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Trends in working life expectancy, working conditions and health in an ageing population

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Trends in working life expectancy, working conditions and health in an ageing population

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COLOFON

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Chapter 1

General introduction

BACKGROUND

Labour participation and retirement

Over the last two decades, labour force participation among older adults in the Netherlands has increased tremendously. In 1992, 38% of the 55- to 60-year-olds participated in paid work, while in 2014 67% in this age category participated (Figure 1) [1]. Among the 60- to 65-year-olds, this proportion increased from 11% in 1992 to 44% in 2014. Over the entire period, labour force participation was higher among men than women. Although the labour participation rates among 55 to 65 year-olds constantly increased over the period 1992 to 2014, the actual retirement age started only to substantially increase since 2006 (Figure 2) [2]. The increased labour participation rates are a result from an increase of the inflow in the labour force at younger ages. This is mainly caused by a change in cohort characteristics, such as an increase in educational level and an increase in female labour participation [3]. The increase in actual retirement age is a result of a delay in the outflow from the labour force, mainly due to the stricter policy measures regarding early work exit introduced since 2006 [4]. Changes in relevant cohort characteristics and policies are described in detail below.

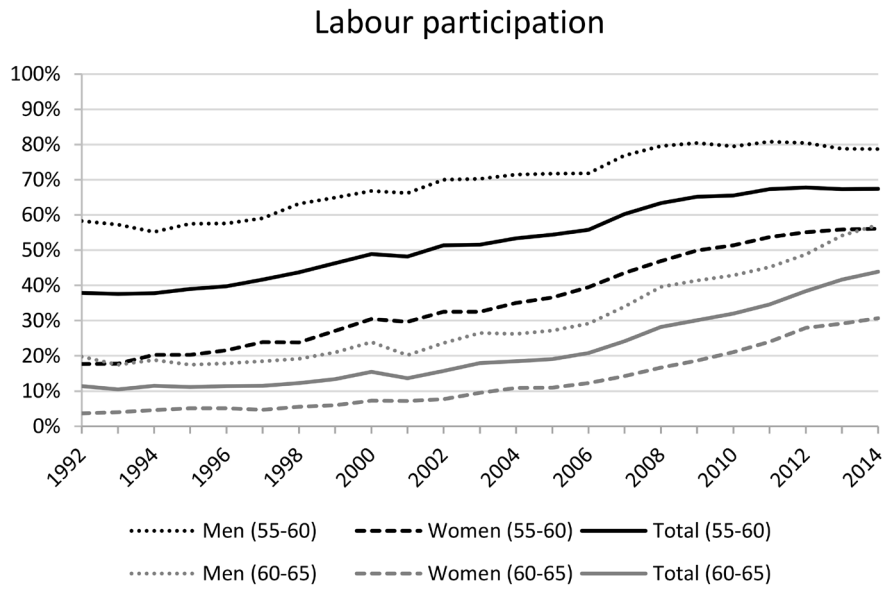

Figure 1. Labour participation rates 1992-2014 (Source: Statistics Netherlands)

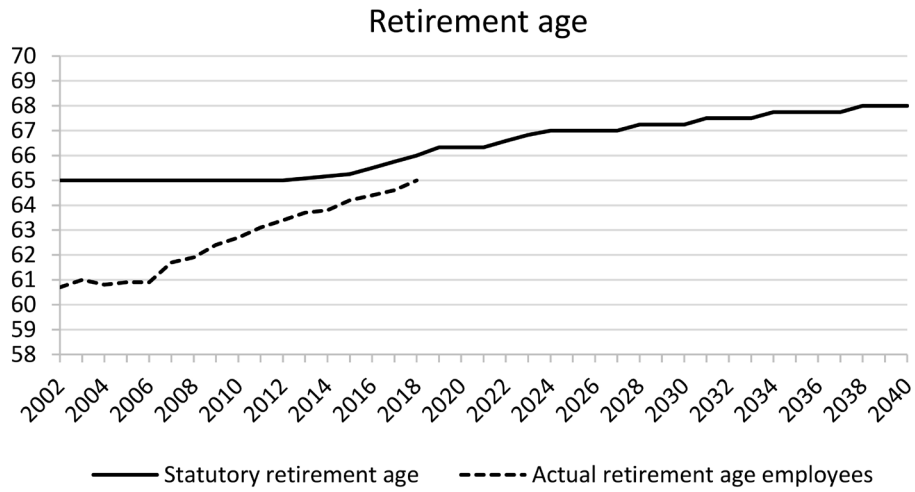

Figure 2. Statutory retirement age (legally defined until 2025, later years are current expectations dependent on the Life Expectancy at age 65) and the average actual retirement age 2002-2018 (Source: Dutch Government & Statistics Netherlands).

Cohort differences

In this thesis, I compare data from 55- to 65-year-olds in 1992/93, 2002/03 and 2012/13, who were born in three different time periods: 1928-1937, 1938-1947 and 1948-1957, respectively. I refer to these three groups as the first, the second and the third *cohort* when cohort differences are discussed. I refer to the *periods* 1990s, 2000s and 2010s when period differences are discussed. A relevant difference between these cohorts is the educational level attained. In the first cohort, for example, approximately 58% of the men and 74% of the women was lower educated (lower general secondary education (in Dutch: MAVO), or less). In the third cohort this proportion had decreased to 35% and 40%, respectively. The main cause of the increased educational level is that girls and children from families with lower socioeconomic status gained the opportunity to receive more years of schooling. The increase in the educational level of these groups paralleled an increase in their job opportunities. Specifically for women, another development took place regarding their family role. Up until 1958 it was arranged by law that married or pregnant women got fired, in order to raise the children. Back then, it was uncommon to re-enter the workforce when their children grew older. In the first and second cohort, an increasing number of women re-entered the workforce. On top of that, an increasing proportion of the women in the second and third cohort no longer exited the workforce when they got married or pregnant. Moreover, in the first cohort, families were stable in the sense that most married couples stayed together their whole lives, in the second and third cohort an increasing number of couples divorced. This may also have resulted in an increase in the number of women (re-)entering the workforce [3]. Other explanations for the increase in the labour participation of women since the

mid-eighties are the desire to supplement a man's income that stagnated as a result of wage moderation, and the rise in the number of part-time jobs [5].

Policies

Since the early 2000s, social security programs and pension schemes have been reformed to extend the working lives of older adults in the Netherlands. These reforms were mainly a response to the rapid decline in the labour force participation of men at older ages since the 1970s and the continuing increase in the life expectancy [6]. For workers in the 1990s, early retirement was common and financially supported by employers and the Dutch government by means of VUT (in Dutch: "regeling voor vervroegde uittreding"). Early exit by older workers was intended to stimulate employment of younger workers and of newcomers to the labour market [7]. Older workers who were not covered by VUT, were likely to use unemployment insurance benefit and disability insurance benefit, as alternative pathways out of the labour market [8]. In the 2000s, workers could still exit the workforce early by pre-pension schemes, but these schemes were financially less attractive than VUT. In addition, the government took measures that impeded early exit by the alternative paths of unemployment and disability [9]. However, the actual retirement age of workers in this period increased only marginally. For workers in the 2010s, early retirement schemes were generally no longer available, and the statutory retirement age, with its accompanying basic state pension, started to increase in steps from age 65 in 2013 to age 65.5 in 2016 [10]. In addition, access to occupational disability schemes was more strictly limited to only those people who are unable to work for a longer period due to illness [9, 11]. Moreover, the maximum unemployment benefit period was also limited [12]. These changes seem to have ensured that in this period only the wealthy and long-term disabled could exit the workforce before the statutory retirement age [13].

Health

The ageing process is generally accompanied by a deterioration in health. In this thesis several health problems are studied which are prevalent in older adults aged 55 to 65 years, and which have been shown to hamper work ability. Three health indicators with relatively high prevalence rates are chronic diseases, disability and poor/moderate self-rated health. In the age category 55 to 65 years, prevalence rates were 42%, 38% and 30%, respectively, in the Netherlands in 2016 [14]. All are associated with reduced workability and early exit from the workforce via several exit ways, i.e. disability pension, unemployment and/or early retirement [15-17]. A fourth health indicator, psychological health problems, is with 12% in 2016 less prevalent among Dutch 55-65-year-olds, and is not age dependent [14]. However, it is strongly related to reduced work ability and early work exit [15, 16]. A final health indicator, cognitive functioning, seems less relevant to study here as prevalence of (mild) cognitive impairment is low, i.e. 5% among 60-65-year-olds according to a study based on data from USA, Europe, Asia and Australia [18]. However, evidence shows that the onset of cognitive decline starts as

early as the age of 45 years [19]. Moreover, several researchers warn that the increase of the statutory retirement age in western societies will likely be accompanied by an increase in the number of workers with mild cognitive impairment (MCI) and dementia [20-22]. Good cognitive functioning is essential because it influences workers' capacity to learn and use the knowledge and skills necessary to perform the job [23].

Health trends

Previous studies examining health trends across successive cohorts of older adults aged 55 to 65 in the general population show that the prevalence of chronic diseases increased and psychological functioning deteriorated over the past twenty years [24-26]. Physical functioning and disability remained stable [25, 27], and cognitive functioning improved over time [28].

Both the increase of older workers over time and the stabilisation or deterioration in (almost all) health functioning domains, may result in poorer health of older workers. In this thesis, I examine health trends in different domains of functioning among the older working population, the older working-age population and former workers, across three successive decades. Four chapters (**Chapters 2-5**) are on the comparison of Dutch (former) workers aged 55 to 65 in the 1990s, 2000s and 2010s. In most of these chapters, I examine health differences between subgroups, such as men and women, different educational levels and different workload groups. One chapter (**Chapter 6**), explores health of the future older working-age population. In view of the further rise in the statutory retirement age in the Netherlands (Figure 2) [29], it will become increasingly common for older adults to continue working in the future [5]. By examining historical trends, we can understand the consequences of changes in societal circumstances for the health status of older workers. Subsequently, such examination allows us to explore future trends in health among older workers. All these insights can provide starting points for interventions, in order to keep workers healthy and to support those who are facing health problems. Below, the rationale for each chapter of this thesis is described in further detail.

Working life expectancy

In this thesis, I introduce a novel measure to gain insight in the health of older workers: "Working Life Expectancy" (WLE). This summary measure is similar to life expectancy but with exit from the workforce as the final state instead of death. The years to the final state can be divided into years in good and poor health [30]. This measure is sparsely used in previous studies, but is recently gaining more attention from researchers [31-38]. It has been applied to evaluate 1) the number of years people work in good and poor health [34, 37], 2) the length of working careers of subgroups such as high versus low educated workers [32, 33, 35, 37] or workers with certain health problems [38], and 3) the number of productive years lost as a consequence of health problems [31].

The increase in the labour force participation of older workers may have influenced working life expectancy with disability. In particular the stricter eligibility rules for the disability pension scheme may have raised WLE with disability. However, also other policy measures that made early exit financially unattractive may have contributed. This could have led to increases in socioeconomic differences, because financial measures generally affect less wealthy people more, such as the lower educated [4]. Therefore, in **Chapter 2**, I examine to what extent WLE with disability of older workers changed across three successive decades. In addition, differences in WLE with disability between men and women, and high and low educated workers are examined.

In recent decades, the prevalence of chronic diseases among older adults increased, as a result of early detection and improved treatment [26]. This means that an increasing number of people are confronted with a chronic disease, and sometimes more than one, during their working life. For most workers, this does not cause any problems and they continue to work without their chronic disease being an obstacle. However, chronic diseases may be accompanied by poor self-rated health which can complicate continuing working [39]. As it has become more difficult to leave the workforce early, it can be expected that workers with a chronic disease nowadays are required to work more years in poor self-rated health than in previous decades. Therefore, in **Chapter 3**, I examine to what extent WLE in poor self-rated health of older workers with chronic diseases changed across three successive decades.

Working conditions

Work itself influences the health of workers when a mismatch occurs between the work demands and work capability of the workers. This is often the case among workers who work in jobs with unfavourable working conditions, and the negative effect of these working conditions are stronger at older age [40]. Previous studies show that unfavourable working conditions are associated with problems in a variety of health domains such as physical, cognitive and psychological functioning. Unfavourable working conditions can be characterised by high physical demands, high psychosocial demands and/or low psychosocial resources. High physical demands, such as heavy lifting, negatively affect physical functioning [41]. High psychosocial demands, such as long working hours, work overload and pressure, negatively affect psychological functioning [42-44]. In contrast, psychosocial demands are associated with better cognitive function in middle and later life [45]. High psychosocial resources, such as job autonomy, are associated with better cognitive and psychological functioning [42, 44-46].

In many Western countries, working conditions have changed over the past twenty years. Physical demands have decreased [47, 48], while psychosocial demands and psychosocial resources have increased [47-50]. Similar developments have taken place in the Netherlands [49].

With the increase of older workers over time, due to an increase in inflow and delay in outflow, it can be expected that people similar to those who did not work (any longer) due to health problems in the 1990s, did work in the 2000s or 2010s. Moreover, the stabilisation in physical functioning, the deterioration in psychological functioning, and improvement in cognitive functioning in the general population may also have affected older workers. For these reasons, I expect that successive cohorts of older workers have become less healthy in physical and psychological sense, and healthier in cognitive sense. As working conditions are associated with health, the abovementioned shifts in working conditions potentially have effectuated the change in health status of older workers. Therefore, in **Chapter 4**, I examine changes in physical, cognitive and psychological functioning across three successive cohorts of workers, and to what extent the shift in working conditions has contributed to these changes.

There is evidence that retirement has a more beneficial effect on health among workers with unfavourable working conditions compared to those with favourable working conditions [51-54]. Workers who are exposed to unfavourable working conditions for a longer period of time and at older ages have higher risks to develop health problems. As a result of prolonged exposure to unfavourable working conditions, it might be too late for these workers to experience improvements in health after retirement. Pertinently, a study among 14,714 employees found that retirees exposed to demanding working conditions aged >55 years benefitted less from retirement in terms of self-rated health than retirees aged ≤55 years [54]. Therefore, in **Chapter 5**, I examine changes over time in health trajectories during the work exit transition for workers with higher versus lower physical and psychosocial work demands, and psychosocial work resources. Here, multiple health domains are examined (self-rated health, psychological functioning, and physical limitations) because working conditions may affect the different health domains differently.

Future health

Generally, the older working population is a healthy selection of the total older working-age population, a fact that is also known as the healthy worker effect [55]. However, because the older working population originates from the total older working-age population, the health of future cohorts of older workers depends on the development in health among the total older working-age population. Explorations of future health are often based on historical health trends. Previous research shows that historical trends in physical health of 60-65-year-olds are not as positive as of the 65+ [27]. The extension of working lives may have limited health gains in this age category. Therefore, in **Chapter 6**, I explore health up to 2040 of Dutch adults aged 60 to 68, as 68 is the expected statutory retirement age for future older workers. In doing so, I take into account the increase of the statutory age and potential negative effects of the extension of working lives. Here, a combined measure of self-reported health and physical limitations is examined.

In **Chapter 7**, the overall discussion section of this thesis, I discuss the expectations for health of the older working population in the coming years based on the findings from all previous chapters.

DATA

In this thesis, I use three different datasets. In **Chapters 2 to 5**, I use data from the Longitudinal Aging Study Amsterdam. In **Chapter 6**, I use data from the Dutch Health Interview Survey and the Dutch Public Health Monitor.

Longitudinal Aging Study Amsterdam (LASA)
LASA is a continuing Dutch population-based cohort study on predictors and consequences of changes in physical, cognitive, social and emotional functioning with ageing [56, 57]. The first LASA cohort, recruited in 1992/93, consists of 3107 older adults aged 55-85, of which 966 aged 55-65 years. In 2002/03 and 2012/13, new cohorts were started with 1,002 and 1,023 older adults aged 55-65 years, respectively. The random samples were taken from the population registries of eleven municipalities in three socioculturally different geographic areas of the Netherlands. Each measurement wave has three components: a main interview, a self-report questionnaire, and a medical interview. Follow-up measurements of each cohort took place every three to four years. The first cohort contains 274 workers aged 55-65 years at baseline, the second cohort 416 workers, and the third cohort 617 workers (≥1 hour/week paid work).

Dutch Health Interview Survey (HIS)
The HIS is an annual cross-sectional health survey conducted by Statistics Netherlands since 1981 [58]. From 1981-1996, respondents were selected by taking a random sample of community households. From 1997, respondents were selected by taking a random sample of non-institutionalised individuals. I use data from the samples participating in 1990-2017. As of 1990, interviews were held face-to-face in the respondent's home. As of 2010, respondents were asked to participate by an online questionnaire. Non-respondents were reapproached and asked to participate by telephone or personal visit. Each year, the total sample consists of approximately 10,000 non-institutionalised persons (all ages) with the exception of the years 2010-2013 (15,000 persons each year). The number of unique respondents aged ≥16 years who participated in the period 1990-2017, and who provided information on health, was 172,599.

Dutch Public Health Monitor (PHM)
The PHM is a repeated cross-sectional health survey of the Community Health Services, Statistics Netherlands and the National Institute for Public Health and the Environment, conducted in 2012 and 2016 [59]. I use data from the 2016 sample. Respondents in 2016 aged ≥19 years were selected by taking a random sample of non-institutionalised individuals (N≈460,000). The sample was invited to fill in an online questionnaire. Part of

the sample received a paper version of the questionnaire immediately, others received the paper version if he/she did not respond. A very low proportion was approached by telephone or personal visit (<0.5%). The number of respondents aged 55-75 who provided information on health was 205,151.

AIM AND OUTLINE OF THIS THESIS

Aim

The main aim of this thesis is to provide insight in the health of the older working population, the older working-age population and former workers, during times when labour participation rates have increased and people are working until older ages. Based on the insight on their health, I will express expectations about the health of the future older working population.

In this thesis, three themes are addressed:
I. Historical trends in working life expectancy (WLE) in poor health
II. Historical trends in working conditions and health
III. Future health

I. Historical trends in working life expectancy in poor health

The first theme is addressed in **Chapters 2 and 3**. In these chapters**,** the consequences of changes in (early) retirement policies on WLE in poor health in the Netherlands are examined by comparing cohort data of LASA of three different time periods: 1992/93-1995/96, 2002/03-2005/06 and 2012/13-2015/16. In **Chapter 2**, respondents aged 55-65 with a paid job at baseline (1992/93, 2002/03 and 2012/13), and with follow-up information on employment status, are included (n=1,074). Disability is measured using the Global Activity Limitations Indicator (GALI). First, a continuous-time three-state survival model is created. Second, WLEs with and without disability are estimated using MSM and ELECT in R. The modifying effects of gender and educational level are also examined. In **Chapter 3**, workers aged 55-65 with a chronic disease at baseline (1992/93, 2002/03 and 2012/13), and with follow-up information on employment status, are included (n=705). Self-rated health is examined using the following question: 'How is your health in general?'. Those who reported to have 'fair', 'sometimes good, sometimes bad' or 'poor' health are classified as having poor health. The analyses are similar to those in **Chapter 2**.

II. Historical trends in working conditions and health

The second theme is addressed in **Chapters 4 and 5**. In **Chapter 4**, trends in physical, cognitive and psychological functioning are examined among three successive cohorts of Dutch workers aged 55 to 65 in 1992/93, 2002/03 and 2012/13. Individuals aged 55-65 with a paid job are included (n=1,307). Physical functioning is measured using the Timed Chair Stand Test, cognitive functioning by a Coding Task and psychological

functioning by the positive affect scale from the Center for Epidemiological Studies Depression Scale (CES-D). The contribution of the change in physical and psychosocial work demands and psychosocial work resources to these trends are examined subsequently. Working conditions are deduced from a general population job exposure matrix, which distinguishes physical demands, psychosocial demands and psychosocial resources. Linear and logistic regression analyses are performed.

In **Chapter 5**, trajectories in health across the work exit transition for older workers with high versus low physical demands, psychosocial demands, and psychosocial resources are examined in the 1990s, 2000s and 2010s. Health is examined with three health indicators: self-rated health, psychological functioning and physical limitations. Self-rated health was measured by a single self-report question: "How is your health in general?", with five response categories. Psychological functioning was measured by the positive affect scale from the CES-D. Physical limitations were measured using self-reports to six questions. Working conditions are deduced from a general population job exposure matrix, which distinguishes physical demands, psychosocial demands and psychosocial resources. Data from 1992/93-1995/96, 2002/03-2005/06 and 2012/13-2015/16 are compared. Selected respondents are aged 55-65 years with a paid job at baseline and no job at follow-up (n=383). Generalised Estimating Equations are performed with working conditions as main determinants and pre- to post-exit trajectories in self-rated health, psychological functioning, and physical limitations as outcomes. Differences across the periods regarding the relation between working conditions and health trajectories are examined.

III. Future health

The third theme is addressed in **Chapter 6**. In this chapter, I explore health up to 2040 of Dutch adults aged 60 to 68 (statutory retirement age for future older workers). Historical trends in health from the Dutch HIS from 1990-2017 (n=172,599) and the health level according the Dutch PHM 2016 (n=205,151) are used. Health is operationalised using a combination of two health indicators: self-rated health and limitations in seeing, hearing and mobility. Two scenarios are explored that are likely for the Dutch situation: a stable (flat) health trend and an improving health trend. First, health trends in 5-year age categories are modelled up to 2040 with a logistic regression analysis using data from HIS 1990-2017. Second, the growth factor from 2016 to 2040 is applied to the health level from the PHM 2016. It is assumed that the two scenarios indicate a bandwidth between which health will develop.

General Discussion

In **Chapter 7**, the results are summarised and interpreted in light of the overall aim of this thesis. In addition, strengths, limitations and implications are discussed.

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Chapter 2

Changes in working life expectancy with disability in the Netherlands, 1992–2016

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ABSTRACT

Objectives: Like other Western countries, the Netherlands has abolished early retirement schemes and is currently increasing the statutory retirement age. It is likely that also older workers with disabilities will be required to work longer. We examine the change in working life expectancy (WLE) with disability of older workers, by comparing data from three periods: 1992-1996, 2002-2006 and 2012-2016.

Methods: Data are from the Longitudinal Aging Study Amsterdam (LASA). Respondents aged 55-65 with a paid job at baseline were included (N = 1074). Disability was measured using the Global Activity Limitations Indicator (GALI). First, a continuous-time three-state survival model was created. Second, WLEs with and without disability were estimated using MSM and ELECT in R. The modifying effects of gender and educational level were examined.

Results: Among those initially in paid employment, total WLE increased over twenty years. For example at age 58, total WLE increased from 3.7 to 5.5 years. WLE with disability at age 58 increased from 0.8 to 1.5 years. There was no difference in WLE with disability between male and female workers or low- and highly educated workers.

Conclusions: Between the 1990s and the 2010s, subsequent generations of older workers with disabilities have extended their working lives. The findings emphasize the importance of workplace interventions that facilitate older workers with disability to maintain well-being and work ability. In addition, the question arises whether current exit routes out of the workforce are still adequate.

INTRODUCTION

Western societies are facing demographic changes such as ageing of the population and shrinkage of the workforce [1]. Like other policy-makers, the Dutch government has taken action to counteract the negative financial consequences of these changes. The policy measures concern discouraging early work exit through early retirement, disability pensions and unemployment by making these routes less attractive. In addition, the statutory retirement age is currently being raised. Parallel to these policy measures, the average actual retirement age has increased from below age 61 in the early 1990s to age 64.5 in 2016 [2, 3].

In the 1990s and early 2000s, employers and the Dutch Government financially supported early retirement, which was common [3]. However, this regulation has been phased out since 2005/2006 and early retirement has become financially unattractive [4, 5]. Furthermore, the statutory retirement age, with its accompanying basic state pension, is increasing gradually from 65 years in 2012 to 67 years and three months in 2022; a further increase is foreseen [6, 7]. Since 1966, workers with occupational limitations due to poor health could rely on the social security system to receive a disability benefit. In 2002, regulations were adjusted to support disabled workers with trainings and trial placements, in order to withdraw them from and prevent them from entering the disability scheme, and in 2006 the qualification criteria for receiving a disability pension became stricter [8, 9]. From 1987, people who became unemployed and met specific criteria were eligible for benefits for more than five years under the Unemployment Insurance Act. An extension with another three and a half years was possible with the “Follow-up-benefit” [9], but this was abolished in 2003. In 2006 the maximum period of receiving unemployment benefits was adjusted to 38 months [10]. The benefit to workers aged 63 years or older to bridge the gap between the unemployment benefit and the basic state pension was reduced [11].

A substantial number of people aged 55 and over is in poor health, which is likely to affect their labour participation [12, 13]. Poor health creates a discrepancy between job requirements and work capabilities [14]. According to a systematic review, self-perceived health, mental health, chronic diseases, musculoskeletal diseases and respiratory diseases increase the likelihood of early exit. This exit has several routes, e.g. via disability benefits, unemployment or early retirement [13]. Older adults who continue working despite poor health may experience reduced productivity. Musculoskeletal complaints, multimorbidity and psychological disorders are associated with low performance and increased sickness absence [15]. Other studies stress that it is not a disease itself that limits work participation, but the consequences of the disease and, in particular, associated disabilities [16, 17].

The extent to which changes in employment policy regulations have affected the number of years older adults work with disability is yet unknown. This can be measured with the working life expectancy (WLE) measure. This summary measure is similar to life expectancy, which is often divided in years into good and poor health [18], but with exit from the workforce as the final state instead of death. Nurminen et al. introduced WLE in a cohort of Finnish municipal workers, and examined the number of years the participants work in different states of work ability [19]. Burdorf and Jansen focused on the years workers lose in the workforce due to low back pain, comparing workers with high versus low physical load [20]. Lièvre et al. compared healthy life expectancy with healthy WLE at age 50 in twelve European countries. In their study, the unhealthy state was a combination of a chronic physical or mental health problem, illness or disability and limitations in daily activities [21]. Although various health measures were used in these studies, all emphasize the importance of considering disability when addressing WLE.

It can be expected that WLE with disability is different for men and women, and low and highly educated workers. Women often work part-time and men full-time [22], consequently the threshold to exit from the workforce may be lower for women. This is in particular the case for women with a partner, because the household is often less dependent on the income of the woman [23, 24]. Lièvre et al. showed that in the Netherlands, at age 50, unhealthy WLE was 2.1 years for men and 1.5 years for women [21]. Based on these gender differences and the policy reforms regarding early exit that have taken place, we expect that in particular men work increasingly more years with disability. With regard to educational level, there is evidence that highly educated workers have the economic resources to exit work early. As early retirement schemes have been diminished and disability schemes have become stricter, we expect that in particular in recent years low educated workers have been working with disability for more years compared to highly educated workers [25].

This study examines the change in WLE of older workers with disability, by comparing cohort data of three different time periods: 1992-1996, 2002-2006 and 2012-2016. Due to policy changes that have limited early retirement routes in the Netherlands, we expect that the number of years older adults work with disability has increased. In addition, we expect that men and low educated people work increasingly more years with disability compared to women and highly educated people, respectively.

METHODS

Sample

Data are from the Longitudinal Aging Study Amsterdam (LASA). LASA is a continuing Dutch population-based cohort study on predictors and consequences of changes in physical, cognitive, social and emotional functioning with ageing [26, 27]. The first LASA cohort (1992/1993) consisted of 3107 older adults aged 55-85, of which 966 aged 55-65. In 2002/2003 and 2012/2013, new cohorts were started with 1,002 and 1,023 older adults aged 55-65, respectively. Follow-up interviews took place every three years. For this study, data of the first two observations were analysed (T0 and T1). Observations in 1992/1993, 2002/2003 and 2012/2013 were considered as baseline for the three cohorts. Respondents with a paid job at baseline were selected (n = 1315). We excluded workers who did not participate in the study at T1 (i) for other reasons than dying (N=125), (ii) due to missing information on health (T0 or T1) or employment status (T1), (iii) because they had opted for a shortened face-to-face interview at T1 (N=30) or a shortened telephone interview at T1 (N=80), or (iv) for other reasons (N=6). The main reasons for not participating at T1 were lack of interest. Only six respondents reported health reasons. Non-response at T1 was not selective in terms of age, gender, educational level and baseline disability. The final study sample consisted of 1074 respondents, of which 23% belonged to the first cohort, 36% to the second cohort and 41% to the third cohort. This reflects that in recent years the proportion of workers in the age category 55 to 65 years increased.

Outcome

The outcome variable consists of three possible states, being in the workforce without disability (state 1), in the workforce with disability (state 2) and out of the workforce (state 3). At baseline, all respondents are in either the first or second state. At follow-up, they are in all three states.

Disability is measured using the Global Disability Indicator (GALI) [28]. In LASA, the following questions are asked: “Do health problems limit your normal daily activities?” (yes, severely; yes moderately; no) and, if so, “Do these limitations last for more than three months?” (yes; no). If both questions were answered positively, the respondent was classified as having disability. This binary variable is commonly used for estimating healthy life expectancies [29]. Two other measures of disability were used to check the robustness of findings: six self-reported questions and a Chair Stand Test. The six questions concerned difficulty in climbing or descending stairs of 15 steps without stopping, getting dressed and undressed, sitting down and standing up from a chair, cutting one’s toenails, walking outside for five minutes, and using public transport. These questions were selected from the validated Organization for Economic Co-operation and Development Questionnaire [30]. If the respondent had (some) difficulties on at least one item, he or she was classified as having disability. The Chair Stand Test involved standing up and sitting down with folded arms, five times at usual pace. The total time needed

was recorded by the interviewers. To categorize this variable, quartiles were used based on the time required in the total LASA sample in this age group [31]. Respondents in the upper quartile (requiring ≥13 seconds to perform the test), those who used their arms, and those who could not perform the test at all, were categorised as having disability.

In state 3, the respondents have stopped working. The age at which people ended paid work was assessed with the question "In which month and which year did you stop doing paid work?". If the month and year of exit from the workforce was unknown (n = 36), the date halfway between the two interviews was used to calculate the age of exit from the workforce. For the deceased respondents (n = 20), the age of exit from the workforce is calculated based on the date of death minus six months, provided this date was not earlier than the baseline interview, because it can be assumed that in most cases there has been a period of illness before death in which respondents did not work.

Covariates

Age at the time of the interview was based on the date of interview and the birthdate. The birthdate and gender were obtained from the municipal registry. Highest level of education completed comprises three levels: low (elementary school, lower vocational education or less), moderate (general intermediate, intermediate vocational, and general secondary education), and high (higher vocational education, college, and university). Age was used as continuous variable; cohort, gender and educational level as dummy variables.

