The Effect of Work on Health and Work Ability

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The Effect of Work on Health and Work Ability

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To my wife Maryam,
and my children Gazal and Erfan;
and in loving memory of my father.

CONTENTS

CHAPTER 1

General introduction

1.1 BACKGROUND

In many industrial countries the labor force is aging. Despite an increased life expectancy, improved living conditions, and better health status, the average time people spend in paid work has decreased in most European countries in the past decades.[1] There are two main reasons for this paradoxical development. One aspect is the delay of young people entering the labor market due to a prolonged education, but the more important reason is that older workers are exiting the labor market in great numbers.[2] In fact, a high proportion of workers leave the market before the statutory, national retiring age. This development, the "early exit trend", has been called "one of the most profound trends in the past 25 years".[3] This trend is hardly sustainable because of the growing financial pressure on governments to cope with the economic burden of retirement pensions in society. One approach that policy makers in most industrial countries have adopted is to encourage older workers to remain longer active in the labor market, both by increasing the labor force participation among workers aged over 50 years and by increasing the statutory retirement age by a few years.[4]

1.2 ILL HEALTH AND LABOR FORCE EXIT

There are several mechanisms of withdrawal from the labor force among elderly workers. Workers may leave the work force due to disability, unemployment, and early retirement, partly depending on eligibility criteria and generosity of disability and retirement benefits.[2] Today in most European countries disability is a major social problem.[5] In various countries the proportion of inactive people due to disability exceeds the proportion of unemployed persons, and disability costs are significantly higher than the cost of unemployment. The success of policies for encouraging older people to remain active until the official age of retirement will depend on a better understanding of aging in the work force and the particular role of health in continuing work or withdrawing from the labor market.[5]

Many health problems, work-related risk factors, lifestyles, and individual characteristics are involved with early leaving of the labor force.[6-9] Several studies have demonstrated that health problems, such as a perceived poor health or the presence of a chronic disorder, contribute to an early exit from work.[4,10] Poor health and health problems also play an important role in the decision to retire. People who reported a poor health or indicated they suffered functional limitations, planned their retirement between one and two years earlier than average.[11,12] Health problems, especially mental disorders and stress symptoms, have also been associated with an increased risk of long-term unemployment.[13] Several physical and psychosocial risk factors in work may influence early exit from work.[9,14] Among workers with a high physical load due to manual materials handling and awkward postures, such as construction workers, prolonged exposure to physical load increased the risk of disability.[15,16] In general, blue-collar workers are more often awarded a disability pension.[9,17] The Danish Work Environment Cohort Study (DWECS) indicated that early retirement in the form of long-term unemployment was influenced by psychosocial work-related factors such as low decision authority and low skill discretion.[18] Other psychosocial factors, such as a positive attitude towards work, a high level of job commitment, and a high job satisfaction, have been associated with a lesser likelihood of early retirement.[19] In another study both low skill discretion and high physical load were independent predictors for long-term sick leave, disability, and early retirement.[16]

Among life-style factors smoking has been associated with permanent disability.[20] Both a low and a high body mass index has been associated with the risk of permanent disability or long-term sickness absence.[6,18]

Despite these findings, the relative importance of determinants of early exit from the work force and the relationships between these determinants and health in the process of leaving work before the official age of retirement are still largely unknown.

1.3 WORK ABILITY

In The Netherlands from the 1970s the “work demand and capacity model”[21] has been used in occupational health to describe the interaction between the work situation and a worker’s capacity to perform work. In this model a work situation is primarily characterized by physical and psychosocial demands and decision latitude. Under normal conditions it is assumed that a worker is capable of coping with these work demands. When an imbalance occurs, adequate recovery will usually take places during a period of sickness absence. In the case of insufficient recovery the short-term effects of work such as fatigue can expand to long-tem effects, such as sickness absence and permanent disability. This model is based on (mis)fit between the worker and his environment, whereby health problems arise as a result of the discrepancy between work load and abilities and skills of the worker. An important predecessor of this model was developed in the field of occupational stress, often referred to as the Person-Environment Fit model, developed in the early 1970s by researchers at the University of Michigan. This model states that strain develops when there is a discrepancy between the supplies of the environment (job), or between the demands of the job and the abilities of the person to meet those demands.

Motives include factors such as participation, income, and self-utilization. Demands include work load and job complexity. This misfit between worker and environment would result in incapacity for work and an absenteeism barrier.[22,23] In recent years the most popular stress model is the demand-control-support (DCS) model.[24,25] Previous studies have shown that a low job control and lack of support were important risk factors for an increased absence.[26]

In recent years these models have been partly substituted by models focusing on work ability in relation to the health status of the worker. Work ability is seen as the equilibrium between the functional capacity of a worker and the demands at work.

In Finland a work ability model has been developed whereby work ability expresses the generic evaluation of the productive capacities of a worker, the worker's health, and his psychological resources.[27,28] In this model work ability has been defined as the degree to which a worker, given his health, is physically and mentally able to cope with the demands at work. In this approach the primary focus of a worker's ability to cope with work demands is on health. Therefore, health is an important part of the work ability, not a determinant of it. Work ability will be influenced by different factors, among others, the physical and psychosocial demands at work, the worker's mental and physical capabilities, and lifestyle factors. The disequilibrium between these determinants and the worker's health lead to productivity loss at work, sickness absence, and work-related disability.

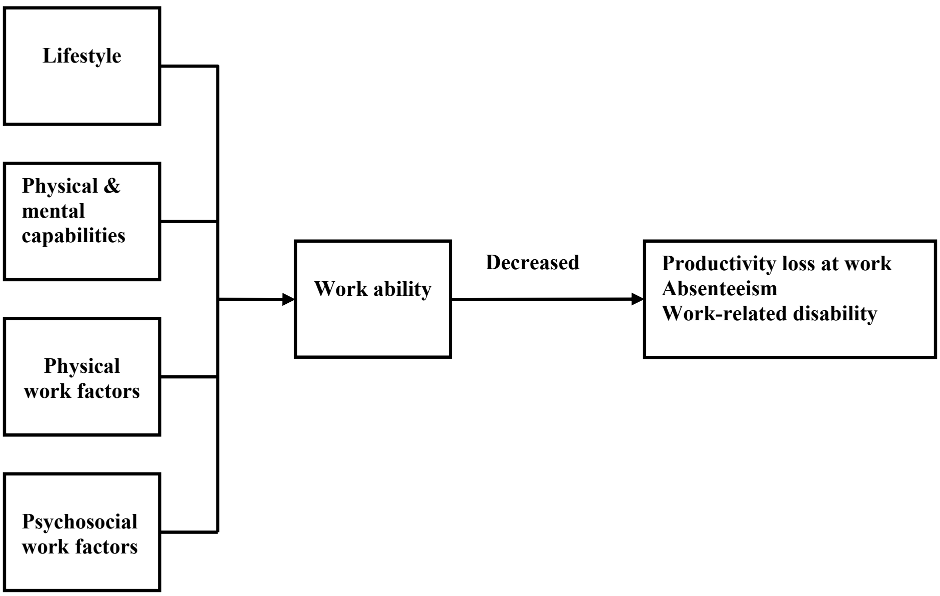

Figure 1.1 Conceptual model for the relationships between work-related physical and psychosocial factors, lifestyle, and work ability and consequences for work performance, such as productivity loss at work, sickness absence, and work-related disability

In recent years, promoting work ability has been considered as an affirmative means to decrease work disability and early retirement.[29,30] Therefore, the four principal target areas of work ability promotion consist of work environment, work organization, workers' health and functional capacity, and workers' professional competence. The promotion of work ability is also believed to be economically beneficial to the work place. A good work ability will not only results in productivity of high quality of work but also contributes to a better health-related quality of life. Being productive at work and being in good health are considered important determinants of prolonging working life and also of retirement in good health.[29,31] Although the relationship between work ability and retirement has been described in several occupational populations, the relative importance of different determinants of a good work ability is less well investigated. In addition, the effect of work ability on productivity at work (an important measure in cost-effectiveness studies) is still largely unknown.

1.4 WORK ABILITY INDEX

Finnish researchers have constructed a questionnaire-based method, the Work Ability Index (WAI), to operationalize the concept of work ability.[33,34] It consists of seven items on (1) subjective estimation of current work ability compared with life time best, (2) subjective work ability in relation to the physical and mental demands of work, (3) number of diagnosed diseases, (4) subjective estimation of work impairment due to diseases, (5) sickness absenteeism during the past year, (6) own prognosis of work ability after 2 years, and (7) psychological resources (enjoying daily tasks, activity and life spirit, optimism about the future). The final index score ranges from 7-49, and is divided into four work ability categories as poor (7-27 points), moderate (28-36 points), good (37-43 points), and excellent (44-49 points) (see table 1).

The work ability index has been promoted in recent years as a valuable tool in occupational health programs dedicated to decrease early exit from the work place.[31] Since workers differ with regard to their capacities and demands of their work, their work ability is differently affected by a particular illness or limitation.[34] It may also be affected by lifestyles, individual characteristics, and work-related risk factors.[35,36] In Finnish studies on municipal employees positive associations with work ability have been reported for leisure-time physical activity, possibilities for development at work,[37,38] work and life satisfaction, and higher education.[14] Physical and psychosocial risk factors that impaired the ability to work consisted of poor work postures, repetitive movements, high physical demands, (essentially the same as high physical demands) lack of freedom, decrease in recognition and esteem at

Table 1.1 The elements of the Work Ability Index[32,33]

	Item	Scale	Explanation
1	Subjective estimation of present work ability compared with the life time best	1-10	0 = very poor to 10 = very good
2	Subjective work ability in relation both to physical and mental demands of the work	2-10	2 = very poor to 10 = very good
3	Number of diagnosed diseases	1-7	1 = 5 or more diseases, 2 = 4 diseases, 3 = 3 diseases, 4 = 2 diseases, 5 = 1 disease, 7 = no disease
4	Subjective estimation of work impairment due to disease	1-6	1 = fully impaired to 6 = no impairment
5	Sickness absence during the past year	1-5	1 = 100 days or more, 2 = 25 - 99 days, 3 = 10 - 24 days, 4 = 1-9 days, 5 = 0 day
6	Own prognosis of work ability in the next 2 years	1, 4,or 7	1 = hardly able to work, 4 = not sure,7 = fairly sure
7	Psychological resources (enjoying daily tasks, activity and life spirit, optimistic about the future)	1-4	1 = very poor to 4 = very good

work, role ambiguity at work, and dissatisfaction with supervisors attitude.[14,28,,38,39] In conclusion, as important determinants of the WAI have been identified psychosocial and physical work factors, worker’s physical and mental capacities, lifestyle, and individual characteristics.

1.5 PRODUCTIVITY

Health problems that lead to functional limitations of workers may cause a decreased productivity. There are two measures of lost productivity: (1) time away from the job due to illness and associated disability (sickness absence),[40] and (2) productivity losses at work due to a reduced health. The phenomenon that workers turn up at work, despite health problems that may prompt absence from work, is sometimes referred to as sickness presenteeism.[41] Since sickness presenteeism may convey the wrong impression that health problems at work should promote absence from work, in this thesis the term productivity loss at work will be used.

