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Cardiovascular disease in older workers

How can workforce participation be maintained in light of changes over time in determinants of cardiovascular disease?

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Summary

A crucial factor in the employability of older people is health. This study focuses on a well-known health problem in the relevant age group: cardiovascular disease (CVD). We examine its prevalence in Dutch 55-64-year-old workers over two decades and aim to explain changes in its prevalence on the basis of changes in multiple determinants of CVD. The findings allow future projection of CVD prevalence among older workers. Moreover, observed changes in determinants of CVD provide directions for focussed, preventative measures to maintain workforce participation.

Using data from the nationally representative Longitudinal Aging Study Amsterdam (LASA) over the period 1992-2013, we found a decrease in CVD prevalence from 13.9% to 9.7%. This slight decline masks larger changes in determinants which oppose one another. The prevalence of overweight and obesity, diabetes, and depression showed substantial increases. If these factors had remained constant, the CVD decline would have been 19.1% steeper. Work characteristics explained 7.0% of the CVD decline. Other important determinants of CVD (female sex, educational level, smoking, sport activity, and blood pressure) together explained another 25.3% of the CVD decline. CVD among older workers may be influenced by taking workplace measures to prevent further unfavourable developments and promoting further favourable developments in the observed determinants.

Samenvatting

Een cruciale factor in het behoud van arbeidsdeelname van oudere werkers is gezondheid. Dit onderzoek richt zich op een bekend gezondheidsprobleem in de relevante leeftijdsgroep: hart- en vaatziekten (HVZ). Wij onderzoeken de prevalentie van HVZ bij Nederlandse, 55-64-jarige werknemers over twee decennia en beogen veranderingen in de prevalentie te verklaren uit veranderingen in verschillende determinanten van HVZ. De resultaten maken voorspelling van de toekomstige prevalentie bij oudere werknemers mogelijk. Bovendien geven de geobserveerde veranderingen in determinanten richting aan preventieve maatregelen ter behoud van arbeidsdeelname.

Met gegevens van de landelijk representatieve Longitudinal Aging Study Amsterdam vonden we over de onderzoeksperiode 1992-2013 een afname in de HVZ-prevalentie van 13,9 tot 9,7%. Deze lichte afname verhult grotere, tegengestelde veranderingen in determinanten. De prevalentie van overgewicht en obesitas, diabetes en depressie nam duidelijk toe. Waren deze factoren constant gebleven, dan was de afname in HVZ-prevalentie 19,1% sterker geweest. Werkkenmerken verklaarden 7,0% van de afname in prevalentie. Andere belangrijke determinanten van HVZ (vrouwelijk geslacht, opleidingsniveau, roken, sporten en bloeddruk) verklaarden nog eens 25,3% van de afname in HVZ.

Het vóórkomen van HVZ bij oudere werknemers kan worden beïnvloed door maatregelen op de werkvloer die de gesignaleerde ongunstige ontwikkelingen in determinanten tegengaan en de gesignaleerde gunstige ontwikkelingen bevorderen.

Executive summary and policy implications

Background. The ageing of the Dutch population causes an increase in the retired portion of the population, with a concomitant rise in pension costs. The current government policy therefore aims to extend the working lives of older workers. The longer that workers are able to remain in the workforce, the longer they will be likely to contribute to pensions, and the more they will be able to spend once they are retired. A crucial factor in the employability of older people is health, because poor health increases with age and is a strong predictor of exit from the labour force. Exit from the workforce due to poor health should be prevented, if at all possible. This study focuses on a highly prevalent health problem in the relevant age group: cardio-vascular disease (CVD). We examine CVD prevalence in older Dutch workers (ages 55-64 years) between 1992-1993 and 2012-2013, and attempt to explain the changes found on the basis of changes over the years in multiple determinants of CVD. The results provide the basis for projections of potential changes in CVD prevalence among workers in the future. Moreover, observed changes in determinants of CVD may provide directions for focussed, preventative measures to maintain workforce participation.

Results. We found a downward trend in the prevalence of CVD from 13.9% to 9.7% between 1992-1993 and 2012-2013. This slight decline masks larger changes in determinants which oppose one another. The prevalence of important determinants of CVD, i.e., Body Mass Index, diabetes, and depression, showed substantial increases. If these factors had remained constant, the decline in CVD would have been 19.1% steeper. Work characteristics attenuated the decline in CVD by 7.0%. Other important determinants of CVD, i.e., female sex, educational level, smoking, sport activity, and blood pressure, together explained 25.3% of the observed decline in CVD.

Conclusions. The implication for the future trend in CVD is that further increases in the workforce participation of women, increases in the educational level, decreases in smoking, as well as a likely further drop in the prevalence of high blood pressure due to increases in antihypertensive drug prescriptions, will further decrease the prevalence of CVD in workers in this age group. However, further increases in the prevalence of diabetes, BMI and depression, as well as increases in average age, may counteract such declines. It is therefore unlikely that the prevalence of CVD among workers will show a clear downward trend in the future.

Policy recommendations

- It is of paramount importance that measures be taken to limit work pressure in workers with CVD. In a recent study, 28% of older workers with CVD reported a need for work adjustment. Their needs concerned predominantly the amount of work, working times, and task adjustment. After one year, implementation of work adjustment proved to be associated with less sick leave.
- It is also important to prevent CVD from occurring by adopting measures that decrease the risk of CVD. Based on our findings, risk factors include diabetes, depression, obesity, physical inactivity, and depression. In addition to work adjustments, prevention of risk of CVD entails early identification of risk factors. This may be achieved through periodic health examinations, disclosure of poor health by workers, and awareness among supervisors and colleagues. Furthermore, the working environment might be made more conducive to a healthy lifestyle, e.g., by actively promoting physical activity during breaks and offering healthy food in the company's canteen.
- It seems advisable to organise prevention in a multidisciplinary network including not only occupational physicians and supervisors in the workplace, but also general medical, paramedical and social services outside the work setting.

1. Introduction

In recent decades, an increase in life expectancy and a decrease in fertility together have led to an increase in the proportion of older people in the population (1). The consequences of this trend, often referred to as the aging of the population, include both a reduction of the younger labour force and an increase in the inactive portion of the population (2). Since the 1990s, encouraging older people to continue working has been a central issue on the political agenda. The main driver has been ensuring the affordability of the social security system and pension and healthcare programs (3-4). In addition, if too many people with experience and knowledge prematurely exit the labour force, this presents a threat to the quality and the amount of the labour supply (4).

Good health is a requirement for working longer. Because health is strongly associated with age, it can be questioned whether the health of older workers allows them to work longer. This study focuses on a condition that is highly prevalent in the age-group of the older workforce: cardiovascular disease (CVD). Workers with this condition have been shown to be at increased risk of labour market exit due to disability or unemployment (5). We examine its prevalence in Dutch older workers aged 55-64 years between 1992-1993 and 2012-2013, and attempt to explain the changes found on the basis of changes over the years in multiple determinants of CVD.