Statistical analyses

Baseline characteristics were examined for the three cohorts, including a breakdown for workers with and without disability. Differences in age were tested using ANOVA, and differences in gender, educational level and disability were tested using χ^2.

In the three-state survival model the times of transitions between the first and second state are interval-censored. This means that the exact transition times between these states are assumed to lie somewhere between two observations and that transitions from state 1 to state 2, or the reverse, may take place several times. State 3 is an absorbing state, meaning that respondents can enter this state only once, the exact transition time of which is used from the data.

First, the model was fitted to the data with the MSM package in R, which estimates hazards for state transitions for age and cohort dummies [32]. Based on the hazards, hazard ratios and transition probabilities were derived. An age-dependent model was used, which assumes that state transitions increase or decrease log linearly with age. Subsequently, using disability prevalence and transition probabilities, WLEs were estimated with ELECT, a set of functions in R [33]. ELECT provides total WLE, divided into WLE with and without disability. Confidence intervals were calculated using simulation based on the maximum likelihood estimation (1000 repetitions). After estimating WLEs

for a range of specified ages, the results are presented in age-based figures. In Figure 1 and 2, the total WLE for all workers, independent of their health state, and for workers who already have disability, are presented. Both are estimated based on the total study sample. To improve readability, we discuss only WLEs at age 58, the median baseline age. WLEs for three categories of workers (workers independent of their health state, workers who already have disability and workers who do not have disability) from age 55 to 68 are available online (supplementary file A).

Second, the modifying effects of gender and educational level were examined. In MSM, additional hazards for state transitions for gender and educational level were estimated. Subsequently, WLEs were estimated stratified by cohort and gender, and by cohort and educational level. WLE estimates for one sub-group (e.g., low educated) were compared with the 95% confidence interval of the estimates for another sub-group (e.g., highly educated) and vice versa, to determine significant differences. In addition, interaction between cohort and gender, and cohort and educational level was tested to check whether state transitions differed for gender and educational level over the cohorts, based on HR with 95% CI.

Third, the robustness of findings was checked by repeating the analyses using indicators of disability based on self-report and the Chair Stand Test. WLEs at age 58 with 95% confidence intervals were compared for the three indicators.

RESULTS

Baseline descriptive characteristics

The proportion of workers with disability increased over the cohorts, as well as the proportion of female workers (*Table 1*). Educational level increased over the cohorts both for workers with and without disability. Moreover, in the third cohort, workers without disability were more often highly educated, while workers with disability were more often moderately educated. Mean age increased only among workers without disability.

Number of years worked with disability

In *Figure 1*, the estimated WLEs are presented for each age year for all initial workers independent of their health state. For example, at the age of 58, total WLE was 3.7 years (95% CI = 3.2-4.2) in the first cohort, 4.6 years (95% CI = 4.0-5.1) in the second cohort, and 5.5 years (95% CI = 4.9-6.0) in the third cohort. Across these cohorts, the estimated number of years worked with disability also increased. It was 0.8 (95% CI = 0.6-1.1), 1.1 (95% CI = 0.8-1.4), and 1.5 (95% CI = 1.2-2.0) years, respectively in the three cohorts. The increase in number of years worked with disability over the three cohorts is related to the increase in the prevalence of disability (see *Table 1*). Furthermore, workers who already had a disability stayed in the workforce longer while having a disability. *Figure 2* shows that at the age of 58, this number of years increased from 2.2 years (95% CI = 1.5-3.1) in the first cohort, to 2.6 (95% CI = 2.0-3.3) in the second, and to 3.4 years (95% CI = 2.7-4.1) in the third cohort.

Table 1. Baseline characteristics of the study sample

	Cohort 1								Cohort 2								Cohort 3								Total			
Disability [a*]	**No disability n = 210**				**Disability n = 38**				**No disability n = 308**				**Disability n = 72**				**No disability n = 343**				**Disability n = 103**				**n = 1074**			
	M	**SD**	**N**	**%**	**M**	**SD**	**N**	**%**	**M**	**SD**	**N**	**%**	**M**	**SD**	**N**	**%**	**M**	**SD**	**N**	**%**	**M**	**SD**	**N**	**%**	**M**	**SD**	**N**	**%**
Gender [a*]																												
Men			129	61			28	74			182	59			46	64			180	52			62	60			627	58
Women			81	39			10	26			126	41			26	36			163	48			41	40			447	42
Educational level [a*** d* e*** f*]																												
Low			89	42			17	45			89	32			31	43			65	19			23	22			323	30
Moderate			74	35			15	39			105	34			24	33			131	38			51	50			400	37
High			47	22			6	16			105	34			17	24			147	43			29	28			351	33
Age [a*** e**]	59.0	2.8			58.8	2.6			58.7	2.7			58.6	2.7			59.4	2.6			59.3	2.6			59.0	2.7		

*** p<0.001; ** p<0.01; * p<0.05; M = mean; SD = standard deviation; n = number of respondents; % = percentage;

a = significant difference among respondents between cohort 1, 2 & 3

b = significant difference between respondents with and without disability in cohort 1

c = significant difference between respondents with and without disability in cohort 2

d = significant difference between respondents with and without disability in cohort 3

e = significant difference among respondents without disability between cohort 1, 2 & 3

f = significant difference among respondents with disability between cohort 1, 2 & 3

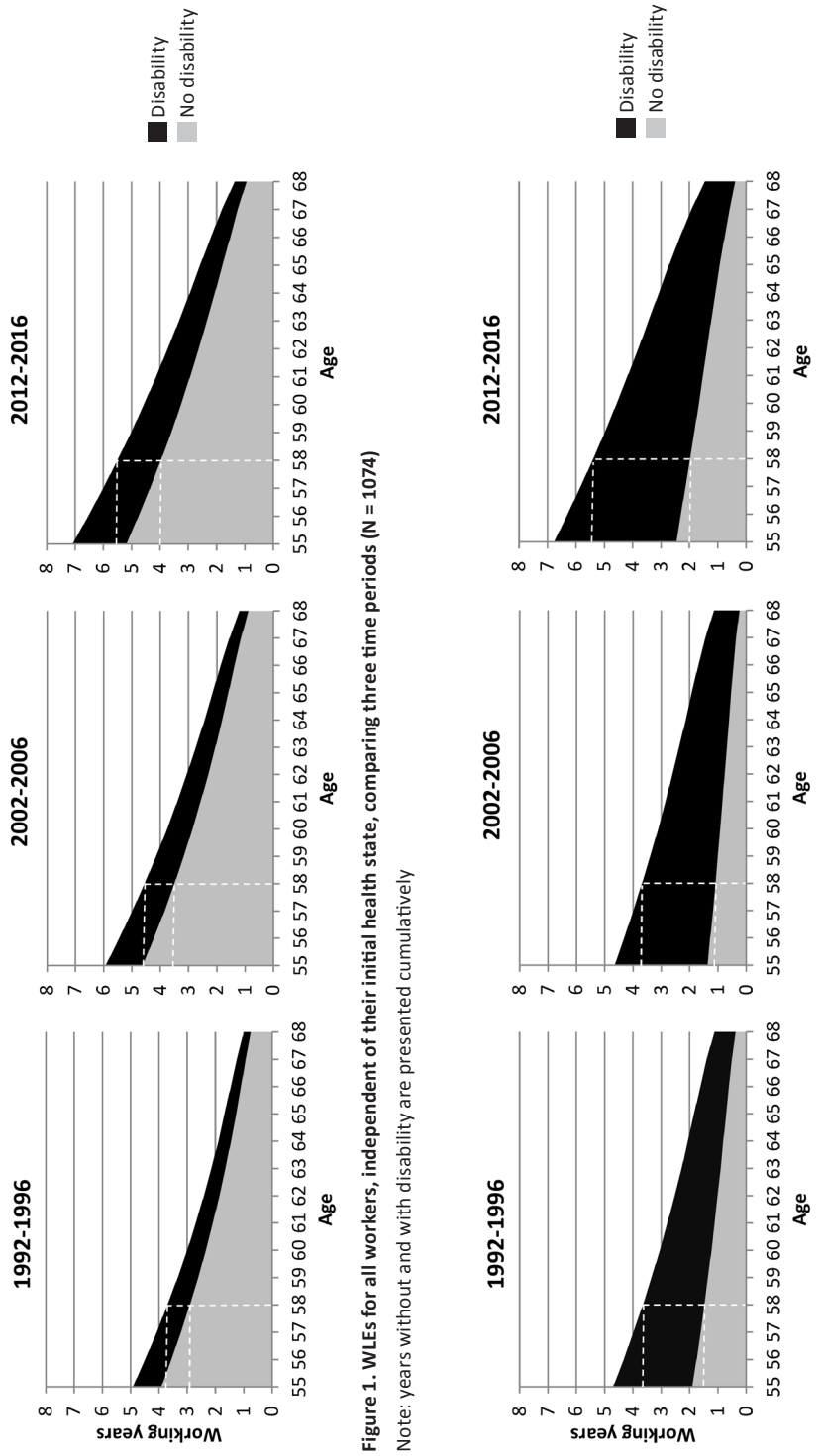

Figure 1. WLEs for all workers, independent of their initial health state, comparing three time periods (N = 1074)

Note: years without and with disability are presented cumulatively

Figure 2. WLEs for workers with disability at the specified ages comparing three time periods (N = 1074)

Note: years without and with disability are presented cumulatively

Gender differences in WLE

There were no gender differences in total WLE, WLE with disability and WLE without disability between workers in the three cohorts. Neither was there an interaction of cohort with gender in state transitions (results available in supplementary file B).

Education-based differences in WLE

Estimates of WLEs stratified by educational level showed no difference in WLE with disability between low and highly educated workers in any of the cohorts (see *Table 2*). There were education-based differences in total WLE in the second and third cohort. Highly educated workers had a higher total WLE compared to low educated workers. Tests of interaction effects of cohort with educational level indicated that differences between low, moderate and highly educated workers did not change over time (results available online in supplementary file C).

Table 2. WLEs at age 58 for all workers, independent of their health state, stratified by educational level (N = 1074)

		WLE without disability		WLE with disability		Total WLE	
	Educational level	Years	95% CI	Years	95% CI	Years	95% CI
1992-1996	**low**	2.60	2.13-3.08	0.86	0.56-1.24	3.46	2.92-4.01
	moderate	2.96	2.44-3.48	0.80	0.51-1.15	3.75	3.14-4.35
	high	3.56*	2.87-4.23	0.60	0.34-0.99	4.16	3.39-4.93
2002-2006	**low**	2.95	2.50-3.48	1.17	0.79-1.60	4.12	3.52-4.77
	moderate	3.36	2.83-3.98	1.07	0.70-1.47	4.43	3.81-5.09
	high	4.14*	3.43-4.84	0.91	0.58-1.31	5.04*	4.26-5.77
2012-2016	**low**	3.32	2.66-3.91	1.81	1.27-2.41	5.14	4.26-5.82
	moderate	3.75	3.12-4.35	1.68	1.18-2.20	5.43	4.64-6.02
	high	4.65*	3.94-5.33	1.29	0.88-1.79	5.94*	5.14-6.68

* = values differ from low educated workers, with $p<0.05$

WLE robustness

There were no differences in WLEs with disability using the GALI, the six self-reported questions and the Chair Stand Test (results available in supplementary file D). This indicates that the estimates for WLEs with disability are robust for differences between disability indicators.

DISCUSSION

This study aimed to examine the change in WLE with disability of older workers comparing cohorts of workers in the 1990s, 2000s and 2010s. WLE with disability of older workers, independent of their health state, increased over the years. There were no differences in WLE with disability between male and female workers, and between low and highly educated workers.

Contextualizing the results

For workers aged 55+, WLE with disability increased over the years. This is due to an increase in both the prevalence of disability among older workers, and the number of years older workers with disability remain in the workforce. The incremental increase in the second and the third cohort suggests a direct effect from the abolishment of early exit routes and stricter requirements for disability benefits. These measures were introduced between 2002 and 2006 [9]. However, other societal developments also have contributed. The increase in educational level and decrease of physical labour has enabled older workers to work until older ages [34]. Moreover, the awareness that peers are also working until older ages has been suggested to enhance older workers' willingness to continue working [35].

This study showed that there were no differences in WLE with disability between male and female workers, nor did this potential difference increase over the years. We hypothesised that women would have a lower WLE with disability compared to men, which is in line with previous research [21]. Women often have part-time jobs with a corresponding lower income, and most of them have a bread-winning male partner who is usually older [23, 24, 36]. Both may lower the threshold for women to exit early [22]. However, working in a part-time job may also facilitate older women to continue working. These opposing factors appear to outweigh each other. Data from Statistics Netherlands show that only since 2012 have women exited the workforce earlier compared to men. The difference increased from 0.1 year in 2012 to 1.0 year in 2016 [2]. However, these small differences in the 2010s did not appear to affect WLE with disability differently for men and women in our study, and did therefore not increase the gender differences.

In addition, we hypothesised that WLE with disability would be higher for low compared to highly educated workers, in particular in the third cohort. Good economic circumstances offer opportunities for early exit [37], and highly educated workers generally have more economic resources to exit work early compared to low educated workers [25]. However, this hypothesis was not supported. There was no difference in WLE with disability between low and highly educated workers. Neither did the effect of educational level change over the cohorts. It seems that the reformed social security is still adequate enough in giving low educated workers the opportunity to exit the workforce early, which keeps socioeconomic differences limited. Data from Statistics Netherlands show that low educated workers indeed more often exit the workforce through disability and unemployment schemes [2]. Another explanation could be that highly educated workers choose to continue working with disability, while low educated workers are required to continue working, which masks socioeconomic differences. It may be expected lower educated workers suffer more from continuing work with disability compared to highly educated workers. First, low educated workers have more often physically demanding jobs, which makes it more difficult to perform the job in

presence of disability [38, 39]. Second, low educated workers are less likely to cope with their disability in their job [40]. Third, highly educated workers more often make use of part-time retirement arrangements, which enables them to continue working with disability while low educated workers continue working in their normal intensity [41]. Therefore, especially among the low educated workers, working with disability could result in a discrepancy between job requirements and work capabilities [14], which in turn can affect their work ability and productivity [42], as well as their well-being [43].

Methodological considerations

The use of data from the Longitudinal Aging Study Amsterdam (LASA) has several advantages. First, LASA is based on a representative sample of the Dutch older population, which offers a representative sample of the older working population as well. Second, LASA started in 1992, which provides an unique opportunity to compare WLE with disability over a period of twenty years. Third, in LASA multiple measures are available for disability. This allowed us to conduct a robustness check of our findings. Similar results were found when different measures of disability are used.

There are also limitations of this study. First, the sample of workers was relatively small. This gives statistical power issues when subgroups are compared. However, in the main analysis the three cohorts were pooled, improving the power. Still, we refrained from building an extended multivariate model and added the covariates gender and educational level separately in the model. Second, we included respondents in paid employment at baseline and exit from work was an absorbing state, meaning that non-workers who returned to work are not represented. Thus, WLE is estimated for workers only and not for all persons at a particular age. This may limit comparability with other studies, e.g. Lièvre et al. and Nurminen et al. [21, 44]. However, it is likely that omitting those who returned to work had only a negligible underestimating effect, because the probability of returning to work is low among older adults [45]. Moreover, the current study sample was too small to analyze non-workers at baseline and those returning to work. Third, selection bias in the form of the healthy worker effect could have played a role [46]. Before the age of 55, people may have exited the workforce already due to disabilities. However, it will not undermine the inference of the WLEs as these are estimated conditionally that one reaches the age of ≥55 while being in a paid job. In addition, we do not think that non-response had led to selection bias, because non-response was not selective in terms of baseline disability, and the main reason for drop-out was lack of interest, thus not health related. Fourth, WLEs are estimated for all ages included in the study sample (55-68 years) because over the entire age range, a proportion of the sample was still active in the workforce. It must be noted that the WLEs estimated at the highest ages are based on the hazards for state transitions computed at the younger ages, and might be less adequate. Therefore, we discussed only the WLE at age 58 years, the median baseline age. Fifth, working with disability is not necessarily related to reduced work ability, as defined by Ilmarinen [47], and

the association with work ability may vary between highly and low educated workers. Unfortunately, there was no measure on work ability available in LASA.

Implications for research and practice

The recent rise in WLE with disability could mean that disabled workers are well supported by their employers or colleagues to continue working, or that contemporary working conditions are more suitable to facilitate prolonged working with disability. Alternatively, disabled workers could be forced to continue working due to their financial situation. This may lead to reduced well-being and productivity of disabled workers. A study among older workers in the 2010s suggests that the increase of WLE with disability is involuntary, as a result of having too little time to adapt to the increased retirement age [39]. More research into differences in well-being and productivity between disabled and non-disabled workers might help to assess the impact of the increase of WLE with disability. In addition, attention has to be paid to the work ability of disabled low educated workers, both in research and at the workplace.

In the meantime, employers should support their disabled employees. Older workers with disability may benefit from managerial support and professional advice on how to cope at work in the presence of disability [48]. However, effective interventions for older workers to maintain their work ability and promote sustainable employability are lacking [49]. In addition, the Dutch government plays an important role in accommodating disabled workers to make a dignified exit from the workforce. The increased WLE with disability asks for re-evaluation of the current exit routes out of the workforce.

In view of the ongoing increase in the statutory retirement age, WLE with disability and possible differences between men and women, and between low and highly educated workers, should be monitored to prevent socioeconomic differences.

Conclusion

Between the 1990s and the 2010s, subsequent generations of older workers have extended their working lives with disability. The findings emphasize the importance of workplace interventions that facilitate older workers with disability to maintain well-being and work ability. In addition, the question arises whether current exit routes out of the workforce are still adequate.

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SUPPLEMENTARY FILE A

Table 1. WLEs for workers *in general* in three time periods (N = 1074)

		WLE without disability		WLE with disability		Total WLE	
Cohort	**Age**	Years	95% CI	Years	95% CI	Years	95% CI
1992-1996	**55**	3.92	3.33-4.47	1.00	0.68-1.35	4.93	4.23-5.48
	56	3.56	3.05-4.01	0.93	0.63-1.27	4.49	3.93-4.99
	57	3.22	2.75-3.67	0.86	0.60-1.16	4.08	3.55-4.57
	58	2.91	2.46-3.32	0.79	0.55-1.10	3.70	3.19-4.18
	59	2.61	2.22-3.03	0.73	0.48-1.00	3.34	2.86-3.81
	60	2.34	1.96-2.76	0.66	0.45-0.96	3.01	2.57-3.48
	61	2.09	1.74-2.47	0.61	0.40-0.91	2.70	2.26-3.12
	62	1.86	1.51-2.27	0.55	0.35-0.85	2.41	2.00-2.88
	63	1.65	1.30-2.08	0.50	0.29-0.78	2.15	1.75-2.60
	64	1.45	1.13-1.84	0.45	0.26-0.71	1.91	1.51-2.33
	65	1.27	0.97-1.58	0.41	0.22-0.63	1.68	1.31-2.04
	66	1.10	0.83-1.42	0.36	0.19-0.59	1.46	1.14-1.83
	67	0.94	0.66-1.20	0.31	0.15-0.51	1.24	0.94-1.53
	68	0.75	0.54-0.95	0.25	0.12-0.39	1.00	0.76-1.20
2002-2006	**55**	4.62	4.03-5.12	1.31	1.00-1.63	5.94	5.33-6.44
	56	4.23	3.70-4.74	1.22	0.89-1.55	5.45	4.87-6.00
	57	3.85	3.37-4.35	1.14	0.85-1.42	4.99	4.45-5.52
	58	3.50	3.00-4.00	1.06	0.77-1.34	4.55	4.00-5.08
	59	3.17	2.73-3.67	0.98	0.69-1.24	4.14	3.63-4.69
	60	2.86	2.41-3.32	0.90	0.60-1.23	3.76	3.25-4.27
	61	2.57	2.16-3.04	0.83	0.54-1.14	3.40	2.89-3.94
	62	2.30	1.88-2.76	0.76	0.48-1.07	3.06	2.54-3.55
	63	2.05	1.64-2.46	0.69	0.43-1.00	2.74	2.27-3.18
	64	1.81	1.41-2.18	0.62	0.36-0.90	2.43	1.97-2.86
	65	1.59	1.22-1.97	0.56	0.31-0.84	2.14	1.70-2.56
	66	1.37	1.04-1.70	0.49	0.26-0.70	1.85	1.49-2.22
	67	1.14	0.84-1.41	0.41	0.20-0.61	1.55	1.20-1.83
	68	0.88	0.68-1.08	0.32	0.16-0.45	1.20	0.97-1.38
2012-2016	**55**	5.19	4.62-5.76	1.90	1.50-2.34	7.09	6.39-7.67
	56	4.76	4.18-5.26	1.78	1.38-2.20	6.54	5.87-7.05
	57	4.35	3.80-4.84	1.65	1.27-2.07	6.01	5.34-6.57
	58	3.97	3.42-4.45	1.54	1.16-1.96	5.50	4.86-6.03
	59	3.60	3.09-4.08	1.42	1.05-1.79	5.03	4.40-5.55
	60	3.26	2.78-3.71	1.31	0.90-1.66	4.57	3.98-5.06
	61	2.94	2.43-3.41	1.20	0.84-1.59	4.14	3.53-4.64
	62	2.63	2.15-3.08	1.10	0.72-1.46	3.73	3.15-4.20
	63	2.34	1.90-2.75	0.99	0.61-1.36	3.33	2.76-3.76
	64	2.06	1.65-2.43	0.89	0.56-1.20	2.95	2.46-3.32
	65	1.79	1.40-2.13	0.79	0.46-1.10	2.58	2.11-2.93
	66	1.52	1.17-1.83	0.68	0.37-0.95	2.20	1.75-2.49
	67	1.25	0.97-1.52	0.56	0.30-0.76	1.80	1.43-2.04
	68	0.94	0.72-1.12	0.42	0.24-0.57	1.35	1.12-1.50

Table 2. WLEs for workers *with a disability at the specified ages* in three time periods (N = 1074)

		WLE without disability		WLE with disability		Total WLE	
Cohort	**Age**	Years	95% CI	Years	95% CI	Years	95% CI
1992-1996	**55**	1.90	0.97-2.86	2.80	1.75-3.90	4.70	3.04-5.80
	56	1.75	0.94-2.59	2.57	1.72-3.44	4.33	3.00-5.26
	57	1.61	0.91-2.35	2.37	1.58-3.19	3.98	2.85-4.90
	58	1.48	0.82-2.17	2.17	1.49-3.05	3.65	2.62-4.54
	59	1.35	0.74-1.98	1.99	1.33-2.76	3.34	2.41-4.11
	60	1.23	0.69-1.85	1.82	1.22-2.73	3.05	2.24-3.90
	61	1.12	0.61-1.70	1.66	1.07-2.47	2.78	2.02-3.57
	62	1.01	0.52-1.57	1.52	0.92-2.37	2.52	1.80-3.28
	63	0.90	0.40-1.42	1.38	0.83-2.14	2.28	1.57-2.97
	64	0.81	0.35-1.34	1.25	0.70-2.00	2.06	1.38-2.75
	65	0.71	0.30-1.19	1.13	0.59-1.82	1.84	1.22-2.47
	66	0.61	0.20-1.06	1.01	0.83-1.42	1.63	1.07-2.17
	67	0.51	0.17-0.91	0.89	0.38-1.50	1.40	0.88-1.84
	68	0.37	0.12-0.72	0.75	0.35-1.20	1.13	0.68-1.44
2002-2006	**55**	1.36	0.75-2.19	3.29	2.50-4.11	4.65	3.61-5.68
	56	1.27	0.72-1.96	3.04	2.32-3.79	4.31	3.35-5.20
	57	1.18	0.66-1.92	2.81	2.15-3.53	3.99	3.11-4.78
	58	1.09	0.58-1.84	2.59	1.97-3.27	3.68	2.85-4.52
	59	1.01	0.53-1.81	2.38	1.75-3.12	3.39	2.58-4.29
	60	0.92	0.45-1.63	2.19	1.56-2.91	3.11	2.24-4.01
	61	0.84	0.36-1.56	2.01	1.33-2.82	2.85	1.92-3.77
	62	0.77	0.30-1.53	1.84	1.21-2.63	2.60	1.70-3.55
	63	0.69	0.27-1.37	1.68	1.05-2.46	2.37	1.53-3.23
	64	0.61	0.18-1.24	1.53	0.90-2.25	2.14	1.26-2.91
	65	0.54	0.15-1.20	1.38	0.75-2.20	1.92	1.01-2.69
	66	0.45	0.12-1.00	1.24	0.66-1.95	1.69	0.94-2.36
	67	0.36	0.08-0.90	1.08	0.52-1.60	1.44	0.73-1.99
	68	0.24	0.06-0.68	0.90	0.42-1.28	1.14	0.60-1.49
2012-2016	**55**	2.46	1.70-3.33	4.31	3.46-5.05	6.77	5.61-7.66
	56	2.30	1.51-3.05	3.99	3.22-4.73	6.29	5.16-7.16
	57	2.14	1.40-2.96	3.69	2.94-4.42	5.83	4.72-6.66
	58	1.98	1.25-2.78	3.41	2.68-4.14	5.39	4.25-6.21
	59	1.82	1.09-2.57	3.14	2.43-3.89	4.97	3.83-5.71
	60	1.67	0.95-2.43	2.89	2.12-3.67	4.56	3.42-5.32
	61	1.52	0.84-2.23	2.65	1.92-3.39	4.17	3.06-4.89
	62	1.37	0.69-2.12	2.42	1.68-3.25	3.80	2.70-4.52
	63	1.23	0.57-1.95	2.20	1.42-2.97	3.43	2.39-4.08
	64	1.08	0.44-1.75	1.99	1.22-2.76	3.07	2.06-3.70
	65	0.93	0.34-1.59	1.78	1.03-2.49	2.71	1.78-3.24
	66	0.76	0.27-1.35	1.57	0.86-2.17	2.33	1.45-2.80
	67	0.58	0.18-1.12	1.34	0.67-1.85	1.92	1.21-2.29
	68	0.38	0.11-0.81	1.07	0.55-1.40	1.44	0.92-1.64

Table 3. WLEs for workers *without a disability at the specified ages* in three time periods (N = 1074)

		WLE without disability		WLE with disability		Total WLE	
Cohort	**Age**	Years	95% CI	Years	95% CI	Years	95% CI
1992-1996	**55**	4.31	3.69-4.82	0.66	0.39-1.01	4.97	4.26-5.51
	56	3.91	3.38-4.37	0.61	0.35-0.93	4.52	3.89-5.05
	57	3.54	3.05-4.01	0.56	0.33-0.87	4.10	3.57-4.59
	58	3.19	2.74-3.64	0.51	0.31-0.81	3.70	3.20-4.19
	59	2.87	2.44-3.32	0.47	0.26-0.73	3.34	2.85-3.83
	60	2.57	2.19-3.01	0.42	0.24-0.69	3.00	2.56-3.44
	61	2.30	1.92-2.71	0.38	0.21-0.64	2.68	2.23-3.13
	62	2.04	1.67-2.45	0.35	0.17-0.59	2.39	1.97-2.84
	63	1.81	1.44-2.26	0.31	0.15-0.56	2.12	1.69-2.59
	64	1.60	1.25-1.98	0.27	0.13-0.48	1.87	1.46-2.31
	65	1.40	1.08-1.73	0.24	0.11-0.43	1.64	1.26-2.03
	66	1.22	0.92-1.57	0.21	0.08-0.44	1.43	1.08-1.81
	67	1.04	0.73-1.33	0.17	0.06-0.34	1.21	0.88-1.52
	68	0.84	0.62-1.06	0.12	0.05-0.25	0.96	0.72-1.19
2002-2006	**55**	5.38	4.76-5.88	0.85	0.59-1.21	6.24	5.58-6.79
	56	4.93	4.34-5.47	0.79	0.52-1.15	5.72	5.08-6.30
	57	4.50	3.96-5.06	0.73	0.45-1.04	5.23	4.62-5.85
	58	4.09	3.55-4.62	0.68	0.43-0.98	4.77	4.17-5.31
	59	3.71	3.23-4.23	0.62	0.37-0.93	4.33	3.79-4.88
	60	3.35	2.85-3.84	0.57	0.35-0.90	3.92	3.39-4.46
	61	3.02	2.56-3.52	0.52	0.28-0.78	3.54	3.02-4.06
	62	2.71	2.24-3.19	0.47	0.24-0.76	3.18	2.66-3.70
	63	2.42	1.96-2.89	0.42	0.22-0.70	2.84	2.31-3.32
	64	2.14	1.68-2.61	0.37	0.16-0.64	2.51	2.00-2.96
	65	1.88	1.46-2.33	0.32	0.14-0.59	2.20	1.76-2.65
	66	1.63	1.24-2.04	0.27	0.11-0.53	1.90	1.47-2.30
	67	1.37	1.01-1.66	0.21	0.08-0.42	1.58	1.20-1.87
	68	1.07	0.83-1.27	0.14	0.05-0.28	1.22	0.95-1.41
2012-2016	**55**	5.98	5.39-6.58	1.20	0.85-1.59	7.18	6.45-7.82
	56	5.49	4.88-6.03	1.12	0.78-1.48	6.61	5.90-7.15
	57	5.03	4.47-5.57	1.03	0.67-1.39	6.06	5.35-6.65
	58	4.58	4.03-5.10	0.96	0.62-1.36	5.54	4.89-6.08
	59	4.17	3.64-4.67	0.88	0.55-1.22	5.04	4.36-5.54
	60	3.77	3.27-4.25	0.80	0.47-1.15	4.57	3.94-5.10
	61	3.40	2.86-3.88	0.73	0.41-1.12	4.13	3.47-4.66
	62	3.05	2.56-3.54	0.65	0.35-0.99	3.70	3.08-4.20
	63	2.72	2.25-3.17	0.58	0.28-0.94	3.30	2.68-3.77
	64	2.40	1.97-2.79	0.51	0.24-0.83	2.91	2.38-3.31
	65	2.10	1.65-2.49	0.43	0.19-0.77	2.53	1.95-2.94
	66	1.80	1.38-2.15	0.36	0.13-0.63	2.15	1.63-2.48
	67	1.49	1.15-1.77	0.27	0.10-0.50	1.76	1.36-2.05
	68	1.15	0.90-1.34	0.17	0.06-0.35	1.32	1.05-1.50

SUPPLEMENTARY FILE B

Table 4. Tests for interaction between cohort and gender (N = 1074)

	No disability -> Disability		No disability -> Exit		Disability -> No disability		Disability -> Exit	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Age in years	1.11	1.00-1.23	1.16*	1.10-1.22	1.11	0.97-1.27	1.11	0.99-1.22
Cohort (cohort 1 = ref)	1.03	0.34-3.15	0.51*	0.29-0.89	0.80	0.24-2.71	0.59	0.20-1.71
Gender (men = ref)	1.09	0.36-3.27	0.83	0.52-1.35	0.93	0.24-3.54	0.98	0.33-2.92
Cohort * Gender	0.86	0.42-1.78	1.27	0.88-1.82	0.90	0.37-2.19	1.19	0.59-2.43

Note: HR = Hazard Ratio; 95% CI = 95% Confidence Interval; * = p<0.05;Cohort number treated as continuous variable

Table 5. WLEs at age 58 for all workers, independent of their health state, stratified by educational level (N = 1074)

		WLE without disability		WLE with disability		Total WLE	
	Gender	Years	95% CI	Years	95% CI	Years	95% CI
1992-1996	**Men**	2.95	2.47-3.45	0.81	0.56-1.13	3.76	3.25-4.30
	Women	2.76	2.26-3.21	0.74	0.47-1.10	3.50	2.97-4.03
2002-2006	**Men**	3.54	3.04-4.07	1.13	0.80-1.49	4.67	4.10-5.18
	Women	3.42	2.90-3.99	0.93	0.64-1.30	4.35	3.77-4.96
2012-2016	**Men**	4.05	3.43-4.58	1.62	1.19-2.07	5.66	4.91-6.23
	Women	3.82	3.26-4.38	1.48	1.03-1.93	5.30	4.57-5.86

Note: * = values differ from male workers, with p<0.05

SUPPLEMENTARY FILE C

Table 6. Tests for interaction between cohort and education level (N = 1074)

	No disability -> Disability		No disability -> Exit		Disability -> No disability		Disability -> Exit	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Age in years	1.11*	1.01-1.24	1.16*	1.11-1.23	1.10	0.97-1.25	1.10	1.00-1.22
Cohort (cohort 1 = ref)	0.95	0.50-1.78	0.77	0.57-1.05	0.72	0.38-1.36	0.84	0.47-1.50
Education level (low = ref)	0.96	0.43-2.14	0.90	0.64-1.24	1.46	0.67-3.18	1.10	0.49-2.44
Cohort * Education level	0.91	0.54-1.51	0.97	0.76-1.23	0.87	0.51-1.48	0.86	0.51-1.44

Note: HR = Hazard Ratio; 95% CI = 95% Confidence Interval; * = p<0.05; Cohort number and education level is treated as continuous variable

SUPPLEMENTARY FILE D

Table 7. Working life expectancies for workers *in general* aged 58 for three disability measures

		WLE without disability		WLE with disability		Total WLE	
Cohort	**Disability indicator**	Years	(95% CI)	Years	(95% CI)	Years	(95% CI)
1992-1996	**GALI**	2.91	2.46-3.32	0.79	0.55-1.10	3.70	3.19-4.18
	1/6 limitations	2.79	2.40-3.22	0.84	0.53-1.21	3.63	3.18-4.12
	Chair Stand Test	2.80	2.38-3.23	0.73	0.51-0.99	3.53	3.06-3.96
2002-2006	**GALI**	3.50	3.00-4.00	1.06	0.77-1.34	4.55	4.00-5.08
	1/6 limitations	3.43	2.99-3.90	1.18	0.86-1.56	4.61	4.11-5.15
	Chair Stand Test	3.43	2.92-3.94	1.12	0.84-1.38	4.55	3.98-5.06
2012-2016	**GALI**	3.97	3.42-4.45	1.54	1.16-1.96	5.50	4.86-6.03
	1/6 limitations	3.78	3.35-4.23	1.76	1.31-2.19	5.54	4.95-6.09
	Chair Stand Test	3.94	3.36-4.40	1.66	1.28-1.99	5.59	4.89-6.14

Note: 95% CI = 95% Confidence Interval; * = WLE differs from GALI estimate with p<0.05; GALI: N = 1074, 1/6 limitations: N = 1068, Chair Stand Test: N = 1049.

