physical health. Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

^b The reference category for this analysis was remaining not depressed, so all comparisons are made to this category.

p* < .05; *p* < .01; ****p* < .001

The reference category for this analysis was remaining not depressed, so all comparisons are made to this category.

Table 8.4 shows the results for the whole sample. Increasing age at baseline was associated with decreased likelihood of remaining depressed (RRR=0.93). The model showed increased likelihood of becoming depressed (RRR=1.13) and becoming not depressed (RRR=1.18) with increasing time in study.

Higher bodily pain (RRR=1.38) and general health (RRR=2.75) scoresⁱ were also associated with increased likelihood of remaining depressed. Higher role physical (RRR=1.17) and general health (RRR=1.78) scores were associated with becoming depressed. Similarly, higher role physical (RRR=1.36), bodily pain (RRR=1.29) and general health (RRR=1.92) scores were associated with becoming not depressed. That is, compared to those who were not depressed, poorer general health scores were associated with all participant groups. In addition, poorer role physical scores was associated with status change.

For male participants (Table 8.5) poorer bodily pain and general health scores were associated with increased likelihood of remaining depressed (RRR=1.95; 2.98), becoming depressed (RRR=1.57; 1.46) and becoming not depressed (RRR=1.65; 1.47). Additionally, poorer role physical scores were associated with increased likelihood of becoming not depressed (RRR=1.64). The model showed increased likelihood of becoming not depressed (RRR=1.26) with increasing time in study.

For women (Table 8.5) increasing age at baseline was associated with decreased likelihood of remaining depressed (RRR=0.91). Poorer role physical and general health scores were associated with increased likelihood of remaining depressed (RRR=1.28; 2.73), becoming depressed (RRR=1.18; 1.87) and becoming not depressed (RRR=1.33; 2.03). Additionally,

ⁱ Reversed so higher scores indicate poorer physical health.

poorer bodily pain scores was associated with remaining depressed (RRR=1.27) and becoming not depressed (RRR=1.22).

Women who remained or became depressed showed role physical effects, while men did not. Men who became depressed showed bodily pain effects while women did not. The strongest general health effects for both men and women were those associated with the likelihood of remaining depressed. Additionally, men showed a time effect for becoming not depressed, while women showed an age effect for remaining depressed.

Box 8.4. Key substantive findings from Model 4.

- Poorer prior bodily pain and general health were associated with remaining depressed.
- For men and women, poorer prior general health was associated with remaining depressed.
- For women, increasing age at baseline was associated with decreased likelihood of remaining depressed.
- Poorer prior general health was associated with becoming depressed.
- For women, poorer prior general health was associated with becoming depressed.
- Poorer prior role physical, bodily pain and general health was associated with becoming not depressed.
- For men, poorer prior bodily pain was associated with becoming not depressed.
- For women, poorer prior role physical and general health was associated with becoming not depressed.

Model 5. Testing change in physical health predictors of change in probable depression status

Table 8.6 shows the results of time and multivariate adjusted generalized estimating equations for change in probable depression status for the overall sample ($N=15,976$). Change in physical health predictors were change in physical function, role-physical, bodily pain, and general health. The model was adjusted for time-varying partner, drinking, and smoking status and baseline sex, education and age. The outcome variable was within-person change in depression status. The reference category of the outcome variable was “remained not depressed”. Hence, the table presents the likelihood of remaining depressed, becoming depressed or becoming not depressed, compared to the reference category, remaining not depressed.

Table 8.6. Generalized estimating equation (GEE) results for change in physical health predictors of change in probable depression status (Model 5).

Variable	Remained depressed ^b				Became depressed				Became not depressed			
	RRR	<i>p</i>	95% Confidence Interval		RRR	<i>p</i>	95% Confidence Interval		RRR	<i>p</i>	95% Confidence Interval	
Time (years)	0.99	0.88	0.86	1.14	1.12	0.06	0.99	1.25	1.13*	0.03	1.01	1.26
Age (years) baseline	0.92***	0.00	0.87	0.97	0.98	0.25	0.95	1.01	0.97	0.06	0.94	1.00
SF-36 physical health scales within-person change ^a												
Physical function	0.85	0.17	0.67	1.07	1.10	0.30	0.92	1.32	0.98	0.78	0.82	1.16
Role physical	1.02	0.84	0.83	1.26	1.36***	0.00	1.15	1.61	0.93	0.35	0.81	1.08
Bodily pain	1.10	0.38	0.89	1.36	1.24*	0.02	1.04	1.47	1.00	1.00	0.84	1.18
General health	2.31***	0.00	1.85	2.87	2.09***	0.00	1.76	2.48	0.99	0.95	0.84	1.18
SF-36 physical health scales baseline												
Physical function	0.88	0.36	0.67	1.15	0.82*	0.04	0.68	0.99	1.02	0.84	0.84	1.24
Role physical	1.24	0.13	0.94	1.62	1.57***	0.00	1.28	1.92	1.32***	0.00	1.10	1.59
Bodily pain	1.41*	0.01	1.10	1.82	1.22	0.05	1.00	1.48	1.21*	0.03	1.02	1.45
General health	3.31***	0.00	2.62	4.19	2.30***	0.00	1.93	2.73	1.86***	0.00	1.58	2.20

^a Items are reverse scored so higher scores indicated poorer physical health. Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

^b The reference category for this analysis was remaining not depressed, so all comparisons are made to this category.

* $p < .05$; ** $p < .01$; *** $p < .001$

To examine whether effects were consistent between men and women, the study analyses were conducted separately for men and women to identify any significant sex differences in change in depression. Table 8.7 presents the results of time and multivariate adjusted generalized estimating equations for change in probable depression status for men and women (Model 5).

Table 8.7. Generalized estimating equation (GEE) results for change in physical health predictors of change in probable depression status according to sex (Model 5).

Variable	Remained depressed ^b								Became depressed								Became not depressed							
	Men				Women				Men				Women				Men				Women			
	RRR	p	95% Confidence Interval		RRR	p	95% Confidence Interval		RRR	p	95% Confidence Interval		RRR	p	95% Confidence Interval		RRR	p	95% Confidence Interval		RRR	p	95% Confidence Interval	
Time (years)	1.00	0.98	0.81	1.25	0.97	0.74	0.80	1.18	1.14	0.11	0.97	1.33	1.09	0.31	0.93	1.28	1.19	0.08	0.98	1.44	1.10	0.16	0.96	1.27
Age (years) baseline	0.97	0.39	0.89	1.05	0.89***	0.00	0.84	0.95	0.97	0.17	0.92	1.02	0.99	0.57	0.95	1.03	0.98	0.54	0.93	1.04	0.96	0.06	0.93	1.00
SF-36 physical health scales within-person change ^b																								
Physical function	0.89	0.68	0.51	1.55	0.83	0.17	0.64	1.08	1.04	0.82	0.74	1.46	1.12	0.30	0.90	1.39	0.85	0.41	0.58	1.25	1.01	0.96	0.82	1.23
Role physical	0.80	0.35	0.49	1.29	1.09	0.46	0.87	1.37	1.35	0.11	0.93	1.96	1.36***	0.00	1.13	1.64	0.96	0.82	0.69	1.35	0.93	0.35	0.80	1.08
Bodily pain	1.96*	0.01	1.20	3.19	0.95	0.66	0.76	1.19	1.45*	0.03	1.03	2.02	1.19	0.09	0.98	1.45	1.25	0.29	0.82	1.89	0.95	0.61	0.79	1.15
General health	2.31***	0.00	1.55	3.45	2.26***	0.00	1.77	2.88	1.62*	0.02	1.09	2.40	2.21***	0.00	1.82	2.69	1.00	1.00	0.67	1.49	0.99	0.93	0.82	1.19
SF-36 physical health scales baseline																								
Physical function	1.00	0.78	0.97	1.02	1.00	0.42	0.98	1.01	0.99	0.16	0.97	1.00	0.99	0.10	0.98	1.00	1.00	1.00	0.98	1.02	1.00	0.84	0.99	1.01
Role physical	1.00	0.84	0.98	1.01	1.01	0.05	1.00	1.01	1.01	0.05	1.00	1.02	1.01***	0.00	1.01	1.02	1.01	0.10	1.00	1.02	1.01*	0.01	1.00	1.01
Bodily pain	1.03*	0.01	1.01	1.05	1.01	0.10	1.00	1.02	1.01	0.07	1.00	1.03	1.01	0.19	1.00	1.01	1.01	0.19	0.99	1.03	1.01	0.08	1.00	1.01
General health	1.05***	0.00	1.02	1.08	1.06***	0.00	1.05	1.07	1.03*	0.01	1.01	1.05	1.04***	0.00	1.03	1.05	1.02	0.07	1.00	1.04	1.03***	0.00	1.02	1.04

^a Items are reverse scored so higher scores indicated poorer physical health. Physical health scores were mean centred and transformed into z-scores to ease interpretation of results.