Labour force participation

Between 1992 and 2012, the Dutch government and its social partners implemented a number of policies which discouraged early exit from the labour force or encouraged working longer (6-8). Since the 1990s, the labour participation (defined as working at least one hour per week (9)) of the older part of the population has increased rapidly. The participation rate of men aged 55-64 years increased from 55.1% in 2002 to 68.6% in 2012. The participation rate of women aged 55-64 years was lower but increased more substantially, from 30.1% in 2002 to 48.4% in 2012 (10-11). Thus, probably in large part as a response to the changed policies, people started to work longer.

Health and work

Ample research has been conducted into the effects of health on early exit amongst older workers (12). These studies feature a wide variation in the operational definition of health. An important distinction can be made between subjective and objective health measures. Self-perceived health is an often-used subjective measure: fair or poor self-rated health has been shown to be associated with early exit from the labour force through disability pension, unemployment and early retirement (13–14). Asking about a person's subjective health, however, raises potential problems due to justification bias; inactive people may have the tendency to report their health to be worse than may actually be the case, in that way justifying the fact that they are inactive (15).

More objective measures of health that are associated with early exit from the workforce include chronic diseases (16). Two of the strongest predictors of leaving the labour force due to a chronic disease are diseases of the musculoskeletal system and cardiovascular diseases (5,13,17–9). In this age group, CVD is the most prevalent disease after musculoskeletal conditions (20–21). Moreover, CVD ranks second among causes of death after cancer (22). What makes CVD of particular interest is that the mortality of CVD has substantially declined, much more so than the mortality of other diseases (23). This implies that current generations are expected to continue living longer with CVD than were previous generations. Added to the increase in older people involved in the workforce, CVD is likely to be a disease that is becoming increasingly common in the workplace.

Cardiovascular diseases

CVD consists of several types of diseases of the heart and arteries, including coronary heart diseases such as angina pectoris, narrowing of the coronary artery, and myocardial infarction. Other manifestations of CVD include cardiac decompensation, cardiac failure, and cardiac arrhythmia. Among these, myocardial infarction has the highest prevalence in 55–64-year-olds at 5.2% in 2014 (21). Regarding trends in coronary heart diseases and cardiac failure, their standardised prevalence has been shown to remain stable for both men and women in the period from 1991 until 2011 (24–25), although there was a shift during this period from acute to chronic coronary heart disease (26).

Determinants of cardiovascular disease

Many factors influence on the onset of CVD. For this study, a selection is made of the most influential factors, particularly those that can be expected to have changed over time (27).

Age

The prevalence of CVD increases with age (20–21). For example, the hospitalization rate for all cardiovascular diseases rises from 3.4% for people aged 55–60 years to 4.6% for people aged 60–65 years (28). This indicates the importance of examining separate age categories within the age group of older workers aged 55-64 years. In addition, figures from Statistics Netherlands show that in the period from 1992 to 2012 the age distribution within the group of 55-64-year-olds was changing in the Netherlands, due to the ageing of the baby-boom generation; the average age increased over this period (29).

Sex

CVD is more common in men than in women. For coronary heart diseases, the prevalence is higher in men in every age category. The average annual incidence of CVD is almost twice as high in men aged 55-64 years as in women in the same age category (30). In the Dutch general population, the share of men in the age group 55-64 has been increasing since 1992 (31). In contrast, within the older workforce, the proportion of women rose steadily (2).

Educational level

Educational level is both directly and indirectly associated with CVD. A higher attained level of education facilitates the acquisition of economic, social and psychological assets and skills. For example, people with a higher educational level have a more positive attitude about health and better access to preventive health services (32-33). Educational level is also indirectly associated with CVD through its influence on many CVD risk factors. For example, the percentage of people smoking cigarettes decreases when the level of education increases (34-35), and there is a negative association between educational level and BMI, especially amongst women (36). Also, a higher educational level seems to protect against depression (37), which is a recently acknowledged risk factor for CVD (38). In the Netherlands, the educational level of people aged 55-65 years increased significantly between 1992 and 2012 both in the general population and in the workforce (39-40).

Weekly working hours

Persons with longer working hours have been shown to have an increased risk of CVD, compared to persons who work standard hours (41). Furthermore, persons who work 55 hours or more per week have a 1.3 times higher risk of experiencing a stroke than persons working the standard 35 to 40 hours per week. This association was found in both men and women (42). Long working hours have also been shown to be associated with poor lifestyle habits such as smoking and unhealthy weight gain, both of which are independent risk factors of CVD (43-45). The average number of usual hours worked weekly is slightly decreasing in the Netherlands over the last decades (46).

Work exposure

Among work characteristics, an important risk factor of CVD is work demands. A distinction is often made between physical work demands (e.g., repetitive movements, use of force and uncomfortable position) and psychosocial work demands (e.g., time pressure, task requirements), on the one hand, and psychosocial resources, on the other hand (e.g., control possibilities, work relationships) (47-48). For the development of CVD, particularly psychosocial work demands have been shown to lead to the onset of several established risk factors of CVD. For example, one study found a relation between psychosocial work demands and hypertension, diabetes, overweight and smoking. The prevalence of these factors was higher for workers with high psychosocial work demands in comparison to workers with low psychosocial work demands (49). In addition, psychosocial work demands may cause work stress, which is also a risk factor of CVD (50). Among psychosocial work demands, mental concentration has been shown to be increasing over time, whereas among psychosocial resources, control possibilities also show an increase (51-52). Moreover, figures from Statistics Netherlands show a positive change in psychosocial working conditions from 2005 to 2012 for workers in the age category 55-65 years (53).

Depression

Depression is acknowledged as an independent risk factor for the development of CVD. Especially clinically diagnosed major depression showed a high risk for the onset of CVD (38). In recent decades, the prevalence of mood disorders, including depression, has remained stable in the Netherlands (54-55).

Diabetes

Diabetes is counted among the main independent risk factors for of CVD (56). Over a period of 20 years, diabetes was found to double the age-adjusted relative risk of CVD in men and to nearly triple it in women (30). Specifically, diabetes is a risk factor for an acute myocardial infarction in both men and women (57). In the Netherlands, the prevalence of diabetes mellitus in both men and women increased between 1992 and 2011, with the largest increase from 2000 (58).

High blood pressure

Another main contributor to CVD is high blood pressure. Both men and women with a high-normal blood pressure have been shown to experience a significantly higher incidence of CVD after ten years than those with an optimal blood pressure (59). High blood pressure (or hypertension) is an important risk factor for the development of CVD, including coronary heart diseases and peripheral arterial diseases (60-61). In both young and old people, hypertension is a significant risk factor of an acute myocardial infarction (57). International scientific reports show a decrease in hypertension over the past decades due to better pharmaceutical treatment, but for the Netherlands such a trend is not yet clear (62-63).

Overweight and obesity
Overweight and obesity are clear risk factors for CVD (64). An association with cardiovascular outcomes was seen for both the overweight category (BMI: 25-29,9 kg/m2) and the obese category (BMI: 30+ kg/m2) (65). Specifically, an increased body-mass index is responsible for a higher risk of heart failure (66). Furthermore, abdominal obesity is a risk factor for myocardial infarction (57). The percentages of overweight in men and women aged 55-65 years in the Netherlands show a slight overall increase from 1992 until 2012, ranging between 51.8% and 60.7%. The size of these percentages indicates that overweight is a major problem (67).