Productivity loss at work may be measured in costs associated with decreased or slowed output, failure to maintain a standard production, additional training time, and errors in work.[42] Lost productivity is an important source of indirect costs of poor health, which often exceed the direct costs for diagnosis and treatment. Meerding et al. have shown that a reduced productivity at work due to health problems was prevalent in 5-12 % of construction workers and industrial workers, with a mean loss in productivity of 12-28%.[44 43] Determinants of work productivity included individual and lifestyle characteristics of the workers, job demands, incentive arrangements, and the work setting.[44] In some studies it has been shown that the available treatment had a measurable impact on an individual's ability to function at work. Workers who used sedative antihistamines against hay fever experienced on average 8% reduction in daily work output in the three days after receipt of the prescription.[43] Workers with a reduced work ability may not being able to fulfill the demands of their job and thus, may experience a reduced productivity. There are no studies available to show the association between work ability and productivity loss.

1.6 OBJECTIVES OF THE THESIS

In order to prevent workers from quitting the work force due to disability, the concept of work ability has been developed as a valuable tool to tailor interventions at individual level. In this thesis we focused on the work ability index (WAI) as a tool for assessing the workers' work ability. There is a need to better understand the relative importance of specific determinants of work ability and to determine the consequence of a reduced work ability in terms of sick leave, disability, and productivity.

The specific objectives of this thesis are:

1) To describe the associations between perceived health and specific diseases with early exit from the work force
2) To evaluate the relative influence of individual characteristics, health, lifestyle factors, and physical and psychosocial work-related factors on work ability.
3) To investigate the effect of a poor work ability on productivity losses at work, sickness absence, and permanent work related disability.

1.7 OUTLINE OF THIS THESIS

Following this general introduction, the thesis is divided into three parts. The first part concerns factors influencing early exit from work force. In this part (chapter 2) we investigated the premature leaving of the work force among elderly workers across 10 different European countries. We also addressed the most important diseases that lead to early exit from work force.

The part 2 we focused on work ability as an important tool in occupational health research. Chapter 3 compares the effects of different physical and psychosocial work-related risk factors, health, lifestyles, and individual characteristics on work ability among construction workers. In chapter 4 the influence of psychological factors and life style on health and work ability among professional workers were investigated.

In part 3 we investigated the relationship between work ability and loss of productivity at work among a large variety of occupational groups (chapter 5). In chapter 6 we determined the predictive value of the work ability index for sickness absence and work related disability. This chapter is a follow-up study among Dutch construction workers also studied in chapter 4, and describes the impact of different individual, lifestyle, and work-related factors and also work ability on sickness absence. Chapter 7 focused on the predictive value of WAI for disability among Dutch construction workers.

The last chapter (chapter 8) of the thesis contains the general discussion of the results from the different study.

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PART 1

CHAPTER 2

Unemployment and retirement and ill health: a cross-sectional analysis across European countries

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Unemployment and retirement and ill-health: a cross-sectional analysis across European countries
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ABSTRACT

Objective: To determine the associations between different measures of health and labor market position across 10 European countries.
Methods: We studied 11,462 participants of the Survey on Health and Ageing in Europe (SHARE) who were 50-64 years old. Logistic regression was used to calculate the associations between health and other determinants and being retired, unemployed, or a homemaker.
Results: A large variation across European countries was observed for the proportion of persons 50-65 years with paid employment, varying among men from 42% in Austria to 75% in Sweden and among women from 22% in Italy to 69% in Sweden. Among employed workers 18% reported a poor health, whereas this proportion was 37% in retirees, 39% in unemployed persons, and 35% in homemakers. A perceived poor health was strongly associated with non-participating in labor force in most European countries. A lower education, being single, physical inactivity and a high body mass index were associated with withdrawal from the labor force. Long-term illnesses such as depression, stroke, diabetes, chronic lung disease, and musculoskeletal disease were significantly more common among those persons not having paid employment.
Conclusion: In many European countries a poor health, chronic diseases, and lifestyle factors were associated with being out of the labor market. The results of this study suggest that in social policies to encourage employment among older persons the role of ill-health and its influencing factors needs to be incorporated.

Key terms: self-perceived health, unemployment, retirement, lifestyle, chronic disease.

INTRODUCTION

In many countries throughout the industrial world the population is ageing; this is largely caused by the increasing life expectancy.[1] Despite an increased life expectancy, improved living conditions, and better health status, the average time people spend in paid work is decreasing in most European countries. This rather paradoxical development is partly due to a delay of young people entering the labor market. However, even more important is that older workers are exiting the labor market in great numbers.[2] Thus, many countries are developing policies to encourage older worker to remain active in the labor market and delay retirement.[3] Clearly, the success of these policies will depend on a better understanding of aging in the workforce and the particular role of health in continuing work or withdrawing from the labor market.

There is ample evidence on the relation between unemployment and ill-health, showing that unemployment may affect people's health but also that health may determine the selection into and out of the workforce.[4] A prospective study among construction workers demonstrated that several health problems, especially stress symptoms and mental disorders, predicted the risk of long-term unemployment. However, this study also pointed at the importance of socio-demographic variables, such as education and sex, and lifestyle factors, such as alcohol consumption and obesity, that may modify the effect of health.[5] Unemployment is only one mechanism of withdrawal from the labor force among elderly workers, since workers may leave the workforce due to disability, unemployment, or early retirement, partly depending on eligibility criteria and generosity of disability and retirement benefits.[2] Several studies have demonstrated that health problems, such as perceived poor health or presence of a chronic disorder, contribute to an early exit from work.[3,6] Although early retirement is regarded as a voluntary withdrawal from the labor market, it has been shown among Finnish workers that during an 11-year follow-up a poor health predicted early retirement through both illness-based and non-illness-based early pension schemes.[7] Thus, it is important to investigate whether the associations between health and non-participation in the workforce are similar across different routes of withdrawal from the labor force and what the effects are of socio-demographic characteristics and other determinants of health.

In this paper we examined the health status among men and women in the age group 50-64 years according to their labor market position. The aims of this study were to describe associations between perceived health and specific diseases with being unemployed, retired, or taking care of household and to analyze whether the observed associations of health with labor market position differ across countries in Europe.

MATERIALS AND METHODS

Study population

The subjects were participants of the Survey on Health and Ageing in Europe (SHARE study). SHARE is a longitudinal survey that aims to collect medical, social, and economic data on the population aged over 50 in ten European Union countries (Sweden, Denmark, the Netherlands, Germany, Austria, Switzerland, France, Italy, Spain, and Greece).[8,9] In the participating SHARE countries the institutional conditions with respect to sampling were so different that a uniform sampling design for the entire project was not feasible. Different registries of national or local level were used that permitted stratification by age. The sampling designs varied from simple random selection of households to complicated multistage designs. The first wave of data was collected by interviews between April and October 2004. The overall household response across the ten SHARE countries in which data collection took place in 2004 was 61.8%, although substantial differences among countries were observed.[9] From the collected 22,177 individuals, we investigated 11,462 subjects who were between 50 to 65 years old. We excluded those individuals over age 65, since we have assumed workers normally retire when they become 65 years old. While this assumption has certainly limitations, given the complexity to define retirement at individual level, it was regarded as the best available definition to facilitate cross-national comparisons.

Labor force participation

The outcome of this study is work status, which was based on self-reported current economic status with six mutually exclusive categories: paid work, retired, unemployed, disabled, homemaker, or others. The definition of being employed in SHARE encompasses all individual who declared to have done any kind of paid work in the last four weeks, including self-employed work for family business. Unemployed were those who were laid off from their last job before being able to benefit from normal pension benefits, and therefore forced to spend some time in unemployment before effectively being retired. Sickness or disability insurance applied to people who exited the labor force early for recognized health problems.[8] We excluded the disabled participants, because this category predominantly includes persons whose health problems at work were an eligibility criterion for receiving a disability pension.

Health measurement

The European version of self-perceived health, a 5-point scale question ranging between very good to poor, was used to define participant with a poor health (less than good). This frequently used question has been shown to be a good indicator for general physical health.[10,11] A second general health measure was long-term illness. SHARE has asked respondents whether they had a chronic disease diagnosed by a doctor in their lifetime and those with a positive answer were asked to report the disease from a limitative list. The questionnaire also included the EURO-D scale for depression diagnosis, which has been validated in an earlier cross-European study on depression.[12] The EURO-D scale of depression takes into account the following 12 items: depression, pessimism, suicidal, guilt, sleep, interest, irritability, appetite, fatigue, concentration, enjoyment, and tearfulness. A sum score over dichotomous answers was calculated, varying from 0 (not depressed) to 12 (very depressed). For the purpose of this study we defined a clinically significant depression as a EURO-D score greater than 3.[8] In the analysis we used tertile cut-off points with a score from 0 to 3 as reference group, a score of 4 to 8 as moderately depressed, and a score from 9 to 12 as heavily depressed.

Individual characteristics

Education was coded according to the 1997 International Standard Classification of Education (ISCED-97) and categorized as low (pre-primary, primary and lower secondary education), intermediate (upper secondary education) and high (post secondary education). Body mass index (BMI) was calculated by dividing body weight in kilogram by the square of body height in meters. According to BMI, we defined the people as normal (BMI below 25), overweight (BMI from 25 to 30), and obese (BMI above 30). Marital status was used to categorize individuals into those who had a partner and those without. Smokers were subjects who were currently smoking; all others were categorized as non-smokers. Alcohol consumption was defined as two or more glasses of alcoholic beverage at least 5 days a week in last six months.[13] Physical activity was used to categorize individuals with vigorous or moderate physical activity and those without.[14]

Statistical Analysis

Logistic regression analysis was used to calculate the association between several determinants and the occurrence of early retirement, unemployment, and homemaker. The Odds Ratio was estimated as the measure of association. For the initial selection of potential variables for the multivariable models, univariate associations with a significant level of $p< 0.10$ were used. In the final multivariable models for each category of labor force withdrawal only variables were included with a significant association ($p < 0.05$) with either early retirement, unemployment, or homemaker.

In the first stage self-perceived poor health and presence of long-term illness were investigated with adjustment for sex, age, country, education, and marital status as potential confounders. In the second stage we assessed different chronic diseases, including depression, as determinants of early retirement and unemployment, while adjusting for self-perceived health and other confounders. Finally, adjusted odds ratios for perceived poor health with retirement and unemployment were calculated within each country, with adjustment for significant lifestyle and sociodemographic variables. Since the number of male subjects was too small in homemakers, the analysis on health and homemaker was performed only in women.

In order to investigate the influence of national labor market conditions, the Pearson correlation coefficient was used to analyze the association between unemployment rates at national level and observed odds ratios for health with early retirement, unemployment, and being homemaker. The statistical analyses were carried out with SPSS version 11.0 for windows statistical software package.