^b The reference category for this analysis was remaining not depressed, so all comparisons are made to this category.

*p < .05; **p < .01; ***p < .001

The reference category for this analysis was remaining not depressed, so all comparisons are made to this category.

Table 8.6 shows the results for the whole sample. Increasing age at baseline was associated with decreased likelihood of remaining depressed ($RRR=0.92$). The model showed increased likelihood of becoming not depressed ($RRR=1.13$) with increasing time in study.

Within-person change in general health scores was associated with remaining depressed ($RRR=2.31$) and becoming depressed ($RRR=2.09$). Also associated with becoming depressed was greater within-person change in role physical ($RRR=1.36$) and bodily pain scores ($RRR=1.24$).

For male participants (Table 8.7) greater within-person change in bodily pain and general health scores was associated with increased likelihood of remaining depressed ($RRR=1.96$; 2.31) and becoming depressed ($RRR=1.45$; 1.62).

For women (Table 8.7), increasing age at baseline was associated with decreased likelihood of remaining depressed ($RRR=0.89$). Greater within-person change in role physical ($RRR=1.36$) and general health ($RRR=2.21$) scores were associated with increased likelihood of becoming depressed. Additionally, greater within-person change in general health scores was associated with remaining depressed ($RRR=2.26$).

Box 8.5. Key substantive findings from Model 5.

- Greater change in general health scores was associated with remaining depressed.
- Greater change in general health and role physical scores was associated with becoming depressed.

- For men and women, greater change in general health was associated with remaining depressed.
- For women, greater change in role physical and general health was associated with becoming depressed.

8.3.2 Summary of results

When looking at the substantive baseline predictors, having poorer general health was associated with increased likelihood of depression. For women, poorer role physical and bodily pain scores were also associated with increased odds. Time-varying predictors showed similar results. Additionally, for women, the odds of having depression declined over time. For lagged predictors, the results were similar again. A full discussion of these results, in addition to the results of the previous analyses chapters, is contained in the following chapter.

Chapter 9

DISCUSSION

9.1 Introduction

The data analyses components of this thesis focused on four major research questions that all fell under the overarching theme concerning the place of mental health in successful ageing research, theory and policy. The four major questions were: i) does the MHI-5 function homogenously across groups, ii) how does physical health influence mental health over time, iii) how does mental health influence physical health over time, and iv) how does physical health influence depression over time. In addressing these four questions and the overarching thesis theme, this chapter summarises the results from the analyses detailed in Chapters 5-8, and compares these results to published research. How these results relate to the place of mental health in successful ageing research, theory and policy will be discussed in detail in Chapter 10.

9.2 Does the MHI-5 function invariantly?

This section refers to the results reported in Chapter 5. This thesis provides not only research into the health of older people, but also further assesses psychometric properties of the most widely used measure of health-related quality of life in research, the SF-36 (Friedman et al., 2005; Garratt et al., 1993; Halvorsrud & Kalfoss, 2007). In studying the invariance properties of the MHI-5, this work was able to add to the literature by discussing previously unreported findings.

Verifying the invariance properties of the MHI-5 was a cautious, thorough and systematic methodological approach to take, given that the MHI-5 was used as the main outcome variable in the subsequent chapters. Given the fundamental importance of group comparisons in ageing research, some mental health assessment tools have previously been evaluated for invariance, including the Life Satisfaction Index (R. H. Lawrence & Liang, 1988), the Center for Epidemiological Studies Depression Scale (CES-D) (Canady, Stommel, & Holzman, 2009; Hertzog, Van Alstine, Usala, Hultsch, & Dixon, 1990) the Mental Health Continuum-Short Form (MHC-SF) (Lamers, Glas, Westerhof, & Bohlmeijer, 2012), and The Perceived

Stress Scale (PSS) (Lavoie & Douglas, 2011) among others (Löwe et al., 2010; Reker & Fry, 2003).

However, despite the importance of invariance testing to gerontological research, it is not commonly performed, and this has not changed since McHorney stated in 1996 that:

measurement invariance of generic health status tools remains assumed rather than confirmed. Demonstration of measurement invariance across population subgroups using structural equation modeling and confirmatory factor analytic techniques should become the rule rather than the exception in future measurement development.
(McHorney, 1996, p. 579)

In the current thesis, ensuring that the MHI-5 was functioning appropriately across group memberships was not only good practice for the subsequent statistical analyses that were performed, but also adds to the literature on the psychometric properties of the MHI-5. The MHI-5 is a robust measurement tool, and is recommended as appropriate for use in analyses of age and gender differences in mental health. Valid comparisons and interpretation of levels of mental health across age and gender groups can now be meaningfully conducted.

9.3 How does physical health influence mental health?

This section refers to the results reported in Chapter 6. This study reported on progression and predictors of change in longitudinal trajectories for mental health in older adults. When looking at the substantive baseline predictors, higher education and general health were associated with better mental health, confirming the existing evidence base. As previously established, smoking was associated with worse mental health; the impact was significantly more pronounced in women than in men. Time-varying predictors showed similar results. Additionally, men's mental health worsened over time, while women's improved. For men, being a non-drinker was associated with worse mental health, while being a risky-drinker was associated with better mental health. Similarly, for lagged predictors, prior general health status was associated with better mental health, particularly amongst women.

Looking at change in mental health, being male, smoking and having higher prior general health were associated with lower improvements in mental health. Being un-partnered was associated with greater improvements in mental health. This is potentially due to the possible influence of removal of the stress associated with caring for a partner. However, this is purely speculative as it is unverifiable using the current data. Risky drinking was associated with lower improvements in mental health for women. Being a non-drinker was associated with lower improvements in mental health for men. Experiencing greater change in general health was associated with greater improvements in mental health. Men reported decreases in mental health score while women's scores increased.

9.3.1 Role of (perceived) physical health

This work fills a gap in the literature by examining in detail the influence of physical health on MHI-5 scores. By using comprehensive longitudinal analyses of a general mental health measure, the results also provide strong empirical evidence to add to the growing literature linking physical and mental health. Physical health appeared as an important predictor of mental health and change in mental health. Mental health appeared to have little association with age, and any association documented appeared to be driven by physical health. General health in particular appeared to be strongly related to mental health. In the current study, the general health variable is a reflection of health beliefs, with low scores indicating that a person believes their health is poor and likely to worsen, and high scores indicate a person who sees their health as excellent (Ware & Sherbourne, 1992). The general health variable includes an item that is an indicator of self-rated health. Self-rated health is influenced by participants' overall view on life rather than only the objective reality of their current health status. Hence this finding is consistent with past research, where self-rated health has also been shown to be associated with various psychological constructs including vitality, distress, depression, and mental health (Burns, Sargent-Cox, Mitchell, & Anstey, 2014; Cano et al., 2003; Harrington et al., 2009; Leibson et al., 1999). For example, people with depression are more likely to exhibit dysfunctional attitudes or negative beliefs that guide self-evaluation (Kovacs & Beck, 1978; Riso et al., 2003).

This indicates that a key intervention to improve mental health for older people may involve not only the enhancement of objective health but subjective health also. A key strategy for this could potentially be education around strategies for coping with age-associated declines in health. This is an observation also made by Sougleris and Ranzijn (2011) who reported proactive coping to be a significant predictor of psychological well-being. One such intervention that has been trialled is an educational program developed by Bode, de Ridder, Kuijer, and Bensing (2007). The program was designed to improve proactive coping competencies in middle and older aged people, which was supported by their research outcomes. The authors hypothesise that improving proactive coping competencies will promote successful ageing in terms of subjective and psychological well-being.

9.3.2 Sex differences

As predicted, there were some key sex differences in mental health outcomes for men and women, with women either improving over time or decreasing at a slower rate, while men consistently decreased. This is an important finding, as it provides greater insight into the previously under-reported area of trajectories of MHI-5 scores for men. The finding aligns with the results of the one study identified in the systematic review that investigated MHI-5 trajectories in men (Hopman et al., 2006). This is also consistent with previous literature reporting on alternative measures of mental health, which show men to be at greater risk of depression as they age (Anstey & Luszcz, 2002; Burns, Butterworth, et al., 2013). There have been a number of causes hypothesised for driving this effect in men, including hormonal changes (Yeap, 2014), decreasing testosterone levels (Carnahan & Perry, 2004; Margolese, 2000), lack of care seeking behaviour, and higher rates of substance abuse (Spar & Muñoz, 2014). Women have also been reported to have greater help-seeking, existential growth, religiosity, and total coping strategies (McDougall, 1997). Canetto (1992) argued that compared to women, men experience fewer changes in roles and health over the life course and are less prepared for the physical changes that occur in later life. Consequently, men have less resilience and limited coping strategies in place to manage the disability and ill health associated with ageing. This results in poorer mental health and increased suicide rates in men (Canetto, 1992).