Smoking
Smoking is independently associated with several types of CVD. An association is found between smoking and the presence of coronary artery disease in both men and women (68-70). Smoking is also strongly associated with an increased risk of an acute myocardial infarction in both men and women and in both younger and older adults (57). Furthermore, smoking importantly influences the onset of (chronic) heart failure (71-72) and coronary heart disease (73-74). The risk of CVD is substantially increased by smoking even a little or by passive smoking (73,75). In the Netherlands, the percentage of people (16 years and older) smoking decreased from 36.5% in 1992 to 33.7% in 2002 and to 24.4% in 2012 (76-77).

Sports activity
Physical inactivity is an important CVD risk factor. A review by *Li et al*. showed that both moderate- and high levels of physical activity substantially reduce the risk of CVD (78). In the Netherlands, the percentage of men and women (18 years and older) meeting the guidelines of the Dutch Healthy Exercise Norm has strongly increased over the years: from 44% in 2001 to 60% in 2009 (79).

Research questions
In the scientific literature, no adequate information can be found on the trends in the health profiles of older adults who are still participating in the labour force. This

is particularly true for the focus of this study, CVD. Therefore our first research question is: *What are the changes in the prevalence of cardiovascular diseases in Dutch older workers in the course of the past 20 years?* As in general the workforce participation in the age group 55-64 has increased, this implies that more people with poor health in general, and with CVD in particular, may be part of the workforce. It may therefore be expected that the prevalence of CVD in workers aged 55-64 years has increased in the period from 1992-1993 to 2012-2013.

The scientific literature has identified many determinants as influential in the onset of CVD in the general population. It is also known that these determinants have changed over the years (80). In the last two decades, the prevalence of diabetes has increased; also the prevalence of overweight and high blood pressure has increased slightly. The average age is increasing, which changes the distribution of ages in the group of 55-64-year-olds. These changes are all indicative of an increase in the prevalence of CVD. However, there are also changes that indicate a decrease in the prevalence of CVD: the prevalence of smoking has strongly decreased and sports activity has increased. Also, the number of weekly working hours has become slightly lower over the years, and psychosocial work demands have decreased. Furthermore, from the 1990s, there are relatively more women in the Dutch working population aged 55-65 years. In addition, the educational level of older people has increased. Only with regard to the prevalence of depression has no change over the years been observed. The extent to which these various trends pertain to older workers is unclear, as is how these trends contribute to an increase or decrease in the prevalence of CVD in older workers. Our second research question is therefore: *What is the explanatory value of changes in demographic, health-related and work characteristics on the change in cardiovascular disease prevalence in older workers over the years?*

2. Methods

Study sample

The sample used in this study is derived from the Longitudinal Aging Study Amsterdam (LASA). LASA is an ongoing, multidisciplinary cohort study focusing on predictors and consequences of changes in physical, cognitive, emotional and social functioning in the ageing population of the Netherlands (81). The cohorts are based on a representative sample of older people (aged 55–85 years) from three geographic regions in The Netherlands (around Amsterdam, Zwolle and Oss).

The data collection started in 1992–1993 amongst a cohort of 3107 respondents aged 55–84 years (cohort 1). In 2002–2003, a new cohort of 1002 respondents aged 55–64 years was recruited (cohort 2). Another new cohort of 1023 respondents aged 55–64 years was added in 2012–2013 (cohort 3) (82). Since the beginning, measurement cycles have been conducted every three years. Data are collected by trained interviewers, who visit the respondents at home. Two separate interviews are conducted: a main face-to-face interview exploring physical, cognitive, emotional and social functioning and a medical interview involving clinical measurements).

The Medical Ethics Committee of the VU University Medical Centre approved the LASA study. All respondents gave informed consent. More detailed information about the LASA sampling and response details can be found elsewhere (81–82).

Data used in this study are from the first measurement cycles of each new cohort, and include all respondents aged between 55 and 65 years (1992–1993: n = 964, 2002–2003: n = 996, 2012–2013: n = 991) who were participating (at least one hour per week) in the labour force. From this sample, those without information on CVD were excluded (n = 1). The study sample eventually consisted of 1305 respondents.

Measurements

Cardiovascular disease

CVD is the dependent variable in this study. The presence of CVD is determined by asking respondents whether they currently have CVD or have had a myocardial infarction (MI) in the past. Myocardial infarction, cardiac arrhythmia, cardiac failure, cardiac decompensation, angina pectoris and narrowing of the coronary artery are included in cardiac diseases. Furthermore, respondents are asked if they currently have a disease or abnormality of the arteries or veins (e.g. arteriosclerosis, blood vessel constriction or dilation of the aorta). Both questions could be answered with yes or no. For this study, two CVD groups are created: 1) no CVD (no CVD and/or MI and no problems with arteries/veins) and 2) CVD (CVD and/or MI and/or problems with arteries/veins).

Cohort number
Cohort number is the main independent variable. The three measurement cycles (1992–1993, 2002–2003 and 2012–2013) have cohort numbers 1, 2 and 3, respectively.

Potential determinants

– *Demographic factors*
Sex. The sex of the respondent is derived from the Dutch population register (male = 1, female = 2).

Age. The age of the respondent is determined using the date of the interview and the person's date of birth, which is extracted from the Dutch population register. The respondent is asked if the information from the register was correct. For this study, the age of the respondent at the time of the main interview was used. The average difference between the age of the respondent at the main interview and the medical interview was negligible (0.09 years). To examine non-linear changes with age, we created five categories, each covering two years (55–56.99 = 1, 57–58.99 = 2, 59–60.99 = 3, 61–62.99 = 4, 63–64.99 = 5).

Educational level. Respondents are presented with a nine-category scale on which to indicate their highest level of education completed. For the present study, three groups of educational level are distinguished: low (elementary education or less), middle (lower vocational education, general intermediate education, intermediate vocational education and general secondary education) and high (higher vocational education, college education or university education) (low = 1, middle = 2, high = 3).

– *Health-related factors*
Blood pressure. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) (mmHg) are measured three or four times with an automatic blood pressure monitor (in 1992–1993: Omron HEM 815F; in 2002–2003 and 2012–2013: Omron HEM-706; Omron Corporation, Tokyo, Japan). In 1992–1993, the measurements took place at the index finger, whereas from 2002–2003 onward, the measurements took place at the upper left arm. The measurements took place after the respondent had had five minutes of rest and was in a seated position. In this study, two blood pressure groups were created, based on the average systolic- and diastolic blood pressure from the multiple measurements: 1) normal blood pressure (SBP <140 mmHg and DBP <90 mmHg) and

2) high blood pressure (SBP ≥140 mmHg and/or DBP ≥90 mmHg) (83). In the main interview, the respondents were asked if they have a high blood pressure. In the first cohort, however, the respondents were not specifically asked for high blood pressure, but they could report it when prompted to report other diseases than those previously asked in the interview. The latter question format is known to lead to underreporting of specific diseases (84). This self-reported information is used when no measurements of blood pressure are available (n = 134; with 28, 29, and 77 in cohorts 1, 2, and 3, respectively).