RESULTS

Table 1 shows the distribution of the respondents according to employment status within each country, stratified by sex. The proportion of retired people differed strongly among European countries, ranging from 8.4% in the Netherlands to 47.8% in Austria. Unemployment ranged from 2.7% in Greece to 9.3% in Germany. The

Table 2.1 Distribution (%) of persons aged 50-64 years, stratified by sex and country, over employment, retirement, and homemaker among 10 European countries in the study population of the SHARE-study

		Employed		Unemployed		Retired		Homemaker	
Country	N	Male	Female	Male	Female	Male	Female	Male	Female
Sweden	1582	75.4	69.5	4.6	3.3	13.7	17.2	0.0	2.1
Denmark	909	67.0	57.9	7.8	6.9	20.0	25.1	0.2	2.4
The Netherlands	1682	60.6	37.9	4.1	2.3	14.4	3.2	0.8	43.3
Germany	1545	59.2	45.8	11.1	7.8	21.4	18.8	0.4	21.3
Austria	984	41.6	23.8	5.0	3.8	46.5	48.8	0.5	19.7
Switzerland	500	77.8	58.0	2.9	3.1	9.9	8.9	1.2	21.8
France	886	56.1	50.7	6.3	7.2	30.1	16.6	1.2	19.3
Italy	1308	44.0	22.4	5.0	1.6	48.1	28.8	0.2	45.0
Spain	1043	59.0	28.8	6.7	6.3	22.0	4.3	0.7	53.9
Greece	1023	69.8	28.6	3.0	2.4	25.2	20.2	0.4	48.0

Table 2.2 Multivariate associations between poor health and long-term illness with early retirement, unemployment, and homemaker, adjusted for country, socio-demographic characteristics and lifestyle factors

		Retired (n=2460)	Unemployed (n=579)	Homemaker (n=1799)[1]
		OR 95%CI	OR 95%CI	OR 95%CI
Perceived poor health		1.99* (1.72-2.29)	2.14* (1.75-2.62)	1.69* (1.43-1.99)
Long-term illness		1.09 (0.97-1.24)	1.34* (1.11-1.62)	0.92 (0.80-1.07)
Female		1.30* (1.14-1.47)	1.15 (0.95-1.38)	-
Age	50-54 yr	1.00	1.00	1.00
	55-59 yr	3.85* (3.19-4.66)	1.22 (0.99-1.49)	1.54* (1.32-1.81)
	60-64 yr	29.98* (24.92-36.05)	1.83* (1.45-2.32)	3.52* (2.93-4.23)
Education	Low	1.88* (1.61-2.19)	1.69* (1.33-2.15)	4.90* (4.06-5.92)
	Middle	1.91* (1.63-2.23)	1.68* (1.33-2.13)	2.18* (1.78-2.66)
	High	1.00	1.00	1.00
Without partner		1.32* (1.13-1.53)	1.93* (1.58-2.36)	0.38* (0.31-0.46)
BMI	<24.9 kg/m^2	1.00	1.00	1.00
	29.9 kg/m^2	1.15* (1.00-1.31)	1.05 (0.86-1.29)	1.23* (1.05-1.43)
	≥30 kg/m^2	1.43* (1.20-1.70)	1.31* (1.01-1.68)	1.34* (1.10-1.64)
Current smoking		1.12 (0.98-1.29)	1.69* (1.40-2.04)	0.84 0.71-1.00)
Current drinking		1.36* (1.16-1.61)	1.34* (1.05-1.71)	1.06 (0.81-1.38)
No physical activity		2.05* (1.52-2.74)	1.43 (0.92-2.23)	1.97* (1.39- 2.79)

[1] Only in women,
* $p < 0.05$
OR = odds ratio, CI = confidence interval

percentage of homemaker among men in all of the countries was extremely small. Sweden has the lowest and Spain has the highest percentage of homemaker's women (2.1% and 48.0% respectively). In some countries there was very little difference in labor force participation between men and women, such as Sweden and Denmark, whereas in other countries labor force participation among women was very low, notably in Greece and Spain.

Among employed workers 18.3% reported a poor health, whereas this proportion was 37.2% in retired workers, 38.9% in unemployed workers, and 35.1% in homemakers. A perceived poor health was strongly associated with non-participation in labor force (Table 2). Long-term illness was present among 36.1% of employed workers, 48.0 % of unemployed workers, 50.1% of retired workers, and 44.1% of homemakers, and was significantly associated with unemployment. Lower and intermediate levels of education were significantly associated with all three mechanism of labor force exit. Having a partner was inversely associated with early retirement and unemployment, whereas it showed a direct significant association with being homemaker. Several lifestyle factors had an effect on non-participation in the work force, most notably lack of physical activity and obesity.

Table 3 shows that depression was the most important health problem associated with all three types of labor force exit. Among other specific chronic diseases, stroke

Table 2.3 Multivariate associations between specific chronic diseases and retirement, unemployment, and homemaker, adjusted for self-perceived health, country, socio-demographic characteristics, and lifestyle factors

Self-reported chronic	Retired		Unemployed		Homemaker[1*]	
disease	OR	95%CI	OR	95%CI	OR	95%CI
Heart attack	1.17	(0.93-1.49)	0.96	(0.66-1.40)	1.20	(0.83-1.75)
Hypertension	1.05	(0.92-1.21)	0.92	(0.74-1.15)	1.11	(0.94-1.31)
Stroke	2.60*	(1.66-4.07)	1.11	(0.53-2.32)	1.27	(0.65-2.47)
Diabetes	1.33*	(1.05-1.68)	1.38	(0.99-1.93)	1.57*	(1.14-2.17)
Chronic lung disease & asthma	1.21	(0.96-1.52)	0.96	(0.68-1.34)	0.80	(0.60-1.06)
Arthritis & osteoporosis	1.39*	(1.18-1.65)	1.12	(0.87-1.44)	1.44*	(1.20-1.72)
Not depressed	1.00		1.00		1.00	
Moderately depressed	1.28*	(1.08-1.52)	1.45*	(1.15-1.82)	1.24*	(1.05-1.47)
Heavily depressed	2.60*	(1.37-4.94)	3.03*	(1.53-6.21)	2.42*	(1.23-4.73)

[1] Only in women
OR = odds ratio, CI = confidence interval
* P < 0.05, adjusted for self-perceived health, sex, age, education, body mass index, marital status, smoking, drinking, and physical activity

was strongly associated with early retirement, and diabetes was significantly related to early retirement and staying at home as homemaker. In each of these models, the odds ratio for poor health was very similar to its value presented in table 2. In addition, when the chronic diseases were adjusted for each other, the results remained almost the same.

Table 4 shows that self-perceived poor health was significantly associated with early retirement in 7 out of 10 European countries and with unemployment in 6

Table 2.4 Multivariate associations between poor health and early retirement, unemployment, and homemaker within 10 European countries, adjusted for socio-demographic characteristics and lifestyle factors

	Retired		Unemployment	
Country	Proportion	OR (95%CI)	Proportion	OR (95%CI)
Sweden	17.8	4.16* (2.97-5.81)	5.2	1.07 (0.57-2.00)
Denmark	26.6	4.40* (2.62-7.52)	10.6	2.48* (1.31-4.68)
The Netherlands	14.9	1.33 (0.71-2.48)	6.1	2.82* (1.50-5.30)
Germany	27.8	2.46* (1.60-3.76)	15.2	2.55* (1.68-3.86)
Austria	60.1	1.67* (1.00-2.80)	12.1	1.48 (0.63-3.47)
Switzerland	12.2	1.64 (0.56-4.79)	4.2	3.99* (1.05-15.11)
France	30.1	1.07 (0.56-2.03)	11.3	1.20 (0.60-2.39)
Italy	54.0	1.45* (1.00-2.10)	8.8	3.77* (1.78-8.01)
Spain	22.0	2.00* (1.19-3.36)	13.4	2.05* (1.08-3.92)
Greece	31.9	2.21* (1.38-3.56)	5.4	1.81 (0.67-4.91)

OR = odds ratio, CI = confidence interval
* P < 0.05, adjusted for self-perceived health, sex, age, education, body mass index, marital status, smoking, drinking, and physical activity

and with being homemaker (only among women) in 3 out of 10 countries. Similar associations were observed for the presence of a long-term illness and retirement and unemployment (results not shown). France was the only country where a perceived poor health was not associated with work status. In most countries a similar effect of unemployment and retirement on perceived poor health was observed, except for Sweden where a poor health was strongly associated with early retirement, but not associated with unemployment. In the Netherlands and Spain this association was only between poor health and unemployment. The unemployment rate at national level was moderately, but not statistically significant, associated with the magnitude of the odds ratio for poor health and unemployment (Pearson correlation coefficient 0.3).

DISCUSSION

In this study we observed that a self-perceived poor health was associated with non-participation in the labor force due to early retirement, being unemployed, or being a homemaker. We also found that, independent from self-perceived poor health, depression, stroke, diabetes, and musculoskeletal diseases were strongly related to these different types of labor force exit. Obesity and physical inactivity had statistically significant association with any type of quitting work. These associations were consistently observed in most European countries, except in France.

Some limitation must be taken into account in this study. The first limitation of the study is the household response rate of 61.8% with an additional response of 86.3% of members within a household. Since non-response bias depends on how much respondents and non-respondents differ with respect to the variables of interest, bias due to non-response rate could not be ruled out in our study. However, the overall response rate of SHARE was comparable with the response rate of the two official Europe-wide surveys (The European Community Household Panel, CHIP, and the European labor force survey, EU-LFP), but it was substantially higher than the response achieved by other cross-sectional community-base surveys on work and health in Europe.[9] Secondly, within each country we did not have enough power to investigate the associations between ill-health and different mechanisms of labor force exit. Although the proportion of persons with a self-perceived poor health differed strongly among countries, similar associations with unemployment and retirement were observed within each country. Finally, the cross-sectional data used in this paper do not permit further explanation of whether poor health determines labor force exit, or poor health is a consequence of becoming unemployed or retired. Previous studies have shown that both mechanisms are probably true.[4,15,16] It has been suggested that stress due to loss of income and general lack of activity in non-participation may lead to deterioration of health.[17-19] On the other hand, according to the healthy worker effect ill and chronically disabled have less chance to be selected into employment and also workers in poor health are more likely to drop out of work.[16]

In this study we found that self-perceived poor health was associated with early retirement, being unemployed, or (only among women) being a homemaker. After adjustment for various lifestyles and sociodemographic factors and presence of several chronic diseases, the observed associations remained remarkably stable with very similar odds ratios. Several studies have also shown that self-perceived poor health influences the probability of entering the labor force and also predicts the risk of early retirement.[3,7] On the other hand, poor health has also been reported as a consequence of becoming unemployed.[4]

Having a disease often negatively affects the capacity to participate in labor force. We found that depression, stroke, diabetes, and musculoskeletal diseases were associated with different types of non-participation in the labor force. This may be true for other diseases as well, but their prevalence was too low to demonstrate an effect on work status. The question of interest is whether maintaining labor force participation is a problem for chronically ill individuals, or whether there is less probability for chronically ill patients to participate in work. One prospective study showed that involuntary job loss among older workers was associated with an increased risk of subsequent stroke,[20] but an extensive review concluded that the contribution of unemployment to cardiovascular disease couldn't be established with certainty.[21] Another study reported that depression, even in childhood, might lead to an early retirement and labor force exit. Gaining insight into the effect of chronic diseases on labor force participation may be helpful to determine the policy measures that are required to improve labor participation among chronically ill or disable individuals.