Drinking behaviour was also a key difference between men and women. Risky drinking was associated with mental health improvements for men but was either not associated or associated with decreases in mental health for women. Not drinking alcohol was associated with decreases in mental health for men, but not for women. This is likely a reflection of the association of social interaction with drinking behaviour (Emslie, Hunt, & Lyons, 2013). It is hypothesised that a primary means of accessing social support for men is through situations involving drinking (Emslie et al., 2013; Tilki, 2006). One of the benefits associated with social support is improvements in mental health (Moak & Agrawal, 2010). The men who are not drinking do not socialise to the same extent and do not receive the protective benefits of social connectedness (Cornwell & Waite, 2009). The effect is not observed for women, who receive social support through different avenues not involving drinking. The proposed explanation for this observation is that the social support received in drinking situations is driving this effect.

This finding draws attention to one of the limitations of working with the DYNOPTA data, which are discussed in detail in Chapter 10. Researchers are limited to using the variables that are available to them in this observational dataset. In this particular case, it was not possible to include a social support variable in the current analyses to further explore this finding. However, the many benefits and possibilities of working with such a large, quality longitudinal dataset outweigh this limitation. Although observational, DYNOPTA provides an important opportunity to investigate mental and physical health at a population level. The dataset has substantial power and numbers of observations allowing greater insight into health and well-being over time, addressing the shortcomings of previous smaller experimental studies (Burns et al., 2014).

9.3.3 Summary

In summary, this study contributes substantially to existing knowledge by further elucidating the association between mental and physical health with high quality longitudinal data. The findings highlight the need for researchers, clinicians and policy makers to be aware of the impact of poor physical health on mental health outcomes for older people. Screening processes and interventions for older people should be designed that take into account this

effect on mental health. Promoting physical health functioning throughout the lifespan may have a protective influence on mental health outcomes in later life. These findings also emphasise the importance of including mental health in all theoretical conceptualisations of successful ageing. These issues will be discussed in detail in Chapter 10.

9.4 How does mental health influence physical health?

This section discusses the results reported in Chapter 7. This study reports on progression and predictors of change in longitudinal trajectories in physical health in older adults. When looking at the substantive predictors of change in physical health, older age, time, smoking and having higher prior mental health were consistently associated with lower improvements in physical health. Experiencing greater positive change in mental health was also consistently associated with greater improvements in physical health scores. This effect was greater for men. For women, older age was associated with lower improvements in bodily pain. That is, the bodily pain of women with higher baseline age did not improve to the same degree as younger women. The effect of time was also more pronounced for women on physical function and role physical outcomes, with scores decreasing more for women per year in the study. Being a non-drinker or a risky drinker was associated with lower improvements in physical health for men only.

9.4.1 Role of mental health

These analyses provide a valuable and comprehensive insight into the impact of mental health on four physical health outcome measures. Mental health appeared as a strong predictor of change in all measures of physical health used in this study.

Essentially, individuals with higher prior mental health scores experienced less improvement in physical health outcomes. This indicates a ceiling effect in that those with poorer mental health have greater capacity to improve future physical health, while those with higher mental health have less scope for improvement. This is potentially an encouraging finding as it suggests those who may benefit most from enhanced well-being, that is, individuals with poorer mental health, are able to experience greater improvements in their physical health.

Additionally, individuals experiencing greater increases in mental health were also experiencing increases in physical health outcomes. The more the mental health of an individual improves, they will experience a reciprocal improvement in their physical health. Again, this is an encouraging finding with extensive implications for public health promotion. However, it is also possible that those with initial lower physical health scores but who are improving are experiencing a subsequent increase in mental health.

These analyses demonstrated that mental health appeared to have the strongest relationship to the measure of role limitations due to a physical problem (role physical). Role physical is an indicator of whether an individual has problems as a result of physical health, such as cutting down the amount of time they spent on activities and accomplishing less than they would like to. This result shows that the perception of being able to complete work related tasks or other daily activities is strongly influenced by mental health status. This result implies that health promotion strategies that aim to improve mental health could evaluate efficacy by assessing people's perceptions and/or ability to complete desired daily tasks.

9.4.2 Sex differences

As predicted, a number of consistent sex differences concerning physical health outcomes emerged in these analyses. The effect described above, i.e., greater change in mental health being associated with greater improvements in physical health scores, was more pronounced for men. Hence, mental health was a stronger influence on physical health for men compared to women. It is proposed that women's physical health may be more influenced by other external factors in addition to mental health. For example, Adler, Epel, Castellazzo, and Ickovics (2000) reported that subjective social status was related to physiological functioning and physical health factors (self-rated health, heart rate, sleep latency, body fat distribution, and cortisol habituation to repeated stress) among 157 women, controlling for objective socioeconomic status. Similarly, in their review of the literature, Matthews and Gallo (2011) reported that physical health was more impacted by socioeconomic status in women in a number of studies. The authors recommend that sex is possibly a moderating factor and researchers should "consider different psychosocial pathways" to physical health outcomes (Matthews & Gallo, 2011, p. 18).

Women are also substantially more likely to be impacted by social stressors, such as domestic violence and gender discrimination. These stressors are well established to seriously impact on life-long physical health outcomes (Loxton, Schofield, Hussain, & Mishra, 2006), more so in women than men (Alejo, 2014), and again may lessen the degree to which mental health influences physical health. This may be due to these stressors taking precedence in influence over physical health when compared to mental health. Alternatively, this observation could be due to women developing coping mechanisms due to greater social support or out of necessity.

In addition to social stressors, when compared to men, women also foster more numerous and more intensive social relationships (Shumaker & Hill, 1991). Women are more likely to be both the beneficiaries and providers of social support. They are also more responsive to other individuals' life events (Heaney & Israel, 2008, p. 196; Shumaker & Hill, 1991) and show increased empathy for others (Rueckert & Naybar, 2008; Schulte-Rüther, Markowitsch, Shah, Fink, & Piefke, 2008). Women display what Eagly (2009) describes as a persistent pattern "of female emotionally supportive and sensitive behaviour, especially in close relationships" (p. 653). Given these gender differences in the structure and function of social support processes, it is possible that women's physical health is less influenced by their own mental health due to protective external psychosocial factors. Men, not having the same extent of social support, are more influenced by their own changes in mental health.

Drinking behaviour was also a key difference between men and women. Being a non-drinker or a risky drinker was associated with lower improvements in physical health for men only. Again, as found in Chapter 6, this result is likely a reflection of the association of social interaction with drinking behaviour (Emslie et al., 2013). It is hypothesised that a primary means of accessing social support for men is through situations involving drinking (Emslie et al., 2013; Tilki, 2006). One of the major benefits associated with social support itself is improved physical health (Berkman, Glass, Brissette, & Seeman, 2000; Uchino, 2004). The men who are not drinking may not socialise to the same extent and do not receive the protective benefits of social connectedness (Cornwell & Waite, 2009). The effect is not observed for women, who are more likely to receive social support through different avenues not involving drinking. The proposed explanation for the observation that for men being a

non-drinker was associated with lower improvements in physical health, is that the social support received in drinking situations is driving this effect. The physical health benefits of social support via drinking are however negated for the risky drinkers, whose alcohol intake appears to instead by having a harmful effect, which is well established in the literature (Adrian & Barry, 2003). This finding suggests that targeted public health interventions to reduce high-risk drinking behaviour should be designed for a male audience. Additionally, providing environments and interventions that facilitate increased social support for men should also be considered.

As noted in Chapter 6, these results need to be interpreted in the knowledge that there are a number of limitations associated with the DYNOPTA dataset, discussed in detail in Chapter 10. These analyses are based on self-report measures. As discussed by Burns et al. (2015), the lack of objective measures of physical and mental health states does not allow for the fact that self-assessment of physical health may be influenced by mental health. That is, poor mental health may lower assessments of physical health, while positive mental health may lift physical health self-assessments.

9.4.3 Summary

This study sought to extend prior research on the longitudinal impact of mental health on physical health. The evidence base was added to by the investigation of longitudinal data for a large sample of older adults that provided detailed physical and mental health information over time. The current study indicates that mental health is consistently associated with various physical health outcomes. Greater change in mental health is associated with increased change in physical health. This finding has extensive implications for the design of evidence-based policy and practice. Primarily, if policy and practice can be designed to effectively promote mental health, substantial improvements in physical health should be observed, discussed in detail in Chapter 10.

9.5 How does physical health influence depression?

This section refers to the results reported in Chapter 8. This study reports on the association between physical health and depression in community dwelling older adults. When looking at the substantive baseline predictors, having poorer general health was associated with increased likelihood of depression. For women, poorer role physical and bodily pain scores were also associated with increased odds of depression. Time-varying predictors showed similar results. Additionally, for women, the odds of having depression declined over time. For lagged predictors, the results were similar again.