Diabetes. The presence of diabetes mellitus (type 1 or 2 is not specified) is determined by self-report and coded as 1) no diabetes and 2) diabetes.

Depression. Depressive symptoms are measured with the Center for Epidemiological Studies Depression scale (CES-D) translated into Dutch (85). The CES-D consists of 20 items, which cover the depressive symptomatology experienced in the past week. For each item, the respondent had four response options: 0) rarely or never, 1) some of the time, 2) occasionally, and 3) mostly or always. The total score of the 20 items ranged from 0 (no depressive symptomatology) to 60 (severe depressive symptomatology). Respondents with a score of ≥ 16 are considered to have depressive symptoms that are clinically relevant (86). In this study, two depression groups are distinguished: 1) no depression (CES-D score < 16) and 2) depression (CES-D score ≥ 16).

Overweight. Body weight is measured using a calibrated balance bathroom scale (Seca, model 100, Lameris, Utrecht, The Netherlands). Respondents are asked to take off their clothes (except their underwear) and shoes. Height is measured using a stadiometer. BMI is calculated by weight in kilograms divided by the square of height in meters, with unit kg m-2. For the present study, BMI is classified as 1) normal weight (BMI < 25), 2) overweight (BMI: 25-29.99), and 3) obese (BMI ≥ 30) (87).

Smoking. The respondent was asked if he or she smokes cigarettes, cigars, pipe, electronic cigarettes or other tobacco. The answer could be: never smoked, currently smoking or past smoking. The literature shows that 15 years after someone quits smoking, the absolute mortality risk of heart disease for that person is almost the same as the risk for a person who has never smoked. Therefore, in this study, the past smoking group is further divided into respondents who stopped less than 15 years ago and those who stopped 15 years or longer ago (88), resulting in codes 1) currently, 2) past < 15 years, 3) past ≥ 15 years, and 4) never.

Sport activity. Sport activity was measured using part of the validated LASA Physical Activity Questionnaire (LAPAQ (89)) that, amongst other physical activities, asks the frequency and duration of sports activities over the past two weeks. Sports included distance walking and cycling (i.e., not as a means of transportation for doing groceries or visiting someone). Respondents could report a maximum of two sports that they practiced most frequently. A sports time score was calculated in minutes per two weeks, by multiplying the frequency and duration of the activities. For this study, sports time was categorised into quartiles, as follows: 0) 0 minutes, 1) 1–179 minutes, 2) 180–411 minutes, and 3) 412 minutes and higher.

– Work factors

Working hours. If respondents reported that they currently participated in paid employment (one hour or more per week or short-term temporary work), the interviewer asked the respondent the number of hours worked per week. For the present study, weekly working hours are divided into four categories: 1) ≤20 hours, 2) 21–34 hours, 3) 35–40 hours, and 4) ≥41 hours. These categories are created based on the situation in the Netherlands. Working 35 to 40 hours a week is considered as having a full-time job (90). Because part-time work is common, two categories are created with a cut-off point of 20 hours a week. The chosen categories are evenly distributed in the study sample: the 25th, 50th, and 75th percentiles of hours work per week are at 20, 34, and 40 hours, respectively.

Work exposure. Work exposure was measured as physical work demands, psychosocial work demands and psychosocial resources at work, in line with the Job-Demand-Resources model (47). These work exposure data were derived from a job-exposure matrix, in which occupational classes of the Netherlands Standard Classification of Occupations 1992 were categorized into the level of probability of exposure to work demands and resources using self-reported data from the Netherlands Working Conditions Survey (n = 18,937 workers from 41 occupational classes). If >50% of workers within one occupational class reported high physical demands, psychosocial demands or resources, the jobs belonging to that occupational class were classified as having 'high probability of exposure' to physical demands, psychosocial demands or resources. Jobs belonging to an occupational class were classified as having 'moderate probability of exposure' if the proportion of respondents with high demands or resources was <50 %, but above the study sample-based total proportion reporting high demands or resources, which was considered as the normative (47).

The three aspects constituting physical work demands (use of force, uncomfortable work, and exposure to repetitive movements) were each categorized as: 0) a low probability of exposure to high demand on this aspect, 1) a moderate probability of exposure to high demand on this aspect and 2) a high probability of exposure to high demand on this aspect. The sumscore Physical work demands ranged from 0 to 6.

The three aspects constituting psychosocial work demands (task requirements, time pressure, and cognitive demands) were categorized in the same way. The sumscore Psychosocial work demands ranged from 0 to 6. Psychosocial resources at work included two aspects (low autonomy and low task variation), which were each categorized into: 0) a low probability of low resources, 1) a moderate probability of low resources and 2) a high probability of low resources. The sumscore Psychosocial work resources ranged from 0 to 4.

Statistical analysis

All analyses were performed in SPSS 22, and statistical significance was set at $p \leq 0.05$. First, descriptive analyses were performed to show the characteristics of the study sample. The continuous determinants (age, sport activity, working hours, and work demands) were checked for linearity of their association with CVD. When non-linearity was found, the determinant was divided into categories. The determinants are presented as relative frequencies. Differences in the relative frequencies between the cohorts were tested using chi-square tests. To find more specific differences between the cohorts, post-hoc analyses were performed to test for trends over time: cohort 1 is compared to cohort 2+3 and cohort 3 is compared to cohort 1+2.

To study the association between cohort and CVD, we performed logistic regression analyses with CVD as dependent variable and cohort number as main independent variable. Odds Ratios (ORs) are reported with their confidence intervals (CIs). Cohort was initially defined as a continuous variable. To check whether the relation between cohort and CVD was linear, we repeated the logistic regression analyses, with cohort as a categorical variable.

To examine potential explanatory factors for the association between cohort and CVD over time, the determinants (with the missing category included) were entered into the basic logistic regression model. First, each determinant was added separately to the basic model to find if, corrected for this determinant, the association between cohort and CVD became stronger or was attenuated. Then, four groups of determinants were created and added to the basic model in the following order: the demographic characteristics sex and age (model 1), determinants with an unfavourable development and thus with a potentially upward effect on the trend of CVD (model 2), work factors (model 3), and determinants with a favourable development and thus with a potentially downward effect on the trend of CVD (model 4). Among the work factors, the physical demands and psychosocial demands showed high intercorrelations with psychosocial resources (>0.6), for which reason demands and resources were entered into separate models 3.

3. Results

Characteristics of the study sample

Descriptive statistics of the study sample appear in table 1. In the course of 20 years, the percentage of people aged 55-64 years that is working has more than doubled: from 28.4% in 1992-1993 to 62.2% in 2012-2013. During this period, a significant change can be seen in the demographic characteristics of the workers in this age group. In 2012-2013, the proportion of women was significantly higher than in the previous years and the mean age had increased. Also, the proportion of highly educated people had increased significantly.

With regard to lifestyle characteristics (smoking, BMI, and sports activity), significant changes took place. A trend towards fewer people currently smoking and more people who stopped smoking more than 15 years ago is seen. Also, the proportion of people who never smoked increased across the cohorts. In BMI, between 1992-1993 and 2012-2013, a clear shift is seen towards a higher proportion of obese people. In contrast, the number of minutes spent on sports activity increased, and the percentage of workers not doing any sport decreased.