There is growing concern about the relationship between health-related behaviors and employment status. We found that certain lifestyle factors, most notably obesity and lack of physical activity, were associated with labor force termination. Obese individuals have reported a poor work ability more often than those of normal weight individuals.[23] Obesity also had a negative impact on self-perceived health among adults.[24] One longitudinal study showed that neither overweight nor obesity at 14 years old predicted unemployment; however, they mentioned that adolescent obesity appears to affect the risk of unemployment through its association with low level of education.[25] We found that physical inactivity was also significantly associated with being out of the labor force. One study has already shown that vigorous exercise during leisure time was statistically associated with improvement in work ability.[26] This finding and the highest level of physical inactivity among those not in labor forces is of particular interest and has implications on policies and programs aiming at promoting healthy ageing. It is suggested that in order to prevent labor force exit attention should be paid to the combined effect of lifestyle and sociodemographic factors on diseases and ill-health.

In 10 European countries, except in France, self-perceived poor health was associated with either being unemployed or retired or homemaker. Sweden was the only country where retired persons more often had a poor health but no difference was observed between those employed and unemployed and also between employed and homemakers. A possible explanation is that the active labor policies and employment protection in Sweden increase the opportunities for people with chronic illness to remain in work.[27]

In conclusion, in many European countries a self-perceived poor health was associated with early retirement, unemployment, and among women being a homemaker. Some chronic diseases such as stroke, depression, diabetes, chronic lung disease, and musculoskeletal diseases were more prevalent among unemployed and retired persons than workers in paid employment. Similar associations were observed for certain lifestyle factors, such as a high body mass index and lack of physical activity. The results of this study have important policy implications on healthy and successful ageing. It is suggested that in social policies to encourage employment among older persons the role of ill-health and its influencing factors needs to be incorporated.

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PART 2

CHAPTER 3

Influence of work-related factors and individual characteristics on work ability among Dutch construction workers

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ABSTRACT

Objective: The objective of this study was to evaluate the association of individual characteristics, health problems, lifestyles, and work-related factors with work ability among Dutch construction workers.
Methods: In this cross-sectional survey, the study population consisted of 19,507 Dutch construction workers who participated in the voluntary periodic medical examination in 2005 and for whom complete information on laboratory tests and spirometry was available. The main outcome of the study was work ability, measured by the work ability index. Independent variables consisted of physical and psychosocial work-related factors, individual characteristic, lifestyle factors, and some objective health indicators. Multiple linear regression models were used to determine the influence of different determinants on work ability.
Result: Physical work load and, to a less extent, psychosocial factors at work together explained 22% of the variability in work ability. Age, leisure-time physical activity, lung obstruction, and cardiovascular risk profile explained about 10% of workers' ability to work, but, when adjusted for work related risk factors, their effects became very small. Awkward back posture, static work postures, repetitive movements, and lack of support at work had the highest influence on work ability.
Conclusion: In the construction industry, work related risk factors were the most important determinants of work ability. This finding suggests that interventions aimed at preventing construction workers from dropping out of the work force should primarily focus on reducing physical and psychosocial load at work.

Key terms: health; lifestyle; work ability index

INTRODUCTION

In order to prevent workers from quitting the workforce due to (work-related) disability, the concept of work ability has been developed as a valuable tool to tailor interventions at individual level. The concept of work ability expresses the interrelation between the productive potential of a worker, the worker's individual characteristics, and work-related factors.[1,2] Thus, the assessment of work ability should measure the ability of workers to perform their jobs, taking into account the specific psychosocial and physical work-related factors, mental and physical capabilities, and health. On the Basis of this concept, Finnish researchers have constructed the so-called work ability index (WAI), which is based on a questionnaire that combines subjective experiences of one's ability to cope with physical and mental requirements at work with information on disease and sick leave.[3]

The work ability index has been promoted in recent years as a valuable tool in occupational health programs dedicated to decrease early exit from the work place.[4] Because of the varying capacity of workers and the varying demands of work tasks, the same disease, injury or limitation in functional capacity may have a different effect on work ability.[5] It has been widely accepted that, in addition to work related risk factors, lifestyle characteristics such as physical activity in leisure time can also affect work ability.[6,7] There is also a clear association between various diseases and poor work ability.[8] Nevertheless, there are few studies that have estimated the relative contribution of potential determinants to the level of work ability, taking into account the broad array of relevant determinants.

The aim of our study was to evaluate the associations between individual characteristics, health problems, lifestyle factors, and physical and psychosocial work-related factors on work ability among Dutch construction workers.

STUDY POPULATIONS AND METHODS

Study population

The study population consisted of workers in the construction industry in the Netherlands who had participated in a voluntary periodic medical examination in 2005. Such a voluntary examination is offered to every construction worker every 4 years. It is estimated by the Arbouw Foundation, responsible for the organization and contracting, that the annual participation is about 60% of all construction workers invited to attend this examination. In the Netherlands, the periodic examination is offered by over 20 different occupational health services with local branches, and it consists of a questionnaire and physical examination. Information from questionnaires was available for 36,741 workers, but after exclusion of incomplete data on laboratory and spirometry tests 19,507 (53.1%) workers were available for the analysis. Given the very small number of female workers, the analysis was limited to male construction workers.

Work ability

Work ability was measured by the work ability index. It consists of an assessment of the physical and mental demands of people in relation to their work, diagnosed diseases, limitations in work due to disease, sick leave, work ability prognosis, and psychological resources. The work ability index is constituted of seven dimensions, and the index is derived as the sum score of the ratings on each dimensions. The range of the summative index is 7-49, which is classified into poor (7-27), moderate (28-36), good (37-43), and excellent (44-49) work ability.[9]

Work related factors

The work related factors in this study consisted of items on psychosocial and physical work related factors. Psychosocial work characteristics were assessed by means of an abbreviated Dutch version of Karasek's job content questionnaire[10], which included two yes-no questions on job demands and on job control. According to this model, the combination of high job demands and low job control is considered to be a job strain situation. In addition, dichotomized questions on supervisor and co-worker support and satisfaction with work were asked. The assessment of physical workload concerned dichotomous questions on regular exposure to the manual handling of materials such as lifting and carrying heavy loads, awkward back postures with a bent or twisted back, static work postures, repetitive movements, and exposure to whole body vibration. Those with positive answers were regarded as exposed. This crude assessment of aspects of physical load did not enable the presentation of information on duration or frequency of exposure.[11]

Individual characteristics and lifestyle factors

Data on age, job type, height, and weight were collected by the questionnaire during the medical examination. The Body Mass Index (BMI) was calculated by dividing body weight in kilogram by the square of body height in meters and used to define persons as normal (BMI < 25 kg/m^2), overweight (BMI 25-30 kg/m^2), or obese (BMI >30 kg/m^2). The lifestyle factors of interest concerned smoking, alcohol drinking, and normal and vigorous activity during leisure time. Subjects were divided in current smokers and former and non-smokers. An open question on average number of alcoholic drinks per week was used to define problematic alcohol drinkers as those who consumed 15 units of alcohol or more per week.[12] The participants were asked about their leisure-time physical activity in a single open question on the frequency of physical activity for at least 30 minutes per day and a single question with 5-answer categories on frequency of strenuous physical activity leading to sweating. Those who reported physical activity for 30 minutes per day on at least 5 days a week were considered to be in agreement with the recommendation on moderate-intensity physical activity, and the participants subjects with vigorous exercises at least 3 times per week were considered in agreement with the recommendation on vigorous-intensity physical activity.[13]

Health

Total blood cholesterol and high-density lipoprotein (HDL) cholesterol were measured in venous blood samples. Spirometry was conducted to measure forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC). The FEV1 and FVC were expressed as percentages of the predicted values, based on reference equations, taking into account the age and height of each participant, recommended by the European Society of Respiratory Disease.[14] On the Basis of the spirometry findings, workers were divided into normal, obstructive and restrictive lung diseases, categorized as mild, moderate, or severe, according to criteria of the American Thoracic Society.[15]

The age, total blood cholesterol, high-density lipoprotein (HDL) cholesterol, smoking habits, and systolic blood pressure of each participant were used to calculate the Framingham Risk Score (FRS) for the 10-year risk of coronary heart disease events (coronary heart disease death and myocardial infarction.[16] The 10-year risk prediction was categorized into no risk (0-9%), low risk (10-15%), moderate (16-20%), and high risk (>20%) of coronary heart death and myocardial infarction.[17]

Statistical analysis

For the main variables we generated descriptive statistic such as means and percentages. When the observed work ability indices were plotted against age, the resulting lines were irregular, in part because of a difference in the sample size per year of age (relatively few workers in the youngest and oldest group). Due to these irregularities, a smoothing procedure was applied to the observed data to generate a smooth curve for the mean work ability index with a 3-year interval. For each year of age, the mean and 5th and 95th percentiles were calculated.

Multiple linear regression models were used to explore the influence of different factors on the work ability index. In the first linear regression model, the influence of individual characteristics, lifestyle factors, and health parameters on the work ability index was evaluated. In the second linear regression model, association between work-related factors and the work ability index were analyzed. Finally, in the third linear regression model, all of the factors from the first and second model were evaluated together for their association with the work ability index. In each model a backward selection approach was used with a p-value threshold of 0.10 for initial selection of relevant variables, and only variables statistically significant at $P<0.05$ were retained in the model. In each model, age was included, regardless of its statistical significance. Since the distribution of work ability index was slightly skewed towards the lower values, a separate analysis was performed without the participants with a work ability score below 28 (classified as poor) in order to evaluate whether these workers biased the results over the observed range of work ability scores. In the current analysis, the choice was made not to investigate the influence of depressive symptoms, musculoskeletal diseases, and job satisfaction, as these factors are partially included in the work ability index itself.

We also dichotomized the participants into those with a poor or moderate work ability versus those with an excellent or good work ability in order to explore the association between different parameters and the occurrence of poor and moderate work ability in a multiple logistic regression analysis. All of these analyses were carried out with the statistical SAS package, version 8.2.[18]

RESULTS

Table 1 shows the characteristic of the study population in the construction industry. The mean age of the workers was 44.1, ranging from 16 to 62 years old. However, most workers were aged between 25 and 55 years and observations above 55 years were scarce. Most of the workers had a blue-collar job (77.6%). The mean BMI was 26.5 and 49.2% of the subjects were overweight, and 15.0% were categorized as obese. The mean WAI was 40.9 ± 5.1. The distribution of excellent, good, moderate, and poor work ability was 34.4%, 49.5%, 14.2%, and 1.9%, respectively. Figure 1 depicts the work ability against age, showing that the average work ability index was close to 43.5 among workers at the age of 20 and around 39.0 at the age of 60 years. Due to a larger proportion of workers with a moderate or poor work ability at a higher age, the lower 5th percentile of the work ability distribution per year of age decreased with older age.