This work provides important input into the debate around older age and depression. The prevalence of probable depression reported in this population (6.76% in men and 7.38% in women) is consistent with the findings of Luppá et al. (2012) and Pirkis et al. (2009). Physical health was found to be consistently associated with depression, extending existing work (Cho et al., 2010; Geerlings et al., 2000; Koster et al., 2006) by studying a much larger sample of participants longitudinally. There was evidence of a small time effect for women, in that there was a reduced risk of developing depression over time. There was also a small age effect for men, suggesting that men who were older at baseline were less likely to have depression. However, depression appeared to have little association with age and time compared to physical health. This finding does bring the “clear answer” that Jorm was unable to provide in his review of the literature (Jorm, 2000), as it suggests that there is little evidence for any substantive effects of age and time on risk of depression.

9.5.1 Role of (perceived) physical health

Physical health, most notably general health, was consistently associated with depression status. Having poorer baseline or time-varying role physical, bodily pain and general health was associated with having depression. However, when the physical health variables were lagged as predictors, only poorer prior general health was strongly associated with having depression.

When looking at change in depression status, poorer prior bodily pain was associated with remaining depressed. The association of pain and depression is well established and to be expected given the associated distress and discomfort (Hawker et al., 2011). These results suggest that pain causes individuals to remain depressed, in keeping with past research in older populations (Mossey & Gallagher, 2004).

Poorer prior general health was also associated with remaining and becoming depressed. As for becoming not depressed, poorer role physical, bodily pain and general health were associated with the improvement in depression. All comparisons are made to the reference category of individuals who remained not depressed over time. This result is unexpected. Potentially, there are a number of participants driving this effect whose physical health was previously lower but improved over time, who then experience a related improvement in depression status. Experiencing greater change in general health was associated with remaining depressed. Similarly, greater change in general health and role physical was associated with becoming depressed.

General health appears to be strongly and consistently related in different ways to the likelihood of experiencing depression, including whether an individual becomes depressed. While all physical health variables were associated with depression in the majority of models, with the exception of physical function, general health had the most substantial association.

The fact that general health was consistently associated with depression is in keeping with past research. The general health variable is a reflection of health beliefs, with low scores indicating that a person believes their health is poor and likely to worsen, and high scores indicate a person who sees their health as excellent (Ware & Sherbourne, 1992). Poorer perceived health is well-documented to be associated with depression (Anstey et al., 2007; Callahan, Hui, Nienaber, Musick, & Tierney, 1994; P. Martin, Rott, Kerns, Poon, & Johnson, 2000; Wu, Parkerson, & Doraiswamy, 2002). People with depression are more likely to exhibit dysfunctional attitudes or negative beliefs that guide self-evaluation more generally (Kovacs & Beck, 1978; Riso et al., 2003).

9.5.2 Sex differences

As predicted, a number of key sex differences in depression outcomes were observed. For men, only baseline and time-varying general health was substantively associated with depression, while for women baseline and time-varying general health, role physical and bodily pain were associated. This suggests that women's depression status is influenced by a broader range of physical health factors when compared to men. Also, as mentioned previously, the odds of having depression decreased for women with time in study while this effect was not observed for men.

Interestingly, when looking at lagged physical health predictors, there were no sex differences. For both men and women, only poorer prior general health was related to depression. Looking at the odds of remaining depressed, the only substantive difference was that for women increasing age was significantly associated. For both men and women, poorer prior general health and greater change in general health was also related to remaining depressed.

For becoming depressed, poorer prior general health and greater change in role physical and general health was significantly associated for women. Also for women, unexpectedly, having poorer prior role physical and general health was associated with becoming not depressed. The same effect was observed for men who had poorer prior bodily pain. Again, there may be a number of participants driving this effect who experienced improvements in physical health over time who subsequently had improved depression status also.

For women, decreased role functioning related to physical health problems was also consistently related to depression. Role physical is an indicator of whether an individual has problems as a result of physical health, such as cutting down the amount of time they spend on activities and accomplishing less than they would like to. Not being able to perform daily activities has been proposed as a predictor of depression (Fiske, Wetherell, & Gatz, 2009). That this effect was only observed for women suggests that not being able to perform desired activities due to physical health problems is strongly linked to women's likelihood of

developing depression. It could be hypothesised that the role physical scale is similar to the general health scale in that it is measuring a belief or perception about capacity rather than actual health status. It is possible that this is the reason both scales are associated with depressive status. However, given the validity of the SF-36 scales there is likely to be a degree of objective reality in these health beliefs.

While general health was most strongly and consistently associated with men experiencing depression, bodily pain was associated to a lesser degree also. This is consistent with past literature (Arola, Nicholls, Mallen, & Thomas, 2010). Past literature has also shown that this relationship is stronger in men (Affleck et al., 1999; Geerlings, Twisk, Beekman, Deeg, & van Tilburg, 2002; Keefe et al., 2004). It is hypothesised that this result indicates that women potentially have more enhanced pain coping abilities than men do (Bendelow, 1993). Affleck and colleagues (1999) suggest:

While women may experience more intense pain, they may be able to limit its emotional consequences better than men. Indeed, even when their greater pain was taken into account, women used more pain coping strategies, especially those that assist emotional regulation in the face of increasing pain. (Affleck et al., 1999, p. 607)

However, the research evidence supporting this conjecture is mixed (Fillingim, King, Ribeiro-Dasilva, Rahim-Williams, & Riley Iii, 2009).

9.5.3 Summary

These findings suggest that past and current physical health is strongly associated with depression and must be considered when creating policy and interventions to reduce depression incidence. Primarily, any policy and practice strategies designed to reduce the prevalence of depression should involve physical health promotion components. General health emerged as strongly associated to depression. Additionally, depression in women appears to be influenced by a greater range of physical health factors than for men. The ability to perform key meaningful activities influences women's depression outcomes, while bodily pain is an important indicator for men. There is little evidence that older age is associated with reduced or increased risk of depression for men or women. These findings

confirm the extensive lifelong benefits of physical health promotion on depression incidence, and greater awareness of at risk populations. The following chapter will provide an overall summary of the findings from this thesis and explore the associated practical and theoretical implications.

Chapter 10

CONCLUSION

This chapter provides an overall summary of the findings of this thesis, and considers the associated implications for theory, policy, practice and future research. Recommendations are made concerning how this research can be utilised. The chapter concludes with a critique of the methods used, including the strengths and limitations of the research.

10.1 Summary of findings

The results of the systematic review reported in Chapter 3 indicated that mental health remains relatively stable over time, with some evidence of a decline for men and older individuals. Both modifiable and non-modifiable factors were found to influence outcomes. Education was associated with positive mental health outcomes, while chronic illness was identified as a correlate of poor mental health. The majority of other influential factors were modifiable lifestyle behaviours, including physical activity, social network size, and alcohol and tobacco use.

The results of the DYNOPTA analyses also suggest mental health remains relatively stable over time, with men's mental health slightly worsening over time while women's slightly improved. The analyses definitively showed that mental and physical health are consistently related to each other over time. In terms of magnitude of influence, the impact of mental health on physical health had the strongest effect when compared to the impact of physical health on mental health. Notably, the strongest effects were:

1. Prior mental health on change in role physical score: higher prior mental health was associated with lower improvements in role physical score. This effect was observed for all physical health variables but was markedly larger for role physical.
2. Change in mental health on change in role physical score: greater change in mental health was associated with greater improvements in role physical score. This effect was stronger for men.

This first effect was hypothesised to be a ceiling effect, as individuals with poorer mental health had greater capacity to improve in terms of future physical health, while those with

better mental health had less scope for improvement. This was interpreted as a positive finding for those with poorer mental health, who may be able to experience much needed improvements in physical health. In this case, the greatest improvements were seen in role physical scores, an indicator of whether an individual may have achievement problems due to physical health, discussed below.

Regarding the second effect, the more mental health improved, individuals experienced greater improvement in role physical score. Overall, men experienced greater changes in physical health as a result of mental health change. It was proposed that the physical health of men may be more influenced by changes in mental health. The physical health of women may be more influenced by other external factors, such as social stressors (Loxton et al., 2006).

Out of the four indicators of physical health, role physical appears to be the most strongly related to mental health. Role physical can be described as a measure of physical self-efficacy, or an assessment of role limitations due to physical health issues. The measure indicates whether an individual believes they have the physical health status that will allow them to complete desired activities. If an individual experiences an improvement in their mental health, their perceived ability to perform desired activities also improves. Given the subjectivity of this self-report data, it is possible that this effect is mediated by a construct such as motivation. However, given the validity of the SF-36, there is likely objective reality to this association in that improved mental health also increases physical-self efficacy, an important component of health and quality of life.