Table 8. Working life expectancies for workers *with a disability* at 58 for three disability measures

		WLE without disability		WLE with disability		Total WLE	
Cohort	**Disability indicator**	Years	(95% CI)	Years	(95% CI)	Years	(95% CI)
1992-1996	**GALI**	1.48	0.82-2.17	2.17	1.49-3.05	3.65	2.62-4.54
	1/6 limitations	0.66*	0.22-1.45	3.31	1.97-4.58	3.97	2.64-5.24
	Chair Stand Test	1.58	0.87-2.28	1.89	1.26-2.65	3.47	2.37-4.36
2002-2006	**GALI**	1.09	0.58-1.84	2.59	1.97-3.27	3.68	2.85-4.52
	1/6 limitations	0.64	0.30-1.24	2.94	2.22-3.83	3.58	2.77-4.59
	Chair Stand Test	1.81	1.16-2.49	2.07	1.62-2.56	3.89	3.12-4.46
2012-2016	**GALI**	1.98	1.25-2.78	3.41	2.68-4.14	5.39	4.25-6.21
	1/6 limitations	1.45	0.90-2.18	3.81	2.94-4.64	5.26	4.24-6.19
	Chair Stand Test	2.28	1.49-2.96	3.38	2.71-3.92	5.66	4.56-6.28

Note: 95% CI = 95% Confidence Interval; * = WLE differs from GALI estimate with p<0.05; GALI: N = 1074, 1/6 limitations: N = 1068, Chair Stand Test: N = 1049.

Table 9. Working life expectancies for workers *without a disability* at 58 for three disability measures

		WLE without disability		WLE with disability		Total WLE	
Cohort	**Disability indicator**	Years	(95% CI)	Years	(95% CI)	Years	(95% CI)
1992-1996	**GALI**	3.19	2.74-3.64	0.51	0.31-0.81	3.70	3.20-4.19
	1/6 limitations	3.09	2.69-3.52	0.49	0.27-0.83	3.58	3.12-4.06
	Chair Stand Test	3.07	2.60-3.49	0.47	0.28-0.73	3.54	3.04-3.98
2002-2006	**GALI**	4.09	3.55-4.62	0.68	0.43-0.98	4.77	4.17-5.31
	1/6 limitations	4.04	3.54-4.54	0.79	0.51-1.18	4.84	4.29-5.41
	Chair Stand Test	3.94	3.39-4.51	0.82	0.55-1.10	4.76	4.13-5.30
2012-2016	**GALI**	4.58	4.03-5.19	0.96	0.62-1.36	5.54	4.89-6.08
	1/6 limitations	4.41	3.92-4.92	1.20	0.81-1.62	5.61	4.96-6.19
	Chair Stand Test	4.65	3.97-5.23	0.91	0.59-1.26	5.56	4.77-6.22

Note: 95% CI = 95% Confidence Interval; * = WLE differs from GALI estimate with $p<0.05$; GALI: N = 1074, 1/6 limitations: N = 1068, Chair Stand Test: N = 1049.

Chapter 3

Working life expectancy in good and poor self-perceived health among Dutch workers aged 55-65 years with a chronic disease over the period 1992-2016

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ABSTRACT

Objectives: Several governments have taken measures to encourage prolonged working. It is therefore likely that older adults with a chronic disease are required to work longer in poor self-perceived health (SPH) than before. This study examines to what extent working life expectancy (WLE) in good and poor SPH changed between 1992 and 2016 in workers with a chronic disease from age 55 onwards.

Methods: Three cohorts (1992, 2002, 2012) of workers with a chronic disease aged 55-65 years were selected from the Longitudinal Aging Study Amsterdam (LASA) with a three-year follow-up each (n=705). A three-state survival model was estimated, modelling transitions between states 'working with good SPH, 'working with poor SPH', and 'exit from work'. WLEs were estimated using MSM and ELECT in R.

Results: Of the workers with a chronic disease, total WLEs at age 55 were 5.2, 5.7, and 6.8 years in cohorts 1992, 2002 and 2012, respectively. Workers initially having poor SPH, had a total WLE of 4.7 years of which 2.4 years in poor health in cohort 1992. These workers had a total WLE of 5.2 years of which 3.3 years in poor health in cohort 2002, and a total WLE of 6.5 years, of which 3.6 years in poor health in cohort 2012.

Conclusions: Workers with a chronic disease extended their working lives by approximately 18 months from 1992 to 2016. In the first decade, unhealthy WLE increased, whereas in the second decade, healthy WLE increased, among both workers in general and workers initially having poor SPH.

INTRODUCTION

Western societies are facing demographic changes such as ageing of the population. This puts a pressure on social security systems. To counteract negative financial consequences, several governments have implemented measures to encourage prolonged working and discourage early exit from the workforce. One of the measures that the Dutch government took is that the statutory retirement age is gradually increasing from 65 years in 2012 to 67 years and three months in 2022 [1]. On top of the financial measures that should stimulate prolonged working among the general population, several measures have been taken to stimulate prolonged working among workers with health problems. Since 1966, workers with occupational limitations due to poor health had the opportunity to receive disability benefits in the Netherlands [2]. However, in 2002, regulations were adjusted to support workers with health problems to continue working and to encourage rapid return to work from the first day of sickness absence [2, 3]. Moreover, in 2006, qualification criteria to enter disability pension became stricter [3, 4]. This implies that older workers with health problems are particularly affected and may need to continue working despite poor health.

Poor health and exit from work were closely related in the recent past. According to a systematic literature review, having a chronic disease increased the likelihood of early exit from work via disability pension and unemployment [5]. As there are fewer possibilities to leave the labour market early, it is likely that also older adults with a chronic disease nowadays are required to work more years in poor self-perceived health than in previous decades. Self-perceived health is a comprehensive measure of health, meaning that it encompasses several aspects of health that are important to an individual. To illustrate, self-perceived health has previously been associated with depression [6, 7] and functional limitations [8]. Furthermore, it is a strong predictor of mortality, even when controlling for specific health indicators and other relevant factors known to predict mortality [9]. Hence, having a poor self-perceived health is not desirable from the perspective of a worker. As self-perceived health has previously been shown to be associated with absenteeism and presenteeism [10], working while feeling unhealthy may not be desirable from an employer's perspective either. It is thus important to examine whether prolonged working among workers with a chronic disease is not at the expense of their self-perceived health.

Success of policies aiming at prolonged working is often illustrated by an increase in the average age of leaving employment, because this is the primary goal of these policies. As working longer in poor self-perceived health is not desirable from the perspective of both workers and employers, one may advocate that prolonged working policies are successful, only if it does not increase time in poor self-perceived health. Thus, the question arises whether people are working more healthy years, or more unhealthy years.

This can be examined using the working life expectancy (WLE) measure. WLE is similar to life expectancy, except for the endpoint, which is exit from work instead of death.

In 2004, Nurminen et al introduced the WLE measure to investigate the number of years that municipal workers worked in different states of work ability [11]. Nurminen argued that the WLE measure, that represents duration of occupancy in a given state of work ability, should be preferred above other measures as an indicator of population health in the context of occupational health [11]. In 2007, Lievre et al introduced the healthy WLE measure, which the researchers defined as the number of years between the age of 50 and 70 years both in good health and employment, and compared healthy WLE of twelve European countries [12]. By combining information on participation in paid work and health status, both operationalisations of WLE show which part of the total WLE from a certain age are spent in good health, and which part in poor health. The Longitudinal Aging Study Amsterdam (LASA) [13, 14] provides the unique opportunity to estimate healthy and unhealthy WLE of older workers, and to compare WLE in good and poor self-perceived health over three cohorts, i.e. from 1992 to 1996, from 2002 to 2006 and from 2012 to 2016. Van der Noordt et al used these data to examine WLE with disability of a Dutch population of older workers [15]. To date, no studies on WLE in good or poor self-perceived health have been performed among older workers with chronic diseases.

To gain insight in the consequences of policies aiming at prolonged working for workers with a chronic disease, insight into healthy and unhealthy WLE among this group is of great value. Therefore, the current study aims to investigate to what extent WLE in good and poor self-perceived health changed between 1992 and 2016 in workers with a chronic disease from age 55 onwards.

METHODS

Design and study sample

Data from the Longitudinal Aging Study Amsterdam (LASA) were used. LASA is an interdisciplinary cohort study that aims to determine predictors and consequences of changes in functioning with aging [13, 14]. The cohort is based on a nationally representative sample of older adults aged 55–85 years and the initial response rate was 60% (n=3805). The study started in 1992. Since then, measurement cycles took place once every three years. Respondents were examined and interviewed in their homes by trained interviewers. Additional cohorts of respondents aged 55-64 years were recruited in 2002 and 2012 using the same sampling frame as for the 1992 cohort. More detailed information on the LASA study design can be found elsewhere [13, 14].

In the present study the first two measurement cycles from the three cohorts were used, i.e. cohort 1: 1992-1996, cohort 2: 2002-2006, and cohort 3: 2012-2016. Inclusion criteria for this study were having an age of 55 to 65 years at baseline, having a paid job of >=1 hours/week at baseline and having one or more chronic diseases at baseline. To assess employment status, respondents were asked if they had a paid job at present, including one or more hours of work per week. Respondents were asked for the presence of a chronic diseases in one question with the following answering options: 1) chronic non-specific lung disease 2) cardiac disease, 3) peripheral arterial disease, 4) diabetes mellitus, 5) cerebrovascular accident or stroke, 6) osteoarthritis, 7) rheumatoid arthritis, 8) cancer and 9) other. In cohort 1, 54% of the workers aged 55 to 65 years had at least one chronic disease. In cohort 2 this was 66% and in cohort 3 this was 73%. Workers who dropped out during follow-up, for other reasons than dying (n=81), and those who had missing information on self-perceived health or employment status at follow-up were excluded (n=87). These in- and exclusion criteria resulted in a study sample of 705 persons (cohort 1 n=134, cohort 2 n=247, cohort 3 n=324).

Self-perceived health

Self-perceived health was assessed using the following question: 'How is your health in general?' This question could be answered according to the following response options: 'very good', 'good', 'fair', 'sometimes good, sometimes bad', and 'poor'. Participants were classified as having good health if they reported to have 'very good' or 'good' health. Those who reported to have 'fair', 'sometimes good, sometimes bad' or 'poor' health were classified as having poor health.

Based on self-perceived health and employment status, respondents can be assigned to one of the following states: State I. 'Working with chronic disease and good health', State II. 'Working with chronic disease and poor health', and State III. 'Exit from work' (see Figure 1. Three-state survival model). To assess the number of months a respondent stayed in state I or state II, information on age at which they left paid employment was needed. This was assessed using the following question: 'In which month and which year did you stop doing paid work?'. Based on the registered date of birth, age at exit from work was calculated. If the month and year of exit were not reported (n=15), the date halfway between the two interviews was used to calculate the age at exit from work. For respondents who died within three years after an interview in which they reported to work, the date of death minus six months was defined as the age of exit from work (n=15).

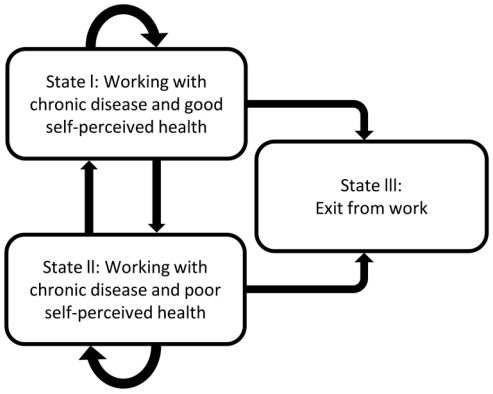

Figure 1. Three-state survival model

Demographics

Age and gender of the respondents at the time of the interviews were obtained from municipal registries. Highest level of education completed comprises three levels: low (elementary school, lower vocational education or less), medium (general intermediate, intermediate vocational, and general secondary education), and high (higher vocational education, college, and university). Gender and level of education were not included in the analyses, but they are used to describe the study population.

Statistical analyses

Descriptive statistics, i.e. means, standard deviations, frequencies, and percentages, were used to report on baseline characteristics. The analyses took place in two steps. First, transition probabilities between the states 'Working with chronic disease and good health' (state I), 'Working with chronic disease and poor health' (state II) and 'Exit from work' (state III) were modelled using a three-state survival model (Figure 1). In the three-state survival model the times of transitions between the first and second state are interval-censored. This means that the exact transition times between these states are assumed to lie between two observations and that transitions from state I to state II, or reversed, may take place several times. State III is an absorbing state, which means that this state can be entered only once. The exact transition time was obtained from the data. The model was estimated using the R-package Multi-State Modelling. Hazards were estimated for transitions between the states for age and cohort dummies [16]. From these hazards, HRs and transition probabilities were derived. An age-dependent model was used, which assumes that state transitions increase or decrease log linearly with age. Second, transition probabilities were used to estimate total WLEs as well WLEs in good and poor self-perceived health. This was done using the R-package Estimating Life Expectancies using Continuous Time. WLEs are reported by cohort, and for groups with good and poor self-perceived health at baseline separately. Differences between WLEs were considered statistically significant when the point estimate of one WLE was

not within the 95% confidence interval of the other WLE, and the other way around. WLEs are also graphically presented [17]. The graphs show WLEs in good and poor self-perceived health on the y-axis for age 55 to 68 years presented on the x-axis, for workers with a chronic disease in general and for workers who initially have poor self-perceived health, respectively. WLEs are shown separately for cohort 1992, cohort 2002 and cohort 2012.

Sensitivity analyses

As described under 'Design and study sample', we included workers having a paid job of >=1 hours/week at baseline in the main analyses. To test whether results were sensitive to this cut-off point of 1 hour/week we also performed sensitivity analyses in which we excluded workers who worked <=8 hours/week at baseline.

Ethical issues

Informed consent was obtained from all participants.

RESULTS

Baseline characteristics

Table 1 shows baseline characteristics of all workers with a chronic disease, and of those who initially had good and poor self-perceived health for the three cohorts separately. The average age varied between 58.8 years and 59.6 years across the three cohorts. All three cohorts included somewhat more men than women (54.6-61.9% men). Educational level increased over time. In cohort 1992 and 2002 most workers had a low level of education, whereas in cohort 2012 workers most workers had an intermediate level. The percentage of workers with a high level of education were 17.2, 28.7 and 35.2 for cohort 1992, 2002 and 2012, respectively. The percentage of workers having poor self-perceived health were, 46%, 46% and 49% for cohort 1992, 2002 and 2012 respectively.

Table 1. Baseline characteristic of the workers with a chronic disease who initially have good and poor self-perceived health and the total group of the three cohorts separately

	Good self-perceived health (n=478)			Poor self-perceived health (n=227)			Total (n=705)		
	Mean (SD) / N (%)			Mean (SD) / N (%)			Mean (SD) / N (%)		
	Cohort 1992 (n=92)	Cohort 2002 (n=169)	Cohort 2012 (n=217)	Cohort 1992 (n=42)	Cohort 2002 (n=78)	Cohort 2012 (n=107)	Cohort 1992 (n=134)	Cohort 2002 (n=247)	Cohort 2012 (n=324)
Age	59.3 (2.7)	59.0 (2.7)	59.5 (2.7)	59.4 (3.0)	58.5 (2.8)	59.6 (2.7)	59.3 (2.8)	58.8 (2.7)	59.6 (2.7)
Sex									
Male	52 (56.5%)	96 (56.8%)	116 (53.5%)	31 (73.8%)	47 (60.3%)	61 (57.0%)	83 (61.9%)	143 (57.9%)	177 (54.6%)
Female	40 (43.5%)	73 (43.2%)	101 (46.5%)	11 (26.2%)	31 (39.7%)	46 (43.0%)	51 (38.1%)	104 (42.1%)	147 (45.4%)
Educational level									
Low	40 (43.5%)	57 (33.7%)	39 (18.0%)	20 (47.6%)	33 (42.3%)	28 (26.2%)	60 (44.8%)	90 (36.4%)	67 (20.7%)
Intermediate	36 (39.1%)	58 (34.3%)	94 (43.3%)	15 (35.7%)	28 (35.9%)	49 (45.8%)	51 (38.1%)	86 (34.8%)	143 (44.1%)
High	16 (17.4%)	54 (32.0%)	84 (38.7%)	7 (16.7%)	17 (21.8%)	30 (28.0%)	23 (17.2%)	71 (28.7%)	114 (35.2%)

Working Life Expectancies

Total group of workers with a chronic disease

Among the total group of workers with a chronic disease, the total WLE at age 55 years was 5.2 years in cohort 1992, 5.7 years in cohort 2002 and 6.8 years in cohort 2012 (Table 2; Figure 2). The increase in total WLE between cohorts 1992 and 2002 was not significant, whereas the increase between cohort 2002 and 2012 was significant. Between cohort 1992 and cohort 2002 there was no difference in healthy WLE, but healthy WLE increased from 4.1 to 5.2 years between cohort 2002 and cohort 2012. Unhealthy WLE was 1.1 years in cohort 1992, 1.6 years in cohort 2002 and 1.6 years in cohort 2012. The increase in unhealthy WLE between cohorts 1992 and 2002 was not significant. Using a cut-off point of >=8 hours/week instead of >=1 hour/week did not lead to relevantly different results.

Workers with chronic disease who initially had poor self-perceived health

Among workers who initially had poor self-perceived health, the total WLE at age 55 years was 4.7 years in cohort 1992, 5.2 years in cohort 2002 and 6.5 years in cohort 2012 (Table 2; Figure 3). The increase in total WLE between cohort 1992 and 2002 was not significant, whereas the increase between cohort 2002 and 2012 was significant. Healthy WLE decreased from 2.3 in cohort 1992 to 1.9 years in cohort 2002, but this decrease was not significant. This decrease was followed by an increase to 2.9 years in cohort 2012. Unhealthy WLE increased from 2.4 in cohort 1992 to 3.3 years in cohort 2002. Between cohort 2002 and cohort 2012 WLE increased to 3.6 years, but this increase was not significant. Using a cut-off point of >=8 hours/week instead of >=1 hour/week did not lead to relevantly different results.

Table 2. Working Life Expectancy (WLE) of the workers with a chronic disease at age 55 years

	Cohort 1992 (n=137)		Cohort 2002 (n=251)		Cohort 2012 (n=324)	
	Years	95% CI	Years	95% CI	Years	95% CI
Workers in general						
Total WLE	5.2	4.4-6.0	5.7	5.1-6.4	6.8	6.1-7.5
Healthy WLE	4.1	3.3-4.8	4.1	3.5-4.7	5.2	4.5-5.9
Unhealthy WLE	1.1	0.7-1.6	1.6	1.2-2.1	1.6	1.2-2.1
Workers with good health						
Total WLE	5.5	4.5-6.3	6.0	5.2-6.7	6.9	6.1-7.7
Healthy WLE	4.9	4.0-5.7	5.2	4.5-5.9	6.3	5.5-7.0
Unhealthy WLE	0.5	0.2-1.1	0.8	0.5-1.3	0.6	0.4-1.1
Workers with poor health						
Total WLE	4.7	3.3-5.7	5.2	4.1-6.1	6.5	5.5-7.3
Healthy WLE	2.3	1.2-3.3	1.9	1.2-2.8	2.9	2.1-3.7
Unhealthy WLE	2.4	1.6-3.3	3.3	2.5-4.1	3.6	2.9-4.3

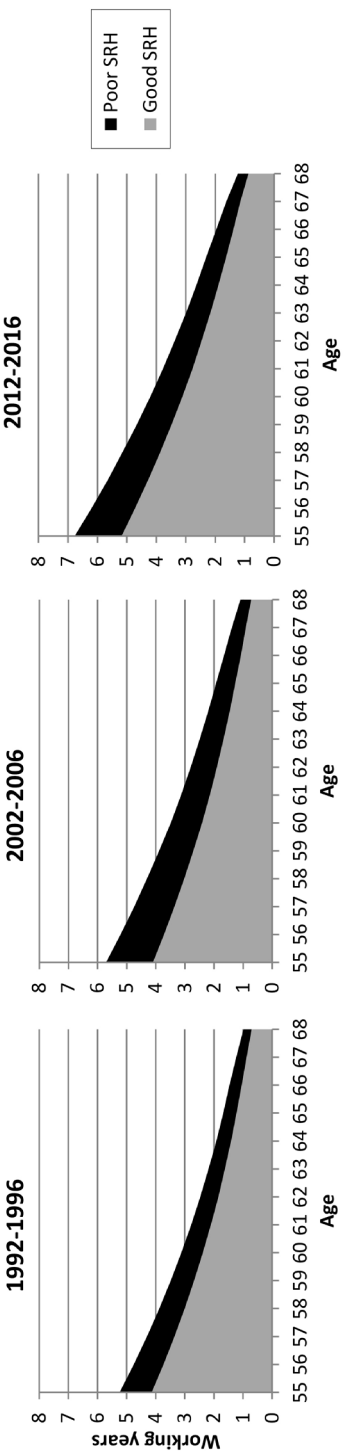

Figure 2. Working life Expectancies (WLEs) for total group of workers with a chronic disease

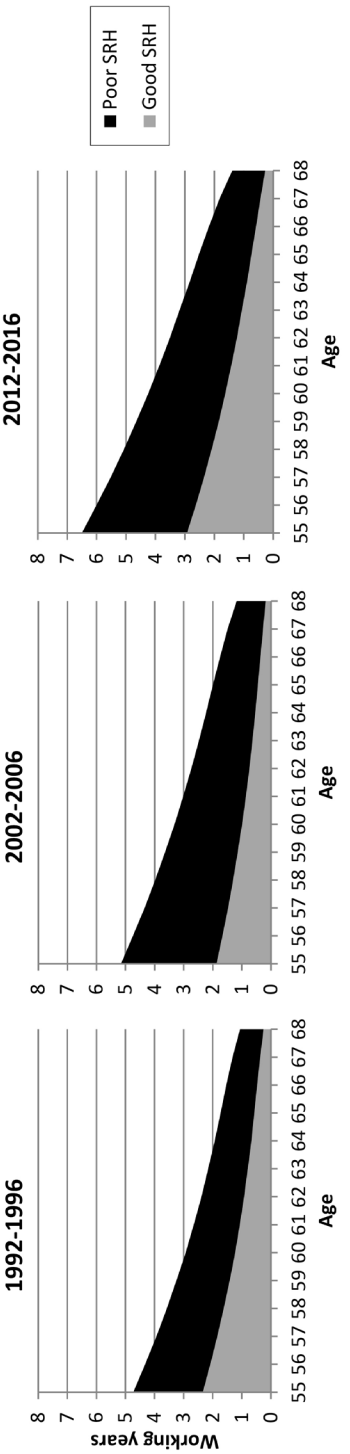

Figure 3. Working Life Expectancies (WLEs) for workers with a chronic disease who initially have poor self-perceived health

DISCUSSION

This study showed that older workers with a chronic disease extended their working lives by about 18 months from 1992-1996 to 2012-2016. Workers who initially had poor self-perceived health extended their working lives by 21 months. In the first decade (period from measurement of cohort 1992 to measurement of cohort 2002) it was unhealthy WLE that increased, and in the second decade (period from measurement of cohort 2002 to measurement of cohort 2012), healthy WLE.

The finding that successive generations of workers with a chronic disease extended their working lives by about 18 months from 1992-1996 to 2012-2016 may be explained by the fact that in this period several measures were taken to encourage people to work longer and discourage early exit from the workforce [1]. Also measures especially pertaining to workers with health problems may explain increasing WLEs of successive generations of workers [3, 4]. The increase in total WLE is in line with the increasing average age of leaving employment in the general population in the Netherlands, i.e. from 60 years and ten months in 2000 up to 64 years and five months in 2016 (figures before 2000 on average age of leaving employment are not available) [18]. However, also other societal developments may have contributed. To illustrate, in the Netherlands there is a general increase in educational level [19], which allow people to have an higher occupational class. Higher occupational class is associated with less hazardous physical working conditions and higher job control [20], this may have enabled workers to continue working until higher ages. Policies aiming at prolonged working indeed seem to have influenced the total WLE of both chronically ill workers who initially have good or poor self-perceived health. Our findings challenge the existing belief that workers with chronic diseases may not be able to prolong their working lives. It should, however, be noted that the study sample of workers with a chronic disease was a healthy selection of the total population with chronic diseases, i.e. a healthy worker effect [21]. The workers in our study sample succeeded in continuing their working careers to the age of 55 years and beyond, whereas the more vulnerable workers with a chronic disease may already have left employment before reaching this age.

Remarkably, the *unhealthy* WLE increased in the first decade (among workers who initially had poor self-perceived health), whereas the *healthy* WLE increased in the second decade (both among workers who initially had good or poor self-perceived health). This may indicate that the different measures to encourage prolonged working that were taken over time had different implications for healthy and unhealthy WLE. The measures that were taken in 2002 were meant to encourage rapid return to work among workers on sick leave [3, 22]. Considering our results, these new regulations seem to have facilitated prolonged working among workers with a chronic disease who perceive their health as poor. Subsequently, the stricter qualification criteria to enter disability pension that were adopted in 2006, seem to have stimulated prolonged

working mainly among workers with a chronic disease who actually felt healthy [3, 4]. It might also indicate that in the nineties, there was still potential for growth in unhealthy WLE, that was no longer present in the second decade. Further research among future generations of older workers with a chronic disease has to reveal this. Another explanation may be the increase in educational level throughout the three cohorts. It may be hypothesised that workers with a higher level of education are less likely to continue working while feeling unhealthy than workers with a lower level of education as they are more likely to have the financial possibility to quit working, i.e. because of higher earnings before and after retirement. The financial possibility to retire early indeed has been shown to contribute to early retirement [23]. A final explanation might be that successive generations of workers with a chronic disease, over time, may attach less importance to the presence of this chronic disease in their assessment of self-perceived health. This is supported by a previous study that showed that between 1992 and 2009 poor self-perceived health is determined less by chronic diseases and more by severe disability [24].

Strengths and limitations

In this study we applied an innovative method among older workers with a chronic disease. The LASA sample is based on a representative sample of the Dutch older population, including a representative sample of the older working population. A limitation of this study is the small sample size in the three cohorts, which resulted in relatively large confidence intervals. However, attrition rate was low. Because of the small sample size, we were not able to correct for confounders or compare subgroups based on, for example, sex and educational level. This would have resulted in statistical power issues. Furthermore, due to the small sample size, we were not able to assess to what extent WLEs were sensitive to the categories used to define poor self-perceived health. A second limitation is that all data relied on self-reports. With regard to chronic diseases, it is not sure whether employees indeed were diagnosed with these chronic diseases and whether all diagnosed diseases were reported. Another issue is the temporal resolution of assessing self-perceived health that is different from the temporal resolution of assessing exit from work, i.e. once in three years and monthly, respectively. However, since self-perceived health has been shown to be a relatively stable health measure, at least over a period of 1-3 years [25, 26], we do not expect bias because of this. A final limitation is that exit from work was an absorbing state in our model, while in practice people may enter the workforce after an initial exit. However, in our study only 3.6% of the non-workers with a chronic disease at the first measurement cycle had re-entered the workforce at the second measurement cycle. Therefore we do not expect major bias from this.