Regarding the other health-related risk factors, a significant change is seen over the two decades in the prevalence of diabetes and high blood pressure. In 2012-2013, the proportion of people with diabetes was significantly higher than in previous years. Between 1992-1993 and 2002-2003, the proportion of people with high blood pressure strongly increased, but decreased after that. The low value in 1992-1993 may be an artefact of the data, because the instrument to measure high blood pressure was changed after 1992-1993 (see Methods). With regard to the prevalence of depression, a marginally significant increase can be seen over the 20-year period.

Although the mean number of working hours per week did not show significant change over time, some of the categories did show significant change. The proportion of people who work fulltime was stable, but a trend towards fewer people working more than 40 hours and more people working between 21 and 34 hours can be seen. Lastly, physical work demands showed a significant decrease over time, whereas both psychosocial work demands and resources showed significant increases.

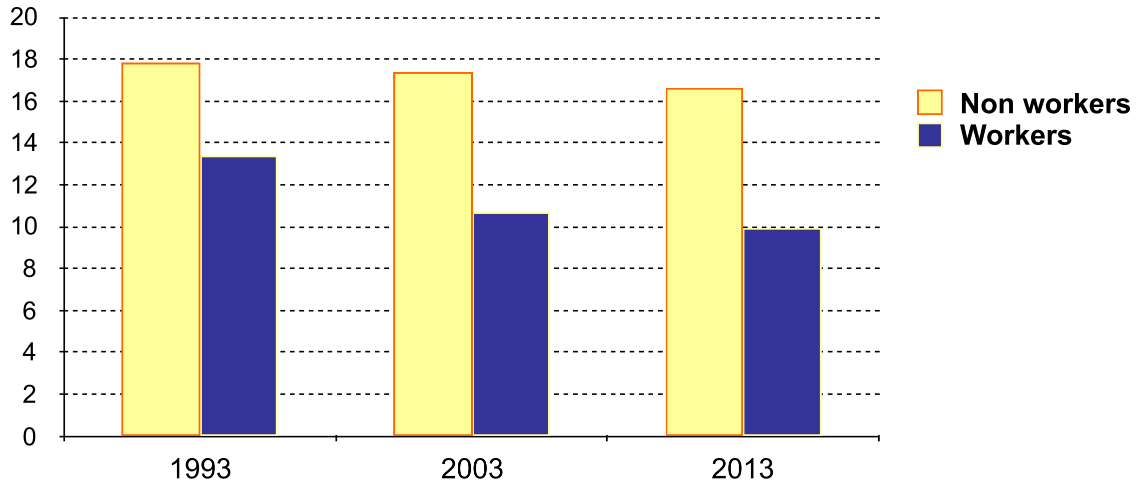
The prevalence of CVD decreased over the years, although not significantly (Figure 1). In 1992-1993, 13.9% of the workers aged 55-64 years had CVD, and this percentage decreased to 10.8% in 2002-2003 and 9.7% in 2012-2013. For comparison, the same-aged non-workers showed higher prevalences of CVD in all three cohorts ($p<0.001$), as well as a similar, non-significant decrease over the decades ($p = 0.393$).

Table 1: Characteristics of the study sample by cohort

cohort (n (% total 55-64))	1992-1993 274 (28.4%)	2002-2003 415 (41.7%)	2012-2013 616 (62.2%)	P*
Sex (n (%))[ac]				0.019
Male	174 (63.5%)	252 (60.7%)	335 (54.4%)	
Female	100 (36.5%)	163 (39.3%)	281 (45.6%)	
Age (n(%))[ac]				<0.001
55-56	80 (29.2%)	154 (37.1%)	138 (22.4%)	
57-59	81 (29.6%)	88 (21.2%)	167 (27.1%)	
59-60	52 (19.0%)	85 (20.5%)	134 (21.8%)	
61-62	30 (10.9%)	54 (13.0%)	107 (17.4%)	
63-64	31 (11.3%)	34 (8.2%)	70 (11.4%)	
Mean age	58.91	58.65	59.35	
Education (n (%))[abc]				<0.001
Low	56 (20.4%)	60 (14.5%)	40 (6.5%)	
Middle	162 (59.1%)	224 (54.0%)	348 (56.5%)	
High	56 (20.4%)	131 (31.6%)	228 (37.0%)	
Body Mass Index (n (%))[abc]				0.001 WM
Normal (<25)	85 (31.0%)	113 (27.2%)	192 (31.2%)	<0.0001 MI
Overweight (25-30)	130 (47.4%)	189 (45.5%)	226 (36.7%)	
Obesity (30+)	27 (9.9%)	83 (20.0%)	118 (19.2%)	
Missing	32 (11.7%)	30 (7.2%)	80 (13.0%)	
Smoking (n (%))[abc]				<0.001 WM
Current	84 (30.7%)	120 (28.9%)	92 (14.9%)	<0.001 MI
Past <15 years	55 (20.1%)	63 (15.2%)	89 (14.4%)	
Past ≥ 15 years	54 (19.7%)	122 (29.4%)	215 (34.9%)	
Never	52 (19.0%)	80 (19.3%)	140 (22.7%)	
Missing	29 (10.6%)	30 (7.2%)	80 (13.0%)	
Sport time in min/2 weeks[abc]				<0.001 WM
No (0 min)	114 (41.6%)	125 (30.1%)	73 (11.9%)	<0.001 MI
Low (1-179 min)	67 (24.5%)	106 (25.5%)	129 (20.9%)	
Middle (180-411 min)	47 (17.2%)	92 (22.2%)	128 (20.8%)	
High (412+ min)	43 (15.7%)	85 (20.5%)	165 (26.8%)	
Missing	3 (1.1%)	7 (1.7%)	121 (19.6%)	
Mean sport time in min (M, sd)[bc]	108 (186)	131 (177)	179 (201)	<0.001
Diabetes (n (%))[ab]				0.038
Diabetes	5 (1.8%)	23 (5.5%)	34 (5.5%)	
No diabetes	269 (98.2%)	392 (94.5%)	582 (94.5%)	
Depression (n (%))[c]				0.066
Depressed	12 (4.4%)	27 (6.5%)	53 (8.6%)	
Not depressed	262 (95.6%	388 (93.5%)	563 (91.4%)	
Blood pressure (n (%))[ab~]				
Normal	232 (84.7%)	215 (51.8%)	368 (59.7%)	<0.001
High (Hypertension)	42 (15.3%)	200 (48.2%)	248 (40.3%)	
Working hours per week (n(%))[abc]				<0.001 WM
≤20	89 (32.5%)	133 (32.0%)	166 (26.9%)	<0.001 MI
21-34	27 (9.9%)	80 (19.3%)	164 (26.6%)	
35-40	91 (33.2%)	145 (34.9%)	214 (34.7%)	
≥41	63 (23.0%)	55 (13.3%)	72 (11.7%)	
Missing	4 (1.5%)	2 (0.5)	X	
Mean working hours (M, sd)[abc]	32.9 (18.4)	30.4 (16.4)	31.1 (14.5)	0.116
Physical work demands (M, sd)[bc]	2.1 (1.5)	1.8 (1.6)	1.4 (1.6)	<0.001
Missing	10	43	3	
Psychosocial work demands (M, sd)[bc]	1.1 (1.9)	1.4 (2.0)	2.0 (2.1)	<0.001
Missing	10	43	3	
Psychosocial work resources (M, sd)[bc]	1.1 (1.3)	1.4 (1.4)	1.8 (1.5)	<0.001
Missing	10	43	3	

* Chi-square test outcome; WM = without the missing category, MI = missing category included
a = chi-square test significant between the three cohorts; b = post hoc analyses significant between cohort 1 and cohort 2+3; c = post hoc analyses significant between cohort 3 and cohort 1+2
~ = when the category 'missing' is included, also a 'c' must be added.