The pathways by which mental health may be influencing physical health are likely to be numerous and interrelated. Building on the work of Hemingway and Marmot (1999), it is proposed that these underlying mechanisms can be grouped into three distinct categories. Thus, mental health is affecting physical health:

- i) By influencing health and lifestyle behaviours such as smoking, diet, drinking, physical and social activity. This relates to constructs such as motivation, as well as personal attitudes towards ageing.
- ii) Through causing direct acute or chronic pathophysiological changes. This concerns stress affecting inflammatory responses that over time impact negatively on physical health outcomes (Black, 2002).
- iii) By influencing access to and quality of medical care. In Australia where health care is accessible to most individuals, this likely relates to motivation and proactive coping, as well as personal and external attitudes towards ageing. However, for vulnerable populations and those living in rural and remote regions, this issue is amplified by accessibility difficulties.

The critical outcome of this research, both the systematic review and the DYNOPTA analyses, is that change and improvement in health outcomes is possible in older age, despite the ageist misperception that this does not occur. This finding needs to be effectively applied in theory, policy and practice to take advantage of modifiable factors to improve quality of life. Recommendations will now be made concerning these issues.

10.2 Theoretical implications

Since its development, the successful ageing concept has played a fundamental role in gerontological research (Bülow & Söderqvist, 2014). This thesis has primarily focussed on Rowe and Kahn's model of successful ageing (Rowe & Kahn, 1987). This theory is currently the prevailing conceptualisation of successful ageing in the research literature and one of the most influential (Bosnes et al., 2016). Rowe and Kahn's theory has been extensively investigated but criticised also (Bülow & Söderqvist, 2014), which the authors are aware of (Rowe & Kahn, 2015). Successful ageing is defined as i) low risk of disease and disease related disability, ii) high cognitive and physical function, and iii) active engagement with life (Rowe & Kahn, 1998, 2015). Their work only acknowledges mental health peripherally.

The results from this thesis show that physical and mental health consistently influence each other over time, with mental health having more influence. This suggests that they are both integral, interrelated components of ageing. The role of mental health in successful ageing theories, specifically the work of Rowe and Kahn (1998), has not been adequately acknowledged.

Theory is important in concept development, and there are many benefits to delineating what successful ageing is. However, for the theory of successful ageing to be useful, there needs to be an accepted operationalised definition. This definition must be holistic and include a measure of mental health. This argument aligns with both the results of the current thesis and with the perspectives of lay people that have been reported in the research literature (Phelan et al., 2004; Reichstadt et al., 2007).

When the theory of Rowe and Kahn is operationalised in research, mental health is rarely included as an indicator of successful ageing. It may be included as an associated factor for comparative purposes but is not included as a core component. Physical and cognitive health as an indicator of successful ageing is the focus in the majority of studies into Rowe and Kahn's model (Cosco et al., 2014).

The work of Cosco et al. (2014) identified a number of issues in the research literature operationalising successful ageing. Primarily, despite Rowe and Kahn's model, there is no accepted definition of what successful ageing actually is. Although the model was developed 30 years ago, this lack of consensus has resulted in a problematic body of research literature. The concept of successful ageing is not currently being utilised in a meaningful way due to heterogeneity. No useful comparisons can be made across populations due to varying operational definitions of successful ageing. Being able to compare populations is integral to public health research. Despite these significant issues, this research, even cross-sectional methodologies, continues to be published (Bosnes et al., 2016).

As the results of this thesis indicate, mental health needs to be included in any operational theory of successful ageing. Indeed, the focus on more biomedical models has been described as inhibiting the advancement of the concept of successful ageing (Cosco et al., 2014; Young, Frick, & Phelan, 2009). The proposed inclusion of mental health is due not only to its relationship with physical health, but also for other pragmatic reasons. Some degree of physical decline and cognitive slowing are accepted processes associated with ageing. However, mental health does not inevitably decline with age; the current results show that it remains relatively stable. Mental health is an ideal resource to utilise in a strength-based theoretical approach to successful ageing, as opposed to a deficit-based approach. Other researchers have acknowledged this fact and attempted to provide alternative models, but none has been accepted and employed as Rowe and Kahn's has (Young et al., 2009).

The utility of a theory depends on its applicability to real world situations. Successful ageing models and theory have the potential to inform the collection of quality, comparable public health data to identify predictors of both good and poor ageing outcomes. Given the current state of global population ageing, this information is becoming increasingly vital. There are many critical non-modifiable factors that influence ageing outcomes, such as structural determinants of health and physical environment (Holstein & Minkler, 2003). However, many influential factors can be modified and are in the control of individuals, to differing degrees. It is important that ageing outcomes not be considered wholly "uncontrollable", as the results of the systematic review in Chapter 3 show. There is much that individuals, practitioners, communities and policy makers can do to improve outcomes (Bülow & Söderqvist, 2014). Developing an accepted holistic operational theory that includes mental health is integral to enabling these critical processes.

10.3 Practice implications

Service providers, clinicians and practitioners should be aware of the strong and consistent relationship between physical and mental health. The implications of this research are that the successful treatment of depression and anxiety may mitigate negative physical health outcomes. More importantly, it is reasonable to surmise that positive mental health and the prevention of depression and related disorders may significantly improve physical health

outcomes. While empirical studies are required, this suggests that the promotion of positive mental health should be evaluated and built into health care systems, and the delivery of health care for physical and psychiatric conditions.

Our current health care system has a focus on more biomedical models of care and health. Traditionally, mental health is not seen as a primary focus of the Australian, and most Western, public health systemsⁱ, which has resulted in opportunities to improve mental health being neglected (World Health Organization, 2005). The importance of mental health in itself, and its influence on physical health in older age needs emphasis. Any service provision and interventions for older people should take into consideration the interplay of physical and mental health. Practitioners should be working with people to improve mental health to achieve reciprocal improvements in physical health. At risk groups, in this case those with low mental health, should be targeted as these are also the groups that will likely experience the greatest improvements in physical health. Gender differences also need to be considered, with the physical health of men being more influenced by mental health. The mental health of men also declines over time and as such, they need to be considered an at risk group.

Promoting mental health throughout the lifespan is likely to have a protective effect on future physical health in later life. The World Health Organization (2005) cluster the personal, social and environmental factors integral to mental health around three themes: “i) the development and maintenance of healthy communities, ii) each person's ability to deal with the social world through skills like participating, tolerating diversity and mutual responsibility, and iii) each person's ability to deal with thoughts and feelings, the management of life and emotional resilience” (p. 26). Whilst the first factor is relevant to policy creation and is discussed below, practitioners can work towards promoting the remaining two factors across the lifespan.

ⁱ This is in comparison to traditional Indigenous Australian beliefs, which have a more holistic approach (Roe, 2010).

In terms of practice tailored for the needs of older people, promotion of resilience and coping with age-related changes has the potential to have a substantial influence on mental health. Proactive coping is an important tool in improving health and capacity perceptions, reducing mental and physical health decline (Ouwehand et al., 2007). Efforts should also be made by service providers to educate people about coping and resilience across the lifespan, with emphasis on older ages when health challenges are likely to intensify.

There are many common dehumanising and homogenising misperceptions about mental health in older age, including that depression and decline are inevitable and natural parts of the ageing process (J. Murray et al., 2006). These myths, in conjunction with societal and systemic ageism, can result in an over-acceptance of disability, dependence and poor health outcomes: a negative self-fulfilling spiralling loop. Educating older people about the falseness of these misperceptions, as well as promoting control over their own mental health is integral to best practice. An important component of this is respecting older people's personhood and encouraging decision making about their health and lifestyle choices (World Health Organization, 2005).

Practitioners can work in partnership with their older clients to prioritise a number of strategies that have been shown to improve mental health. Promotion of physical activity is a critical intervention in promoting positive mental health and treating mental illness. Social activity is also integral and protective of mental health. For men, this should be discussed in relation to alcohol intake, as social activity in the context of risky drinking should be avoided. Practitioners should assess and address sensory disabilities that may impede social activity and mental health, particularly hearing loss (Kiely, Anstey, & Luszcz, 2013). Promotion of social activity is likely to also improve coping and resilience, as relationships can provide active coping assistance (Thoits, 2011). Encouraging smoking cessation is likely to have positive mental health outcomes, and the addiction should not be accepted in older people, who still have the ability to change their lifestyle habits and experience associated benefits. Interventions and practice designed to improve mental health should consider physical health as an indicator of efficacy. A legislative framework to organise and facilitate these practice strategies should be developed by organisational and government bodies, discussed in the following section.

10.4 Policy implications

The policy implications of this research are embedded within a broader discussion of how the needs of the ageing population are currently addressed and planned for. In addition, in any discussion of the needs of older people, the importance of improving quality of life throughout the life-span is important.

The results of this research indicate the importance of inclusion of mental health in policy applicable to the current generation of older people, but also future planning strategic documents. Mental health is consistently related to physical health outcomes, and appears to have a major impact in some associations.