Implications for workers, employers and society

The overall increase in total WLE of workers with a chronic disease without an increase in years working in poor self-perceived health in the last decade could imply that this

group became well able and supported to prolong their working lives. On the other hand, it could also imply that this group feels forced to work longer, with potentially negative consequences for their productivity [10]. Now that working (longer) with health problems becomes more common, it becomes increasingly important that employers support this group of workers to prolong their working lives. It is likely that they have specific needs with regards to prolonged working. To illustrate, a study among older workers with and without chronic diseases showed that workers with chronic diseases benefitted more from psychosocial resources at work, such as social support and autonomy, than workers without chronic diseases [27].

Furthermore, healthy and unhealthy WLE may be used as an indicator to monitor the health of the working population. Healthy and unhealthy WLE may be used as an additional criterion for success of policies aiming to prolong people's working lives, in addition to figures regarding the average age of leaving employment. By doing so, a connection is created between policies aiming at prolonged working and ambitions related to successful ageing. After all, successful ageing does not only involve sustained engagement in social and productive activities in society, but also avoidance of disease and disabling conditions [28, 29]. Governments may commit themselves to promoting health of older workers by introducing the healthy and unhealthy WLE indicator, setting targets, and to collect data needed to monitor these targets. Future research could focus on healthy and unhealthy WLE of vulnerable groups in the labour market, e.g. workers with low socioeconomic position and workers in flexible jobs, as well as developments over time. Thus, it can be monitored what the consequences of social policies are for the healthy and unhealthy WLEs of different groups in the labour market.

Conclusion

Total WLE of successive generations of workers with a chronic disease increased by approximately 18 months between 1992 and 2016. Remarkably, in the first decade, *unhealthy* WLE increased, whereas in the second decade, *healthy* WLE increased. Now that working longer with health problems becomes more common it becomes increasingly important to enable this group to continue working sustainably. Healthy and unhealthy WLE may be valuable information in the future debate on prolonged working of vulnerable groups in the labour market.

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Chapter 4

Trends in working conditions and health across three cohorts of older workers in 1993, 2003 and 2013: A cross-sequential study

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ABSTRACT

Background Over the past decades, the number of older workers has increased tremendously. This study examines trends from 1993 to 2013 in physical, cognitive and psychological functioning among three successive cohorts of Dutch older workers. The contribution of the changes in physical and psychosocial work demands and psychosocial work resources to change in functioning is examined. Insight in health of the older working population, and in potential explanatory variables, is relevant in order to reach sustainable employability.

Methods Data from three cohorts (observations in 1993, 2003 and 2013) of the Longitudinal Aging Study Amsterdam (LASA) were used. Individuals aged 55-65 with a paid job were included (N=1307). Physical functioning was measured using the Timed Chair Stand Test, cognitive functioning by a Coding Task and psychological functioning by the positive affect scale from the CES-D. Working conditions were deduced from a general population job exposure matrix. Linear and logistic regression analyses were performed.

Results From 1993 to 2013, time needed to perform the Timed Chair Stand Test increased with 1.3 seconds (95%CI=0.89-1.71), to a mean of 11.5 seconds. Coding Task scores increased with 1.7 points (95%CI=0.81-2.59), to a mean of 31 points. The proportion of workers with low positive affect increased non-significantly from 15% to 20% (p=0.088). Only the improvement in cognitive functioning was associated with the change in working conditions. The observed decrease of physically demanding jobs and increase of jobs with higher psychosocial resources explained 8% of the improvement.

Conclusions Changes in working conditions may not contribute to improved physical and psychological functioning, but do contribute to improved cognitive functioning to some extent. Further adjustment of physical work demands and psychosocial work resources may help to reach sustainable employability of older workers.

BACKGROUND

Over the last decades, there have been demographic and work environment changes that may have influenced health of the older working population in Western countries. First, as a result of the ageing population and consequential need of prolonging working lives, employment rates of older people have increased. Second, due to technological developments and a transition towards a more service-based society, less jobs are physically demanding and more jobs require cognitive and communicative abilities (1-4). Generally, working conditions impact physical, cognitive and psychological health, and this impact might be greater for older workers as they need more time to recover from physically or psychosocially demanding tasks than younger workers (5-8). Insight in the health trends of older workers is relevant in order to reach sustainable employability of older workers (9). We study the change in physical, cognitive and psychological functioning of older workers aged 55 to 65 over twenty years and whether this change is related to change in working conditions.

To assess working conditions, we investigate three types of working conditions that fit into the job demands-resources model: physical demands, psychosocial demands and psychosocial resources (10). Physical demands are for example the necessity to use force or to work in uncomfortable positions (11, 12). Psychosocial demands are for example high time pressure or high cognitive demands (11-13). Psychosocial resources are for example job autonomy (i.e. the ability to make decisions regarding work), and help the worker in reducing work demands, achieving work goals and personal development (12, 14).

Evidence shows that these working conditions are associated with a variety of health domains such as physical, cognitive and psychological functioning. High physical demands, such as heavy lifting, impair physical functioning (15). High psychosocial demands, such as long working hours, work overload and pressure, negatively affect psychological functioning (8, 16, 17). In contrast, psychosocial demands are associated with better cognitive function in middle and later age (7). High psychosocial resources, such as job autonomy, counterbalance the effects of physical and psychosocial demands on physical, psychological and cognitive functioning, and are associated with improvement in cognitive and psychological functioning (7, 8, 10, 16).

In many European countries, working conditions have changed over the past twenty years. Physical demands have decreased (2, 3), while psychosocial demands, e.g. work intensity and cognitive demands, have increased (2-4, 18) and psychosocial resources, e.g. autonomy at work, have also increased (18).

Previous studies examining health trends show that physical and psychological functioning deteriorated and cognitive functioning improved across successive cohorts of older adults over the past twenty years (19-24). Explanations for these changes are increased

prevalence of specific diseases, such as arthritis and diabetes mellitus, and obesity (21, 22) and increased educational level (19), respectively. The contribution of changes in working conditions to health trends across cohorts of older adults has not been studied yet.

This study examines trends in physical, cognitive and psychological functioning across three successive cohorts of Dutch workers aged 55 to 65 in 1993, 2003 and 2013. The contribution of the changes in physical and psychosocial demands and psychosocial resources to change in functioning is examined. First, we expect a deterioration of physical functioning, which is counterbalanced by the change in working conditions (Hypothesis 1a & 1b). Second, we expect an improvement in cognitive functioning, which is partly attributed to the change in working conditions (Hypothesis 2a & 2b). Third, we expect a deterioration of psychological functioning, which is not affected by the change in working conditions because of the counterbalancing effects of increased psychosocial demands on the one hand, and increased psychosocial resources on the other hand (Hypothesis 3a & 3b).

METHODS

Study design and sample

This study has a cross-sequential design. It uses data from the Longitudinal Aging Study Amsterdam (LASA), an ongoing study of physical, emotional, cognitive and social functioning of older adults age 55 and above in the Netherlands (25, 26). Data from the three cohorts, collected in 1993, 2003 and 2013, were used. Individuals aged 55 to 65 years with paid work ≥1 hour per week were included. The cut-off point of one hour ensures that all types of jobs, including part-time, temporary or seasonal, are taken into account because the corresponding working conditions of all these types of jobs may have influenced health (27). This sample of workers consisted of 1307 respondents (cohort 1, 1993: n=274; cohort 2, 2003: n=416; cohort 3, 2013: n=617). In addition, a same aged sample of non-working individuals was used for a comparison of the health trends (n=672; n=577; n=374, respectively).

Outcome variables

Physical functioning

Physical functioning was measured by the Timed Chair Stand Test, involving standing up without the use of arms five times as quickly as possible. Time in seconds was recorded and used as a continuous variable. Participants who were not able to perform the test (n=16), who performed the test incorrectly (n=18), who performed the test in >25 seconds (n=3) and who had not performed the test for unknown reasons (n=22), were excluded. Physical performance tests are good predictors of morbidity, hospitalisation and death (28). The Timed Chair Stand Test has been shown to be a valid and reliable measure for functional mobility in a sample of older females (29).

Cognitive functioning
Cognitive functioning was measured by an adjusted version of the Alphabet Coding Task-15. The Coding Task involves a form given to the participant, showing two rows of characters. Each character in the upper row belongs to a character in the bottom row. The participant is asked to make as many combinations as possible. This is done in three cycles of one minute. The mean score of the three cycles was calculated and used as a continuous variable (30). Participants who had not participated in the medical interview (n=135) or had not executed the Coding Task for other reasons (n=5) were excluded. The Coding Task is believed to reflect various processes such as attention processes, memory function, and perceptual organisation and speed, but its validity has not been assessed (31).

Psychological functioning
Psychological functioning was measured by positive affect, a subscale of the Center for Epidemiologic Studies Depression Scale (CES-D) (32). Positive affect was chosen, because we expected that more variation would be found when using it instead of the full CES-D (33). Cronbach's alpha of positive affect (items 4, 8, 12 and 16) in our sample was 0.71. Items have four response categories, ranging from (0) 'rarely to never' to (3) 'mostly or always'. Items scores were summed. The variable was dichotomised because of a right-skewed distribution of the continuous variable, with the cut-off set at the first quartile to identify workers with low positive affect. Twenty-three respondents were excluded because they had not (fully) responded to the CES-D for unknown reasons.

Main determinants

Working conditions
Working conditions of the current job were deduced from the general population job exposure matrix (GPJEM) for 55 to 65 year olds (12). The GPJEM indicates levels of exposure probability of physical and psychosocial demands and psychosocial resources, based on job category. Physical demands involve the necessity to use force during work, working in uncomfortable positions, and performing repetitive movements. Psychosocial demands involve time pressure, task requirements, and cognitive demands. Psychosocial resources involve job autonomy and variation in activities at work. Working conditions scores range from low to high exposure probability (physical demands: 0-4; psychosocial demands: 0-6; psychosocial resources: 0-4) (12).

Covariates
Covariates used in this study were chosen based on three criteria, of which at least two should be met. First, the covariate is expected to have changed in the (working) population over the past two decades. Second, the covariate is expected to be associated with working conditions. Third, the covariate is expected to be associated with one of the health outcomes studied. The following covariates were therefore included: sex, age, education level, partner status, chronic diseases, alcohol use,

smoking, BMI, physical activity, working hours and mastery. Sex and date of birth were obtained from municipal registries. The highest educational level completed categorised into low, intermediate and high, according to the International Standard Classification of Education (34). Partner status was measured by the question: "Are you currently living with someone, whom you consider to be your partner?". Self-report of chronic diseases was categorised into having 0, 1 or >1 chronic diseases. Respondents were asked for the presence of a chronic diseases in one question with the following answering options: 1) chronic non-specific lung disease 2) cardiac disease, 3) peripheral arterial disease, 4) diabetes mellitus, 5) cerebrovascular accident or stroke, 6) osteoarthritis, 7) rheumatoid arthritis, 8) cancer and 9) other. The self-reports on chronic diseases are fairly accurate when compared to general practitioner information (35). Self-rated health was measured by a single self-report question: "How is your health in general?", with five response categories, dichotomised into good versus less than good health (36). Alcohol use was based on the Garretsen index (37), which categorises alcohol use into light, moderate, and excessive. Smoking was categorised into never smoked, smoked ≥15 years ago, smoked <15 years ago, and currently smoking (38). Body Mass Index (BMI) was calculated from measured height and weight and was divided in the categories normal weight (BMI<25), overweight (25≤BMI<30) and obese (BMI≥30) (38). Regarding physical activity, the number of minutes per day were calculated based on the frequency and duration of all types of physical activity performed in the previous two weeks, i.e. walking outdoors, biking, gardening, light household activities, heavy household activities and two of their most frequently performed sports activities (39). The number of working hours per week was used as a continuous variable. Working hours above 80 were adjusted to 80 hours. Mastery, i.e. the extent to which a person perceives himself or herself to be in control of events and ongoing situations, was used as a continuous variable measured by the Pearlin Mastery scale (40).

Data analyses

Multiple imputation

Of the respondents 14% had at least one missing value on the working conditions or covariates. Multiple imputation was performed to make inferences based on all variables described above (except for self-rated health). A pooled sample of twenty imputations was used.

Health trends

For each health outcome trends were analysed using linear regression analyses adjusted for sex and age (in quartiles). First, the association between cohort number and the health outcomes were analysed for workers and non-workers separately, and means and proportions are presented in Figure 1a-c. Second, these trends in health functioning were analysed for the total sample of workers and non-workers, with an interaction term between cohort number and work status to examine whether the trends differed

between workers and non-workers. Third, differences in health functioning between workers and non-workers in each cohort separately were assessed.

The contribution of working conditions

The contribution of working conditions to the health trends were analysed using linear and logistic regression (Table 2). Multiple models were assessed for each health outcome. In Model 1, the relationship between cohort number and health outcomes was examined adjusted for sex and age. In Model 2, relevant covariates were included. In Model 3 (a/b/c), working conditions were added separately. In Model 4, working conditions were added together. Tolerance appeared <0.50 for psychosocial demands and resources, which correlated highest with physical demands. New variables were constructed for psychosocial demands and resources, in which the residuals of physical demands were removed, and were used in Model 4. The effect sizes of dummy variables for cohort 2003 and 2013 in Model 2 were compared to Model 1, and in Model 3 and 4 to Model 2, to examine the contribution of the trend in covariates and working conditions, respectively, on the trend in health functioning. If one of the effect sizes of dummy variables cohort 2003 or 2013 increased or decreased more than 10%, we considered it as relevant suppressor(s) or explanatory variable(s). All analyses were performed in SPSS 22. The assumptions of regression analyses were checked and proved to be met.

Sensitivity analysis

We compared self-rated health of respondents with and without missing values on the health outcomes, using chi-square analyses. If the excluded respondents were in poorer self-rated health, we examined whether the proportion of excluded respondents differed between the cohorts. Self-rated health was chosen because it has few missing values (n=1) and it has been shown to be associated with physical, cognitive and psychological functioning (36, 41).

RESULTS

Study characteristics

In Table 1, basic characteristics of Dutch workers aged 55 to 65 are shown within each cohort. Over the successive cohorts, the proportion of workers increased from 29% to 62%. The proportion of women increased among the workers (from 36% to 46%). Mean age decreased slightly at first, and increased subsequently, indicating that in 2003 in particular the proportion of 55-60-year-olds has increased, and in 2013 the proportion of 60-65-year-olds. Mean exposure to physical demands decreased, and exposure to psychosocial demands and psychosocial resources increased. This is a result of a change from sectors representing manual labour to sectors representing office jobs.

Table 1. Descriptive statistics of successive cohorts of older workers, N=1307

		Cohort 1: 1992/1993 (N=274)	Cohort 2: 2002/2003 (N=416)	Cohort 3: 2012/2013 (N=617)	P-value[a]
% of total cohort		29%	42%	62%	<0.001
Basic demographics					
Sex	Males	174 (64%)	253 (61%)	336 (54%)	0.019
	Females	100 (36%)	163 (39%)	281 (46%)	
Age	Mean	58.9 (2.7)	58.6 (2.6)	59.4 (2.6)	<0.001
Working conditions					
Physical demands	Mean score (0-4)	2.1 (1.6)	1.7 (1.6)	1.4 (1.6)	<0.001
Psychosocial demands	Mean score (0-6)	1.1 (1.9)	1.5 (2.0)	2.0 (2.1)	<0.001
Psychosocial resources	Mean score (0-4)	1.1 (1.3)	1.5 (1.4)	1.8 (1.5)	<0.001
Occupational sector	Administrative/ commercial	74 (27%)	110 (27%)	142 (23%)	<0.001
	General	20 (7%)	26 (6%)	43 (7%)	
	Pedagogical	19 (7%)	34 (8%)	68 (11%)	
	Agricultural	27 (10%)	20 (5%)	18 (3%)	
	Natural science	0 (0%)	1 (0%)	23 (4%)	
	Technical	53 (19%)	91 (22%)	81 (13%)	
	Transport	11 (4%)	19 (5%)	40 (6%)	
	(Para)medical	11 (4%)	19 (5%)	46 (7%)	
	Juridical/security	6 (2%)	15 (4%)	26 (4%)	
	Cultural/linguistic	4 (2%)	12 (3%)	28 (5%)	
	Social science	9 (3%)	18 (4%)	20 (3%)	
	Care services	34 (12%)	44 (11%)	58 (9%)	
	Management	5 (2%)	6 (1%)	23 (4%)	
Covariates					
Education	Low	153 (56%)	204 (49%)	225 (36%)	<0.001
	Intermediate	65 (24%)	81 (19%)	164 (27%)	
	High	56 (20%)	131 (31%)	228 (37%)	
Partner status	No partner	47 (17%)	70 (17%)	102 (17%)	0.973
	Partner	227 (83%)	346 (83%)	515 (83%)	
Working hours per week	Mean (range 1-80)	32.7 (18)	30.3 (16)	31.1 (14)	0.094
Self-reported chronic diseases	0	125 (46%)	144 (35%)	169 (27%)	<0.001
	1	92 (34%)	150 (36%)	203 (33%)	
	> 1	57 (21%)	122 (29%)	245 (40%)	
Mastery	Mean	18.7 (3.0)	18.9 (3.0)	19.1 (3.0)	0.141
Alcohol use	Does not drink	23 (8%)	22 (5%)	60 (10%)	0.009
	Non-excessive	224 (82%)	335 (81%)	503 (82%)	
	(Very) excessive	27 (10%)	59 (14%)	54 (9%)	

Table 1. Continued

		Cohort 1: 1992/1993 (N=274)	Cohort 2: 2002/2003 (N=416)	Cohort 3: 2012/2013 (N=617)	P-value[a]
Smoking	Never smoked	58 (21%)	86 (21%)	163 (26%)	<0.001
	Smoked ≥ 15 years ago	61 (22%)	130 (31%)	248 (40%)	
	Smoked < 15 years ago	61 (22%)	68 (16%)	101 (24%)	
	Currently smoking	94 (34%)	132 (32%)	105 (17%)	
BMI	Normal (< 25)	98 (36%)	124 (30%)	217 (35%)	0.003
	Overweight (25 - 30)	144 (53%)	203 (49%)	265 (43%)	
	Obesity (≥ 30)	32 (12%)	89 (21%)	135 (22%)	
Physical activity	Mean (min/day)	147 (120)	133 (106)	132 (104)	0.138[b]

a. On Pearson chi-square test or oneway ANOVA.
b. P-value of log-transformed means = 0.802.

Physical functioning

Figure 1a shows that physical functioning of successive cohorts of workers deteriorated over time, supporting Hypothesis 1a. In 1993, workers performed the Timed Chair Stand Test on average in 10.2 seconds and in 2013 in 11.5 seconds ($p<0.001$). Among non-workers, this is 11.4 and 12.6 seconds, respectively ($p<0.001$). The interaction term between cohort number and work status is insignificant, implying that there is no difference in the trends between workers and non-workers ($p=0.411$). In each cohort, physical functioning is better among workers compared to non-workers ($p<0.05$).

Among workers, the deterioration in physical health of the cohorts is also shown in the first column of Table 2 (Model 1). The effect of cohort number on physical health remains significant after adjustment for covariates (Model 2). Working conditions do not affect the deterioration in physical functioning, in contrast to Hypothesis 1b (see Model 3a/b/c for the contribution of the separate types of working conditions and Model 4 for the joint model).

Cognitive functioning

The cognitive functioning of successive cohorts of workers improved over time, supporting Hypothesis 2a (Figure 1b). Among workers, the mean coding task score increases from 29.3 in 1993 to 31.0 in 2013 ($p<0.001$). Among non-workers, it increases from 26.7 to 28.6 ($p<0.001$) over the same period. These trends do not differ significantly (interaction term: $p=0.558$). In each cohort, cognitive functioning is better among workers compared to non-workers ($p<0.001$).

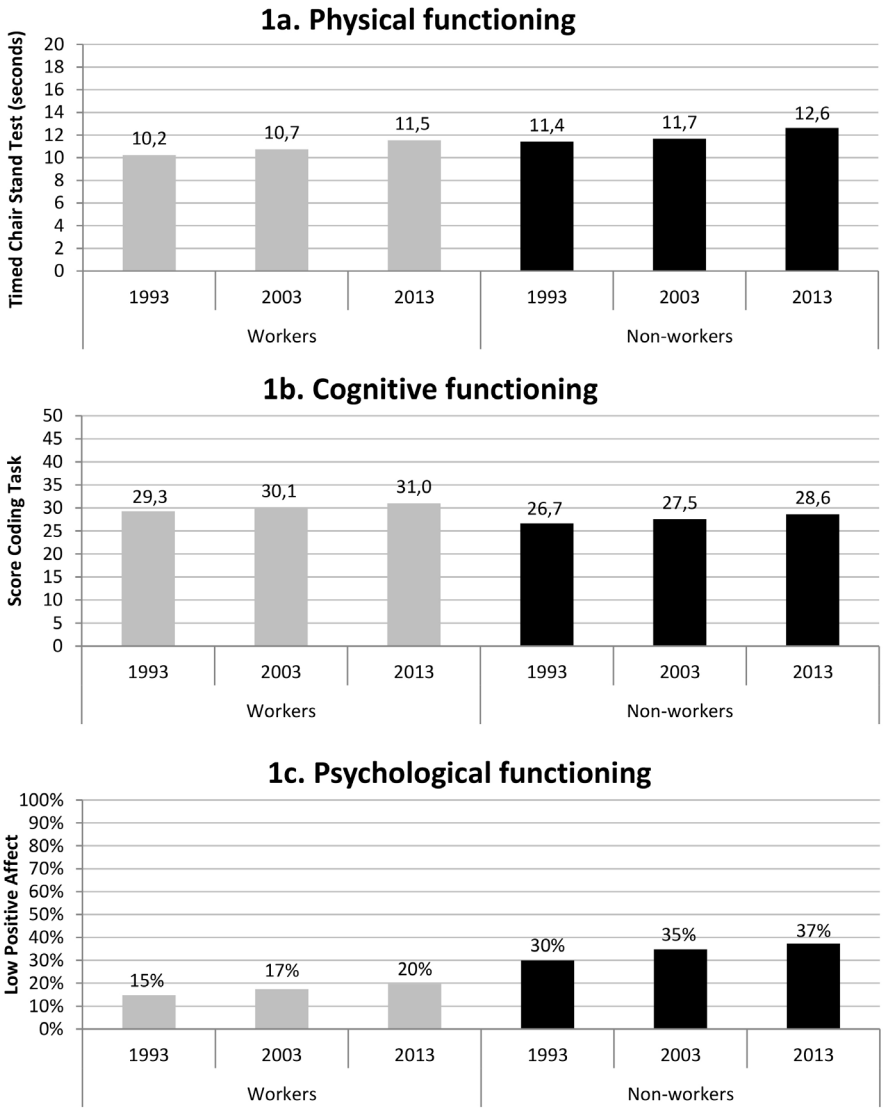

Figure 1. Trends in health among successive cohorts of workers and non-workers, adjusted for sex and age. Note: 1a. Workers n = 1248; Non-workers n = 1474. 1b. Workers n = 1167; Non-workers n = 1443. 1c. Workers n = 1284; Non-workers n = 1565.

Table 2. Trends in health among successive cohorts of older workers

		Physical functioning N = 1248	Cognitive functioning N = 1167	Psychological functioning N = 1284
		B (95% C.I.)	**B (95% C.I.)**	**OR (95% C.I.)**
Model 1	Cohort (ref. 1993)			
	2003	0.51 (0.07-0.94)*	0.79 (-0.16-1.73)	1.21 (0.80-1.82)
	2013	1.30 (0.89-1.71)***	1.70 (0.81-2.59)***	1.39 (0.95-2.04)
Model 2	Cohort (ref. 1993)			
	2003	0.50 (0.06-0.94)*	0.36 (-0.53-1.26)	1.17 (0.74-1.85)
	2013	1.25 (0.82-1.67)***	0.66 (-0.21-1.54)	1.39 (0.90-2.14)
Model 3a	Cohort (ref. 1993)			
	2003	0.52 (0.08-0.96)*	0.28 (-0.60-1.17)	1.18 (0.75-1.87)
	2013	1.28 (0.85-1.71)***	0.49 (-0.37-1.36)	1.41 (0.91-2.18)
	Working conditions			
	Physical demands (0-4)	0.09 (-0.02-0.21)	-0.66 (-0.89--0.43)***	1.04 (0.93-1.17)
Model 3b	Cohort (ref. 1993)			
	2003	0.50 (0.07-0.94)*	0.36 (-0.54-1.25)	1.17 (0.74-1.85)
	2013	1.26 (0.83-1.69)***	0.65 (-0.23-1.52)	1.39 (0.90-2.14)
	Working conditions			
	Psychosocial demands (0-6)	-0.04 (-0.13-0.06)	0.07 (-0.13-0.26)	1.02 (0.93-1.12)
Model 3c	Cohort (ref. 1993)			
	2003	0.50 (0.06-0.94)*	0.29 (-0.61-1.18)	1.19 (0.75-1.88)
	2013	1.24 (0.82-1.67)***	0.54 (-0.34-1.42)	1.42 (0.92-2.19)
	Working conditions			
	Psychosocial resources (0-4)	0.02 (-0.11-0.15)	0.35 (0.08-0.63)*	0.93 (0.82-1.06)
Model 4	Cohort (ref. 1993)			
	2003	0.50 (0.06-0.94)*	0.29 (-0.60-1.17)	1.20 (0.76-1.90)
	2013	1.26 (0.83-1.68)***	0.52 (-0.35-1.39)	1.43 (0.92-2.21)
	Working conditions			
	Physical demands (0-4)	0.09 (-0.03-0.21)	-0.62 (-0.86--0.38)***	1.04 (0.92-1.17)
	Psychosocial demands (0-6)	-0.05 (-0.16-0.06)	-0.10 (-0.33-0.12)	1.06 (0.95-1.18)
	Psychosocial resources (0-4)	0.14 (-0.03-0.31)	0.10 (-0.34-0.36)	0.91 (0.76-1.08)

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

Model 1. Model adjusted for sex and age

Model 2. Model 1 + educational level, partner status, chronic diseases, alcohol use, smoking, BMI, physical activity, working hours, mastery

Model 3. a. Model 2 + physical demands; b. Model 2 + psychosocial demands; c. Model 2 + psychosocial resources

Model 4. Model 2 + physical demands, psychosocial demands and psychosocial resources

The improvement in cognitive functioning among successive cohorts of workers can for 61% be explained by the covariates added in Model 2 (Table 2). In particular the rise in educational level explains this improvement (result not shown in Table). The change in working conditions explains it also partly, given the decrease of >10% in B for cohort 2013, from 0.66 in Model 2 to 0.52 in Model 4, supporting Hypothesis 2b. After inclusion of the other covariates, change in working conditions explained another 8% of the change in health from cohort 1 to cohort 3. In particular, the decrease of physically demanding jobs (Model 3a) and increase of jobs with high psychological resources (Model 3c) contributed.

Psychological functioning

The proportion of workers with low positive affect rises non-significantly (15% in 1993 and 20% in 2013; p=0.088), providing no sufficient support to Hypothesis 3a (Figure 1c). The proportion of non-workers with low positive affect increases (30% in 1993 to 37% in 2013; p<0.001). These trends do not differ significantly (interaction term: p=0.631). In each cohort, psychological functioning is better among workers compared to non-workers (p<0.001).

The non-significant increase of the proportion of workers with low positive affect is not related to change in covariates (Model 2, Table 2), and neither to the change in working conditions (Model 3a/b/c and Model 4), in contrast to Hypothesis 3b.

Sensitivity analysis

Workers with missing values on physical and cognitive functioning were in poorer self-rated health compared to workers with no missing values (p<0.001 and p<0.01, respectively). There was no difference in self-rated health between workers with and without data on psychological functioning (p=0.668). Missing values regarding physical functioning were relatively evenly distributed over the three cohorts. Missing values regarding cognitive functioning were most prevalent in cohort 2003.

DISCUSSION

This study assesses trends in physical, cognitive and psychological functioning among Dutch workers aged 55 to 65 from 1993 to 2013. In particular, the contribution of the decrease in physical work demands and increase of psychosocial work demands and resources to these trends are examined.

The findings show that physical functioning deteriorated across three successive cohorts of older workers, which supports Hypothesis 1a. Although there are no validated cut-off points for the Timed Chair Stand Test to determine the severity of functional mobility, we consider the increase of 1.3 seconds to a mean of 11.5 seconds for workers to perform the Timed Chair Stand Test as substantial. In comparison, another study shows

that the mean score for healthy subjects was 12.5 seconds and for subjects with high risk of fallings, 14.8 seconds (age category 74-98) (42).

Hypothesis 1b, stating that the decline in physical functioning is counterbalanced by the change in working conditions, is not supported. There is no association between working conditions and physical functioning at all. Potentially, the beneficial effects of the decrease in physical demanding jobs were cancelled out by the negative effects of the increase of non-physical demanding jobs, in which sedentary behaviour is common and also negatively affects physical functioning (43). Another explanation is that the Timed Chair Stand Test does not cover all aspects of physical functioning, as especially the lower limbs are tested (44). A systematic review showed that there is reasonable evidence for an association between physically demanding work and work-related musculoskeletal disorders. However, this applies only to neck, low back, upper limb and hip disorders. There was no or insufficient evidence for non-specific lower limb and knee disorders (15).

Hypothesis 2a and 2b, stating that cognitive functioning will improve and that this change can partly be attributed to the change in working conditions, are supported. Remarkably, the decrease of physically demanding jobs and increase of jobs with psychosocial resources contributed particularly, while previous research shows that in particular psychosocial demands are associated with cognitive functioning (7). Naturally, the decrease of physically demanding jobs and increase of jobs with high psychosocial resources is also accompanied by an increase of jobs with cognitive demands. The improvement in cognitive functioning is also explained by the rise in educational level, in accordance with results from previous research (19).

Hypothesis 3a, stating that psychological functioning will deteriorate over the successive cohorts, is not supported by our study. Although the increased prevalence of low positive affect from 15% to 20% is not significant in our sample of workers, an increase of five percentage points is considered relevant given that workers with psychological health problems have lower workability and productivity (45).