Figure 1. Prevalence of cardiovascular disease in non-workers and workers aged 55-64 years. Longitudinal Aging Study Amsterdam (n=2,951).



Association of cardiovascular disease and cohort

Table 2 shows the results of the logistic regression analysis of the association between cohort and CVD with cohort as a continuous variable. The result shows a marginally significant, negative association between cohort and CVD (p = 0.081).

Table 3 shows the result of the same logistic regression analysis, but with cohort as a categorical variable. Compared to 1992-1993, the odds of having CVD is 0.755 times as high in 2002-2003 and 0.670 times as high in 2012-2013. The first odds ratio (OR) is not

Table 2: Logistic regression analysis of the association between cohort and cardio-vascular disease with cohort as continuous variable

	B	*Sig*	*OR*	*95%CI for OR*	
				Lower bound	Upper bound
cohort	-0.193	0.081	0.824	0.663	1.024
constant	-1.667	0.000	0.189		

B=regression coefficient, Sig=significance, OR=Exp(B)=odds ratio, 95%CI= 95% confidence interval

Table 3: Logistic regression analysis of the association between cohort and cardio-vascular disease

	B	*Sig*	*OR*	*95%CI for OR*	
				Lower bound	Upper bound
1992-1993					
2002-2003	-0.281	0.234	0.755	0.476	1.198
2012-2013	-0.400	0.071	0.670	0.434	1.034
constant	-1.826	0.000	0.161		

B=regression coefficient, Sig=significance, OR=Exp(B)=odds ratio, 95%CI= 95% confidence interval significant, but the second OR is marginally significant with a p-value of 0.071. Thus, a monotonically downward trend in CVD is seen over 20 years.

Cohort is used as a categorical variable in the subsequent analyses because the relation between cohort and CVD is not found to be entirely linear.

Change in prevalence of CVD adjusted for determinants of CVD

As is seen in Table 1, several determinants had more than 5% missing values. In all, complete data were available for 985 participants (75.5%). Therefore, multiple imputation was applied for each cohort separately. The imputation concerned body mass index, smoking, sport activity, working hours, and work demands and resources. The determinants with complete data (age, sex, education, depression, diabetes, and high blood pressure) were used as predictors, along with the number of chronic diseases and sense of mastery. Thirty imputations were performed. The following analyses are based on the pooled, imputed dataset.

Table 4 displays the odds ratios of Cohort 2 versus Cohort 1 and of Cohort 2 versus Cohort 1, based on logistic regression analyses adjusted for age, sex, and each single determinant of CVD. Here, OR(cohort 2 vs 1) and OR(cohort 3 vs 1) show the trend in the prevalence of CVD over the first ten years of the study period, and over the full 20 years, respectively. These ORs for the basic model, including age and sex only, amount to 0.798 and 0.686, respectively. In the next lines, the basic model is expanded by one determinant at a time (indicated by '+' in the first column), and the ORs of cohort are listed for the expanded model. In the columns to the right of each OR column, the percentage of reduction in OR is shown, which is calculated as follows:
(OR(cohort in basic model) – (OR in expanded model) / (OR(cohort in basic model) – 1).

Each of the first set of determinants, which showed an unfavourable development, had a strengthening effect of the ORs of cohort. Therefore, the OR reduction is indicated as a negative percentage. Among these, depression had the smallest effect. The strengthening of the association implies that the decline in the prevalence of CVD would have been greater if the prevalence of obesity, diabetes and depression had remained at the same level throughout the study period. The model including all three determinants (lower section of Table 4), shows that the 20-year decline would have been 19.1% steeper.

Among the work-related set of determinants, working hours further strengthened the association between cohort and CVD, but work demands and resources attenuated this association. Among these, psychosocial resources had the weakest effect. Due to its high association (r>0.60) with both physical and psychosocial work demands,

Table 4. Cardiovascular diseases in workers aged 55-64 years: changes over 20 years (OR(cohort)) and effect of single determinants (OR reduction). Longitudinal Aging Study Amsterdam.

Model (n=1305)*	OR (cohort 2 vs 1)	OR reduction[1]	OR (cohort 3 vs 1)	OR reduction[1]	Sig (cohort 3 vs 1)+
Cohort, Age, Sex (Basic)	0.798		0.686		0.094
+ Body Mass Index	0.758	-19.8%	0.670	-5.1%	0.079
+ Diabetes	0.763	-17.3%	0.654	-10.2%	0.061
+ Depression	0.790	-4.0%	0.666	-6.4%	0.072
+ Working hours	0.762	-17.8%	0.669	-5.4%	0.080
+ Physical work demands	0.828	+14.9%	0.745	+18.8%	0.198
+ Psychosoc w demands	0.819	+10.4%	0.735	+15.6%	0.180
+ Psychosoc w resources	0.809	+5.4%	0.713	+8.6%	0.139
+ Education	0.833	+17.3%	0.734	+15.3%	0.178
+ Smoking	0.856	+28.7%	0.757	+22.6%	0.229
+ Sport time	0.831	+16.4%	0.738	+16.6%	0.195
+ Hypertension	0.811	+6.4%	0.695	+2.9%	0.115
Basic + Unfavourable determinants	0.725	-36.1%	0.626	-19.1%	0.042
+ Work characteristics	0.719	-2.2%	0.652	+7.0%	0.075
+ Favourable determinants	0.812	+ 33.1%	0.740	+25.3%	0.240

* Entries are based on imputed models
\+ Test of Cohort 2 vs 1 is always less significant and therefore is not shown.
1 OR(cohort) of basic model is compared with OR(cohort) of extended model for each determinant separately. In the lower table section, results are shown from cumulative addition of determinants.

psychosocial resources are omitted from a model including all work characteristics studied. In the model with the work characteristics added to the unfavourable determinants (lower section Table 4), it is observed that the association of cohort and CVD is attenuated by 7.0%, compared to the model without work characteristics.

Finally, all determinants with a favourable development attenuated the association of cohort and CVD. This implies that their favourable development explains part of the decrease in the prevalence of CVD. Among these, hypertension had the weakest effect. In the complete model, with these determinants added (lower section Table 4), the favourable determinants explained 25.3% of the decline in the prevalence of CVD.

Association of determinants and cardiovascular disease

Table 5 shows the associations between each determinant and CVD in the complete model, including all determinants studied. The first row shows that cohort is not

Table 5. Cardiovascular diseases in workers aged 55–64 years: model including all determinants. Longitudinal Aging Study Amsterdam.