The individual and economic cost of poor mental health is clear. The impact mental health also has on physical health is adding to this burden. Current policy that affects Australian older people underemphasises or fails to mention the importance of mental health in healthy ageing outcomes. This is potentially due to the theories of healthy and successful ageing also failing to adequately acknowledge the role of mental health. Policy will have to be designed that promotes all components of successful ageing, not just in older age, but also across the life-span.

An Australian strategic document, the Prime Minister's Science Engineering and Innovation Council (2003) report on promoting healthy ageing, minimises the role of mental health in the promotion of healthy ageing. Psychological health and well-being is primarily discussed in the context of other factors, such as the importance of physical activity and nutrition. This is an important health promotion, prevention and management strategy. However, any discussion of healthy ageing needs to emphasise mental health as a key indicator.

As the 2015 Intergenerational Report emphasises, it is important for the economic health of Australia that older people are able to participate in the workforce (Commonwealth of Australia, 2015). There are many benefits associated with participation in the workforce for

older people themselves, both social and financial. Workforce participation and productivity is highly reliant on health (Strazdins et al., 2016). The work of Strazdins and colleagues (2016) suggests that any policies designed to increase workforce participation should include components to support physical activity and health service access. The findings from this thesis strongly suggest that mental health promotion needs to be considered in any such policy also. Currently, this is not the case.

When the 2016 Federal Budget was released, there was a notable neglect of preventative health and health promotion measures. These are key components to promoting healthy ageing and reducing the costs of preventable illnesses. Health promotion measures need to be occurring not only for older Australians, but for the general population also as these are the future generation of older people. It is clear that the decisions individuals make regarding their health behaviours earlier in life influence their long-term health into older age. The Council on the Ageing stated that the health component of the 2016 Federal Budget was “underwhelming” for older Australians (COTA, 2016, p. 8).

Outside of Australia, in The National Service Framework for Older People released by the UK Government (Department of Health, 2001), one of the eight standards specifically concerns mental health. Additionally, the aim of the standard does not only concern treatment for those with mental health problems:

To promote good mental health in older people and to treat and support those older people with dementia and depression. (Department of Health, 2001, p. 90)

More recently in the UK Annual Report of the Chief Medical Officer on the health of baby boomers, an entire chapter was devoted to mental health (Davies, 2016). However, this work has only a disease focus, with little to no discussion of promotion of good mental health and its relationship to physical health.

The World Health Organization Mental Health Action Plan (2013) states that:

Policies, plans and services for mental health need to take account of health and social needs at all stages of the life course, including infancy, childhood, adolescence, adulthood and older age. (World Health Organization, 2013, p. 10)

The Action Plan (World Health Organization, 2013) is international policy of particular relevance to physical and mental health care integration in Australia (Happell et al., 2015).

In a discussion of how to apply the Action Plan to evaluate policy, Happell and colleagues (2015) recommend that “Health policy could be greatly strengthened by drawing on special knowledge of consumers, policy makers, health practitioners and carers” (p. 375). The authors recommend, consistent with the World Health Organization Action Plan, a “whole-of-person” approach (Happell et al., 2015, p. 375). Their policy analysis suggests that Australia does not currently have a cohesive national-level policy concerning the improvement of physical health of people with a mental illness. Where state-level policy does exist there is little evidence that it is being implemented. The authors believe that this is of concern given that preventable factors that affect life expectancy appear to be having a larger impact on people with mental illness. D. Lawrence, Hancock, and Kisely (2013) reported that in Western Australia the difference in longevity between those with and without mental illness increased between 1985 to 2005. The majority of excess mortality in those with mental illness was due to physical health conditions such as cardiovascular disease and cancer. Happell et al. (2015) recommended national-level policy needs to be created to ensure that the World Health Organization Mental Health Action Plan is implemented in Australia to ensure that the physical health of people with mental illness is promoted.

Given the findings of the current thesis, the recommendations made by Happell et al. (2015) should be expanded to not only encompass improving physical health outcomes for people with mental illness, but policy should be in place that acknowledges the relationship between physical and mental health for all individuals. Positive mental health promotion is a currently underutilised strategy for physical health improvement. However, it is clear that the relationship between physical and mental health is more critical in people with mental illness, who are disproportionately impacted by physical health conditions and associated mortality.

It appears that research evidence is not currently informing policy in Australia. Vellas (2014) recommends that this occur systematically, suggesting that we need to focus on primary care health promotion, that is GPs advising older people about health behaviours, in addition to targeting frail older people to prevent physical and mental decline. As also identified by Happell et al. (2015), there are currently gaps between policy and implementation. If policy is created in this area, there will need to be evaluations of its implementation, including in primary health care and health promotion.

Mental health promotion policy needs to be multi-domain and include more peripheral non-health socio-political activities also (World Health Organization, 2005). Improving and enabling access to education, housing, economic security and community networks would have substantial positive outcomes for older people. In terms of effective policy that considers gender differences, there also needs to be awareness that men's mental health appears to decline while women's remains reasonably stable or improves. Given the potential seriousness of this pattern, that is, the high rates of suicide in older men, legislation should be put in place that treats men as an at risk group for diminishing mental health. A possible causative factor for this pattern is men experiencing less social support, having lower resilience and proactive coping abilities. Targeted policy that aims to provide men with social support outside the context of risky drinking is needed.

The research evidence strongly indicates that these policy activities, coupled with tobacco control, improved nutrition and increased physical activity, would greatly improve the ageing experience. As always, a life course perspective that includes extrinsic determinants of health is needed in any policy creation (Liu & Su, 2016). Any policy and practice strategies should be evaluated for viability and efficacy, which will be discussed in the following section.

10.5 Future research implications

In terms of future research, ideally, analyses should occur on objective longitudinal data to confirm the results from this self-report data. However, given the validity of the SF-36 as an assessment tool it is recommended that policy and practice interventions now be the focus of

future research. With the addition of the results from these large-scale longitudinal analyses, the successful ageing evidence base is now sufficiently placed to proceed with research that is more practical. Interventions should be carefully designed, informed by this empirical research, to optimise successful ageing outcomes across the lifespan, as discussed above. The interventions will also need to be assessed for both cost-efficacy and their ability to sustainably improve quality of life in older people.

Future research should focus on testing the efficacy of interventions designed to reduce internalised ageist attitudes and improve proactive coping and resilience regarding challenges associated with ageing. As discussed above, these policy and practice interventions should occur in diverse health and non-health areas (World Health Organization, 2005). The results of the current thesis suggest that these interventions should be having a substantial impact on mental health, and consequently, physical health outcomes. As such, it is recommended that the outcome variables assessed not only be measures of ageism, coping and resilience, but also both subjective and objective mental and physical health. Ideally, these interventions will occur across the lifespan, with potentially intensive intervention in midlife and older age to assist with adaptation to the challenges associated with ageing. Efficacy assessments should occur longitudinally to monitor the sustainability of any effects.

10.6 Limitations

All data sources have issues that must be acknowledged and discussed. DYNOPTA is a large population-based longitudinal dataset that has provided powerful and robust findings due to its sample size and quality methodology. However, despite DYNOPTA's strengths, a number of limitations should be considered in relation to interpreting the findings of this thesis, which will now be discussed.

10.6.1 Self-report assessments

The SF-36, the measure used to assess the main variables of interest, namely mental health, physical health and depression, carries a number of issues. The data used relied on self-reported assessments of physical and mental health, as well as sociodemographic and lifestyle

behaviours. There was no clinical diagnosis data concerning depression and mental health included in DYNOPTA. In addition, no objective physical health assessments were available.

Self-reported subjective health and lifestyle behaviour measurement is an essential element of both clinical and life-course research (Hobson & Meara, 1997). However, self-reported data has the potential to impact on validity. Brener, Billy, and Grady (2003) proposed that self-report behaviours, in their research specifically health-risk behaviours, are affected by both cognitive and situational factors. These in turn may be used to explain the source of validity problems that may emerge when using self-report data. The authors propose that the cognitive perspective:

focuses on the mental processes underlying self-reported data and attributes validity problems to inaccuracies arising from comprehension, recall, and other cognitive operations. (Brener et al., 2003, p. 437)

While the situational perspective:

focuses on validity problems that arise from factors related to social desirability and interviewing conditions. (Brener et al., 2003, p. 437)

In relation to the data analysed in this thesis, the information collected from participants was not of a particularly complex or sensitive nature which would have minimised both situational and cognitive influences on validity. Collecting objective and clinical data on the variables investigated in the current project would be labour intensive and expensive work (Crosby, DiClemente, & Salazar, 2011), and was not the purpose of DYNOPTA. Instead, the studies used here were designed to minimise threats to validity. In addition, as discussed in this thesis, the SF-36 has been extensively validated against mental and physical health standards (Rumpf et al., 2001; Ware & Gandek, 1998).