Hypothesis 3b, stating that the deterioration in psychological functioning was not affected by the change in working conditions, was supported. This was hypothesised because the negative effect of increased psychosocial work demands was expected to be counterbalanced by the positive effect of increased psychosocial work resources. However, in contrast to previous studies (8, 16, 17), these two types of working conditions separately did not affect psychological functioning. Potentially, the expected effect of the change in working conditions was overestimated. One of the systematic reviews that found ‘moderate’ evidence for an association between psychosocial work demands and psychological functioning stressed that there was an indication of publication bias resulting in an overestimated association (17).

Methodological considerations

The use of LASA data provides the unique possibility to compare three large cohorts over twenty years. In addition, LASA contains a sample of the Dutch older population, which may decrease the risk of selection bias. Data on the same tests and questionnaires were available for each of the cohorts. This made it possible to study trends and the contribution of covariates to these trends.

A second strength of this study is the choice for objective health measures from the LASA data (25, 26). This decreases the chance of information bias and such measures can be sensitive to changes the respondent does not perceive yet (28).

There are also a number of limitations. A first limitation is that the GPJEM has only partly been validated. Rijs et al. examined the association between the GPJEM and health, but research on the association between the GPJEM and self-reported working conditions should still be performed (12). In addition, the GPJEM does not take heterogeneity within job categories into account, because information is aggregated (12). This limitation might have biased our findings toward the null.

Second, we used data on the current job. Workers with reduced functioning may have already switched their job because they were no longer able to perform high physical or psychosocial demanding tasks, and other, better fitting jobs were available. Data on the longest job was only available in cohort 1. It showed that only a small minority of the respondents reported a different longest job compared to the current job, and the associated working conditions remained on average the same. Therefore, we do not expect bias because of this.

Third, reversed causality may have played a role. Our findings indicate that the change in working conditions contributed to the improvement in cognitive functioning. However, such improvement may cause an increased interest from workers to perform jobs with high psychosocial demands and resources. In favour of the first, a systematic review based on longitudinal studies showed that high psychosocial demands and resources at one point in time were prospectively associated with higher levels of cognitive function in midlife and late life (7).

Fourth, workers in poor self-rated health had more often missing data regarding cognitive functioning, and were therefore excluded from the analyses. They were also more prevalent in cohort 2003, than in cohort 1993 and 2013. Still, we do not expect bias from this because the proportion of workers with missing data regarding cognitive functioning was low (<2%).

Implications for practice and further research

This study shows a significant deteriorating trend in physical functioning and non-significant deteriorating trend in psychological functioning among workers from 1993 to 2013. The change in working conditions hardly contributed to these observed trends. Taking into account that only since 2012 the statutory retirement age has increased (46), this suggests that without any interventions, future generations of older workers will be less healthy in physical and psychological sense. This may be caused by further deterioration of physical and psychological public health and further increase of the proportion of older adults participating in the workforce. These developments in health may hamper sustainable employability, which is a shared responsibility of workers, employers and policy makers. One aspect is that employers must ensure that the job requirements meet the work capabilities of older workers and support older workers with health issues, to prevent early work exit (47, 48). More research is needed to examine the optimal work context (9).

This study also shows an improving trend in cognitive functioning among workers from 1993 to 2013, and the change in working conditions contributed to some extent to this improvement. According to a study on labour market forecasting, the number of physically demanding jobs are expected to further decrease, while the proportion of higher education jobs will further increase (49). Moreover, the educational level of future cohorts of older adults continues to increase as well (50). Therefore, the job requirements of future jobs are increasingly likely to meet the work capabilities of future older workers. Further adjustment of physical and psychosocial working conditions may help to reach sustainable employability of older workers (16). However, the proportion of elementary and lower-education jobs is expected to remain stable, with 30% of all jobs (49). In future research should be searched to effective ways to support these workers in order to reach the retirement age while working in good wellbeing, work ability and productivity (51).

Conclusions

This study shows that physical and psychological functioning of three successive cohorts of older workers aged 55-65 deteriorated and cognitive functioning improved in the period from 1993 to 2013. This change in functioning is largely a reflection of the change in functioning of the total population of 55-65 years-olds. The decrease in physically demanding jobs and increase in jobs with high psychosocial demands and resources hardly contributed to understanding of the observed trends in physical and psychological functioning. Only cognitive functioning benefitted to some extent from these changes in working conditions.

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Chapter 5

Changes in the association between working conditions and health across the work exit transition: a comparison across three successive cohorts of older workers in the 1990s-2010s

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ABSTRACT

Background: In Western societies, older workers are required to extend their working lives in order to limit state pension costs. The extension of working lives in occupations with unfavourable working conditions may negatively affect health both before and after work exit. This study examined health trajectories across the work exit transition for older workers with high versus low physical demands, psychosocial demands, and psychosocial resources in the 1990s, 2000s and 2010s.

Methods: Data from the Longitudinal Aging Study Amsterdam (LASA) includes three cohorts with baseline measurements in 1993, 2003 and 2013 with 3-year follow-up each. Selected respondents are aged 55-65 years with a paid job at baseline and no job at follow-up (N=383). Generalised Estimating Equations are performed with working conditions as main determinants and pre- to post-exit trajectories in self-rated health, mental health, and physical limitations as outcomes. Differences across the periods regarding the relation between working conditions and health trajectories are examined.

Results: Self-rated health trajectories between workers exposed to higher versus lower physical demands diverged from the 1990s to the 2000s, but did not continue to diverge in the 2010s. From the 2000s, post-exit self-rated health was worse for workers with high physical demands than for those with lower physical demands. No consistent divergence in self-rated health trajectories was found for psychosocial demands or resources. Work demands-related trajectories in mental health or physical limitations were not found to be consistently diverging over time.

Conclusions: The extension of working lives may be a double burden for workers with high physical demands, because their self-rated health is more affected during the final working years and they do not benefit as much from work exit. Ill health can be prevented by improving the working conditions or by adapting the statutory retirement age for workers with unfavourable working conditions.

INTRODUCTION

In many Western societies, older workers are required to extend their working lives in order to limit state pension costs [1]. This generally applies to all older workers, irrespective of their working conditions, i.e., physical and psychosocial demands, and psychosocial resources. Although the proportion of jobs with physically demanding working conditions has decreased due to technological developments, jobs with psychosocial demands have increased and those with low psychosocial resources (e.g. low autonomy) remained stable [2-5]. To illustrate the situation of the Dutch 55 to 65 year olds in 2016: 15% had a physically demanding job (with no or insufficient occupational health and safety measures), 29% had a job that required hard work (almost) all of the time, and 33% had no or low autonomy in deciding how to perform their job [6].

Compared to younger workers, older workers are more at risk of developing health problems from exposure to unfavourable working conditions [7]. At higher ages, workers need more time to recover from physically or psychosocially demanding tasks. Long-term exposure to these tasks may lead to health problems [8]. Independent of age, working conditions are associated with different aspects of health. For example, working in a job with high physical work demands is associated with physical limitations and poor self-rated health [9, 10]. Workers who have low autonomy suffer more often from work-related mental health problems [11]. Moreover, the combination of high psychological job demands and low decision latitude is associated with relatively high depression scores [12].

Health trajectories across work exit of workers with different working conditions have not been studied extensively yet. Most studies focused on the effect of retirement on health, without considering working conditions. A systematic review showed that there is strong evidence that retirement is beneficial for mental health, but contradictory evidence was found for the effect on self-rated health and physical limitations [13]. However, the effect of work exit depends on the working conditions of workers. French workers with high physical and psychosocial work demands were in poorer pre-exit self-rated health, but benefitted more from the work exit transition compared to low exposure groups [14]. A Dutch study showed similar results regarding psychosocial demands [15]. In contrast, another study showed that on average, self-rated health of Finnish workers remained stable across the retirement transition, but that individuals with high physical demands and job strain were at risk of health decline during the retirement transition years [16]. Finnish workers with high physical demands had more physical limitations before and after retirement compared to those with lower exposure. However, these differences narrowed across the retirement transition as workers with high physical demands improved compared to lower exposure groups [17]. Workers with high physical demands may have benefitted from the relief from the high demands placed on their work [18]. Regarding mental health, a British study showed that individuals retiring from poorer

working conditions, i.e. high psychosocial demands and low psychosocial resources, experienced more pronounced improvements in mental health upon retirement [19]. In contrast, two other studies showed a stronger beneficial effect of retirement for workers in high socioeconomic groups, whose working conditions generally have been more favourable, compared to workers in low socioeconomic groups [20, 21].

Recent societal developments, in which older workers are required to extend their working lives, have resulted in an increase in the average retirement age from 60 in the early 1990s to 64.5 in 2016 in the Netherlands [22, 23]. In the cited studies showing a more beneficial effect of retirement on health among workers with unfavourable working conditions compared to favourable working conditions, the average retirement age was low: between 55 and 60.5 years [14, 15, 17, 19, 24]. The question is whether differences in health trajectories between favourable and unfavourable working conditions have remained the same over a period when the actual retirement age has increased. Workers who are exposed to unfavourable working conditions over a longer period of time and at an older age are likely to have greater health problems compared to those who previously retired earlier. Moreover, it might be too late for these workers to experience better health after retirement. For example, French retirees exposed to unfavourable working conditions aged 55 and over benefitted less from retirement than retirees younger than 55 years [14]. Finnish workers exposed to unfavourable working conditions were more at risk of health decline during the retirement transition years compared to workers with favourable working conditions, and their average retirement age was 62-64 years [16]. Thus, it seems that the age of work exit is relevant in the health effects of work exit between different working exposure groups.

The hypotheses for this study are that health trajectories across the work exit transition between workers with higher versus lower levels of work demands and resources have started to diverge more over a period when the average age of work exit has risen, to the disadvantage of workers with higher physical and psychosocial demands, and lower psychosocial resources (Hypothesis 1). As a result, we expect to find greater differences in work-related post-exit health recently as compared to one or two decades ago (Hypothesis 2). Insights from this study may contribute to the debate on the importance and appropriateness to further extend working lives of workers in jobs with unfavourable working conditions [25].

This study examines changes over time in health trajectories from pre- to post-exit, for workers with higher versus lower physical demands, psychosocial demands, and psychosocial resources. Three health indicators are examined: self-rated health, mental health, and physical limitations. Data from three cohorts of workers across a period of twenty years are compared. To capture the effect of policy change regarding work exit and the accompanying increased work exit age, analyses are adjusted for personal characteristics including sex and lifestyle factors.

METHODS

Study sample

The study sample was derived from the Longitudinal Aging Study Amsterdam (LASA), an ongoing Dutch cohort study investigating physical, emotional, cognitive and social functioning in late life [26, 27]. The first LASA cohort consists of 3,107 older adults aged 55-85 in 1993 who were interviewed face-to-face every three years, 964 of which were 55-64 years old. In 2003 and 2013, new cohorts were included with 996 and 991 older adults aged 55-64, respectively; all with the same follow-up schedule. For this study, data from the first two waves (T0 and T1) of each cohort were used. We included only respondents aged 55-64 years with a paid job (≥1 hour/week) at T0 and who had stopped working at T1. This allows us to observe health trajectories between work (T0) and post-work (T1), for all three cohorts. Respondents who dropped out (n=252) and those who continued working at follow-up (n=680) were excluded. The total sample (N=383) consisted of 110 participants from cohort 1, 131 from cohort 2, and 142 from cohort 3.

Determinants

Working conditions

Working conditions were assessed using the validated General Population Job-Exposure Matrix (GPJEM) [9], which determines the level of work demands of older workers based on respondent's job description and its corresponding code of the Netherlands Standard Classification of Occupations 1992 [28]. Physical demands were based on the exposure probability of using a lot of force, working in an uncomfortable position and making repetitive movements. Psychosocial demands were based on the exposure probability of working under a lot of time pressure, having a lot of task requirements and experiencing cognitive demands, i.e., intensive thinking, need to keep focused, and requiring much concentration. Psychosocial resources were based on the probability of having autonomy and variation in job activities [9]. Physical demands and psychosocial resources scores ranged from 0 to 4, psychosocial demands ranged from 0 to 6. Higher scores indicate a higher exposure probability.

Work exit

Our definition of work exit covers all forms of exit from paid work, i.e. (early) retirement, disability, unemployment and inactivity. Respondents were asked whether they have a paid job and if applicable, when (month and year) they stopped. Age at exit was calculated based on the 15th day of the month and year of exit from work and the birthdate obtained from the municipal registries. When a respondent had not provided information on the date of exit from work, we took the date halfway between two interviews (n=28). Time after exit was calculated subtracting age at exit from age at follow-up.

Change over time
The three measurement intervals 1993-1996, 2003-2006, and 2013-2016 are denoted by the 1990s, 2000s and 2010s. The pre-exit observation is denoted by observation number T0, and the post-exit observation is denoted by observation number T1.

Lifestyle factors
Smoking was categorised into never smoked, smoked ≥15 years ago, smoked <15 years ago, and currently smoking. Body Mass Index (BMI) was calculated from measured height and weight and was included in the categories normal weight (BMI<25), overweight (25≤BMI≤30) and obese (BMI>30).

Outcome
Health
Self-rated health was measured using a single self-report question: "How is your health in general?", with five response categories (scale 1-5) [29]. For mental health we used positive affect, a subscale of the Center for Epidemiologic Studies Depression Scale (CES-D) [30]. Positive affect has been shown to be highly sensitive to the outcomes of an individual's activities [31, 32]. Items have four response categories, ranging from (0) 'rarely to never' to (3) 'mostly or always'. Items scores were summed. The variable was dichotomised because of a right-skewed distribution of the continuous variable, with the cut-off set at the first quartile (score ≤7) to identify respondents with low positive affect. Physical limitations was measured using self-reports to six questions (scale 0-6). These questions concern difficulty in climbing/descending stairs of 15 steps, getting dressed/undressed, sitting down on/standing up from a chair, cutting one's toenails, walking outside for five minutes, and using public transport [33]. The variable was dichotomised because of a right-skewed distribution, with the cut-off set at ≥1 physical limitation(s).

Analyses
Analyses were performed in SPSS 22; statistical significance was set at $p \leq 0.05$. Due to a substantial number of missing values in the determinants (7% of the respondents had at least one missing value in working conditions and/or lifestyle factors), multiple imputation was performed to allow inferences based on all data. A pooled sample of ten imputations was used.

Descriptive analyses were performed to show the characteristics of the study sample by period. To test whether baseline characteristics changed over the three periods, unweighted trend analyses using Chi-square tests were performed for categorical variables and one-way ANOVA tests for continuous variables.

Multivariate Generalised Estimating Equations (GEEs) were estimated with health at T0 (pre-exit) and T1 (post-exit) as the outcome. Analyses were performed for the three health indicators separately. Self-rated health was examined with a linear model and

for mental health and physical limitations a logistic model was applied. In each analysis, an exchangeable correlation structure was used to account for interdependency of repeated measurements within the respondents [34]. Each model consisted of the three T0 working conditions, a dummy for observation number, two period dummies, two-way interactions between working conditions and observation number, three-way interactions between working conditions, observation number and period dummies, and the potential confounders sex, time after exit, BMI and smoking. We considered baseline age but because it did not affect the results, it was not included in the final model. The three working conditions were interrelated, i.e. tolerance appeared too low (<0.50) for psychosocial resources, which correlated highest with physical demands. Therefore, a new variable was constructed for psychosocial resources, in which the residuals of physical demands were removed. Pre-exit and post-exit were included in the analyses with 1 for T0 and 0 for T1. This way, the model yields post-exit health differences between higher versus lower levels of exposure to working conditions. All variables, except for observation number and period, were centred to the mean. The purpose of the three-way interactions is to provide a model for each period, by changing the reference category of the period dummies. This way, we used a parsimonious model in which the potential confounders are treated similarly.

Hypothesis 1 (*Health trajectories diverge more strongly in the later periods, to the disadvantage of workers with higher physical and psychosocial demands, and lower psychosocial resources*) is tested by examining whether the regression coefficients of the two-way interactions of one period exceeded the corresponding 95% confidence intervals of an earlier period. Hypothesis 2 (*Greater differences in work-related post-exit health in the 2010s and 2000s compared to the earlier periods*) is tested by examining whether the regression coefficients of type of working conditions of one period exceeded the corresponding 95% confidence intervals of an earlier period.

The health trajectories across the work exit transition are also expressed in mean scores (self-rated health) and probabilities (for low positive affect and ≥1 physical limitations) and presented in graphs. These graphs present the modelled health trajectories of the lowest and highest exposure group of the specific working condition disaggregated by period, adjusted for all potential confounders.

RESULTS

Descriptive findings

Average age at work exit increased from 60.4 years in the 1990s, to 61.1 in the 2000s and to 62.7 in the 2010s (Table 1). The proportion of women increased, mean exposure to high physical demands decreased, and psychosocial demands and psychosocial resources increased from the 1990s to the 2010s. From the 2000s to the 2010s, the proportion of current smokers decreased and from the 1990s to the 2000s the

proportion of obese workers increased. The proportion with at least one physical limitation increased among workers from the 1990s to the 2000s and among former workers from the 1990s to the 2010s. The proportion of former workers with a low positive affect increased from the 1990s to the 2000s.

Table 1. Descriptive pre- and post-exit characteristics of workers in the three periods and in the total sample

	1990s	2000s	2010s	Total	p-value*
N	110 (29%)	131 (34%)	142 (37%)	383 (100%)	
Pre-exit characteristics					
Age					
Range 55-65	58.9 (2.5)	59.5 (2.5)	61.0 (2.5)	59.9 (2.7)	p<0.001[bc]
Sex					
Men	72 (64%)	78 (60%)	71 (50%)	209 (56.5%)	
Women	38 (36%)	53 (40%)	71 (50%)	161 (43.5%)	p=0.042[c]
Physical demands					
Range 0-4	2.1 (1.4)	1.9 (1.6)	1.5 (1.6)	1.8 (1.6)	p=0.005[c]
Psychosocial demands					
Range 0-6	1.0 (1.8)	1.4 (1.8)	1.9 (2.1)	1.5 (2.0)	p=0.003[c]
Psychosocial resources					
Range 0-4	1.1 (1.3)	1.3 (1.4)	1.6 (1.4)	1.4 (1.4)	p=0.019[c]
Work exit age					
Between T0 and T1	60.4 (2.5)	61.1 (2.4)	62.7 (2.5)	61.5 (2.7)	p<0.001[abc]
Smoking					
Currently	34 (31%)	37 (28%)	19 (13%)	90 (23%)	
Past <15 years	26 (24%)	19 (15%)	23 (16%)	69 (18%)	
Past ≥15 years	27 (24%)	43 (33%)	63 (44%)	132 (34%)	
Never	23 (21%)	32 (24%)	37 (26%)	92 (24%)	p=0.001[bc]
BMI					
<25	35 (32%)	35 (27%)	55 (39%)	125 (33%)	
25-30	66 (60%)	68 (52%)	56 (39%)	190 (50%)	
>30	9 (8%)	28 (21%)	31 (22%)	68 (18%)	p=0.006[ac]
Self-rated health					
Score 1-5	2.1 (0.7)	2.1 (0.8)	2.2 (0.9)	2.2 (0.8)	p=0.298
Mental health					
Low positive affect (≤7)	23 (21%)	30 (24%)	26 (19%)	79 (21%)	
missings	2	7	2	11	p=0.515
Physical limitations					
≥1 physical limitations	9 (8%)	32 (24%)	40 (28%)	81 (21%)	
missings	1	0	1	2	p<0.001[ac]
Post-exit characteristics					
Self-rated health					
Score 1-5	2.1 (0.7)	2.1 (0.8)	2.2 (0.8)	2.1 (0.8)	p=0.960

Table 1. Continued

	1990s	2000s	2010s	Total	p-value*
Mental health					
Low positive affect (≤7)	16 (15%)	37 (30%)	28 (20%)	81 (22%)	
missings	2	7	2	11	p=0.383[a]
Physical limitations					
≥1 physical limitations	30 (28%)	40 (31%)	56 (40%)	126 (33%)	
missings	1	0	1	2	p=0.037[c]
Time after work exit					
Years	1.6 (0.8)	1.5 (0.8)	1.4 (0.8)	1.5 (0.8)	p=0.122

Note: data expressed as mean (SD) or n (%)

* Unweighted trend analyses tested by One-way ANOVA & Chi-square test

a = difference between 1990s and 2000s with p<0.05

b = difference between 2000s and 2010s with p<0.05

c = difference between 1990s and 2010s with p<0.05

Self-rated health

Table 2 shows that for workers with an average exposure to the working conditions, there was no difference between T0 and T1 in the 1990s, 2000s and 2010s. This means that in each period, mean self-rated health did not change across the work exit transition.

Figure 1 illustrates the self-rated health trajectories of workers with the highest and lowest physical demands (1A), psychosocial demands (1B) and psychosocial resources (1C), disaggregated by period. The results in Table 2 show whether trajectories between workers with higher versus lower demands/resources increased across the periods, and whether post-exit differences increased.

With regard to work-related differences in the health trajectories, Table 2 shows that the interaction term between observation number and physical demands in the 2000s (B=-0.08) differed from the 1990s (B=0.03). This means that the self-rated health trajectories from pre- to post-exit between workers with higher and lower physical demands differed more in the 2000s compared to the 1990s, at the disadvantage of those with higher physical demands. This supports Hypothesis 1. However, the trajectories did not further diverge in the 2010s (B=-0.06, which is not different from the B's in previous periods). Moreover, the estimates for the interaction terms of the two other working conditions did not differ across the periods.

With regard to work-related differences in post-exit health, Table 2 shows that self-rated health was worse for former workers in jobs with higher compared to lower physical demands in the 2000s and 2010s (B=0.21 and B=0.12, respectively), and these differences are larger than in the 1990s. Self-rated health was also worse for

former workers in jobs with lower compared to higher psychosocial resources in the 2010s (B=-0.19), which differed from the 2000s. This supports Hypothesis 2. The post-exit differences in self-rated health are partly a result of the fact that workers with unfavourable working conditions in more recent periods no longer benefit from work exit (in the case of physical demands) and partly a result of pre-exit health differences that continue to exist after work exit (in the case of psychosocial resources).

Table 2. Regression of poor self-rated health on working conditions at baseline (N = 383)

	1990s		2000s		2010s	
	B	95% CI	B	95% CI	B	95% CI
Constant	2.14		2.11		2.22	
Observation number						
T0 vs T1	-0.04	-0.16;0.09	0.00	-0.13;0.12	0.07	-0.06;0.20
Health trajectories						
Obs.*physical demands	0.03	-0.07;0.12	-0.08[a]	-0.19;0.02	-0.06	-0.16;0.04
Obs.*psychosocial demands	0.01	-0.06;0.08	-0.05	-0.13;0.03	-0.04	-0.12;0.03
Obs.*psychosocial resources	0.15	0.01;0.30	0.07	-0.05;0.19	0.08	-0.05;0.21
Post-exit health						
Physical demands	-0.01	-0.09;0.08	0.21[a]	0.11;0.32	0.12[a]	0.03;0.21
Psychosocial demands	0.02	-0.05;0.09	0.09	0.00;0.18	0.01	-0.06;0.09
Psychosocial resources	-0.11	-0.27;0.04	-0.05	-0.18;0.08	-0.19[b]	-0.32;-0.06
Confounders						
Sex (female vs male)	-0.09	-0.24;0.05	-0.09	-0.24;0.05	-0.09	-0.24;0.05
Time after work exit	0.01	-0.08;0.09	0.01	-0.08;0.09	0.01	-0.08;0.09
BMI (ref <25)						
25-30	0.18	0.03;0.33	0.18	0.03;0.33	0.18	0.03;0.33
>30	0.43	0.21;0.65	0.43	0.21;0.65	0.43	0.21;0.65
Smoking (ref = currently)						
Past <15 years	-0.23	-0.42;-0.05	-0.23	-0.42;-0.05	-0.23	-0.42;-0.05
Past ≥15 years	-0.13	-0.32;0.05	-0.13	-0.32;0.05	-0.13	-0.32;0.05
Never	-0.17	-0.37;0.03	-0.17	-0.37;0.03	-0.17	-0.37;0.03

Note 1. Multivariate model. Note 2. Higher values indicate *poorer* self-rated health. Note 3. [a] = Estimate differs significantly from estimate in 1990s; [b] = Estimate differs significantly from estimate in 2000s.

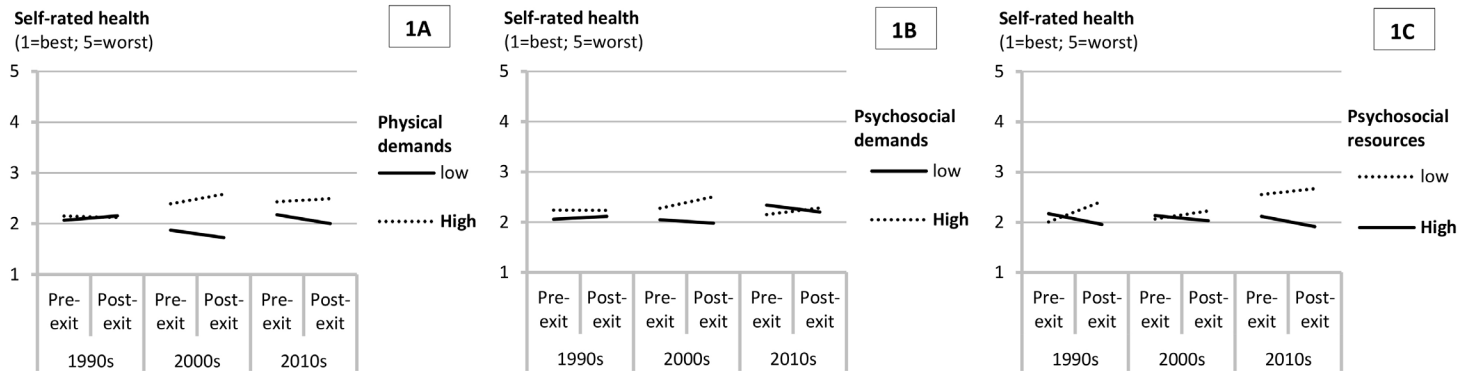

Figure 1. Self-rated health trajectories for workers with the highest and lowest physical demands (1A), psychosocial demands (1B) and psychosocial resources (1C), disaggregated by period, adjusted for all potential confounders

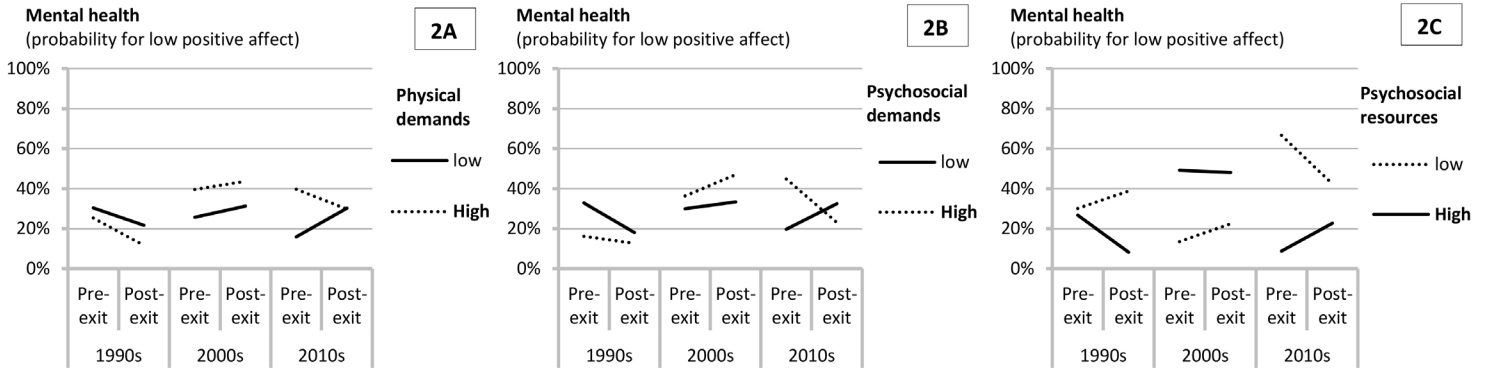

Figure 2. Mental health trajectories for workers with the highest and lowest physical demands (2A), psychosocial demands (2B) and psychosocial resources (2C), disaggregated by period, adjusted for all potential confounders

Mental health

Table 3 shows that for workers with average working conditions, the odds for a low positive affect was higher during the final working years compared to after the work exit transition in the 1990s (OR=1.96), indicating that mental health improved after work exit. In the 2000s and 2010s, mental health did not change across the work exit transition for these workers.

Figure 2 illustrates the mental health trajectories of workers with the highest and lowest physical demands (2A), psychosocial demands (2B) and psychosocial resources (2C), disaggregated by period. The results in Table 3 show whether trajectories between workers with higher versus lower demands/resources increased across the periods, and whether post-exit differences increased.

With regard to work-related differences in the health trajectories, Table 3 shows that health trajectories between workers with higher versus lower psychosocial demands in the 2010s (OR=1.32) differed from the 1990s. Also, the health trajectories between workers with higher versus lower psychosocial resources in the 2010s (OR=0.59) differed from the 1990s and 2000s. However, this finding does not support Hypothesis 1, because the mental health trajectories of workers with unfavourable and favourable working conditions converged instead of diverged in the 2010s.

Post-exit mental health between workers with higher and lower psychosocial resources changed across the periods (OR=0.61; OR=1.34, and OR=0.80, respectively). However, these findings do not support Hypothesis 2 either, because we expected that former workers in jobs with lower psychosocial resources would be increasingly in poorer post-exit mental health compared to those with high psychosocial resources. The results show that in the 2000s former workers in jobs with higher compared to lower psychosocial resources were surprisingly, although insignificantly, in poorer post-exit health, which caused the differences between the periods.