Model (n=1305)*	OR	95%CI Lower bound	95%CI Upper bound	Sig
Cohort				
– 2 vs 1	0.812	0.487	1.353	0.423
– 3 vs 1	0.749	0.447	1.223	0.240
Sex	0.542	0.339	0.864	0.010
Age				
– 57–58 vs 55–56	1.262	0.752	2.121	0.387
– 59–60 vs 55–56	1.118	0.638	1.960	0.698
– 61–62 vs 55–56	1.404	0.753	2.615	0.285
– 63–64 vs 55–56	***2.709***	***1.483***	***4.951***	***0.001***
Education				
– Low vs High	1.004	0.492	2.046	0.992
– Middle vs High	1.018	0.607	1.707	0.945
Body Mass Index				
– Overweight vs Normal	1.533	0.959	2.453	0.075
– Obesity vs Normal	1.605	0.909	2.834	0.103
Smoking				
– Past <15 years vs Current	***1.703***	***1.012***	***2.866***	***0.045***
– Past ≥15 years vs Current	0.783	0.463	1.326	0.363
– Never vs Current	0.766	0.427	1.375	0.372
Sporttime				
– No vs High	1.061	0.622	1.808	0.828
– Low vs High	***0.544***	***0.302***	***0.981***	***0.043***
– Middle vs High	0.849	0.486	1.483	0.564
Diabetes	2.366	1.197	4.674	0.013
Depression	1.912	1.040	3.518	0.037
Hypertension	0.865	0.582	1.287	0.475
Working hours				
– 21–34 vs ≤20	0.861	0.493	1.506	0.600
– 35–40 vs ≤20	0.922	0.556	1.528	0.752
– ≥40 vs ≤20	0.519	0.263	1.026	0.059
Physical work demands	1.101	0.958	1.265	0.177
Psychosocial work demands	1.019	0.899	1.154	0.771

* Calculations based on dataset pooled from 30 missing value imputed datasets

significant, implying that no change in CVD prevalence is observed when accounting for all determinants studied. Furthermore, note that only a few determinants have unique, independent associations with CVD, as highlighted in bold italics in table 5: sex, age, smoking, sport time, diabetes and depression. The associations of the determinants are described in turn below.

Demographic determinants

The odds of having CVD are 0.542 times lower in women compared to men ($p = 0.010$). The odds of having CVD increase with age, but are substantially raised only when comparing workers aged 63–64 to those aged 55–56: their odds of having CVD are 2.709 times as high ($p = 0.001$). Regarding educational level, neither low- nor middle-educated workers have significantly raised odds compared to their high-educated counterparts.

Health-related determinants
Both overweight and obese workers have higher odds of having CVD, compared to workers with normal weight (ORs 1.533 and 1.605, respectively), but only the odds ratio for overweight is marginally significant at $p = 0.075$. Meanwhile, the odds ratio for obesity is higher than for overweight, but may not have reached significance because of the lower number of cases in this category. Workers with diabetes have significantly higher odds of having CVD (OR 2.336, $p = 0.013$). Likewise, the odds of having CVD are significantly higher in depressed workers, compared to workers without depression (OR 1.912, $p = 0.037$).

The odds of having CVD are significantly higher in workers who stopped smoking less than 15 years ago, compared to those who currently smoke (OR 1.703). In contrast, the odds of having CVD in workers who stopped smoking more than 15 years ago and in workers who have never smoked are lower, compared to workers who currently smoke, but not significantly so (ORs 0.783 and 0.766, respectively). More time spent on sports was not clearly associated with lower odds of CVD; curiously, workers who were engaged in sports activities but who spent relatively little time doing so (1–179 minutes/2 weeks) showed significantly lower odds than workers who spent a lot of time on sports (>412 minutes/2 weeks) (OR 0.544, $p = 0.043$). Regarding high blood pressure, no significant odds ratio was found (OR 0.865).

Work characteristics
Working more hours a week is negatively associated with CVD. The odds of having CVD are 0.519 times lower in people who work more than 40 hours per week, compared to those who work 20 hours or less per week. This odds ratio, however, does not reach the significance level of 0.05. There is a positive association of both physical and psychosocial work demands with CVD, but for neither type of demands were the ORs significant (OR 1.101 with $p = 0.177$ and OR 1.019 with $p = 0.771$, respectively).

4. Discussion and Conclusion

This study investigated the time trend in the prevalence of cardiovascular disease amongst Dutch older workers over the course of 20 years, and attempted to explain the changes found on the basis of changes in determinants of CVD. The results show a downward trend in the prevalence of CVD from 13.9% to 9.7% between 1992–1993 and 2012–2013. This downward trend was only marginally significant. However, we had expected an increase in CVD prevalence among workers, because policy measures have made exit from the workforce before the statutory retirement age more unattractive for workers in both good and poor health. Non-workers showed a higher prevalence, also with a non-significant decline over the years. Meanwhile, these findings are in line with an international study that found that incidence of acute myocardial infarction and angina pectoris decreased globally between 1990 and 2010 (91) and a study from Sweden in middle-aged people (45–64 years) that found a slow but steady decrease of ischemic stroke starting in the mid-1990s (92). A recent Dutch study also showed a decline between 1998 to 2007 in the incidence of myocardial infarction by 38% in men and 32% in women (80).

In order to examine the explanatory value of changes in demographic, health-related and work characteristics on the changes in CVD over the years, we tested a series of models. We saw, first of all, that the association between cohort and CVD (adjusted for sex and age) was slightly weakened. This means that the changes over the years in the sex and age composition of the workforce explain to a small extent the decline in CVD between 1992–1993 and 2012–2013. The explanatory effect of age is limited to the first decade; during this period, the post-WWII baby-boom generation reached the age of 55, so that the average age in the 55–64-year-olds shifted to a younger average. The explanatory effect of sex is more consistent, and is based on the continually increasing share of women in the workforce.

Second, turning to more substantial determinants of CVD, we observe that further adjustment for BMI, diabetes, and depression substantially strengthened the association between cohort and CVD (by 19.1%). If these determinants would have remained unchanged, the association between cohort and CVD would have been 19.1% stronger and a significant decrease of CVD among older workers would have been observed over the 20-year period. The addition of work characteristics attenuated this association slightly (by 7.0%). Among these characteristics, working hours showed a negative association with CVD, in contrast with findings in the earlier literature (41). As this is a cross-sectional study, reversed causation is likely. That is, it seems more likely that workers with CVD reduced their working hours, than that workers who worked long hours weekly were protected against CVD. When the final model was also adjusted for educational level, smoking, sports activity, and blood pressure, we saw that the association between cohort and CVD became substantially weaker than in the previous model (by 25.3%) – and even weaker than in the bivariate analysis. This means that the favourable changes in educational level, smoking status, and sports activity of older workers are explanatory factors of the decrease in the prevalence of CVD among older workers. This cannot be said for higher blood pressure, as its association with CVD was not significant. In the final model it seems that, all together, the determinants only have a small explanatory value on the change in prevalence of CVD over the years. However, the changes over the years in BMI, depression, and diabetes have a strong suppressive effect on the association between cohort and CVD, and the changes over the years in educational level, smoking and sports activity have a strong explanatory effect on the association between cohort and CVD. Thus, when we distinguish between suppressor and explanatory factors, we see clear effects on the association between cohort and CVD.