The MHI-5 entails only five assessment items, measuring the psychological constructs of anxiety, depression, loss of behavioural or emotional control and psychological well-being. As such, the mental health assessment properties of the MHI-5 could be perceived to be

limited due to its brevity and possible lack of depth compared to other more extensive measures. However, unlike the MHI-5, many common alternative measures of mental health have a focus on mental illness as the primary construct of interest, and do not include positive aspects of emotional well-being. See, for example, the Geriatric Depression Scale (Yesavage et al., 1982), and the Goldberg Anxiety and Depression Scale (Goldberg, Bridges, Duncan-Jones, & Grayson, 1988). However, the brevity of the MHI-5 needs acknowledgement in relation to the broader issue of the trade-off between sample size and depth of assessment in research (Sahlqvist et al., 2011). When conducting large scale longitudinal studies there are ethical and financial implications of asking participants to complete overly long questionnaires. Consequently, concise measures are selected and the data collected may comparably lack depth as a result. However, although brief, the MHI-5 is a well-validated and reliable measure of mental health status (Ware & Gandek, 1998), and has been found to have sound psychometric properties in older populations (Beusterien et al., 1996; Friedman et al., 2005).

10.6.2 Cohort effects

The sample used in this thesis includes a broad age range, with baseline data collected between 1996 and 2001. Hence, the sample combines different birth cohorts, and as such, the results may be subject to “cohort effects”. Cohort or generation effects are:

generally conceptualized as variation in the risk of a health outcome according to the year of birth, often coinciding with shifts in the population exposure to risk factors over time. (K. M. Keyes, Utz, Robinson, & Li, 2010, p. 2)

Historical events can potentially modify the way people age (Pruchno, Heid, & Wilson-Genderson, 2016). As such, older people may experience different trajectories of health and well-being according to birth cohort. Hence, results may not be applicable to future generations of older people. Data from different cohorts may also be homogenised in this dataset, with significant patterns of change specific to particular cohorts unidentifiable.

Unlike countries that experience substantial shifts in political and socioeconomic forces, Australia has been high income and politically stable for decades. This historical stability will likely minimise any cohort effects.

Again, the well-validated assessment tools used in these studies were chosen to minimise such effects. The invariance analyses included in this thesis also found the SF-36 to be functioning consistently across age groups, suggesting that no significant cohort effects exist.

10.6.3 Sample bias

Longitudinal studies are most likely to have sample bias, in that individuals who participate may have higher education, income and health than the general population. Such studies often under-represent minority groups, including Indigenous people, people from culturally and linguistically diverse groups, people with disabilities, people with low literacy, and people living in rural and remote areas.

The under-representation of Indigenous people is particularly problematic in the Australian context where Aboriginal and Torres Strait Islander people have significantly different and lower health outcomes and life expectancy than non-Indigenous people (Australian Health Ministers' Advisory Council, 2015; Gubhaju et al., 2013). Unfortunately, Indigenous Australians are under-represented in the DYNOPTA data (Anstey et al., 2011).

Consequently, there is a significant gap in the knowledge we have about the longitudinal health of older Indigenous Australians. Any conclusions that are drawn from this research need to be done so in the context that they are applicable only to non-Indigenous Australians. This has implications for the creation of evidence based health policy for all Australians. In their discussion of the topic Anstey et al. (2011) conclude that:

there is an urgent need to develop an evidence base for public health research into the health of adult Indigenous Australians, particularly older adults. (Anstey et al., 2011, p. 335)

The authors also stress that such research should be designed and follow the NHMRC protocols for conduct of research with Indigenous Australians (National Health and Medical Research Council, 2003).

Individuals with better health are more likely to participate and remain in longitudinal studies. The disproportionate enrolment of study participants in good health is labelled the “healthy cohort effect”. As with all longitudinal studies of ageing, the sample will be subject to survival bias. That is, the longitudinal sample bias towards healthy survivors will influence the results.

Given the current thesis’ focus on mental health and depression, those living in institutional care were not included in the analyses due to this population experiencing higher levels of depression. This work focuses on the health of older adults living in the community. Hence, the frailer older population is not represented in the current study.

The studies that contributed to DYNOPTA were selected due to their excellent sampling techniques that optimised the probability of representative data being collected. An awareness of these potential sources of biases is necessary in the interpretation of this data.

10.6.4 Contributing studies

One of the strengths of DYNOPTA is the large sample size. However, this sample size was arrived at by harmonising studies that applied different methodologies. Hence, the different sampling, inclusion and exclusion criteria, and data collection methods introduce the potential for variability. However, the key variables of interest in this thesis are taken from the SF-36. The SF-36 was administered in all studies according to consistent guidelines.

Additionally, the inclusion of the large all female ALSWH resulted in much fewer men in the DYNOPTA sample compared to women. However, there was still a large number of men,

which allowed for meaningful analyses and gender comparisons. In the current research literature, the longitudinal investigation of men's MHI-5 score has not been investigated, extensively. Although the number of men is disproportionate to the number of women, the outcomes of these analyses has added extensively to the research literature.

10.6.5 Sample attrition

Sample attrition effects the vast majority of longitudinal studies, especially those with older people as participants. Sample attrition results in missing data, and may occur due to death, or withdrawal due to illness or other reasons. Sample attrition increases with each occasion of measurement, and can result in a biased sample. However, the statistical analyses applied account for such missing data. The benefits and knowledge gained from population based longitudinal studies outweigh the problems associated with a biased sample due to attrition, but the effect of sample attrition should be kept in mind when interpreting results. However, given the size of DYNOPTA, these effects will be minimised.

10.6.6 Availability of variables

DYNOPTA includes many different variables, but is slightly limited in that contributing studies contributed different variables. This means that variables that may exist in DYNOPTA that would have been useful to include, do not necessarily occur in the studies that included the variables of interest in this thesis, namely the SF-36. Hence, the current analysis did not control for measures of self-reported or clinical diagnoses of chronic diseases. It was also not possible to include cognitive health in the analyses. These measures were only available in a limited subsection of DYNOPTA studies that did not include the SF-36 in their variables. Experiencing serious disease increases the likelihood of mental health issues and depression.

10.7 Strengths

Despite these limitations, the findings from the current thesis contribute essential and novel information to the understanding of the relationship between mental and physical health. The

influence of mental health on physical health has especially provided an elucidating addition to the research literature. The knowledge generated from these analyses proves the importance of large-scale longitudinal studies of population health. The use of DYNOPTA has demonstrated many best practice research techniques. DYNOPTA is a cost-effective, very large, high quality, representative longitudinal study. It is composed of data collected using exemplary methodology, and contains validated and reliable outcome measures.

10.8 Conclusion

This research identified critical information on correlates of mental health outcomes that can be exploited in policy and practice. The analyses of such a large dataset provides invaluable evidence to inform practice and policy interventions aiming to improve physical and mental health. These results suggest that any proposed health interventions or policies that target mental health will generate substantial positive effects in physical health also. This research has provided critical information concerning how to optimally support successful ageing outcomes of older people. Improving the health and quality of life of the ageing population is an objective that must be prioritised by practitioners and policy makers. Mental health is a critical resource in an evidence and strength-based approach to the promotion of successful ageing.

Appendix 1. Detailed search strategy

All searches in English and for humans

Medline, Web of Knowledge, EBM Reviews & ProQuest, Embase:

1. SF-36
2. SF36
3. short form 36
4. mental health index
5. MHI-5
6. MHI5
7. 1 or 2 or 3 or 4 or 5 or 6
8. Aging
9. Aged, 80 and over
10. Aged
11. Longevity
12. Geriatrics
13. aged
14. geriatric
15. aging
16. ageing
17. older people
18. elderly
19. gerontology
20. 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19

21. Longitudinal Studies

22. longitudinal

23. repeated measure

24. 21 or 22 or 23

25. 7 and 20 and 24

PsycInfo

1. SF-36

2. SF36

3. short form 36

4. mental health index

5. MHI-5

6. MHI5

7. 1 or 2 or 3 or 4 or 5 or 6

8. Aging

9. Aged, 80 and over

10. Aged

11. Longevity

12. Geriatrics

13. Aging

14. Psychological aging

15. Geriatrics

16. Gerontology

17. aged
18. geriatric
19. aging
20. ageing
21. older people
22. elderly
23. gerontology
24. 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23
25. Longitudinal Studies
26. Repeated Measures
27. longitudinal
28. repeated measure
29. 25 or 26 or 27 or 28
30. 7 and 24 and 29