Table 3. Regression of poor mental health on working conditions at baseline (N = 372)

	1990s		2000s		2010s	
	OR	95% CI	OR	95% CI	OR	95% CI
Observation number						
T0 vs T1	1.96	1.12;3.46	0.80[a]	0.50;1.29	0.77[a]	0.43;1.39
Health trajectories						
Obs.*physical demands	1.13	0.68;1.87	1.03	0.69;1.53	1.37	0.91;2.07
Obs.*psychosocial demands	0.92	0.66;1.28	0.95	0.68;1.35	1.32[a]	0.98;1.78
Obs.*psychosocial resources	1.57	0.93;2.64	1.18	0.72;1.93	0.59[ab]	0.35;1.00

Table 3. Continued

	1990s		2000s		2010s	
	OR	95% CI	OR	95% CI	OR	95% CI
Post-exit health						
Physical demands	0.83	0.55;1.26	1.14	0.82;1.60	0.99	0.74;1.33
Psychosocial demands	0.93	0.58;1.49	1.10	0.80;1.52	0.92	0.71;1.20
Psychosocial resources	0.61	0.33;1.15	1.34[a]	0.88;2.02	0.80[b]	0.50;1.25
Confounders						
Sex (female vs male)	0.72	0.44;1.20	0.72	0.44;1.20	0.72	0.44;1.20
Time after work exit	1.13	0.86;1.49	1.13	0.86;1.49	1.13	0.86;1.49
BMI (ref <25)						
25-30	0.81	0.49;1.35	0.81	0.49;1.35	0.81	0.49;1.35
>30	0.99	0.53;1.84	0.99	0.53;1.84	0.99	0.53;1.84
Smoking (ref = currently)						
Past <15 years	0.67	0.34;1.32	0.67	0.34;1.32	0.67	0.34;1.32
Past ≥15 years	0.75	0.42;1.34	0.75	0.42;1.34	0.75	0.42;1.34
Never	0.69	0.35;1.34	0.69	0.35;1.34	0.69	0.35;1.34

Note 1. Multivariate model. Note 2. Values above 1 indicate higher odds for low positive affect. Note 3. [a] = Estimate differs significantly from estimate in 1990s; [b] = Estimate differs significantly from estimate in 2000s.

Physical limitations

Table 4 shows that for workers with average working conditions the odds for at least one physical limitation was higher after work exit compared to the final working years in the 1990s and 2010s (OR=0.20 and OR=0.56, respectively). The OR for the 2000s (0.66) has the same direction, but does not reach significance.

Figure 3 illustrates the trajectories in physical limitations of workers with the highest and lowest physical demands (3A), psychosocial demands (3B) and psychosocial resources (3C), disaggregated by period. The results in Table 4 show whether trajectories between workers with higher versus lower demands/resources increased across the periods, and whether post-exit differences increased.

With regard to work-related differences in the health trajectories, Table 4 shows that the interaction terms between observation number and psychosocial resources in the 2000s and 2010s (OR=1.21 and OR= 1.01, respectively) differed from the 1990s (OR=3.70), which means that the trajectories in physical limitations between workers with higher and lower psychosocial resources differed between these periods. However, it does not support Hypothesis 1 because the trajectories in physical limitations between workers with higher versus lower psychological resources diverged in the 1990s but no longer diverged in the 2000s and 2010s.

With regard to work-related differences in post-exit physical limitations, Table 4 shows that in the 2000s and 2010s, former workers from jobs with higher physical demands had more physical limitations compared to those with lower physical demands (OR 1.39 and 1.32, respectively), but the differences did not increase significantly over time. Table 4 also shows that the difference in physical limitations between former workers from jobs with higher and lower psychosocial resources decreased from the 1990s to the 2000s (OR 0.34 and 0.94, respectively), and remained stable through the 2010s (OR 0.95). In fact, in the 2000s and 2010s there was no longer a significant difference in physical limitations between these former workers. Therefore, Hypothesis 2 is not supported.

Table 4. Regression of functional limitations on working conditions at baseline (N = 381)

	1990s		2000s		2010s	
	OR	95% CI	OR	95% CI	OR	95% CI
Observation						
T0 vs T1	0.20	0.07;0.60	0.66[a]	0.43;1.02	0.56	0.37;0.83
Health trajectories						
Obs.*physical demands	1.19	0.57;2.44	1.13	0.83;1.53	0.96	0.73;1.25
Obs.*psychosocial demands	0.65	0.33;1.28	0.87	0.64;1.19	1.08	0.86;1.35
Obs.*psychosocial resources	3.70	1.51;9.10	1.21[a]	0.74;1.97	1.01[a]	0.66;1.54
Post-exit health						
Physical demands	1.14	0.79;1.66	1.39	1.03;1.86	1.32	1.01;1.73
Psychosocial demands	1.28	0.93;1.76	1.19	0.91;1.56	0.96	0.76;1.20
Psychosocial resources	0.34	0.17;0.68	0.94[a]	0.62;1.42	0.95[a]	0.65;1.39
Confounders						
Sex (female vs male)	1.21	0.77;1.92	1.21	0.77;1.92	1.21	0.77;1.92
Time after work exit	1.09	0.84;1.41	1.09	0.84;1.41	1.09	0.84;1.41
BMI (ref <25)						
25-30	2.07	1.23;3.48	2.07	1.23;3.48	2.07	1.23;3.48
>30	3.96	2.13;7.39	3.96	2.13;7.39	3.96	2.13;7.39
Smoking (ref = currently)						
Past <15 years	0.87	0.44;1.70	0.87	0.44;1.70	0.87	0.44;1.70
Past ≥15 years	0.69	0.38;1.25	0.69	0.38;1.25	0.69	0.38;1.25
Never	0.81	0.43;1.70	0.81	0.43;1.70	0.81	0.43;1.70

Note 1. Multivariate model. Note 2. Values above 1 indicate higher odds for ≥1 functional limitations. Note 3. [a] = Estimate differs significantly from estimate in 1990s; [b] = Estimate differs significantly from estimate in 2000s

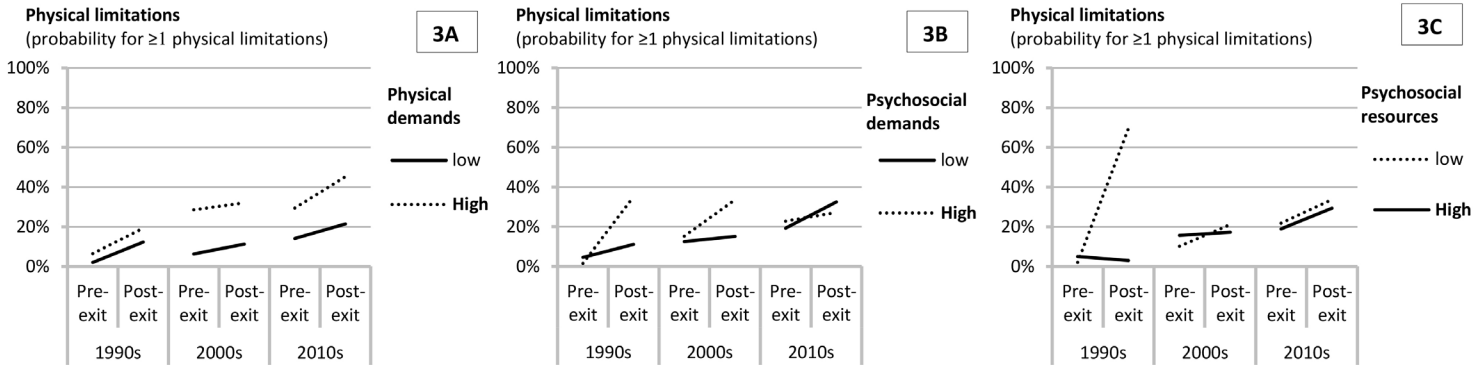

Figure 3. Trajectories in physical limitations for workers with the highest and lowest physical demands (3A), psychosocial demands (3B) and psychosocial resources (3C), disaggregated by period, adjusted for all potential confounders

DISCUSSION

This study examined health trajectories in self-rated health, mental health and physical limitations across the work exit transition for older workers with higher versus lower physical demands, psychosocial demands, and psychosocial resources in the 1990s, 2000s and 2010s. First, it was hypothesised that differences in health trajectories between these workers increased from the 1990s to the 2010s. Second, it was hypothesised that there are greater differences in work-related post-exit health in the 2010s and 2000s compared to the 2000s and 1990s, respectively. Both hypotheses were supported by this study with regard to self-rated health only.

Previous studies have shown that self-rated health differs between workers with favourable and unfavourable working conditions before and after work exit [14, 15, 35, 36]. Our results indicate that the extension of working lives leads to even greater post-exit differences in self-rated health between workers with higher versus lower physical demands and psychosocial resources, at the disadvantage of those with higher physical demands and lower psychosocial resources (Hypothesis 2). These increased differences can be partly attributed to the increase in health differences that occurred during working life. We assume that these differences are a consequence of a longer period of exposure in combination with exposure during ages in which people are becoming more vulnerable [7, 37]. In addition, increased post-exit health differences between workers with higher versus lower physical demands are also caused by increasingly diverging trajectories, which we hypothesised (Hypothesis 1). This finding indicates that the consequence of the policy of extending working life is that work exit only benefits workers in jobs with lower physical demands and no longer benefits workers in jobs with higher physical demands. This results in a 'double burden' of the extension of working lives for former workers in jobs with higher physical demands.

With regard to mental health our study provides no support for the hypotheses. In fact, there was no clear association between working conditions and mental health before or after work exit at all. This is surprising, as previous studies have shown that unfavourable working conditions are related to poorer mental health during working life [36, 38], and remain after work exit [39]. Potentially, our specific measure of positive affect does not capture mental health in the same manner as other instruments, such as the SF-12, General Health Questionnaire and EURO-D as used in earlier other studies. Positive affect has been shown to react specifically to (the disappearance of) activities, i.e. leisure activities and the size of the social network [32]. It is possible that positive affect reacts differently to working conditions and the loss of work. Further research is needed.

With regard to physical limitations no support for the hypotheses is found. However, we found substantial differences in post-exit physical limitations between workers with higher versus lower physical demands, which were statistically significant in the

2000s and 2010s. This is in line with previous research [9, 17] and is likely a result from differences in physical limitations that occurred during working life. This suggestion is supported by results of other studies [9, 24, 36]. Our results indicate that the extension of working lives over the past two decades has not increased differences in physical limitations between (former) workers with favourable and unfavourable working conditions. Potentially, the effects of the extension of working lives were biased towards the null, because the GPJEM used to measure working conditions was not able capture the working conditions in the same manner in each period [40]. For example, because high physical demands have become less harmful in the same type of jobs, due to technological developments [2]. Another explanation is that working until the age of, on average, 62.7 in the 2010s is not more harmful for physical limitations compared to working until the age of 60.4 years in the 1990s. The average age of work exit already increased to age 65 in 2018 and further extension of working lives is expected for the future [41, 42]. This may still lead to more physical limitations among older workers with high physical demands in the future and should therefore be monitored.

It is remarkable that the extension of working lives in jobs with, in particular, high physical demands did negatively affect self-rated health, but did not affect physical limitations. Potentially, self-rated health is more sensitive to the extension of working lives compared to physical limitations. For example because workers with high versus low physical demands experience more dissatisfaction regarding an extended working life, which is expressed in poorer self-rated health but not in more physical limitations [43].

In this study, we aimed to examine the effects of increased work exit ages due to policy changes that have taken place in the past two decades. Respondents from the 1990s had a lot of possibilities to leave the workforce early and many people used this opportunity, regardless their working conditions and health status [23]. For respondents from the 2000s, it became more difficult to exit the workforce via disability benefits [44], and in the 2010s early exit was financially unattractive [45]. This resulted in different reasons for exit from work in each period, i.e., a decrease of disability benefits and (early) retirement and increase of unemployment over time (see Appendix A). In most research, different exit routes are analysed separately [46]. Apart from the fact that this was not possible with our sample size, we have deliberately chosen to analyse all exit routes combined, because now the composition of our successive cohorts reflects the policy changes. By adjusting for sex, the lifestyle factors smoking and BMI, and for time after work exit, we tried to preclude other effects. We did not adjust for educational level as it was highly correlated to the working conditions and we did not want to overadjust and consequently bias results towards the null [47].

A strength of this study is the use of a representative sample of the older working population. In addition, the cohort-sequential design of LASA enabled us to compare the health trajectories during different time periods. There are also a number of limitations.

First, the number of respondents eligible for the analyses of this study was quite low and stratification by period led to even smaller samples. Therefore, the analyses should be replicated using larger samples.

Second, the health trajectories were based on mean estimates before and after work exit using GEE. This method is often used, but does not take into account the possibility that individuals may have different developmental trajectories [16]. As a consequence, certain associations may have been missed for specific subgroups because opposite findings may have levelled each other out. Latent trajectory analysis offers the possibility to examine specific trajectories within subgroups, but larger samples are needed.
Third, working conditions are obtained from a General Population Job-Exposure Matrix (GPJEM) [9]. This GPJEM does not take heterogeneity within job categories into account, because information is aggregated. However, the advantage of the GPJEM is that it is not influenced by individual characteristics, such as health, which may lead to reversed causality [48, 49]. Furthermore, the GPJEM is developed based on working conditions reported by 55-65-year-olds over the period 2005-2010 [9]. Therefore, it is possible that it does not capture the working conditions in the same manner in each period. This may have biased our results towards the null.

This study shows that differences in self-rated health and physical limitations related to differences in working conditions remain present after work exit, and are substantial in the 2000s and 2010s. This is critical for both individuals and society. Ex-workers in poor health are less likely to participate in society through voluntary work and informal care [50-52]. In addition, poor health leads to health care costs [53]. Post-exit health differences could be limited by improving the working conditions of workers at older ages or by an adapted statutory retirement age for workers with unfavourable working conditions [54, 55]. In view of the ongoing increase in the average retirement age in the Netherlands since 2006, we stress the importance of monitoring pre- and post-exit health in workers with higher versus lower levels of work demands and resources in larger samples [45].

We conclude that the present study indicates that the extension of working lives has more adverse effects on self-rated health among former workers with higher physical demands compared to former workers with lower physical demands. These increased differences in post-exit self-rated health are a result of increased differences that occurred in the final working years, and of the fact that workers with high physical demands do not benefit from work exit in the same manner as workers with low physical demands do. The extension of working lives may therefore be a double burden for workers with high physical demands. The study found no support for an increased effect of the extension of working lives on the association between working conditions and mental health or physical limitations.

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APPENDIX A: EXIT ROUTES

	1990s	2000s	2010s
Retired	77 (70%)	85 (65%)	84 (59%)
Unemployed	5 (4%)	13 (10%)	21 (15%)
Disability pension	11 (10%)	17 (13%)	10 (7%)
Unknown	17 (16%)	16 (12%)	27 (19%)
Total	110	131	142

Chapter 6

Future health prior to state pension age – explorations for the Netherlands 2040

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ABSTRACT

Objectives: In many Western countries, the state pension age is being raised to stimulate prolonged working. In the Netherlands, the state pension age is expected to be raised to 68 years in 2040. It is not yet well understood whether health of the 60+ permits this increase. In this study, health of Dutch adults aged 60 to 68 is explored up to 2040.

Methods: Data are from the Dutch Health Interview Survey (HIS) 1990-2017 (N≈10,000 yearly) and the Dutch Public Health Monitor (PHM) 2016 (N=205,151). Health is operationalised using combined scores of 1) self-reported health and 2) limitations in hearing, seeing or mobility. Categories are: good, moderate and poor health. Two scenarios are explored that are likely for the Dutch situation: a stable health trend and an improving health trend. First, health trends in 5-year age categories were modelled up to 2040 with a logistic regression analysis using HIS 1990-2017. Second, the growth rate from 2016 to 2040 was applied to the health level from the PHM 2016. We assume that the two scenarios indicate a bandwidth between which health will develop.

Results: In 2016, 63% of men aged 60-65 had good, 25% had moderate and 12% had poor health. Among women, this distribution was 64%, 22% and 14%, respectively. In 2040, the health distribution among men aged 60-68 is estimated to be 63-71% in good, 17-28% in moderate and 9-12% in poor health. Among women this is estimated to be 64-69%, 17-24% and 12-14%, respectively.

Conclusions: Up to 2040, at least the same and probably a larger proportion of the working-age population is expected to reach the state pension age in good health. However, due to the large birth cohorts from the 1960's and 1970's reaching age 60+, in combination with the increasing state pension age, also the absolute number of working-age people in poor and moderate health will increase. Policies aiming at sustainable employment will therefore remain important, even in the case of most favourable health trends.

INTRODUCTION

In many Western countries, the state pension age is being raised to stimulate the extension of working lives and to contribute to financial sustainability of state pensions. In the Netherlands, the state pension age is linked to the life expectancy at age 65 years (LE65) with a factor of two third. This means that with each year that LE65 increases, the state pension age will increase by eight months. In 2016, the state pension age was 65 and six months. In 2040, the state pension age is expected to be 68 years. It is not yet known whether the health status of the 60+ population permits this increase. In this study, the health of Dutch adults aged 60 to 68 is explored up to 2040.

There are only few studies exploring future health [1]. Studies examining chronic diseases and multimorbidity show that their prevalence is likely to increase in the coming years [2, 3]. In line with the Dutch Public Health Foresight Study, we focus on self-reported health and functional limitations because they better predict labour participation compared to having a chronic disease [4]. The Dutch Public Health Foresight Study shows that average health is expected to remain the same for the total Dutch population, but will improve among older adults (aged ≥45 years) [2, 5]. These improvements can be attributed to an increase in educational level, improvement in living conditions and improvement in lifestyle and health care (i.e. prevention, care and cure) [6].

Up until now, health has not been explored specifically for the older working-age population. Based on historical health trends, which form the basis for the exploration of future health, there is reason to believe that the future health trend of this age category will be less favourable. Six studies studying historical health trends across different age categories in different countries, show that the historical health trends of the 60-65-year-olds do not follow the same, more positive, trends of the 65+ [7-12]. Only one German study showed that there was an improvement in physical functioning among 50-65-year-olds from 1997 to 2011 [13]. Findings from a European study from 2004-2013 show that disability trends among 50-64-year-olds differ across indicators and countries, but the subsample of the Netherlands shows a stable trend according to all indicators [10]. Another Dutch study shows that the number of functional limitations of 55-65-year-olds increased between 1992 and 2002, but remained stable in the period from 2002 to 2012 [14]. A Canadian study also examined health of adults aged below the age of 55, and showed that there was also no improvement among younger age categories [11].

It is not well understood why physical health trends of 60-65-year-olds are not as positive as of the 65+. Steiber et al. suggest that increases in employment rates and extension of working lives may have contributed to the stable trend, as for many people daily routines involve lower levels of health-beneficial physical activity. Moreover, these authors argue that the decline in physically demanding jobs and the increase in office-jobs has increased occupational sitting, which in turn increased physical health risks [9]. Seeman

et al. suggest that the cause may lie in that more recent cohorts of adults are entering older adulthood with longer duration of obesity or overweight, leading to more physical health problems [8]. An alternative explanation could be that younger adults are already healthier compared to older adults, which limits health gains among the younger adults.

With regard to the Dutch situation, it is plausible that the extension of working lives explains why there was no improvement in health among 50-64-year-olds, as found in two Dutch samples [10, 14]. From 2006 to 2017, employment rates of 60-65-year-olds have increased with 31 percentage points and the actual retirement age increased from age 61 to age 64.6 [15, 16]. Working until higher ages may have negative health effects, as older workers need more time to recover from physically or psychosocially demanding tasks. Extended exposure to these tasks may lead to health problems [17, 18]. In addition, the extension of working lives is accompanied by an increase of the proportion of workers who also provide informal care [19]. Combining these tasks may cause a double burden for older workers, which in turn affects their health status [20]. The explanations suggested by Steiber et al. and Seeman et al. are less likely for the Dutch situation. First, a Dutch study shows that the decline in physically demanding jobs did not affect the average health status of successive cohorts of older workers [21]. Second, another Dutch study shows that the prevalence of obesity has only increased among men and remained stable among women aged 55-65 from 1992-2012 [22]. Third, the Dutch Public Health Foresight Study shows that average health is expected to improve among all older adults aged ≥45 years, which indicates that health gains are still possible among all age categories of older adults [2, 5].

For future health trends of the older working-age population, we suggest that there are two likely scenarios. On the one hand, it can be expected that the stable health trend will continue and that this will also be realistic for the 65-68-year-olds. This would be due to the extension of working lives as a result of the expected increase of the average retirement age, and the expected increase of the demand for informal care in this age category [23-25]. On the other hand, it can be expected that health of 60-65-year-olds will improve in the coming years, just as is expected for the surrounding ages according to the Dutch Public Health Foresight Study [5]. This could occur if the adverse health effects of the extension of working lives do not exist or have been temporary. Several measures to encourage the extension of working lives followed shortly after each other, and the retirement age that older workers had planned on was repeatedly delayed. As a result, older workers were unable to prepare themselves for working longer which may have had adverse health effects [26]. Currently, there is a well-defined plan of raising the Dutch state pension age the coming years and there are no indications that there will be any additional stricter measures [27]. It can be expected that current workers have more realistic expectations of the retirement age, and that they prepare themselves for these final working years by investing in their market value. For example by investing

in their skills [28], but also in intangible assets, such as a broad social network, good physical and mental health and a good work-life balance [29].

The aim of this study is to explore health of Dutch adults aged 60 to 68 years up to 2040. Two scenarios are developed that are assumed likely for the Dutch situation: a stable health trend (i.e. constant health status over time) and an improving health trend. We assume that the two scenarios indicate a bandwidth between which health will develop. To assess health, a combined measure of self-reported health and functional limitations is used. To arrive at scenarios, first, projections of the proportion of men and women aged 60-68 in good, moderate and poor health are made until 2040. Second, the projections are expressed in the absolute number of persons over 60 years of age up until the state pension age in each health category for 2030 and 2040.

METHODS

Study samples

Data are used from the Dutch Public Health Monitor (PHM) 2016 and the Dutch Health Interview Survey (HIS) 1990-2017 [30, 31]. The PHM is a repeated cross-sectional health survey of the Community Health Services, Statistics Netherlands and the National Institute for Public Health and the Environment, conducted in 2012 and 2016. Respondents in 2016 aged ≥19 years were selected by taking a random sample of non-institutionalised individuals (N ≈ 460,000). For the analyses, respondents aged 55-75 were included who provided information on health and limitations (N = 205,151). There were 4,474 missing self-reports regarding health and limitations (2%).

The HIS is an annual cross-sectional health survey conducted by Statistics Netherlands since 1981. The sample consists of approximately 10,000 non-institutionalised persons (all ages) each year with the exception of the years 2010-2013 (approx. 15,000 persons each year). For the analyses, respondents aged ≥16 years were included who participated between 1990 and 2017, responded to both parts of the questionnaire, and provided information on health and limitations (N = 172,599). There were 48,128 missing self-reports regarding health and limitations (22%). Approximately 20% was because the participants did not respond to the second part of the questionnaire in which functional limitations was included, and approximately 2% did not provide information on their health status for other reasons.

Two datasets are used, complementing each other. The strength of the PHM 2016 is its large sample size, which provides estimations of health in the specific age categories with more accuracy. The strength of the HIS 1990-2017 is that it provides long-term health trends, but the health estimate in each age category is less accurate as the annual samples are relatively small (approx. 220 men and 220 women in each 5-year age category).

Variables

Demographics

Age and sex are used as demographic variables. Age was used in five-year categories. In PHM, five-year age categories are constructed using birthyear which categorizes the age as of 31 December 2016. In HIS, age at the interview date is available.

Health

Health is operationalised using a combination of two health indicators: self-reported health and limitations in hearing, seeing or mobility. Self-reported health was assessed with one question: 'How is your health in general?', with response options: 'very good', 'good', 'fair', 'poor' and 'very poor'. The indicator scores 'healthy' if the answer is 'very good' or 'good' [32]. Functional limitations were assessed using seven questions of the OECD-indicator: Able to 1. follow a conversation in a group of three or more persons (with or without a hearing aid); 2. have a conversation with one person (with or without a hearing aid); 3. read the small print in the newspaper (with or without glasses or contact lenses); 4. recognise somebody's face at a distance of four metres (with or without glasses or contact lenses); 5. carry an object of five kilogrammes, for instance a shopping bag over a distance of ten metres; 6. pick up something from the floor from an upright position; 7. walk 400 metres without stopping (with or without a cane). Response options are: 'with no difficulty', 'with some difficulty', 'with a lot of difficulty', 'not at all'. The indicator scores 'healthy' if the answers to all seven questions are 'with no difficulty' or 'with some difficulty' [33]. The combined health indicator for this study consists of three categories: good health (healthy according to both indicators), moderate health (healthy according to only one indicator) and poor health (unhealthy according to both indicators). The combined health indicator was chosen, because in an additional analysis it proved to be more predictive of labour market participation (expressed in currently working, non-working, receiving disability pension and retired) compared to one single indicator. In a multinomial regression model, the variance explained in labour market participation was 18% for the combined health indicator, compared to 15% and 11% for self-reported health and limitations, respectively (measured by Nagelkerke R^2).

Data analyses

Scenario A, in which a stable trend is assumed, is implemented as follows. First, health of 55- to 75-year-old men and women is assessed in five-year age categories using the PHM 2016. Second, average health of 60-65-year-olds of PHM 2016 was applied to 60-68 year-olds in 2040. As it was observed that the 65-70-year-olds were healthier compared to the 60-65-year-olds, possibly attributable to adverse effects of the extension of working lives, the health of the 65-68-year-olds was thus also considered to be affected by these adverse effects. Third, to calculate health status for ages 60 up to the state pension age (Table 1) for each year between 2016 and 2040, average health of 60-65.5 year-olds of PHM 2016 and estimated health of 60-68 year-olds in 2040 of step 1 was interpolated linearly.

Scenario B, in which an improvement in health is assumed, is implemented as follows: First, we interpolated the data assuming a linear age-related decrease in health between the ages of 55 and 70, because we assume that there will be no (longer) adverse health effects of the extension of working lives. Prevalence of good health (men and women) and poor health (women) among 60-65-year-olds was calculated as the average of the 55-60- and 65-70-year-olds. Prevalence of poor health of 60-65- and 65-70-year-old men was calculated by applying the same percent change that was calculated in good health among men. The latter was necessary as the proportion of men in poor health was lower among the 65-70-year-olds compared to the 55-60-year-olds. Health according to this reconstructed data is called PHM 2016*. Second, using HIS 1990-2017, health status in five-year age categories was modelled up to 2040 using logistic regression analysis in R. Third, the resulting growth rate for age categories 60-65 and 65-70 from 2016 to 2040 was applied to the health status in the corresponding age categories of PHM 2016* which resulted in the health estimates for 2040. Fourth, health status between 2016 and 2040 was interpolated linearly for both age categories. Fifth, average health for age 60 up to the state pension age was calculated for each calendar year, taking into account the stepwise increase of the state pension age according to current law and expectations (Table 1).

Finally, both scenarios are expressed as the absolute number of persons over 60 years of age up until the state pension age that are expected in good, moderate and poor health in 2030 and 2040. This is done by multiplying the percentages by absolute numbers according to the population forecast 2018 of Statistics Netherlands [34].

Weighting

Both datasets are weighted to the non-institutionalised Dutch population of each corresponding calendar year. The weight factors are provided by Statistics Netherlands.

Historical health trend

The projection of health up to 2040 for Scenario B is based on analysis of the historical trend. We used HIS to determine this health trend in five-year age categories. We estimated two trends in health. Firstly, for the period 1997-2017, and secondly, for 1990-2017. The first was estimated because since 1997, the sample was randomly derived from non-institutionalised persons, instead of non-institutionalised households, and is therefore less biases. This trend showed that health improved in the age categories 55-60, 65-70 and 70-75 years, but did not improve in the age category 60-65 years (Table 2). As this trend did not provide the growth rate needed for Scenario B, the trend for 1990-2017 was also estimated. This trend showed that health improved in all age categories, and thus provided the necessary growth rate.

Table 1. State pension age

Year	State pension age*
2016	65 + 6 months
2017	65 + 9 months
2018	66
2019-2021	66 + 4 months
2022	66 + 7 months
2023	66 + 10 months
2024-2027	67
2028-2030	67 + 3 months
2031-2033	67 + 6 months
2034-2037	67 + 9 months
2038-2040	68

***** Legally defined until 2025; state pension ages in later years are current expectations dependent on the Life Expectancy at age 65 [27]

Table 2. Health trends for separate age categories for periods 1990-2017 and 1997-2017

	1990-2017		1997-2017	
	Men	**Women**	**Men**	**Women**
55-60				
Good health	**+**	**+**	**+**	**+**
Moderate Health	**-**	**-**	**-**	**0**
Poor health	**-**	**0**	**0**	**0**
60-65				
Good health	**+**	**+**	**0**	**0**
Moderate Health	**0**	**-**	**0**	**0**
Poor health	**-**	**0**	**0**	**0**
65-70				
Good health	**+**	**+**	**+**	**+**
Moderate Health	**-**	**-**	**-**	**-**
Poor health	**-**	**-**	**0**	**0**
70-75				
Good health	**+**	**+**	**+**	**+**
Moderate Health	**-**	**-**	**0**	**-**
Poor health	**-**	**-**	**0**	**-**

+/- = proportion increases/decreases significantly at the 5% level; 0 = no significant trend in health

RESULTS

Scenarios

Figure 1 presents health by five-year age categories for men and women, observed in the PHM 2016 (solid line) and reconstructed (dotted line; called PHM 2016*). They serve as starting point for scenarios A and B, respectively. Figure 2 presents the two scenarios up until 2040, which show the bandwidth for the percentage of people who are expected to be in good health (green-yellow striped area) and in poor health (red-yellow striped area).

Good health

Assuming a stable health trend (Scenario A), 63% of men aged 60-68 years are in good health in 2040 (Figure 2). Assuming an improving health trend (Scenario B), this is 71%. Among women aged 60-68 years, the expected proportion in good health is expected to range between 64% (Scenario A) and 69% (Scenario B).

Poor health

Assuming an improving health trend (Scenario B), 9% of 60-68-year-old men are in poor health in 2040 (Figure 2). Assuming a stable health trend (Scenario A) this is 12%. For 60-68-year-old women, the proportion in poor health is expected to range between 12% (Scenario B) and 14% (Scenario A).