Table 3.1 Characteristics of 19,507 Dutch construction workers who participated in a voluntary periodic medical examination in 2005. (BMI = body mass index, HDL = high density lipoprotein, FEV1 = forced expiratory volume in 1 second, FVC = forced vital capacity)

	N	***Mean***	***SD***	***%***
Age	19507	44.1	11.2	
White collar job (%)	4368			22.4
BMI (kg/m^2)	19493	26.5	3.7	
Blood pressure (mm Hg)				
Systolic	19396	133.2	16.5	
Diastolic	19400	82.6	9.8	
Cholesterol (mg/dl)				
Total	19456	212.5	40.8	
HDL	19242	55.4 (24.6)	24.6	
Spirometry				
FEV1% predicted	19493	99.2	17.1	
FVC % predicted	19493	100.4	16.1	
Lifestyle				
Smoker (%)	6185			31.7
Problematic alcohol drinker (%)	2965			15.2
Moderate intensity activity (%)	12536			69.1
Vigorous intensity activity (%)	3583			18.8
Work related psychosocial load				
Low job control (%)	12570			64.4
High work demands (%)	11546			59.2
Job strain (%)	7486			38.4
Lack of support at work (%)	2452			12.8
Work related physical load				
Manual materials handling (%)	8784			45.0
Awkward back postures (%)	4608			23.6
Static working postures (%)	7334			37.6
Repetitive movements (%)	4299			22.0
Whole body vibration (%)	2709			14.0

Table 2 shows the influence of individual characteristics, lifestyle factors, and health parameters on the work ability index. Age and job type 9.4% of the variability in the work ability index. By adding body mass index, leisure-time physical activity, presence on pulmonary problems, and the 10-year risk for cardiovascular heart disease the explained variability increased to 10.2%. Problematic alcohol consumption (beta = -0.008) was not statistically significant.

(Table 3.2)

Table 3 shows the association between work-related factors and the work ability index. The presence of exposure to whole-body vibration was not statistically significant. The combined effect of physical load factors at work was responsible

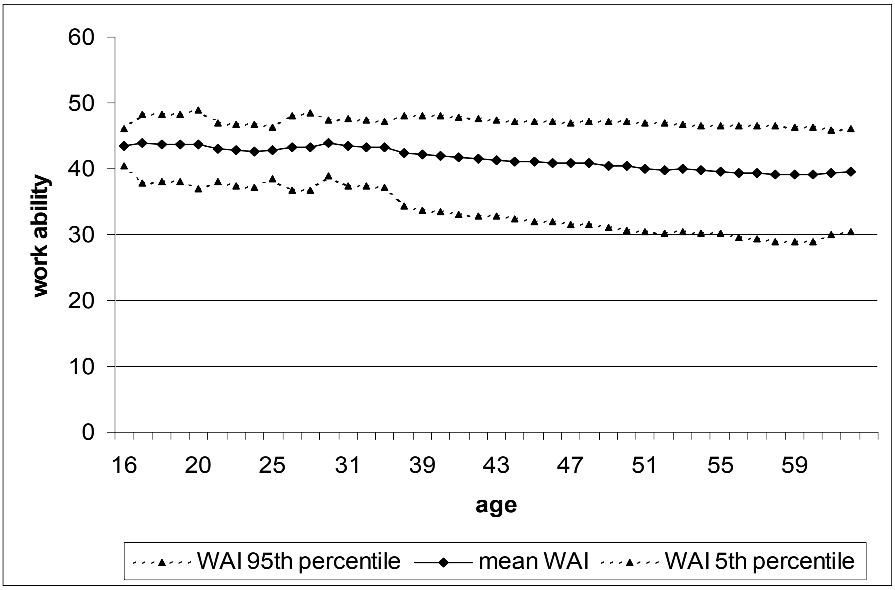

Figure 3.1 The work ability index against age among 19,753 construction workers in the Netherlands in 2005

Table 3.2 Results of the multivariate analysis [explained variance (R^2) = 0.10] of the associations of individual characteristics, lifestyle factors, and health measures with the work ability index among construction workers in the Netherlands in 2005

	N	β	SE
Individual characteristic			
Age (year)	19507	-0.12	0.004*
White collar	4368	1.83	0.090*
Lifestyle			
Normal weight	6987	Reference	-
Overweight	9596	-0.17	0.083
Obese	2924	-0.74	0.115*
Moderate intensity activity	12536	0.24	0.081*
Vigorous intensity activity	3583	0.35	0.095*
Smoker	6185	-0.24	0.095*
Health problem			
Normal lung function	17666	Reference	
Mild lung obstruction	1274	-0.63	0.149*
Moderate lung obstruction	340	-0.75	0.280*
Severe lung obstruction	227	-0.86	0.334*
Cardiovascular heart disease risk			
No risk	13504	Reference	-
Low risk	3299	-0.19	0.115**
Moderate risk	1931	-0.11	0.147
High risk	773	-0.07	0.211

*P value< 0.05
**P value < 0.10

Table 3.3 multivariate analysis [explained variance (R^2) = 0.22] of the association of physical and psychosocial work-related factors with the work ability index, adjusted for age and job type, among construction workers in the Netherlands in 2005

Work related factors	***β***	***SE***
Work related physical load		
Repetitive movements	-1.16	0.09*
Static work postures	-1.42	0.08*
Awkward back postures	-1.80	0.09*
Manual materials handling	-0.42	0.08*
Work related psychosocial load		
Lack of support at work	-1.49	0.10*
High work demands	-0.28	0.07*
Low job control	-0.72	0.07*

* P value < 0.05

for about 13.8% of variability, whereas psychosocial work related factors explained about 4.3% of the variability in work ability among the workers. Awkward back postures, static work postures, and lack of support at work had the highest influence on the work ability index.

In the final multivariate model (table 4) age, obesity, lung obstruction, physical load and psychosocial load were all associated with the work ability index. Problematic alcohol drinking, the cardiovascular heart disease profile, and whole-body vibration did not make a statistically significant contribution to the work ability index. Of all the factors associated with the work ability index, the physical and psychosocial work-related factors were the most important. The large effect of a white-collar-job in table 2 (1.83 points) decreased by 75% when adjusted for the work-related physical and psychosocial work factors. The analysis concerning the study population without the workers with a poor work ability showed very similar results.

Table 5 shows the factors associated with the occurrence of a poor or moderate work ability in the study population. The results of the logistic regression analysis were very similar to that of the linear regression model in that the same physical and psychosocial work related factors were associated with a poor or moderate work ability.

DISCUSSION

This study showed that the work ability index among Dutch construction workers was predominantly influenced by physical and psychosocial work related factors. Individual and lifestyle characteristics and several physical health measures explained some variability in workers' work ability, but their contribution was low.

Table 3.4 multivariate analysis [explained variance (R^2) = 0.23] of the association of individual characteristics, lifestyle factors, health measures, and work related factors with the work ability index, adjusted for age and job type, among construction workers in the Netherlands in 2005

	β	**SE**
Individual characteristics		
Age	-0.11	0.003*
White collar	0.45	0.096*
Lifestyle		
Normal weight	Reference	-
Overweight	-0.17	0.077*
Obese	-0.62	0.106*
Moderate intensity activity	0.23	0.076*
Vigorous intensity activity	0.59	0.089*
Health problem		
Mild lung obstruction	-0.49	0.138*
Moderate lung obstruction	-0.67	0.261*
Severe lung obstruction	-0.75	0.311*
Work related factors		
Work related physical load		
Repetitive movements	-1.16	0.097*
Static work postures	-1.40	0.085*
Awkward back postures	-1.84	0.097*
Manual materials handling	-0.50	0.082*
Work related psychosocial load		
Lack of support at work	-1.46	0.104*
High work demands	-0.29	0.073*
Low job control	-0.70	0.073*

* P value < 0.05
** P value < 0.10

Some limitations of this study must be taken into account. First of all, its cross-sectional design did not permit further exploration of causal relationships between these factors and work ability. Second, complete data on laboratory tests and pulmonary function tests were available only for 53% of the workers. One of the reasons for this low proportion of complete data was the lack of resources for conducting the required tests in small occupational health services. Since an analysis of the influence of work-related factors on the work ability index of all of the construction workers who filled out a questionnaire (N = 36,741) showed results similar to those of the analysis presented in the current article on workers who filled out the questionnaire and completed the physical examination (N = 19,507), we think that that the potential bias due to selective participation was limited. Third, the data were drawn from the voluntary medical examination of workers and information on non-respondents was not available. It was estimated that about 60% of the invited workers took part in the examination. Therefore, we do not know whether more unhealthy workers took part in the physical examination or not. Selective participation may have influenced

Table 3.5 multivariate analysis of the association of individual characteristics, lifestyle factors, health measures, and work related factors with the presence of poor or moderate work ability index among construction workers in the Netherlands in 2005

	OR	95%CI
Individual characteristic		
Age (year)	1.05	1.04 – 1.06
White-collar worker	0.85	0.75 – 0.97
Lifestyle		
Normal weight	1	-
Overweight	1.08	0.98 – 1.06
Obese	1.37	1.22 – 1.55
Moderate intensity activity	0.97	0.89 – 1.06
Vigorous intensity activity	0.79	0.72 – 0.89
Health problem		
Normal lung function	1	-
Mild lung obstruction	1.24	1.06 – 1.46
Moderate lung obstruction	1.41	1.07 – 1.86
Severe lung obstruction	1.27	0.89 – 1.80
Work related factors		
Work related physical load		
Repetitive movements	1.56	1.41 – 1.72
Static work postures	1.91	1.73 – 2.10
Awkward back postures	2.05	1.86 – 2.27
Manual materials handling	1.21	1.01 – 1.34
Work related psychosocial load		
Lack of support at work	1.73	1.55 – 1.92
High work demands	1.11	1.01 – 1.21
Low job control	1.35	1.24 – 1.46

the results of our study, but the potential effect of this source of differential bias is unknown. Finally, since many of the occupational heath services were involved in the laboratory tests and spirometry measurements and no interlaboratory quality assessment were conducted, it is expected that the interlaboratory differences would have contributed to substantial measurement error.