Appendix 2. SF-36 Questionnaire Australian version and scales

<p>Q1 These first questions are about your health now and your current daily activities. Please try to answer every question as accurately as you can. In general, would you say your health is: (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Excellent 2. Very Good 3. Good 4. Fair 5. Poor 	General health
<p>Q2 Compared to one year ago, how would you rate your health in general now? Would you say it is: (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Much better than one year ago 2. Somewhat better than one year ago 3. About the same as one year ago 4. Somewhat worse now than one year ago 5. Much worse now than one year ago 	Not used in scoring scales
<p>Q3a The following questions are about activities that you might do during a typical day. As I read each item, please tell me if your health now limits you a lot, limits you a little, or does not limit you at all, in these activities. First, vigorous activities, such as running, lifting heavy objects, participating in strenuous sports. Does your health now limit you a lot, limit you a little, or not limit you at all? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes, limited a lot 2. Yes, limited a little 3. No, not limited at all 	Physical functioning
<p>Q3b What about moderate activities, such as moving a table, pushing a vacuum cleaner, bowling or playing golf. Does your health now limit you a lot, limit you a little, or not limit you at all? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes, limited a lot 2. Yes, limited a little 3. No, not limited at all 	Physical functioning
<p>Q3c And what about lifting or carrying groceries? (Interviewer: If necessary, ask does your health now limit you a lot a little, or not at all?) (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes, limited a lot 2. Yes, limited a little 3. No, not limited at all 	Physical functioning
<p>Q3d Climbing several flights of stairs? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes, limited a lot 2. Yes, limited a little 3. No, not limited at all 	Physical functioning
<p>Q3e Climbing one flight of stairs? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes, limited a lot 2. Yes, limited a little 3. No, not limited at all 	Physical functioning

<p>Q3f Bending, kneeling or stooping? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes, limited a lot 2. Yes, limited a little 3. No, not limited at all 	Physical functioning
<p>Q3g Walking more than one kilometre? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes, limited a lot 2. Yes, limited a little 3. No, not limited at all 	Physical functioning
<p>Q3h Walking half a kilometre? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes, limited a lot 2. Yes, limited a little 3. No, not limited at all 	Physical functioning
<p>Q3i Walking 100 metres? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes, limited a lot 2. Yes, limited a little 3. No, not limited at all 	Physical functioning
<p>Q3j Bathing or dressing yourself? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes, limited a lot 2. Yes, limited a little 3. No, not limited at all 	Physical functioning
<p>Q4a The next four questions ask about your physical health and your daily activities. During the past four weeks, have you had to cut down on the amount of time you spent on work or other regular daily activities as a result of your physical health? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes 2. No 	Role physical
<p>Q4b During the past four weeks, have you accomplished less than you would like as a result of your physical health? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes 2. No 	Role physical
<p>Q4c During the past four weeks, were you limited in the kind of work or other activities you do, as a result of your physical health? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes 2. No 	Role physical
<p>Q4d During the past four weeks, have you had any difficulty performing the work or other activities you do, for example, it took extra effort? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes 2. No 	Role physical
<p>Q5a The following three questions ask about your emotions and your daily activities. During the past four weeks, have you cut down the amount of time you</p>	Role emotional

<p>spent on work or other regular daily activities as a result of any emotional problems, such as feeling depressed or anxious? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes 2. No 	
<p>Q5b During the past four weeks, have you accomplished less than you would like as a result of any emotional problems, such as feeling depressed or anxious? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes 2. No 	Role emotional
<p>Q5c During the past four weeks, did you not do work or other regular daily activities as carefully as usual as a result of any emotional problems, such as feeling depressed or anxious? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Yes 2. No 	Role emotional
<p>Q6 Again during the past four weeks, to what extent has your physical health or emotional problems interfered with your social activities like visiting friends or relatives? Would you say: (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Not at all 2. Slightly 3. Moderately 4. Quite a bit 5. Extremely 	Social functioning
<p>Q7 During the past four weeks, how much did pain interfere with your normal work, including both work outside the home and housework? Did it interfere: (Single response. Read options)</p> <ol style="list-style-type: none"> 1. Not at all 2. Slightly 3. Moderately 4. Quite a bit 5. Extremely 	Bodily pain
<p>Q8 How much bodily pain have you had during the past four weeks? Have you had: (Single response. Read options)</p> <ol style="list-style-type: none"> 1. None 2. Very mild 3. Mild 4. Moderate 5. Severe 6. Very severe 	Bodily pain
<p>Q9a The following questions are about how you feel and how things have been with you in the past four weeks. As I read each statement, please give me the one answer that comes closest to the way you have been feeling. How much of the time during the past four weeks did you feel full of life? Would you say all of the time, most of the time, a good bit of the time, some of the time, a little of the time or none of the time? (Single response. Read options)</p> <ol style="list-style-type: none"> 1. All of the time 2. Most of the time 3. A good bit of the time 	Vitality

<p>4. Some of the time 5. A little of the time 6. None of the time</p> <p>Q9b And how much of the time during the past four weeks have you been a very nervous person? Would you say all of the time, most of the time, a good bit of the time, some of the time, a little of the time or none of the time? (Single response. Read options)</p> <p>1. All of the time 2. Most of the time 3. A good bit of the time 4. Some of the time 5. A little of the time 6. None of the time</p> <p>Q9c And how much of the time during the past four weeks have you felt so down in the dumps that nothing could cheer you up? (Single response. Read options)</p> <p>1. All of the time 2. Most of the time 3. A good bit of the time 4. Some of the time 5. A little of the time 6. None of the time</p> <p>Q9d How much of the time during the past four weeks have you felt calm and peaceful? (Single response. Read options)</p> <p>1. All of the time 2. Most of the time 3. A good bit of the time 4. Some of the time 5. A little of the time 6. None of the time</p> <p>Q9e And how much of the time during the past four weeks did you have a lot of energy? (Single response. Read options)</p> <p>1. All of the time 2. Most of the time 3. A good bit of the time 4. Some of the time 5. A little of the time 6. None of the time</p> <p>Q9f And how much of the time during the past four weeks have you felt down? (Single response. Read options)</p> <p>1. All of the time 2. Most of the time 3. A good bit of the time 4. Some of the time 5. A little of the time 6. None of the time</p> <p>Q9g How much of the time during the past four weeks did you feel worn out? (Single response. Read options)</p> <p>1. All of the time 2. Most of the time 3. A good bit of the time 4. Some of the time</p>	<p>Mental health</p> <p>Mental health</p> <p>Mental health</p> <p>Vitality</p> <p>Mental health</p> <p>Vitality</p>
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<p>5. A little of the time</p> <p>6. None of the time</p> <p>Q9h How much of the time during the past four weeks have you been a happy person? (Single response. Read options)</p> <p>1. All of the time</p> <p>2. Most of the time</p> <p>3. A good bit of the time</p> <p>4. Some of the time</p> <p>5. A little of the time</p> <p>6. None of the time</p> <p>Q9i How much of the time during the past four weeks did you feel tired? (Single response. Read options)</p> <p>1. All of the time</p> <p>2. Most of the time</p> <p>3. A good bit of the time</p> <p>4. Some of the time</p> <p>5. A little of the time</p> <p>6. None of the time</p> <p>Q10 During the past four weeks, how much of the time has your physical health and emotional problems interfered with your social activities like visiting friends and relatives? Would you say: (Single response. Read options)</p> <p>1. All of the time</p> <p>2. Most of the time</p> <p>3. Some of the time</p> <p>4. A little of the time</p> <p>5. None of the time</p> <p>Q11a Now I'm going to read you a list of statements. After each one, please tell me if its definitely true, mostly true, mostly false, or definitely false. If you don't know just tell me. Firstly, "I seem to get sick a little easier than other people". Would you say that's definitely true, mostly true, mostly false, or definitely false, or you don't know? (Single response. Read options)</p> <p>1. Definitely true</p> <p>2. Mostly true</p> <p>3. Don't know</p> <p>4. Mostly false</p> <p>5. Definitely false</p> <p>Q11b What about the statement, "I am as healthy as anybody I know". Would you say that's definitely true, mostly true, mostly false, or definitely false, or you don't know? (Single response. Read options)</p> <p>1. Definitely true</p> <p>2. Mostly true</p> <p>3. Don't know</p> <p>4. Mostly false</p> <p>5. Definitely false</p> <p>Q11c What about the statement "I expect my health to get worse". Would you say that's definitely true, mostly true, mostly false, or definitely false, or you don't know? (Single response. Read options)</p> <p>1. Definitely true</p>	<p>Mental health</p> <p>Vitality</p> <p>Social functioning</p> <p>General health</p> <p>General health</p> <p>General health</p>
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- 2. Mostly true
 - 3. Don't know
 - 4. Mostly false
 - 5. Definitely false

Q11d And finally, what about the statement "My health is excellent". Would you say that's definitely true, mostly true, mostly false, or definitely false, or you don't know?

(Single response. Read options)

- 1. Definitely true
 - 2. Mostly true
 - 3. Don't know
 - 4. Mostly false
 - 5. Definitely false
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General health

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