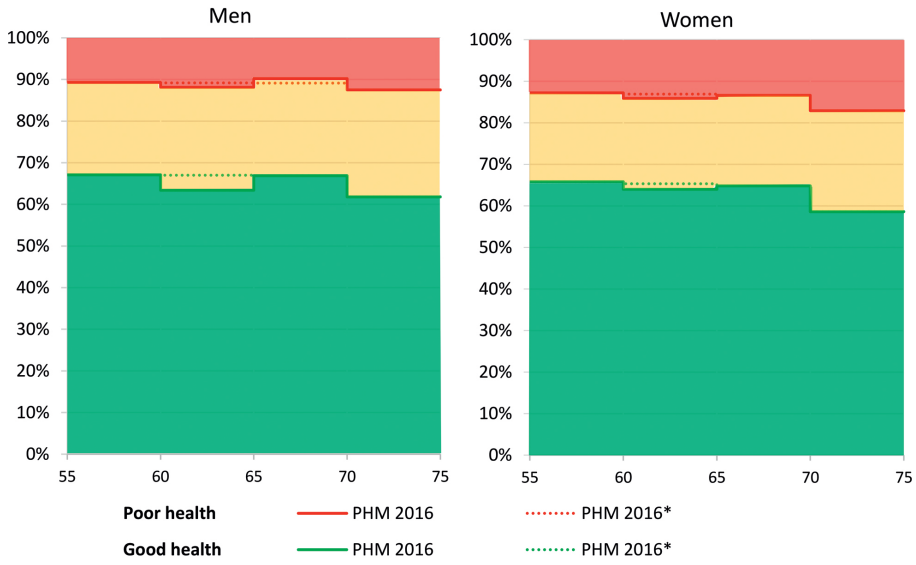

Figure 1. Health by age and gender in 2016, observed (PHM 2016) and reconstructed (PHM 2016*)
Note. Prevalence of good health is below the green line and prevalence of poor health above the red line, the intermediate area is prevalence of moderate health

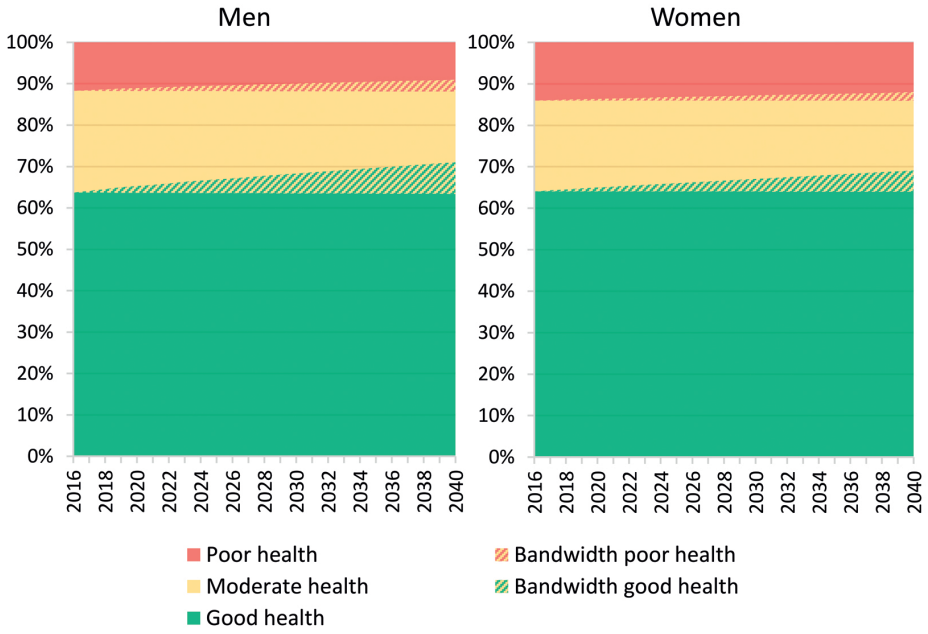

Figure 2. Projections in health for persons over 60 years of age up until the state pension age according to two scenarios (2016-2040).

Population estimates

In Table 3, the health distribution according to the two scenarios is applied to the Dutch population forecasts for 2030 and 2040. It shows that according to both scenarios, the absolute number of people aged 60 up to the state pension age in all three health categories will increase. The largest increases relative to 2016 are expected in 2030. Up to this year, the expected number of people aged 60-67.25 (state pension age in 2030) in good health will increase the most: with approximately 391,000 to 456,000. But also the number of 60-67.25-year-olds in moderate health (101,000-140,000) and poor health (52,000-77,000) will increase.

Table 3. Health distribution among men and women from age 60 up until the state pension age, in 2016, 2030 and 2040 (absolute numbers (x1000) and growth rates)

	2016	2030		2040	
		Scenario A	Scenario B	Scenario A	Scenario B
Men					
Good health	367	+193 (+53%)	+232 (+63%)	+124 (+34%)	+183 (+50%)
Moderate health	142	+73 (+52%)	+49 (+35%)	+50 (+35%)	+13 (+9%)
Poor health	67	+34 (+50%)	+20 (+29%)	+25 (+37%)	+2 (+4%)
Total	576	+300 (+52%)	+300 (+52%)	+199 (+34%)	+199 (+34%)
Women					
Good health	371	+198 (+53%)	+224 (+60%)	+147 (+40%)	+188 (+51%)
Moderate health	127	+67 (+53%)	+52 (+41%)	+51 (+40%)	+26 (+21%)
Poor health	81	+43 (+53%)	+32 (+40%)	+33 (+40%)	+16 (+20%)
Total	579	+308 (+53%)	+308 (+53%)	+230 (+40%)	+230 (+40%)
Men and women					
Good health	738	+391 (+53%)	+456 (+62%)	+271 (+37%)	+372 (+50%)
Moderate health	268	+140 (+52%)	+101 (+38%)	+100 (+37%)	+39 (+14%)
Poor health	149	+77 (+52%)	+52 (+35%)	+58 (+39%)	+19 (+12%)
Total	1154	+608 (+53%)	+608 (+53%)	+429 (+37%)	+429 (+37%)

DISCUSSION

The aim of this study is to explore future health of Dutch adults from age 60 to the state pension age, up until 2040. Two possible scenarios are described and estimated: a stable health trend and an improving health trend. We assume that these two scenarios indicate a bandwidth between which health will develop. According to the estimations, the majority of 60-68-year-olds is expected to be in good health (63-71% of men and 64-69% of women), but also a large proportion is expected to be in moderate health (17-28% of men and 17-24% of women) or poor health (9-12% of men and 12-14% of women) in 2040.

In view of the increased state pension, the results suggest that the majority of the older working-age population should be capable to extend their working lives. The people in moderate or poor health may have difficulty working longer due to their health problems. Both self-reported health and functional limitations have been associated with disability pension and unemployment, and self-reported health also with early retirement [4]. More recent research shows that poor health is becoming a weaker predictor of work exit, that the proportion of older workers with health problems increases and that older workers work more years with health problems [35, 36]. It is not well understood whether people with health problems continue working because they are well capable, because they have no opportunity to stop working, or both.

However, previous research shows that work ability and productivity is lower among older workers with health problems compared to those without health problems [37]. With the extension of working lives this association may become even stronger.

Working beyond the age of 60 may also result in a greater proportion of people with health problems. This is suggested by previous researchers, but there is no conclusive evidence [9]. Our study provides new indications that health is negatively affected by the extension of working lives. First, the results of the health trend of the HIS 1997-2017 show a stable health trend for 60-65-year-olds, while the surrounding age categories show an improving health trend. As was mentioned in the introduction, from 2006 to 2017, employment rates of 60-65-year-olds have increased with 31 percentage points and the actual retirement age increased from 61 to 64.6 years [15, 16]. Second, according to PHM 2016, 64% of women was in good health and 63% of men, although men generally report their health and functioning better compared to women [38]. The close similarity of these percentages may be due to the fact that the employment rate among 60-65-year-old men was higher (63%) compared to women (43%) in 2016 [16]. Third, PHM 2016 shows that in 2016, 60-65-year-olds were less healthy compared to 65-70-year-olds. This phenomenon has recently (2013-2015) been observed in several European countries, not only in the Netherlands, but also in Belgium, Luxembourg, Denmark, Finland and Sweden [39]. It may mean either that health improves after retiring, which is supported by some studies but contradicted by others [40], or that health of the cohort of 65-70-year-olds was not as much affected by the extension of working lives five years earlier. After all, in 2011, employment rates of 60-65-year-olds were 14 percentage points lower compared to 2016, i.e. 39% and 53%, respectively [16].

Methodological considerations

There is a great deal of uncertainty about how the health of over-60s will develop. Especially the deviating historical health trend of 60-65-year-olds compared to older age categories creates this uncertainty. Therefore, we decided to estimate two scenarios that are likely for the Dutch situation, and are assumed to indicate a bandwidth between which health will develop.

The first scenario is based on the historical stable physical health trends found by two different studies using Dutch samples in this age category [10, 14]. This may be limited evidence, and only covering physical health and not self-reported health, but the stable trend is also supported by the results of the current study of the health trend of 60-65-year-olds in HIS from 1997 to 2017.

The second scenario is based on the improving health trend that is expected for 60-65-year-olds, if this age category follows the same trend as the surrounding ages according to the Dutch Public Health Foresight Study [5]. To estimate the extent of improvement, we used the health trend in five-year age categories from HIS 1990-2017 to model health up to

2040, and applied the modelled trend of 60-65- and 65-70-year-olds to the health status of 60-68-year-olds of the PHM 2016. Using historical health trends to make projections for future health is the current state of the art [41]. It has some disadvantages as it does not take into account developments in educational level, lifestyle or health care. Also, using a different historical period would have given a different projection. However, using the period from 1990 onwards is in line with the Dutch Public Health Foresight Study [5].

Theoretically, a third scenario could also be examined, namely a deteriorating health trend. However, we rejected that option because there are currently no indications that future cohorts of 60-68-year-olds will be in poorer health than the 60-65.5-year-olds in 2016.

The data used have some advantages and disadvantages. Both datasets PHM and HIS include only non-institutionalised persons [30, 31]. This may not be an issue, as we are more interested in the potential working population. The institutionalised population concerns only a small proportion in the age category 60-70 years (1% in 2016), but it is important to keep in mind that the health levels and trends may deviate from those in the total population [11, 42, 43]. The HIS is a large survey, but when it is used to accurately estimate health in specific age categories, the sample is too small to draw conclusions on health in each separate year. Its strength is the availability of historical data, which allows us to estimate longitudinal health trends. A disadvantage of PHM is that age was not available for the interview date, so we used age at the 31st of December. However, we assume that it would not have changed the results if the exact date had been available, because prevalence of good, moderate and poor health fluctuated somewhat between successive age years. By using five-year age categories we attempted to level out this fluctuation. The strength of the PHM is its large sample size, which provides estimations of health in these specific age categories with more accuracy compared to HIS. By combining the historical health trends from the HIS with the point prevalence of health from the PHM, we used the best available data from the Netherlands.

Health was measured by a combination of two often-used indicators: self-reported health and limitations in hearing, seeing or mobility [32, 33]. This combination has not been used before and its limitation is that the results are not comparable with results from other literature. However, we think this combined health indicator is more suitable than each indicator separately, because it gives a more comprehensive indication of health status. Self-reported health may also include a mental health component, while self-reported limitations may be more indicative of the capability of continuing work [44].

Implications for practice and further research

What do the explorations for future health of Dutch adults from age 60 to the state pension age imply for the current policy on the state pension age? The scenarios show that the majority of the population in the older working-ages will be in good health. The proportions of over 60-year-olds in moderate and poor health may remain stable

or decrease in the coming years. However, when the proportions are expressed in absolute numbers it turns out that the total number of over-60-year-olds in moderate and poor health will increase according to both scenarios. In 2016, there were 417,000 over-60s in poor and moderate health before state pension age. By 2030, that number is expected to increase to at least 570,000. This is due to a large generation having reached this age category and to the raised state pension age. In 2040, these numbers will drop again to at least 475,000.

People in both moderate and poor health have an increased risk to drop-out early from the labour force, or to continue working reluctantly while their work ability and productivity decreases [4, 37]. Both situations are undesirable from both a societal and an individual point of view. It is therefore necessary to continue taking measures to keep workers healthy and employable up until the state pension age. Research on effective interventions in this regard have reached increasing attention in the past twenty years, but results are inconclusive and effect sizes small [45-47]. More research is needed on effective interventions, with a special focus on more vulnerable categories such as lower educated workers and the growing category of self-employed workers [47].

It is also important to monitor the developments in health of over-60-year-olds during the coming years. The state pension age had been raised by only six months in 2016 and short and long-term health effects of working beyond age 65 are not known yet. Potentially, working at these higher ages is harmful, especially in professions with high physically and psychosocially demanding jobs [17, 18]. Moreover, if the stable trend among 60-68-year-olds continues in the coming years, it is unlikely that the health in age categories ≥70 years will continue to improve. A stabilisation or decline in the health of over-70s should therefore be anticipated. This could have far-reaching consequences, for example for (informal) care, health care costs, life expectancy and the quality of life of individuals.

Conclusions

This study's explorations suggest that the majority of the older working-age population will be in good health and thus should be capable to extend their working lives, but also that a substantial share of people will be in moderate or poor health and thus may have difficulty working longer. A stable or improving health trend may not be an obstacle to raising the state pension age. However, as the state pension age has been raised by only six months in 2016 and health effects of the extension of working lives are not clear yet, health of adults aged 60+ should be monitored in the coming years to confirm our estimations. Moreover, due to the increase in state pension age and large birth cohorts from the 1960's and 1970's reaching ages 60+, the absolute number of people aged 60+ in poor and moderate health that participates in labour will increase. Policy aiming at sustainable employability will therefore remain important, even in the case of the most favourable health trends.

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Chapter 7

General discussion

Over the last decades, labour participation rates of older adults have increased in the Netherlands and people have extended their working lives from below age 61 in the early 1990s to age 64.4 in 2016 [1, 2]. With the increase of the statutory retirement age in the coming years, it is expected that workers will extend their working lives even further [3].

In this thesis, three themes are addressed:
I. Historical trends in working life expectancy (WLE) in poor health
II. Historical trends in working conditions and health
III. Future health

The main aim of this thesis was to provide insight in the health of the older working population, the older working-age population and former workers, during times when labour participation rates have increased and people are working until older ages.

In this final chapter, the main findings from this thesis are summarised and discussed. Based on the findings of all chapters, I express my expectations about the health of the future older working population. Furthermore, methodological considerations are discussed and implications for policy, practice and future research are addressed.

MAIN FINDINGS AND REFLECTIONS

I. Historical trends in working life expectancy in poor health
In **Chapters 2 and 3**, the first theme is addressed. In these chapters, I hypothesised that the extension of working lives is accompanied by an increase in the WLE in poor health in the Netherlands. This is supported by results presented in both chapters. **Chapter 2** shows that over a period of twenty years, from the 1990s to the 2010s, total WLE at age 58 increased from 3.7 years to 5.5 years. Across these periods, the estimated number of years worked with disability increased gradually from 0.8 to 1.5 years. This is not only a result of an increase of the proportion of workers with disability, but also a result of workers in poor health staying in the workforce longer while having a disability, i.e., at age 58 2.2 years in 1990s and 3.4 years in the 2010s. **Chapter 3** shows that also among a specific group of workers, i.e., those with a chronic disease, an increase of the WLE in poor self-rated health was observed. From the 1990s to 2010s, WLE at age 55 in poor self-rated health increased from 1.1 years to 1.6 years. This increase occurred in the first decade, i.e., from the 1990s to the 2000s.

It is remarkable that WLE with disability (**Chapter 2**) in the total working sample increased gradually over twenty years, while WLE in poor self-rated health (**Chapter 3**) in the sample of chronically ill workers increased only from the 1990s to the 2000s. The discrepancy in the rise of WLE in poor health between the total sample and the sample of chronically ill workers tentatively implies that the increase might be attributable

to different policy measures in the Netherlands. For example, policy measures taken in 2002 were meant to encourage rapid return to work among workers on sick leave, which may have facilitated the extension of working lives of workers with a chronic disease who perceive their health as poor. On the contrary, the stricter qualification criteria to enter disability pension that were adopted in 2006 may have stimulated the extension of working lives of workers with a chronic disease who actually felt healthy [4, 5]. I did not study these measures and was therefore not able to link specific measures to the data. Alternatively, the examination of two different health indicators could be an explanation (see methodological considerations). Another observation from these two studies is that total WLE was approximately just as high among the full sample of workers as among chronically ill workers in each decade. This indicates that chronically ill workers are not by definition more vulnerable to early work exit.

The reason for the observed extension of working lives in poor health can be twofold. On the one hand, it could mean that workers in poor health are well able to continue working despite their health problems, and possibly that they are well accommodated to continue working. On the other hand, it could mean that workers in poor health are not quite able to continue working but do so because they have no financial possibility to stop working. Previous research suggests that people with fewer financial resources are more at risk of the latter [6-8]. This may lead to greater socioeconomic differences.

II. Historical trends in working conditions and health

In **Chapters 4 and 5**, the second theme is addressed. In **Chapter 4**, I hypothesised that the extension of working lives of successive cohorts of older workers is accompanied by a deterioration in physical and psychological functioning, but with an improvement in cognitive functioning. Specifically the role of the change in working conditions, i.e., a decrease in physical work demands and an increase in psychosocial work demands and psychosocial work resources, in these trends in functioning was examined. The results supported the hypothesis that in twenty years, workers aged 55-65 had become less healthy regarding physical and psychological functioning, and more healthy regarding cognitive functioning. Cognitive functioning benefitted to some extent from the changes in working conditions, but its improvement was mainly attributable to increases in educational level of successive cohorts. I was not able to find evidence for a contribution of the decrease in physically demanding jobs and increase in jobs with high psychosocial demands and resources to the observed trends in physical and psychological functioning. Thus, this negative trend in physical and psychological functioning could (partly) be attributed to the extension of working lives in itself (see methodological considerations).

In **Chapter 5,** changes over time in health trajectories during the work exit transition for workers with higher versus lower physical and psychosocial work demands, and psychosocial work resources are examined. First, I hypothesised that differences in

health trajectories between these workers increased over time, to the disadvantage of workers with unfavourable working conditions. The results support this hypothesis with regard to self-rated health, but not with regard to psychological health and physical limitations. Second, I hypothesised that there are greater differences in work-related post-exit health in the later periods (2000s and 2010s) compared to the earlier period (1990s). This was supported by the results with regard to post-exit self-rated health, but not with regard to post-exit psychological health and physical limitations. The increase in the differences in post-exit self-rated health between former workers with high versus low physical demands are partly a result of an increase in the difference in self-rated health that occurred in the final working years. For another part, it is also a result of the fact that workers with high physical demands do not benefit from work exit in the same manner as workers with low physical demands do. Extension of working lives may therefore be a double burden for workers with high physical demands.

Previous studies have shown that unfavourable working conditions are associated with poorer health during working life [9-14] and after work exit [9, 11-16]. Over the past twenty years, the proportion of physically demanding jobs decreased and the proportion of jobs with high psychosocial demands and resources increased. It is therefore remarkable that the shift in working conditions barely influenced the average health status of the older working population, as shown in **Chapter 4**. The job-exposure matrix-derived way of measuring working conditions may be one explanation (see methodological considerations). Findings from **Chapter 5** provided insight leading to another explanation, namely that in the 1990s, there was no difference in pre-exit health between workers with favourable and unfavourable working conditions. In the later decades, such differences were observed for a selection of working conditions and health outcomes. Additional analyses in the full sample of workers from **Chapter 4**, not reported there, show that the association between working conditions and physical and psychological functioning has indeed increased across the decades, to the disadvantage of those with unfavourable working conditions. For example, the association between physical demands and physical functioning became only significant in the 2010s. Thus, whereas physical work demands were more prevalent in earlier decades, their effect on health was greater in the last decade. This phenomenon could be a plausible explanation why the shift in working conditions did not affect the trends in functioning. Regardless the role of working conditions, I observed in **Chapter 4** a negative trend in physical and psychological functioning, which could (partly) be attributed to the extension of working lives in itself. **Chapter 5** shows that the extension of working lives affects self-rated health of workers with unfavourable working conditions more than workers with favourable working conditions, especially those with high physical demands. Thus, both chapters indicate that with the extension of working lives, older workers with unfavourable working conditions are becoming increasingly vulnerable to health problems.

III. Future health

In **Chapter 6**, the third theme is addressed. The previous chapters focused on the older *working* population. In this chapter, I explored health of the Dutch older *working-age* population, up to the year 2040. The older working-age population includes the total older population that is considered able and likely to work in a predetermined age range. I chose age 60 to age 68 (i.e., the statutory retirement age in 2040). Historical trends were used to explore future developments. Based on the stability of the historical health trend of 60-65-year-olds and the improvement in the health trend of people among surrounding ages (55-60; 65-70; 70-75), it is estimated that health of Dutch adults in the years prior to the statutory retirement age will remain the same or improve to a certain extent up to 2040. In a relative sense, the proportion of working-age people in good health will stay the same or increase. At the same time, the absolute number of older working-age people in poor and moderate health will also increase. These increases are due to the extension of working lives as a consequence of the increase in the state pension age and large birth cohorts from the 1960's and 1970's reaching ages 60+.

Future older working population

Up until 2040, the statutory retirement age will increase stepwise to 68 years. Earlier policy measures to stimulate extension of working lives have appeared to be effective, in a way that the average retirement age and the proportion of older adults in the workforce increased [3, 7]. It is therefore expected that the proportion of older workers and the average retirement age will further increase [3].

The findings of this thesis provide multiple indications that future cohorts of older workers will become less healthy with regard to self-rated health, disability/physical functioning and psychological functioning. First, **Chapter 2, 3 and 4** have shown that the extension of working lives is accompanied by an increase in WLE with disability and WLE in poor self-rated health, and with poorer average physical and psychological functioning of the 55-65-year-old working population. If these trends are extrapolated to the future, a relatively unhealthier older workforce can be expected. Second, **Chapter 5** shows that in the final working years differences in self-rated health between workers with unfavourable working conditions are becoming larger. This indicates that in particular workers with unfavourable working conditions are becoming less healthy when working lives are extended. Third, **Chapter 6** shows that in the past decades the self-reported health level of 60-65-year olds remained the same. This is contrary to the findings on the trend in objectively measured health among workers and non-workers in **Chapter 4**, which showed a decline. This discrepancy might be due to the use of different measurement instruments (see methodological considerations). In **Chapter 6**, I argued that in the future a stabilisation or improvement in self-reported health can be expected among 60-68-year-olds. This is promising, however, a stabilisation or improvement of health in the total working-age population may also result in an unhealthier older working population, if the proportion of older workers continues to

increase. Moreover, I noted that with the increased statutory retirement age and the large birth cohorts reaching 60+ in the coming years, the absolute number of older workers in poor health is also likely to increase.

METHODOLOGICAL CONSIDERATIONS

Data

Chapters 2 to 5 are based on data from the ***Longitudinal Aging Study Amsterdam*** (LASA). LASA is a large and ongoing cohort study since 1992, covering a wide range of variables. Every ten years, the cohort is complemented with a new cohort of 55-65-year-olds. This design makes it possible to examine cohort differences in a valid manner by using identical measurements in each cohort [17, 18]. Attrition and representativeness are often concerns in longitudinal cohort studies, but it seems not to be an issue in LASA [19]. In LASA, attrition is mainly due to mortality and the mortality rates were almost similar to mortality rates in the Dutch general population in various years, even when stratified by sex and age group (differences <1%). Also the sample of workers in LASA seems representative for the Dutch working population. Both in the measurement wave 2002/03 and 2012/13 the labour participation rate (≥1 hour/week) of 55-65-year-olds was almost similar to the participation rates in the population, according Statistics Netherlands (difference stratified by sex and educational level on average 2.6%) [19]. Additional analysis using participation rates of ≥12 hours/week (earliest measurement in 1996 from Statistics Netherlands) indicate that participation rates were also almost similar in 1993 (Figure 1). Moreover, it is unlikely that attrition over time of these samples may have affected the representativeness. The main reason for drop-out in the age category of 55-65 years was lack of interest to participate, and non-response was not selective in terms of baseline disability [20].

There are also some limitations to this study. Because the focus of the chapters using LASA data (**Chapters 2-5**) is on the working population only, and labour participation rates of the 55-65 year-olds were especially low in the early 1990s and 2000s, the sample size was often small. This led to reduced power, and the impossibility to make relevant distinctions such as between severe and mild health problems, because severe health problems are not highly prevalent in the age category 55-65 years. Therefore, the chapters using LASA data focus on a combination of mild and severe health problems, with the vast majority having mild problems.

In LASA, there was no measure for workability and productivity available yet. It is therefore unclear if the increase in WLE with disability and poor health (**Chapters 2 and 3**), and the deterioration in physical and psychological functioning in older workers (**Chapter 4**), also affects their employability. Nevertheless, this could be expected because another Dutch study shows that both physical and psychological health problems are associated with reduced work ability and productivity [21].

Chapter 6 is based on data from the ***Dutch Public Health Monitor*** 2016 and the ***Dutch Health Interview Survey*** 1990-2017 [22, 23]. Both datasets include only non-institutionalised persons. This may not be an issue as I was interested in the working-age population, which generally concerns non-institutionalised persons only. It is important to keep in mind that the health levels and trends may deviate from those in the total population and from other studies [24]. However, it is not likely that the inclusion of only non-institutionalised persons influenced the conclusions of this thesis.

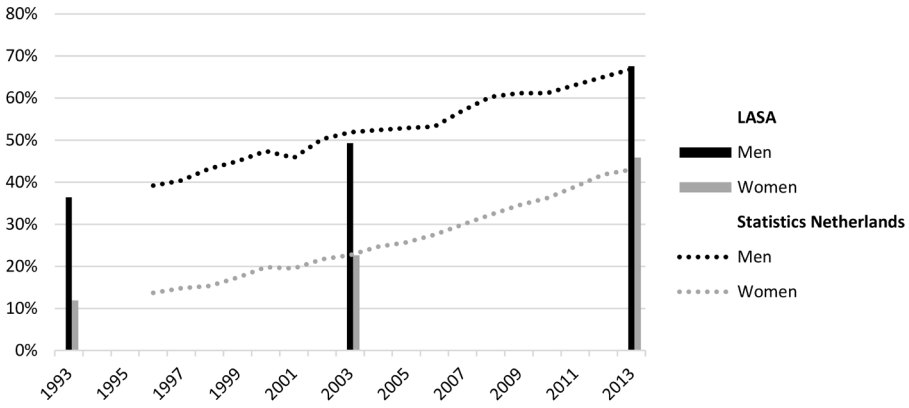

Figure 1. Labour participation rates (≥12 hrs./week) in LASA compared to data from Statistics Netherlands

Age, period, cohort effects

When researching changes in health in successive cohorts, the question arises whether the observed changes are age, period or cohort effects. Age effects are a result of influences associated with the (biological) aging process, period effects are a result of influences associated with each time period studied, and cohort effects are a result of influences associated with membership in each birth cohort [25]. The main point of discussion about age-period-cohort analysis in the literature is the identification problem. The identification problem entails that age, period, and cohort effects cannot be disentangled given their perfect multicollinearity, because: *age = period - cohort*. One method to deal with the identification problem is using a *reduced two factors model*. This model includes only two time components in the model specification, for example age and period. When considering age and period effects only, it is assumed that changes over time are not affected by birth cohort membership and that period effects, for example the economic situation in specific years, play the major role in explaining these changes [26]. In **Chapter 3**, I used this method.

Because in **Chapters 2-5** I included only workers, the respondents do not reflect the composition of the total 55-65-year-old population in each period. As described in the introduction of this thesis, the number of older workers increased over time due to an increase in the inflow at younger ages and a delay in the outflow. The increase in the

inflow is mainly explained by an increase in the employment rate of women, and by an increase in the average level of education (cohort effects) [27]. Thus, the proportion of women and average educational level increased across the successive cohorts of older workers in LASA. The delay in the outflow is mainly the result of stricter policy measures regarding early work exit introduced since 2006 (period effects) [28]. As a result, the mean age in the successive cohorts of older workers in LASA increased across the decades. Because both changes have been so dominant, I would not feel comfortable to assume that only the period effects played a role in the observed trends and to ignore the cohort effects. Therefore, where possible (in **Chapters 2, 4 and 5**), I used an *age-period-cohort characteristics model*, which means that proxy variables, such as gender, educational level and lifestyle factors, are added to a model including age and period, to substitute the cohort variable. This method may solve the identification problem, but if inappropriate proxy variables are chosen it can lead to an incorrect model and false conclusions [26]. The proxy variables that I used were carefully selected based on the literature and are therefore considered appropriate. Still, results should be interpreted with caution.

Below I explain why I believe that the addition of proxy variables provides more insight into the period effects. Furthermore, I elaborate on the way period effects may have contributed to the observed changes in health of the older working population.

In **Chapter 2**, I concluded that WLE with disability increased over the successive decades. I also observed that this was the case for both men and women, and for low, intermediate and highly educated workers. This implies that the increase in proportion of women and the increase in educational level did not cause the increase in WLE with disability. It is therefore cautiously assumed that the delay in work exit, i.e. the extension of working lives, has been the main cause.

In **Chapter 4**, I had the possibility to add more proxy variables. Although it was not the aim of this chapter to fully explain the trends in physical, cognitive and psychological functioning across three successive decades (in particular, the role of change in working conditions was examined), the results can be used to provide more insight into birth cohort related differences. In this chapter, I not only adjusted for gender and educational level as proxies for cohort, but also for chronic diseases, Body Mass Index (BMI) and lifestyle factors (i.e. smoking, alcohol consumption and physical activity). The results show that, for example, the deteriorating trend in physical functioning over the three successive decades was not attenuated by these cohort changes. This implies that probably neither the increase in the proportion of women in the working population was the cause of this deteriorating trend, nor the cohort changes that took place in the total samples of 55-65-year-olds (such as the increase in chronic diseases). Actually, adjusting for age did not attenuate the deteriorating trend either. However, this only means that the increase in the average age of the working population in itself

does not explain the deteriorating trend in physical functioning. It may still mean that *working* until older ages, i.e., not having the opportunity to leave the workforce early, does. It is therefore again cautiously assumed that the extension of working lives has been the main cause.

Working life expectancy (WLE) indicator

In **Chapters 2 and 3**, I used a novel indicator to assess the health status of the older working population: working life expectancy, specifically in poor health. This indicator resembles the well-known healthy life expectancy (HLE) indicator [29], but I used work exit as final state instead of death. This indicator combines prevalence figures of poor health with duration of labour participation, and estimates the average number of years older workers stay in the workforce while being in good and poor health. This can be determined for the total older working population and can be distinguished into those who are already in good or in poor health, for each age. Just like HLE, the advantage of WLE (in good or in poor health) over standard prevalence figures is that it provides insight into whether the extension of working lives is mainly accompanied by increases in working years in good or in poor health [29].

A disadvantage of the way I measured WLE, is that workers only were included and that work exit was the final state (Figure 2). This way, I did not take into account that people could (re-)enter the labour market. Alternatively, I could have used a five-state model like Parker et al., in which death is the final state and backward transitions from a non-working state to a working state is allowed (Figure 2) [30]. However, a five-state model is not preferred with a relatively small sample size, because not all transitions would have been undertaken by a sufficient number of respondents. Moreover, as I was interested in the working population and only included data with two observations (baseline and one follow-up), a five-state model would not have changed our findings.