Measuring work ability is a complex task. Good health and a good functional capacity form the basis of the work ability index, and they are highly dependent on professional skills, personal motivation, and organizational and ergonomic factors in the work place.[19] Strong intercorrelations have been found for work ability, health, lifestyle, and satisfaction with life.[7] However, some of these reported associations must be interpreted with great care since the work ability index includes a number of diagnosed diseases and a question on job satisfaction. The health-related dimensions in the work ability index (i.e. diagnosed diseases, functional limitations, and sickness absence) have a large influence of the wok ability score. In this study population, many of the workers lost point because of the presence of diseases and subsequent consequences in terms of functional limitations or sickness absence. This finding implies that health is indeed a major factor in work ability. It has been shown that the work ability index is highly predictive for sickness absence and work disability, both among younger and older workers.[20,21] Therefore, recognition of the factors that affect work ability would help to prioritize preventive measures for high-risk workers. The result of our current study showed a large influence of work-related factors on workers' work ability. These findings may partly reflect the specific study population, but previous studies have also reported that poor work postures and repetitive movements were associated with an impaired ability to work.[2,22-24] Physical demands of work consistently explained both the variation and change in work ability.[23] There are some indications that preventing the development of a poor work ability depend on organizational and psychosocial factors[25], but our study could not corroborate these findings due to lack of information on these potentially important factors.

Age has been acknowledged as an important factor with respect to impaired ability.[2,22] Among the construction workers in our study, the mean work ability index dropped by approximately 10% over a 40-year age span. Figure 1 demonstrates that, at a specific age, the variability in work ability is larger than the variability across age. This finding was also reflected in the modest contribution of age to the total explained variance in work ability, as presented in table 4. This result suggests that occupational health programs aimed at maintaining and promoting employability of workers with generic measures for workers at a particular age will be less successful than individually tailored programs based on work ability.

Although in this study lifestyle factors had a limited influence on work ability, a study among aging industrial workers indicated that unhealthy lifestyles themselves are an important factor with respect to decreased work ability.[26] Regular physical exercise at a moderate level has a positive effect on perceived work ability[27] and lowers the risk of several diseases including cardiovascular disease, type 2 diabetes, and musculoskeletal disease.[28] Lack of physical exercise is also a risk factor for obesity and hypertension.[28-30] Vigorous physical exercise in leisure time has been recommended with advancing age in order to prevent the decline in physical capacities, and for adopting other healthy lifestyles.[31] On the other hand, because of the multifactorial nature of work ability, changes in the work ability index will not easily be obtained in due course by an exercise program, especially among workers with a high work ability index.[32] Although the evidence for a causal effect of regular physical activity on improvement in work ability is still limited, there is sufficient evidence in general to advise a physically active lifestyle in workers.

When the health indicators for respiratory problems and cardiovascular risks were entered into the regression model, the explained variance increased only by 0.2%. When adjustment was made for work-related factors, the 10-year risk percentage profile for coronary heart disease was no longer statistically significantly associated with the work ability index. Pulmonary problems showed a negative association with work ability and these associations were not influenced by work-related factors. Since the work ability index is self-reported, and the Framingham Risk Score has no obvious effect on worker's health, it may be expected that no association would be observed. However, the limited influence of respiratory problems and cardiovascular risks on work ability may also stem from the presence of a healthy worker effect because the study population did not include workers receiving long-term disability benefits or those who changed jobs because of health problems. This selection may have resulted in lower prevalence of these health indicators and, as a consequence, in a loss of power to detect meaningful associations.

It can be concluded that, in highly physically demanding jobs, such as those in the construction industry, psychosocial and physical work-related factors are the most important factors associated with work ability. This finding, although based on a cross-sectional analysis, suggests that, in these workplaces with high physical loads ergonomic interventions are of great importance for maintaining the work ability among workers.

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CHAPTER 4

The influence of psychological factors and life style on health and work ability among professional workers

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The influence of psychological factors and life style on health and work ability among professional workers
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ABSTRACT

Objectives: The purpose of this article is to explore the associations of psychosocial factors at work, life style, and stressful life events on health and work ability among white-collar workers.
Methods: A cross-sectional survey was conducted among workers in commercial services (n=1141). The main outcome variables were work ability, measured by the work ability index (WAI), and mental and physical health, measured by the Short-Form Health Survey (SF-12). Individual characteristics, psychosocial factors at work, stressful life events, and lifestyle factors were determined by a questionnaire. Maximum oxygen uptake, weight, height, and biceps strength were measured during a physical examination.
Results: Work ability of white-collar workers in commercial services industry was strongly associated with psychosocial factors at work such as teamwork, stress handling, and self-development and, to a lesser extent, with stressful life events, lack of physical activity, and obesity. Determinants of mental health were very similar to those of work ability, whereas physical health was influenced primarily by life style factors. With respect to work ability, the influence of unhealthy life style seems more important for older workers, than for their younger colleagues.
Conclusion: Among white-collar workers mental and physical health were of equal importance to work ability, but only mental health and work ability shared the same determinants. The strong associations between psychosocial factors at work and mental health and work ability suggest that in this study population health promotion should address working conditions rather than individual life style factors.

Keywords: work ability, functional health, psychosocial factors, physical activity

INTRODUCTION

Many Western countries face the challenge of an aging population, which also affects the workforce. From the biological perspective, aging means a progressive deterioration in various physiological systems, which is accompanied by changes in physical and mental capacities of workers.[1] Aging of the workforce will result in an increased prevalence of work-relevant symptoms and diseases. Therefore, the role of (functional) health in working life is of interest, especially since modern welfare states are prolonging working life by increasing the statutory retirement age. A recent study on the relation between health and working life showed that a perceived poor health predicts staying or becoming unemployed.[2] This calls for better adjustments of the working life demands with the individual's health as a crucial element for a longer career at work. Within this framework, the concept of work ability has been developed as an important tool to identify workers at risk for imbalance between health, capabilities and demands at work.

The work ability concept is based on the assumption that work ability is determined by an individual's perception of the demands at work and the ability to cope with them. The Work Ability Index (WAI) is a well-accepted instrument to conceptualize work ability. Several studies have shown that a low score on the index is highly predictive of work disability during follow-up.[3,4] Previous research, predominantly in physical demanding jobs, showed that the WAI is negatively influenced by older age, high physical work demands, high psychosocial work demands (e.g. lack of possibilities to control one's own work), unhealthy lifestyle (lack of physical activity), and a poor physical fitness.[1,5-7]

Few studies have addressed determinants of work ability in occupational populations with predominantly mental demands at work. Among office workers Sjögren-Rönkä[8] showed that low stress at work and a better self-confidence were directly related to a higher work ability. Seniority in the job and job satisfaction were also associated with a better work ability among office workers.[9] However, the knowledge of determinants of work ability in mental demanding occupations is scarce and hence, it remains unclear whether in these jobs the relative importance of personal and work-related factors is similar to their well-known contribution in physically demanding jobs.

The purpose of this study was to explore the associations of psychosocial factors at work, stressful life events, and life style on health and work ability among white-collar workers.

METHODS

Subjects

In the period between 2003-2007 a total of 2666 white-collar workers from six companies in commercial services were invited for a health examination. Twenty percent of the subjects were employed at three consultancy firms, 62% at two insurance companies and 18% at an information technology company. The health examination consisted of two parts, i.e. a questionnaire and a physical examination. Both parts were offered independently to workers and their participation was entirely voluntary. The response for the questionnaire was 69.4% (n=1850). The response on the physical examination was 67.8% (n=1808). Selection of subjects with both a filled out questionnaire and a physical examination comprised the study population of 1141 (42.8%) subjects.

Work ability

Work ability was measured with the Work Ability Index (WAI). The WAI consists of an assessment of the physical and mental demands of an individual in relation to his work, previously diagnosed diseases, limitations in work due to disease, sick leave, work ability prognosis, and psychological resources. The WAI constitutes of seven dimensions and the index is derived as the sum of the ratings on these dimensions. The range of the summative index is 7-49, which is classified into a poor (7-27), moderate (28-36), good (37-43), or excellent (44-49) work ability.[6]

Functional health status

Functional health status was assessed using the Short-Form Health Survey (SF-12) version 2, the shortened alternative for the 36-item health survey. This measure provides two weighted summary scores assessing physical function (physical health component summary, PCS) and mental well-being (mental health component summary, MCS).[10] The mental health summary score ranges from 8 to 74, whereas the physical health summary score ranges from 4 to 73, with a higher score indicating a better health state.

Psychosocial factors at work

Psychosocial factors at work were measured by the Stress monitor.[11] The original monitor consists of four dimensions, whereas three dimensions (teamwork, stress handling, and self-development) were used in the current study. The three dimensions consist of 27 items on a 5-point scale varying from 'totally disagree' to 'totally agree'. The dimension teamwork (Chronbach's alpha = 0.85) reflects social support and work spirit and consists of 12 items, e.g. "I can rely on my colleagues and trust them" and "We are not a team at work". The stress handling dimension (Cronbach's alpha= 0.77) reflects active coping and self-efficacy and consists of 7 items, such as "In difficult situations I do not wait and see, but take action" and "I can cope well with the demands of my job". The dimension self-development (Cronbach's alpha =0.82) reflects possibilities for self-fulfillment and consists of 8 items. Examples are: "My abilities are full employed" and "I need a new challenge". The scores on items within each dimension were transformed to a 0-100 scale with a higher score indicating good teamwork, better stress handling, and more opportunities for self-development in work. The sum scores for the variables teamwork, stress handling, and self-development were not normally distributed. Tertiles were calculated to assign subjects into low, intermediate and high levels per dimension.

Stressful life events

The occurrence of stressful life events in the past 12 months was measured using a shortened Social Readjustment Rating Questionnaire (SRRQ).[12] The original SRRQ consists of 43 life events (e.g., divorce, job change, death of family members and so forth), listed by rank order based on their mean life change values. Life change values classify the impact of the events and were obtained by scaling the life events based on the amount of coping required to deal with the event. The total score counts the life change values of all events in the past 12 months. In the current study the 25 events most appropriate for the population under study were selected. In theory, the total score can range from none of these events (0) up to all events (1077).

Life style factors

Life style factors were measured with the Dutch version of the Stanford Wellness Inventory.[13] Lifestyle factors of interest concerned moderate physical activity, vigorous activity, smoking, and alcohol use. The questionnaire has single questions on regular participation in moderate activities for 30 minutes or more and participation in vigorous activities for 20 minutes or more, both on a 5-point scale ranging from 'never' to '5 days or more per week'. Those who reported moderate physical activity on at least 5 days per week were considered in agreement with the recommendation on moderate-intensity physical activity, and subjects with vigorous exercises at least 3 times per week were considered in agreement with the recommendation on vigorous-intensity physical activity.[14] Current smoking was assessed with the question “Do you smoke?”. A 5 point-response scale was used to assess alcohol drinking by average number of alcohol drinks per week (1-7, 8-14, 15-21, 22-28, more than 28). Problematic drinkers were defined as those who consumed more than 14 units of alcohol per week for women and more than 21 units for men.[15]

Physical examination

Physical examinations were performed using MicroFit equipment in accordance with the protocol of the American College of Sports Medicine (ACSM, 1975). During the physical examination biometry was recorded, including weight, height, biceps strength, and cardio respiratory fitness. The body mass index (BMI) was used to define subjects as normal (BMI <= 25), overweight (BMI 25-30), or obese (BMI >=30). Maximal isometric muscular strength of the biceps was measured after one practice trial with a calibrated dynamometer with the subjects in standing position with 90-degree flexion in the elbows for three seconds. The isometric biceps strength was calculated as the average of several hundred readings over the 3-second period. Cardio respiratory fitness was assessed by a 12-minute sub maximal bicycle ergometer test, supervised by instructors. Subjects pedaled at 60 rev.min-1 for 12 minutes on the cycle ergometer at an exercise intensity designed to produce a heart rate between 120 and 170 beats per minute in order to reach a level of 80% of the theoretical maximal heart rate of the participant for three minutes after a warming up period of minimal three minutes. This level was sustained for 3 minutes and the heart rate was measured at the end of each minute. The VO2max (mL.min-1.kg-1) was calculated by the work intensity (watts) and heart rates at the end of all the stages at exercise level.