The observed decline in CVD prevalence is notable in light of the rise in awareness of chronic conditions over the years in the Dutch population (93). In particular, both citizens and general practitioners have become more alert to the possibility of diabetes in patients with vague complaints or risk factors of diabetes (94). Because of this growing awareness, people may be diagnosed earlier with diabetes, and therefore receive more effective treatment. This means that it is increasingly probable that people are diagnosed with conditions that increase the risk of CVD, but that these conditions can be treated and controlled. Thus, CVD may develop only later in life. Although we did include diabetes, it is difficult to take awareness into account in a population-based study such as ours, as this concerns both medical professionals and citizens.

Strengths and limitations

An important strength of this study is the use of a representative sample of the older working population. This sample is derived from the Longitudinal Aging Study Amsterdam (LASA), which is very comprehensive and thus ensures that data of most important determinants of CVD are available. Another strength is that CVD and its determinants were measured the same way across all of the three cohorts. The one exception is blood pressure, to which we devote some discussion below.

The study has also some limitations. First, we did not study more than 14 determinants because of the need to restrict the number of determinants in order maintain sufficient power (95); particularly in 1992–1993 the sample of older workers – and thus the number of CVD cases – was rather small. While we were able to include five of the six established risk factors for CVD (69) (smoking, physical activity, body mass index, diabetes and blood pressure), we could not include the sixth risk factor, cholesterol. A second limitation is that the data collection is divided between the main- and medical interview. Not all respondents agreed to participate in the medical interview after participating in the main interview. This causes missing data on some of the determinants (BMI, smoking, and sports activity), which led us to perform the main analyses in a multiply imputed dataset. Third, high blood pressure was not measured the same way in the three cohorts. In cohorts 2 and 3, a better measurement instrument was used (at the upper arm instead of at the index finger), yielding more cases of hypertension. Moreover, in cohorts 2 and 3 the interviewer asked the respondents specifically if they had high blood pressure, whereas in cohort 1, the respondents could report high blood pressure only when prompted for 'other diseases', a practice which notoriously leads to underreporting. Since self-reports were used only when measurements were not available, this issue concerns only a limited number of participants, most of them from cohort 3. Both changes are likely to have caused underestimation of high blood pressure in cohort 1. A fourth limitation is that half of the factors studied rely on self-reports by the respondents, including the outcome measure (CVD). Recall bias can be a problem and misclassification of the measurements can occur. However, a study comparing self-reports of chronic diseases to general practitioner data showed that in cardiac disease, over-reporting has increased significantly over the years (93) – a fact that encourages us to believe it plausible that the decrease found in CVD over the years is not a result of misclassification. Fifth, to address our research questions, we selected a sample of workers. The prevalence of CVD in workers proved to be lower than in non-workers. This may imply that the workers had recovered better from their disease than had the non-workers. This can be considered a 'relative' healthy worker effect. Finally, the minimum age in our dataset was 55. Workers younger than 55 may already have exited the workforce due to CVD. However, according to recent numbers, the prevalence of heart disease in 45-54-year-olds is less than 4% (96).

Further research and practical implications

For this study, data was used until 2012-2013. After this moment, the Dutch government raised the statutory retirement age to 66 years in 2018, and to 67 in 2021; from 2022, the statutory retirement age is planned to be linked to life expectancy (97). This means that future studies on CVD in older workers should also include people aged 65-70 years.

Several factors that were not available in our study may contribute to the decline in the prevalence of CVD over the years. Most importantly, high LDL-cholesterol levels and low HDL-cholesterol levels are important determinants of CVD (98). A Dutch study shows that cholesterol levels have recently improved, mostly due to increased prescription of cholesterol lowering drugs (80). A similar trend has been reported in other Western countries (62). Again, this development may further contribute to a decrease in the prevalence of CVD over time in older Dutch workers. It is recommended that these risk factors be examined in future studies of older workers, together with the factors included in our study.

Earlier studies have shown that having CVD is a risk factor for an early exit from the labour force. This study shows that the prevalence of CVD in older workers is decreasing over the years. Meanwhile, the percentage of older workers with CVD was still 9.7% in 2012–2013. Moreover, the workforce participation in this age group has grown substantially, so that in an absolute sense more workers will have CVD. In order to prevent untimely exit from the workforce, it is paramount that measures be taken to decrease work pressure in workers with CVD. In a recent study (99), 28% of older workers with CVD reported a need for work adjustment. This percentage is higher than for workers with other prevalent diseases such as diabetes (23%) or COPD (25%), but lower than for workers with musculoskeletal or mental disorders (both 40%). Among workers with CVD, their needs concerned predominantly the amount of work, working times, and task adjustment. The same adjustments ranked highest among those with mental disorders and diabetes, both of which have been shown to be determinants of heart disease in our study. For musculoskeletal diseases and COPD, adjustments of tools or furniture ranked highest. According to the study by Boot and colleagues (99), after one year, implementation of work adjustment proved to be associated with less sick leave.

To further reduce the number of workers with CVD and thereby decrease the risk of exit from the labour force due to CVD, it is important to prevent the occurrence of the disease by addressing CVD risk factors. Our findings indicate that risk factors include diabetes, depression, obesity, physical inactivity, and depression. In addition to work adjustments, prevention of risk of CVD entails early identification of risk factors. This may be achieved through periodic health examinations, but also through disclosure of poor health by workers, and awareness among supervisors and colleagues. Furthermore, the working environment might be made more conducive to a healthy lifestyle, e.g., by actively promoting physical activity during breaks and offering healthy food in the company's canteen).

In 2007, the Netherlands Society of Occupational Medicine (NVAB) published guidelines to deal with workers with CVD (100). However, almost half of occupational physicians see no possibility to adhere to such guidelines (101). It therefore seems advisable to organise prevention in a multidisciplinary setting including not only occupational physicians but also supervisors in the workplace and general health and social services outside the work setting.

Conclusion

This study shows that the prevalence of CVD in older Dutch workers decreased in the period from 1992–1993 to 2012–2013. Findings indicate that the changes over the years in BMI, diabetes, depression, and working hours led to a weaker decline in the prevalence of CVD than if no changes would have occurred (suppressor effects). Changes over the years in work demands, educational level, smoking, sports activity, and blood pressure proved to be explanatory factors of the decrease in the prevalence of CVD among older workers. Changes over the years in all determinants together had a small, weakening effect on the change observed in the CVD prevalence among older Dutch workers, suggesting that the explanatory factors studied were slightly more powerful than the suppressors over the past decades. The implication for the future trend in CVD is that further increases in the participation of women, increases in the educational level, decreases in smoking, as well as most likely decreases in blood pressure due to increases in antihypertensive drug prescriptions, will further decrease the prevalence of CVD in workers in this age group. However, further increases in diabetes, BMI, and depression, as well as increases in average age, may counteract such declines. In sum, it is not likely that the prevalence of CVD among workers will show a clear downward trend in the future. Future developments may be influenced by close monitoring of each factor, and by the timely adoption of measures to prevent further unfavourable developments and to promote further favourable developments.

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