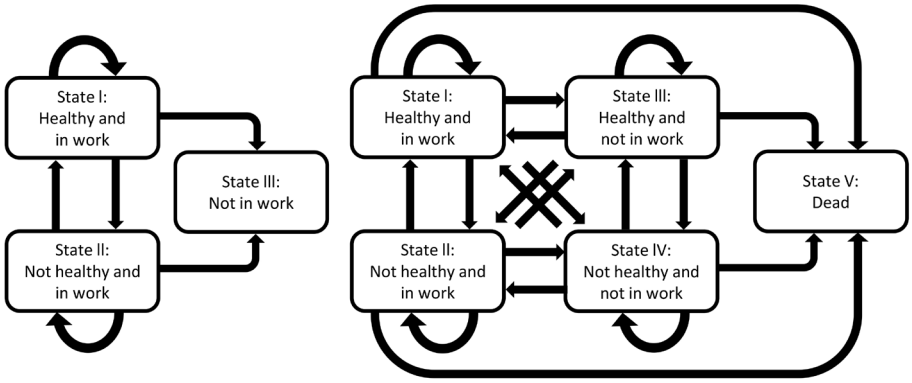

Figure 2. Three-state and five-state models

Definitions of health

In this thesis, the examined health domains and indicators were carefully chosen. For the selection of the health domains I decided to include a wide range of domains, of which previous research has shown an association with labour participation or working conditions [9-16, 31-38]. Subsequently, I selected the most objective health indicators available because these indicators decrease the chance of information bias and can be sensitive to changes the respondent does not perceive yet [39]. Where possible, health indicators were also harmonised between the different chapters. Table 1 presents the examined health domains with corresponding health indicators in each chapter and summarises the main findings.

Examining a wide range of health domains has the advantage that it allows conclusions about several health domains which are all important in the work context. For example, It allows me to conclude that over the last three decades, health of older workers deteriorated in physical and psychological sense, but improved in cognitive sense. A disadvantage of examining a wide range of domains, is that deviating results can be difficult to explain. The deviating findings of **Chapter 2 and 3** are an example, which show that WLE with disability increased gradually over twenty years in the total working sample, while WLE in poor self-rated health increased only from the 1990s to the 2000s in the sample of chronically ill workers. This discrepancy in the rise of WLE in poor health between the total sample and the sample of chronically ill workers may imply that this increase is attributable to different policy measures in the Netherlands. However, also the examination of two different health domains or the selection of a sample of chronically ill workers compared to the total sample of workers could be an explanation. Previous literature has shown that different constructs of health influence workability differently, and that chronic diseases, disability and self-rated health are not correlated equally across successive decades [21, 40].

A disadvantage of the use of different health indicators is that results are not always comparable. For example, **Chapter 4** shows that physical functioning (measured by a physical performance test) deteriorated over time among both workers and non-workers aged 55-65-years old. By contrast, **Chapter 6** shows that there was a stable historical self-reported health trend among 60-65 year-olds and an improving health trend among people with surrounding ages, when using a combined measure including physical limitations (measured by the OECD-indicator that includes self-reported limitations in hearing, seeing or mobility) and self-rated health. A question difficult to answer is whether these contrasting results are caused by the use of different health constructs, or by other factors (e.g. different time frames, age categories or datasets).

Table 1. Overview of examined health domains, health indicators and main findings per chapter

Chapter	Health domain	Main findings
2: Changes in working life expectancy with disability in the Netherlands, 1992–2016	Disability · Global Activity Limitation Indicator (GALI) · Six self-reported questions on ADL-tasks · Timed Chair Stand Test	From the 1990s to the 2010s, WLE with disability increased gradually. This applies to all three disability indicators.
3: Working life expectancy in good and poor self-perceived health among Dutch workers aged 55–65 years with a chronic disease over the period 1992–2016	Self-rated health · Single general question Chronic disease · Single question	From the 1990s to the 2000s, WLE in poor self-rated health increased among workers with a chronic disease.
4: Trends in working conditions and health across three cohorts of older workers in 1993, 2003 and 2013: a cross-sequential study	Physical functioning · Timed Chair Stand Test	From the early 1990s to 2010s, physical functioning deteriorated among successive cohorts of older workers. Working conditions did not affect this trend.
	Psychological functioning · Positive affect (subscale from CES-D)	From the early 1990s to 2010s, psychological functioning deteriorated among successive cohorts of older workers. Working conditions did not affect this trend.
	Cognitive functioning · Coding Task	From the early 1990s to 2010s, cognitive functioning improved among successive cohorts of older workers. Cognitive functioning benefitted to some extent from the changes in working conditions.

Table 1. Continued

Chapter	Health domain	Main findings
5: Changes in the association between working conditions and health across the work exit transition: a comparison across three successive cohorts of older workers in the 1990s-2010s	Physical limitations · Six self-reported questions on ADL-tasks	From the 1990s to the 2010s, differences between workers with favourable versus unfavourable working conditions in trajectories in physical limitations across the work exit transition did not increase. Post-exit differences did not increase either.
	Psychological functioning · Positive affect (subscale from CES-D)	From the 1990s to the 2010s, differences between workers with favourable versus unfavourable working conditions in psychological functioning trajectories across the work exit transition did not increase. Post-exit differences did not increase either.
	Self-rated health · Single general question	From the 1990s to the 2010s, differences between workers with favourable versus unfavourable working conditions in self-rated health trajectories across the work exit transition increased, to the disadvantage of workers with unfavourable working conditions. Post-exit self-rated health differences between workers with high versus low physical demands also increased.
6: Future health prior to retirement – explorations for the Netherlands 2040	Self-reported health (Combination of self-rated health and physical limitations) · Single general question · OECD-indicator on limitations in hearing, seeing or mobility	Historical trends (1997-2017) show that self-reported health remained stable among 60-65-year-olds, but improved among surrounding ages (55-60; 65-70; 70-75). It is estimated that health of Dutch adults in the years prior to the statutory retirement age will remain the same or improve to a certain extent up to 2040.

Working conditions

There are also some limitations regarding the measurement of working conditions. In LASA, in order to examine cohort differences, I was limited to the use of the general population job exposure matrix (GPJEM) for 55- to 65-year-olds. The GPJEM indicates levels of exposure probability of physical and psychosocial demands and psychosocial resources, based on job category. A first limitation is that the GPJEM has only partly been validated. Rijs et al. examined and demonstrated an association between the GPJEM and health, but research on the association between the GPJEM and self-reported working conditions should still be performed [12]. In addition, a job exposure matrix such as the GPJEM does not take heterogeneity within job categories into account, because information is aggregated. This means that changes in working conditions within jobs over time are not noticed. This limitation might have biased our findings toward the null when most changes in working conditions had been within job categories. A job exposure matrix also has advantages compared to self-report and direct measurement of worker exposure. A job exposure matrix may be more precise compared to self-reported working conditions and has no risk of recall or reporting bias by participants with concurrent health problems [41]. Also, a job exposure matrix may capture the working conditions over a longer period of time while direct measurement may misclassify the level of work demands and resources in jobs where exposures vary over a longer time than the period of observation [42].

IMPLICATIONS FOR POLICY AND PRACTICE

Support of older workers

Sustainable employability has been an item on the political and research agenda for years. It has been known for some time that not everyone reaches the statutory retirement age in good health and that as a result, many drop out from the labour force early. This thesis adds to the existing knowledge that the extension of working lives is accompanied by deterioration of health in the older working population and highlights that support of older workers will become even more important in the coming years. It also emphasises that extra attention should be paid to those working in unfavourable working conditions, because these workers generally have more health problems and may have more difficulty to continue working until the statutory retirement age.

Previous research on the effectiveness of interventions regarding sustainable employability has reached increasing attention in the past twenty years, but results were inconclusive and effect sizes were small [43-45]. A life course approach, in which people are supported to stay healthy and employable throughout their working life, seems to hold the most promise [44, 46]. One important strategy to stay employable throughout working life is investing in education in knowledge and skills [47]. An integrated approach also seems to be effective, with a focus on a variety of factors such as a healthy lifestyle and good working conditions [44, 48]. But how can working conditions

be improved? Evidence of the effectiveness of such interventions is unfortunately weak. Changing physical working conditions may be the easiest, i.e., making physical actions less demanding by using ergonomic tools or technology. But there will always be a need of manual labour [3]. For these jobs, participatory ergonomics, in which workers are actively involved in developing and implementing workplace changes, are recommended [49]. One of these changes could be the alternation of tasks, in order to let recovery take place in the burdened bodily functions [50]. With regard to psychosocial demands, one can think of reducing workload and work stress, for example by time and place flexible policies [51] or by mindfulness training [52]. With regard to psychosocial resources, one can think of skill discretion, i.e., variation in tasks and opportunities for development, and decision authority in timing and method [10]. Of course, there is no one-size-fits-all solution. It is therefore important to examine at the individual level how working conditions can be adapted.

Statutory retirement age

The explorations of health of the future older working-age population in this thesis do not seem to be obstacles to raising the state pension age to 68 in 2040. After all, if it is agreed that under health conditions applicable in 2016 people were able to work until the age of 65.5, most people should also be able to work under the same (or even better) health conditions until the age of 68. However, this statement should be amended with several caveats. First, it is based on health in general, and does not imply that all individuals are able to work until the age of 68. Second, because the statutory retirement age has only been raised by six months in 2016, the health effects of working beyond age 65 are not clear yet. It is possible that further extension of working lives has such negative effects, that health of the over-65-year-olds will deteriorate. It is therefore crucial to monitor health of the older working-age population in the coming years.

Alternative exit routes

In **Chapter 2**, I concluded that up until 2016 the available exit routes were sufficient in the context of socioeconomic inequalities, because there was no significant difference in the WLE with disability between low and highly educated workers. I also expressed my concerns about the future, as with the extension of working lives, these differences could unfold in the future. The results of **Chapters 4 and 5**, which indicate that the extension of working lives is in particular harmful for workers with unfavourable working conditions, support these concerns. In the Netherlands, early retirement on grounds of ill-health is possible via a disability scheme. A recent study on WLE in the Netherlands shows that low educated workers rely on this possibility more often and on average earlier in life [53]. A disadvantage of a disability scheme is that it is the final solution; health problems are already present and impede a person's ability to perform his or her work for at least two years. In particular for people with unfavourable working conditions, it would be better to change tasks, switch jobs or exit the workforce before

health problems have reached such a severe stage where the person is no longer able to perform the job. At this moment, a legislative proposal is being prepared which will make it possible for those working with unfavourable working conditions to exit the workforce (at most) three years before the statutory retirement age. Employers and employees within the sectors jointly determine which occupations it concerns [54]. I think this is an elegant concession for these workers. However, there are some disadvantages of such an arrangement. First, there will always be people with health problems who want to use the scheme but are not eligible. Second, it is well possible that some people desire to leave the workforce even earlier. Third, and most importantly, the danger of such an arrangement lies in the fact that workers and employers may invest less in the sustainable employability of this occupational group because they have the possibility to exit the workforce earlier [28]. It is therefore important to communicate clearly who is eligible for this scheme, and to motivate workers in such occupations and their employers to still invest in sustainable employability.

DIRECTIONS FOR FUTURE RESEARCH

Monitoring

The findings described in this thesis show that the extension of working lives is accompanied by a deterioration of health in the older working population. Moreover, it indicates that because of the extension of working lives, no health gains were achieved in the total older working-age population. The findings are based on data up until 2016. In this year, the statutory retirement age was 65.5 years. With the expected further increase of the statutory retirement age, further extension of working lives is expected. It is possible that further extension of working lives will have such negative effects, that health of the over-65-year-olds will even deteriorate. It is therefore crucial to monitor health of the older working population and the older working-age population in the coming years. In addition, it is recommended to monitor differences in health between workers with favourable and unfavourable working conditions.

(H)WLE as monitoring instrument

In **Chapter 3**, I proposed that 'WLE in poor health' or 'Healthy Working Life Expectancy' (HWLE) could be used as an indicator to monitor the health of the working population. Moreover, I proposed that it may be used as criterion for success of policies aiming to extend people's working life, in addition to figures regarding the average age of leaving employment. The use of HWLE as a monitoring instrument is recently also proposed by Parker and colleagues in a highly prominent journal (The Lancet). These researchers state that "*Monitoring of healthy working life expectancy as the population continues to age and the State Pension age continues to rise will be crucial to detect changes in population behaviour due to policy and health interventions*" [30]. For monitoring purposes, I endorse the recommendations of Parker et al., to use a five-state model that represents the general population, and to measure health by the GALI-indicator,

which I also used in **Chapter 2** [30]. By using a standard operationalization of HWLE, results will be comparable with other countries and within countries when routinely updated [30, 55]. For optimal usability, it needs to be discussed how many years HWLE are considered 'successful' and how many years in WLE in poor health are 'acceptable'.

Mechanisms

This thesis shows that the extension of working lives is accompanied by deterioration of health in the older working population, and it is cautiously concluded that the extension of working lives is the main cause. However, more research into the role of the extension of working lives is needed to confirm this conclusion. Moreover, research into the factors or mechanisms that contribute to good or poor health in the final working years is needed. Finally, research into the motivation, workability and productivity of workers in poor health who continue working is needed to assess whether the extension of working lives in poor health is desirable at all. For some older workers an extended working life may be a positive experience, while for others it may be harmful. Therefore, this research should also examine specific categories, such as workers with favourable versus unfavourable working conditions.

Sufficient data

To monitor HWLE and to further investigate the role of the extension of working lives, appropriate data is needed. An appropriate dataset should consist of a large nationally representative sample, that is longitudinal and with high frequency (≤2 years) assessed, and can be linked to registers of Statistics Netherlands. Moreover, this dataset should include information on determinants of interest, such as health (preferably the GALI-indicator), working conditions, work motivation, productivity, and lifestyle factors. At this moment, there is no such dataset available. The European Union-Statistics on Income and Living Conditions (EU-SILC) might be eligible to monitor HWLE, as it includes information on GALI and work characteristics, and can be linked to register data. However, the number of over 50-year-olds in this sample is potentially too small. Investing in large longitudinal cohort datasets is necessary to monitor HWLE and to provide full insight into the role of the extension of working lives.

Interventions

As mentioned earlier in this discussion, results from previous research on the effectiveness of interventions regarding sustainable employability are inconclusive and effect sizes are small [43-45]. More research is needed into the effectiveness of interventions, with a special focus on more vulnerable people such as workers with unfavourable working conditions [44].

CONCLUSION

This thesis shows that with the extension of working lives, the WLE in poor health increased and physical and psychological health of older workers deteriorated. Cognitive functioning improved. The thesis also shows that workers with unfavourable working conditions are at risk to suffer disproportionally from the policies that encourage the extension of working lives, also after work exit. For future generations, further extension of working lives is foreseen. In this discussion, I have argued why I expect that physical, psychological and self-rated health of the future older working population will continue to deteriorate. Therefore, I want to stress the importance of supporting older workers, and in particular those with unfavourable working conditions, to remain sustainably employable. For optimal support, more research into the effectiveness of interventions is needed. Moreover, monitoring health of the older working population and the older working-age population is crucial in the next few years, because with the increase in the statutory retirement age we are entering new territory.

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Appendices

SUMMARY

Over the last decades, labour participation rates of older adults have increased in the Netherlands and people have extended their working lives from below age 61 in the early 1990s to age 64.4 in 2016. With the increase of the statutory retirement age in the coming years, it is expected that workers will extend their working lives even further. A good health is important to allow for extending working lives.

This thesis aims to provide insight in the health of the older working population, the older working-age population and former workers in the Netherlands, during times when labour participation rates have increased and people are working until older ages. This insight is necessary to express expectations for health of the future older working population, and to prevent or limit any problems associated with extending working lives.

Three themes are addressed in this thesis: I. Historical trends in working life expectancy in poor health of the older working population from 1992 to 2016; II. Historical trends in working conditions and health of the older working population from 1992 to 2016; III. Future health of the older working-age population up until 2040. By examining these themes, three datasets are used: The Longitudinal Aging Study Amsterdam (LASA) (theme I and II), the Dutch Health Interview Survey from and the Dutch Public Health Monitor (theme III).

I. Historical trends in working life expectancy in poor health
In **Chapters 2 and 3**, it is examined whether the extension of working lives of successive cohorts of workers aged 55 to 65 years was accompanied by an increase in the working life expectancy in poor health. Working life expectancy concerns the estimated number of working years older workers are expected to continue working at a specific age (e.g. age 55). The working years can be divided into years in good and poor health**.** This summary measure is similar to the (un)healthy life expectancy but with exit from the workforce as the final state instead of death. **Chapter 2** shows that over a period of twenty years, from the 1990s to the 2010s, working life expectancy with disability increased. This is a result of an increase of the proportion of workers with disability and a result of workers in poor health staying in the workforce longer while having a disability. **Chapter 3** shows also among a specific group of workers, i.e., those with a chronic disease, an increase of the working life expectancy in poor self-rated health.

II. Historical trends in working conditions and health
In **Chapter 4**, it is examined whether the extension of working lives of successive cohorts of older workers was accompanied by changes in physical, psychological and cognitive functioning. Specifically the role of the changes in working conditions, i.e., a decrease in physical work demands and an increase in psychosocial work demands and psychosocial

work resources, in these trends in functioning is examined. The results show that in twenty years, workers aged 55 to 65 years had become less healthy regarding physical and psychological functioning, and more healthy regarding cognitive functioning. Cognitive functioning benefitted to some extent from the changes in working conditions, but the improvement is mainly attributable to increases in educational levels of successive cohorts. There is no evidence for a contribution of the decrease in physically demanding jobs and increase in jobs with high psychosocial demands and resources to the observed trends in physical and psychological functioning. Thus, the changes in working conditions seem to have very limited effects on the health of the older working population.

In **Chapter 5**, changes over time are examined in health trajectories during the work exit transition for workers with higher versus lower physical and psychosocial work demands, and psychosocial work resources. The results show that differences in self-rated health trajectories across the work exit transition became larger over time between workers with lower versus higher physical demands, to the disadvantage of the latter. In addition, differences in post-exit self-rated health between workers with lower versus higher physical demands were larger in the later periods (2000s and 2010s) compared to the earlier period (1990s). The increase in the differences in post-exit self-rated health between former workers with high versus low physical demands are partly a result of an increase in the difference in self-rated health that occurred during the working years. For another part, it is a result of the fact that workers with high physical demands do not benefit from work exit in the same manner as workers with low physical demands do. This chapter suggests that extension of working lives may be a double burden for workers with high physical demands. However, no increased difference is observed across the successive cohorts between workers with favourable and unfavourable working conditions in trajectories of psychological health and physical limitations.

III. Future health

In **Chapter 6**, the health of the Dutch older working-age population is explored up to the year 2040. Historical health trends from 1997 to 2016 show a stable trend for 60-65-year-olds and an improvement in the health of people among surrounding ages (55-60; 65-70; 70-75). It is therefore presumed that the health of Dutch adults in the years prior to the statutory retirement age will remain the same or improve to a certain extent, but will not deteriorate, up to 2040. Subsequently, an estimation for the extent of improvement is made. According to both scenario's (health will remain the same or improve), the proportion of working-age people in poor and moderate health will stay the same or decrease in a relative sense. At the same time, the absolute number of older working-age people in poor and moderate health will increase. These increases are due to the extension of working lives as a consequence of the increase in the state pension age and to large birth cohorts from the 1960's and 1970's reaching ages 60+.

Conclusion

In **Chapter 7**, I concluded that with the extension of working lives of successive cohorts, the WLE in poor health increased and physical and psychological health of older workers deteriorated. Cognitive functioning improved. The findings in this thesis also suggest that workers with unfavourable working conditions are at risk to suffer disproportionally from the policies that encourage the extension of working lives, also after work exit. For future generations, further extension of working lives is foreseen. I argued why I expect that physical, psychological and self-rated health of the future older working population will continue to deteriorate.

These findings emphasize the importance of supporting older workers, and in particular those with unfavourable working conditions, in order to remain sustainably employable. A life course approach, in which people are supported to stay healthy and employable throughout their working life, seems to hold the most promise. For optimal support, more research into the effectiveness of interventions is needed. Moreover, monitoring health of the older working population and the older working-age population is crucial in the next few years, because with the increase in the statutory retirement age we are entering new territory. The '(un)healthy working life expectancy' could be used as an indicator to monitor the health of the working population in the coming years, under the condition that suitable data becomes available. An appropriate dataset should consist of a large nationally representative sample, that is longitudinal and with high frequency (≤2 years) assessed, should include information on health and other determinants of interest, and should be able to be linked to registers of Statistics Netherlands.

SAMENVATTING

In de afgelopen decennia steeg de arbeidsdeelname van oudere volwassenen in Nederland. Ook zijn mensen langer door gaan werken. Zo werkte men in de vroege jaren negentig gemiddeld tot 61 jaar en in 2016 gemiddeld tot 64,4 jaar. Met de stijging van de AOW-leeftijd is het te verwachten dat werkenden de komende jaren nog langer door zullen (moeten) werken. Een goede gezondheid is een belangrijke factor om langer doorwerken mogelijk te maken.

Dit proefschrift heeft als doel de verandering in de gezondheid van de oudere beroepsbevolking (werkenden), de potentiële oudere beroepsbevolking (werkenden en niet-werkenden) en de voorheen werkenden (o.a. gepensioneerden) in Nederland in kaart te brengen, in tijden van stijgende arbeidsdeelname en langer doorwerken. Dit inzicht is nodig om een uitspraak te kunnen doen over de verwachte gezondheid van de toekomstige beroepsbevolking, en om eventuele problemen die gepaard gaan met langer doorwerken te voorkomen of te beperken.

Dit proefschrift behandelt drie thema's: I. Historische trends in de werkduurverwachting in ongezondheid van de oudere beroepsbevolking van 1992 tot 2016; II. Historische trends in werkomstandigheden en gezondheid van de oudere beroepsbevolking van 1992 tot 2016; III. Verwachte gezondheid van de potentiële oudere beroepsbevolking in de toekomst tot 2040. Om deze thema's te onderzoeken zijn drie databronnen gebruikt: de Longitudinal Aging Study Amsterdam (LASA) (thema I & II), de CBS Gezondheidsenquête en de Gezondheidsmonitor (thema III).

I. Historische trends in de werkduurverwachting in ongezondheid
In hoofdstuk 2 en 3 is onderzocht of langer doorwerken van opeenvolgende cohorten van werkenden in de leeftijd van 55 tot 65 jaar gepaard ging met een toename in de werkduurverwachting in ongezondheid. De 'werkduurverwachting' betreft de gemiddelde tijd vanaf een bepaalde leeftijd (bijvoorbeeld 55 jaar) dat een werkende naar verwachting nog werkt, onder de aanname dat kansen op stoppen met werken en gezondheidsbeperkingen gelijk blijven. De werkduurverwachting kan worden opgedeeld in jaren in goede en in slechte gezondheid. Deze relatief nieuwe maat is vergelijkbaar met de (on)gezonde levensverwachting, maar dan met stoppen met werken als eindstadium, in plaats van overlijden. **Hoofdstuk 2** laat zien dat over een periode van twintig jaar, van begin jaren 1990 tot begin jaren 2010, de werkduurverwachting met gezondheidsbeperkingen inderdaad steeg. Deze stijging heeft twee oorzaken. Enerzijds nam het aandeel werkenden met een gezondheidsbeperking toe. Anderzijds bleven werkenden met een gezondheidsbeperking langer aan het werk in de latere perioden. **Hoofdstuk 3** laat zien dat ook onder een specifieke groep van oudere werkenden, namelijk werkenden met een chronische ziekte, de werkduurverwachting in matige of slechte ervaren gezondheid toenam over dezelfde periode.

II. Historische trends in werkomstandigheden en gezondheid

In **hoofdstuk 4** is onderzocht of langer doorwerken van opeenvolgende cohorten oudere werkenden gepaard ging met veranderingen in fysiek, mentaal en cognitief functioneren. In het bijzonder werd hierbij de rol van veranderingen in werkomstandigheden bestudeerd. In de opeenvolgende cohorten oudere werkenden nam de fysieke werkbelasting af maar nam de psychosociale werkbelasting toe. De beschikbaarheid van psychosociale werkhulpbronnen, zoals het hebben van autonomie, nam ook toe. De resultaten laten zien dat over een periode van twintig jaar, de fysieke en mentale gezondheid van werkenden in de leeftijd van 55 tot 65 jaar minder goed is geworden. Daarentegen is hun cognitieve functioneren verbeterd. De verbetering in het cognitieve functioneren kan deels worden verklaard door de genoemde veranderingen in de werkomstandigheden, maar wordt voornamelijk verklaard door de stijging van het opleidingsniveau van de opeenvolgende cohorten. Er is geen bewijs voor een bijdrage van de veranderde werkomstandigheden aan de afname in het fysiek en mentaal functioneren. De veranderingen in werkomstandigheden lijken dus een zeer beperkte invloed op de gezondheid van oudere werkenden te hebben.

In **hoofdstuk 5** is onderzocht of langer doorwerken van opeenvolgende cohorten oudere werkenden gepaard ging met veranderingen in het verloop van de gezondheid (het gezondheidstraject) van vóór tot na de transitie van werk naar niet-werk. Hierbij werden de gezondheidstrajecten van werkenden met gunstige en ongunstige werkomstandigheden met elkaar vergeleken. De resultaten laten zien dat in de latere cohorten (begin jaren 2000 en 2010), maar niet begin jaren 1990, de ervaren gezondheid slechter was bij degenen die hadden gewerkt onder zwaardere fysieke werkomstandigheden in vergelijking met degenen die hadden gewerkt onder lichtere fysieke werkomstandigheden. Dit verschil in ervaren gezondheid is enerzijds een gevolg van een ongelijkheid die is ontstaan tijdens het werkzame leven. Anderzijds is dit verschil te verklaren doordat werkenden met zwaardere fysieke werkomstandigheden in de latere cohorten geen gezondheidsverbetering ervoeren na het stoppen met werken. Deze resultaten suggereren dat langer doorwerken als een dubbele belasting kan worden ervaren door werkenden met zware fysieke werkomstandigheden. Er is echter geen consistent verschil in trajecten van mentale gezondheid en fysieke beperkingen gevonden in de opeenvolgende cohorten tussen werkenden met gunstige en ongunstige werkomstandigheden.

III. Verwachte gezondheid in de toekomst

In **hoofdstuk 6** is de toekomstige gezondheid van de potentiële oudere beroepsbevolking verkend tot het jaar 2040. Uit historische trends blijkt dat de gezondheid van 60- tot 65-jarigen stabiel bleef over de jaren 1997-2016, terwijl omliggende leeftijdsgroepen (55-60; 65-70; 70-75 jaar) een verbetering in gezondheid doormaakten. Op basis hiervan is verondersteld dat de gezondheid van oudere volwassenen tussen de leeftijd van 60 en de AOW-leeftijd gelijk zal blijven of zal verbeteren, maar niet zal verslechteren.

Vervolgens is er een schatting gedaan voor de verwachte verbetering in gezondheid. Op basis van beide scenario's (het gelijk blijven van de gezondheid of de verbetering van de gezondheid) zal het aandeel personen in matige of slechte gezondheid in relatieve zin gelijk blijven of afnemen. Tegelijkertijd zal het absolute aantal personen in matige of slechte gezondheid toenemen. Deze toename is niet alleen het gevolg van de stijging van de AOW-leeftijd maar ook van de verwachting dat in de komende jaren een relatief groot aantal mensen de leeftijd van 60 en ouder bereikt door een verschuiving van de bevolkingsopbouw.

Conclusie

In **hoofdstuk 7** heb ik geconcludeerd dat met het langer doorwerken van opeenvolgende cohorten, de werkduurverwachting in ongezondheid toenam en dat de fysieke en mentale gezondheid van oudere werkenden af nam. Het cognitief functioneren verbeterde daarentegen. Ook heb ik gesteld dat de resultaten van dit proefschrift suggereren dat personen die werken onder zware fysieke arbeidsomstandigheden disproportioneel lijden onder de beleidsmaatregelen die langer doorwerken stimuleren. Voor toekomstige generaties oudere werkenden wordt een verdere verlenging van het werkzame leven verwacht. Ik heb beargumenteerd waarom ik verwacht dat de fysieke, mentale en ervaren gezondheid van de toekomstige oudere beroepsbevolking verder zal afnemen.

Deze bevindingen onderstrepen het toenemende belang om oudere werkenden te ondersteunen, met name degenen die werken onder ongunstige arbeidsomstandigheden, zodat zij duurzaam inzetbaar blijven. Een levensloopbenadering, waarin werkenden worden gestimuleerd om gezond en inzetbaar te blijven tijdens hun gehele werkzame leven, is hiervoor het meest veelbelovend. Meer onderzoek naar werkzame interventies om dit doel te bereiken, is nodig. Verder is het belangrijk de gezondheid van de oudere beroepsbevolking en de potentiële oudere beroepsbevolking te blijven monitoren in de komende jaren, omdat we ons met de stijging van de AOW-leeftijd op een nieuw terrein van langer doorwerken zullen begeven. De '(on)gezonde werkduurverwachting' kan in de komende jaren een goede indicator zijn voor de gezondheid van de beroepsbevolking, mits een geschikte databron beschikbaar komt. Een dergelijke databron dient te bestaan uit een grote landelijke representatieve steekproef, die longitudinaal en met een hoge frequentie (≤2 jaarlijks) wordt uitgevoerd, de gewenste informatie over gezondheid en andere factoren bevat en gekoppeld kan worden aan CBS-registers.

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ABOUT THE AUTHOR

Maaike van der Noordt was born on April 10th 1987, in Rotterdam. She completed her secondary education (VWO) at the Montessori Lyceum Rotterdam. Maaike obtained a Bachelor's degree in nursing at the Hogeschool Utrecht (2009). Thereafter, she obtained her Premaster's degree (2011) and graduated cum laude for a Master's degree (2012) in Health Sciences at the VU University Amsterdam. After her graduation, she started working as a scientific researcher at the Centre for Health and Society, at the National Institute for Public Health and the Environment (RIVM). In 2015, Maaike started her PhD project at the Longitudinal Aging Study Amsterdam as part of the Department of Epidemiology and Biostatistics, Amsterdam UMC. Maaike also worked as a visiting researcher at the German Centre of Gerontology (DZA) in Berlin (August 2016). During her PhD she obtained a Master's degree in Epidemiology after following the Postgraduate Epidemiology Program (EPIDM) at the VU University Medical Center Amsterdam. In May 2019, she returned to the RIVM, where she works as a scientific researcher to date.

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