Statistics

The effects of individual characteristics (age and sex), life style, psychosocial factors at work, stressful life events, life style, and physical condition on the outcome variables work ability, and mental and physical health were investigated with linear regression analysis. Probability plots and Kolmogorov-Smirnov tests showed that none of the determinants measured at continuous level were normally distributed. However, the evaluation of the distributions of residuals in the regression analyses showed that for those variables measured at ratio scale (i.e. age, VO2max, and biceps strength), the assumption of linearity was not violated. These variables were included in the linear regression analyses as continuous variables. Due to considerable ceiling effects for the psychosocial variables and skewed distribution for life stress events, these variables were treated as categorical variables, defined by cut-off values based on tertiles.

The analysis started with univariate regression models to determine the single effects of all determinants of interest. A backward regression technique was used to determine the multivariate model with the best overall fit. In this analysis independent variables with a p-value of 0.05 or less were retained in the final model.

The results of the regression analyses are presented by the regression coefficients and associated standard errors. A regression coefficient is an expression of the change in the work ability score due to a change in one unit of measurement of the independent variable of interest. For categorical variables this reflects the effect on the work ability score of the presence of this determinant.

The regression analysis on determinants of work ability was stratified for three age groups. All significant determinants in the multivariate model for one age group were included in the models for other age groups as well in order to provide an appropriate comparison.

All analyses were carried out with the Statistical Package for Social Sciences version 11.0 for Windows.[16]

RESULTS

The study population included 769 men (67%) and 372 (33%) women in a variety of jobs (table 1). The median for age was 35.7 years (18-63). The distribution of excellent, good, moderate and poor work ability was 42.8%, 45.4%, 9.7%, and 2.1%, respectively. Subjects scored almost equal on mental health as on physical health, whereas the Pearson correlation coefficient between both measures of health was -0.20. The Pearson correlation coefficients between WAI and mental and physical health were 0.49 and 0.35, respectively. The three psychosocial factors at work were strongly interrelated with Pearson correlation coefficients varying from 0.45 to 0.57.

Table 2 shows the results of the linear regression analysis on determinants of mental and physical health. In the univariate analysis mental health was statistical significant influenced by psychosocial factors at work, stressful life events, and life style factors, whereas physical health was influenced by lifestyle factors and bicep strength. The multivariate model explained 22% of the variance in mental health. An increase in age with one year increased the mental health score with 0.1 point, and decreased the physical health score with 0.1 point. In the multivariate analysis most determinants remained statistically significant, albeit with a lower regression coefficient, especially for teamwork and self-development. The multivariate model

Table 4.1 Characteristics of 1141 commercial workers who participated in a voluntary medical examination

Characteristics	Cases	Median (min-max)	Frequency
Individual characteristics			
Age (yr)	1141	35.7 (18-63)	
Male	769		67.4%
Work ability			
Excellent (44-49)	488	42.1 (9-49)	42.8%
Good (37-43)	518		45.4%
Moderate (28-36)	111		9.7%
Poor (7-27)	24		2.1%
Health			
Mental health component summary (MCS)(8-74)	1141	54.2 (10.9-67.9)	
Physical health component summary (PCS)(4-73)	1141	53.4 (18.2-70.6)	
Psychosocial factors at work			
Teamwork (0-100)	1136	81.0 (27-100)	
Stress-handling (0-100)	1136	68.0 (11-100)	
Self-development (0-100)	1136	78.0 (9-100)	
Stressful life events (0-100)	1136	5.5 (0 - 38.4)	
Life style			
Lack of moderate physical activity (<5 days per week)	798		70.2%
Lack of vigorous physical activity (<3 times per week)	886		78.0%
Current smoker	145		12.8%
Problematic alcohol use	42		4.5%
Physical examination			
Overweight (BMI 25-30kg/m^2)	371		34.6%
Obesity (BMI ≥30kg/m^2)	57		5.3%
VO_2 max (ml/kg/min)	1117	35.9 (11.4-61.7)	
Biceps strength (kg)	1134	37.0 (8.0-94.0)	

explained only 5% of the variance in physical health. It is of interest to note that neither problematic alcohol uses nor overweight or obesity were associated with physical health.

Table 3 shows the results of linear regression analysis on determinants of work ability. In the univariate analysis work ability was statistical significant influenced by psychosocial factors at work, stressful life events, lack of vigorous physical activity, and obesity. The multivariate model explained 29% of the variance in work ability. Again, in the multivariate model most determinants remained statistically significant, although with lower regression coefficients. The influence of stressful life events increased in the multivariate model.

No significant interaction was observed for age, sex, and psychosocial factors at work.

Table 4 shows that in each age group sex, stress handling, and self-development were associated with the work ability index. Lifestyle factors were associated with

Table 4.2 Results of backward regression analysis: effects of psychosocial factors at work, stressful life events, lifestyle and physical condition on mental health and physical health among workers in commercial services (n=1141)

	Mental Health (MCS) Univariate model		**Mental health (MCS) Multivariate model**		**Physical health (PCS) Univariate model**		**Physical health (PCS) Multivariate model**	
	β	**SE**	**β**	**SE**	**β**	**SE**	**β**	**SE**
Individual characteristics								
Age (yr)	0.09*	0.03	0.07*	0.02	-0.07*	0.02	-0.09*	0.02
Male	2.41*	0.51	1.52*	0.47	1.66*	0.38	1.91*	0.38
Psychosocial factors at work								
Low vs. high teamwork	-5.90*	0.56	-2.71*	0.66	-0.92*	0.43	n.s	
Intermediate vs. high teamwork	-2.39*	0.57	-0.70	0.58	-0.68	0.45	n.s	
Low vs. high stress-handling	-6.94*	0.56	-4.71*	0.62	-0.26	0.45	n.s	
Intermediate vs. high stress-handling	-2.39*	0.58	-1.42*	0.59	0.01	0.46	n.s	
Low vs. high self-development	-5.44*	0.60	-2.12*	0.65	-0.73	0.46	n.s	
Intermediate vs. high self-development	-2.19*	0.58	-0.59	0.57	-0.81	0.45	n.s	
Stressful life events								
High vs. low stressful life events	-3.13*	0.59	-3.13*	0.54	-0.62	0.44	n.s	
Intermediate vs. low stressful life events	-1.91*	0.59	-1.98*	0.53	-0.05	0.44	n.s	
Life style								
Lack of moderate physical activity	-0.14	0.53	n.s.		-0.01	0.39	n.s	
Lack of vigorous physical activity	-1.27*	0.58	-1.37*	0.52	-1.79*	0.43	-1.71*	0.42
Current smoker	-2.02*	0.72	-1.96*	0.65	-1.14*	0.54	n.s	
Problematic alcohol use	-1.76	1.27	n.s.		-1.61	0.92	n.s	
Physical examination								
Obesity (BMI ≥30) vs. normal (BMI<25)	-0.84	1.14	n.s		-1.54	0.83	n.s	
Overweight (BMI 25-30) vs. normal	0.34	0.54	n.s		-0.30	0.39	n.s	
VO_2 max (ml/kg/min)	-0.01	0.03	n.s		0.05*	0.02	n.s	
Biceps strength (kg)	0.03	0.02	n.s		0.04*	0.02	n.s	

n.s= not significant, p>0.05

work ability only in the oldest age group of workers over 45 years. Obesity no longer was statistically significant.

Table 4.3 Results of backward regression analysis: effects of psychosocial factors at work, stressful life events, lifestyle and physical condition on work ability among workers in commercial services (n=1141)

	Work ability Univariate model		Work ability Multivariate model	
	β	SE	β	SE
Individual characteristics				
Age (yr)	-0.07*	0.02	-0.09*	0.01
Male	2.13*	0.31	2.08*	0.28
Psychosocial factors at work				
Low vs. high teamwork	-4.02*	0.32	-1.32*	0.40
Intermediate vs. high teamwork	-1.52*	0.34	-0.20	0.35
Low vs. high stress-handling	-4.39*	0.34	-2.75*	0.35
Intermediate vs. high stress-handling	-1.41*	0.35	-0.79*	0.35
Low vs. high self-development	-4.11*	0.35	-2.20*	0.39
Intermediate vs. high self-development	-1.67*	0.34	-0.91*	0.34
Stressful life events				
High vs. low stressful life events	-1.36*	0.36	-2.01*	0.32
Intermediate vs. low stressful life events	-0.97*	0.36	-1.14*	0.32
Life style				
Lack of moderate physical activity	0.49	0.32	n.s	
Lack of vigorous physical activity	-0.71*	0.35	-0.71*	0.31
Current smoker	-0.68	0.44	n.s	
Problematic alcohol use	-0.52	0.74	n.s	
Physical examination				
Obesity (BMI ≥30) vs. normal (BMI<25)	-2.02*	0.68	-1.21*	0.59
Overweight (BMI 25-30) vs. normal (BMI<25)	-0.49	0.32	-0.32	0.28
VO_2 max (ml/kg/min)	0.03	0.02	n.s	
Biceps strength (kg)	0.03	0.01	n.s	

n.s= not significant, p>0.05

DISCUSSION

This study showed that work ability of white-collar workers in commercial services industry was strongly associated with psychosocial factors at work, such as teamwork, stress handling, self-development, and, to a lesser extent, with stressful life events, lack of physical activity, and obesity. Work ability was strongly associated with mental and physical health. Determinants of mental health were very similar to those of work ability, whereas physical health was influenced primarily by lack of life physical activity.

Some limitations must be taken into account in this study. First, the cross-sectional design does not permit exploration of causal relationships between the determinants and work ability. Therefore, it remains unknown whether, for example, a poor stress handling will decrease work ability or decreased work ability will cause a poorer

Table 4.4 Results on backward regression analysis per age group: effects of psychosocial factors at work, stressful life events, lifestyle and physical condition on work ability among workers in commercial services (n=1141)

	Age ≤ 32 yr (n=335)		Age 32-45 yr (n=366)		Age >45 yr (n=200)	
	Work ability Multivariate model		**Work ability Multivariate model**		**Work ability Multivariate model**	
	β	**SE**	**β**	**SE**	**β**	**SE**
Individual characteristics						
Male	1.43*	0.42	1.37*	0.49	3.19*	0.83
Psychosocial factors at work						
Low vs. high teamwork	-0.44	0.61	-1.40*	0.63	-1.07	0.98
Intermediate vs. high teamwork	-0.49	0.50	-0.39	0.60	-0.58	0.89
Low vs. high stress-handling	-2.85*	0.55	-3.22*	0.63	-2.44*	0.95
Intermediate vs. high stress-handling	-0.96	0.52	-1.08	0.61	-0.83	0.86
Low vs. high self-development	-2.59*	0.64	-1.64*	0.59	-3.57*	1.01
Intermediate vs. high self-development	-1.27*	0.51	-0.92	0.57	-1.63	0.84
Stressful life events						
High vs. low stressful life events	-1.25*	0.49	-1.67*	0.51	-2.60*	0.84
Intermediate vs. low stressful life events	-0.64	0.53	-1.78*	0.52	-0.34	0.72
Life style						
Lack of moderate physical activity	-0.28	0.47	0.02	0.51	1.45*	0.70
Lack of vigorous physical activity	-0.58	0.49	-0.56	0.53	-1.62*	0.79
Problematic alcohol use	1.70	0.93	-0.85	1.19	-2.62*	1.33

n.s= not significant, p>0.05

stress handling. Nevertheless, the results are still of interest as they give a first insight in important factors for interventions among white-collar workers. Second, data were drawn from voluntary participation. Information on non-response for both measures showed that age and sex did not bias response. Non-response differences between questionnaire and physical examination did not show any bias; none of the questionnaire variables were associated with not participating in the physical examination; and also none of the physical examination variables were associated with not participating in the questionnaire. Third, the reliability of the physical examination highly depends on the professional skills of the instructor and the standardization of the examination. The maximum oxygen uptake was indirectly calculated using the heart rate, which can be easily increased by minor distractions, such as room temperature, and talking during the test.

In this study among white-collar workers in commercial services industry the proportion of workers with poor work ability was 2.1% and the mean WAI was 41.1 (sd=5.1). These results are slightly higher than the Finnish reference data in mentally demanding work (mean 39).[6]

Work ability in this study population was influenced by sex, age, psychosocial factors at work, stressful life events, and life style factors. These factors together explained 29% of the total variance in work ability in this study population. Male sex increased work ability with 2 points, which means 4% of the maximum score. An increase in age of 40 years decreases the WAI score with 4 points, which is 7.3% of the maximum score, which indicates a rather modest influence of age on work ability. Psychosocial factors each had an effect on WAI comparable to sex, whereas the combined effect of the psychosocial factors is approximately 1.5 fold the effect of 40 years of aging. Lack of vigorous physical activity decreases the WAI score with only 0.7 points, which is no more than 1.5% of the maximum score. Obesity (5% of the population) compared to normal weight decreases the WAI score with 1.2 points, which is 2.4% of the maximum score.

Each psychosocial factor at work was negatively associated with work ability. Univariate results showed comparable strength in associations, while the multivariate model showed lower regression coefficients, especially for teamwork. It seems that the association between teamwork and work ability was more influenced by other determinants included in the multivariate model, than the associations between work ability and stress handling and self-development.

In previous research inconsistent results were found regarding the influence of psychosocial factors at work on work ability. For example, in the metal industry an increase in teamwork and increase in opportunities for development was not predictive of an increase in work ability during 2-year follow-up.[17] Negative associations between mental stress and work ability have been found among office workers (b=-0.17), but this association was minimized when including age in the regression model.[18] Among bus drivers significant associations were observed for high control by superiors and lack of responsibility at work with lower WAI scores.[18]

The negative association of stressful life events with work ability in the current study is in agreement with earlier findings by Pohjonen,[19] who found an increased risk for poor work ability (OR=3.62 (2.2-5.9)) for a hard life situation outside of work.

The results showed that a lack of vigorous physical activity was associated with a decreased work ability, whereas associations between work ability and biceps strength and maximum oxygen uptake were not found in the multivariate model. The lack of significant results for maximum oxygen uptake and biceps strength is in line with findings of Eskelinen et al.[20], Nygård et al.[21], and Pohjonen.[7] It may be hypothesized that in mentally demanding jobs a good physical condition is not required to meet the work demands and, thus, will have no influence on work ability.

Stratification by age showed the importance of lifestyle in the oldest age group, but not among younger workers. This effect may be explained by the fact that health problems due to an unhealthy lifestyle, most notably diabetes mellitus and cardiovascular disease, occur primarily at older age. In the total study population, obesity was significantly associated with a lower work ability, whereas no significant associations were found in the stratified analyses. This is partly due to lack of statistical power in these data with smaller numbers of workers, since the magnitude of the regression coefficients were comparable but the standard errors increased substantially.

The Pearson correlation coefficient of mental and physical health was -0.20, which was in line with results of Van Duijn et al.[22] In a univariate analysis both mental health and physical health were associated with work ability. However, determinants of work ability were similar to determinants of mental health. This finding can be explained by the fact that the work setting of the white-collar workers in the current study is characterized by high mental demands. An exception to the similarity in factors influencing both mental health and work ability was smoking. Smoking was related to mental health, but not to work ability.

The results of the current study outline the importance of work-related factors in white-collar workers, with regard to work ability. The combined impact of psychosocial factors is much stronger than is for individual factors, and is amendable to change, in contrast to individual factors as age, and sex.

In conclusion, among white-collar workers in commercial services industry psychosocial factors at work, stressful life events, lack of vigorous physical activity, and obesity were significant related to work ability. The strong associations between psychosocial factors at work and mental health and work ability suggest that in this study population health promotion should address working conditions rather than individual life style factors. Although the importance of life style factors seems to increase with aging of the worker.

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CHAPTER 5

Productivity loss in the workforce: associations with health, work demands, and individual characteristics.

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Productivity loss in the workforce: associations with health, work demands, and individual characteristics.
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ABSTRACTS

Background: Decreased productivity at work is an important consequence of work-related disease.

Methods: The study population consisted of 2252 workers in 24 different companies in the Netherlands in 2005-2006 (response 56%). Self-reported loss of productivity on the previous workday was measured on a 10-point numerical rating scale by the Quantity and Quality method. Logistic regression analysis was used to explore the associations between work demands, health problems, individual characteristics, and lifestyle factors with the occurrence of productivity loss.

Results: About 45% of the workers reported some degree of productivity loss on the previous workday, with an average loss of 11%. Moderate and severe functional limitations due to health problems (OR=1.28 and 1.63, respectively) and lack of control at work (OR=1.36) were associated with productivity loss at work with population attributable risks of 7%, 6%, and 16%, respectively.

Conclusion: Productivity losses at work frequently occur due to health problems and subsequent impairments, and lack of control over the pace and planning of work. This will substantially contribute to indirect costs of work-related diseases.

Key words: health, lifestyle, productivity loss, work-related factors

INTRODUCTION

Hazardous work can result in injuries and work-related diseases, and subsequent consequences in terms of absenteeism and work disability.[1] Compensation claims, disability and sickness absence have been considered as indicators to measure the health status of working populations.[2] However, evidence is emerging that health problems with subsequent functional limitations may also cause a decreased productivity while at work.[3] Meerding and colleagues have shown that a reduced work productivity at work due to health problems was prevalent in 5 - 12 % of construction workers and industrial workers, with an estimated mean loss of 12 - 28 % in productivity.[4] Among computer workers with musculoskeletal complaints while at work, productivity losses of 15% have been reported, whereby this reduced productivity exceeded the productivity loss due to sickness absence.[5] Brouwer and co-workers found that 7% of the workers in a trade company had health problems that reduced their productivity at work, resulting in an overall loss of 1% of all working hours during regular work days.[6] These findings indicate that the economic consequences of the occurrence of illness and disease are not limited to health care costs and sickness absence, but should also encompass the reduced productivity at work due to health complaints. The costs and benefits of allocation of interventions at the workplace will be substantially influenced by these indirect costs.[7]

Apart from health problems, determinants of productivity loss may include individual characteristics of workers, lifestyle factors, job demands, and the work setting.[8] In one study an increased body mass index was one of the most prominent causes of failure to maintain the productivity standard.[9] Other studies have also shown that obesity could have a negative impact on workers, not only through absenteeism but also through productivity loss at work.[10,11] In their review Schmier and colleagues presented indications that overweight or obese workers are at risk for higher productivity losses which may prompt employers to consider implementing health promotion programs to help employees achieve and maintain a healthy lifestyle.[12]

Specific illnesses and diseases may lead to a reduced productivity while at work. Workers with migraine headache reported that 60-70% of their annual productivity losses of about 4.2 days was the result of an impaired performance while at work.[13,14] Workers with osteoarthritis complaints during work time reported an average of 9% productivity loss.[15] Work related factors seem also important determinants of productivity loss. Having control in one's work, including being able to determine the pace of work, makes people more disposed to be present when having health problems, whereas those with a lower degree of control may more often be on sick leave.[16]

These studies have demonstrated that health problems at work can have substantial economic consequences since the health of workers will affect their ability to work.

However, there is little insight into the relative importance of health, work-related factors and individual characteristics for productivity loss at work. The main aims of this study were to evaluate the associations between health problems and productivity loss at work, and to evaluate the influence of work-related factors, lifestyle factors, and individual characteristics on the associations between health problems and productivity loss at work.

MATERIAL AND METHODS

Study population

The study population consisted of workers in 24 different companies who worked in 15 branches of industry in the Netherlands in 2005 - 2006. These different branches consisted of public administration, commercial services, health care, plastics industry, printing industry, power plants, construction industry, and agriculture. These companies had commissioned an occupational health organization to launch a program to investigate the employability of the workforce and as part of this program a questionnaire survey was conducted on health, work demands, work ability, and productivity. All companies participating in this program during 2 years enrolled all workers in the study population. The occupational health organization had send an invitation to all eligible workers by regular mail, and provided workers with an individualized password to fill out the questionnaire on a secure website. Informed consent was obtained from all participants at the time of enrolment and confidentiality of information was guaranteed. Complete data on productivity, work-ability, and health problems were available for 2252 workers (1214 blue-collar and 1038 white-collar subjects). The response varied from 33% to 97% across companies with an overall response of 56%.

Productivity

The main outcome of this study was productivity loss, measured with the QQ method.[6] Respondents were asked to indicate how much work they actually performed during regular hours on their last regular workday as compared with normal. The quantity of productivity was measured on 10-point numerical rating scale with 0 representing “nothing” and 10 representing “normal quantity”.[4,6] The workers were dichotomized based on their productivity score into those with productivity loss (score less than 10) and those without (productivity score = 10), since the productivity scores were not normally distributed. In their study Meerding et al showed that the self-reported productivity in the QQ instrument correlated significantly with objective work output (r = 0.48).[4]

Work-related factors

The work-related factors consisted of physical and psychosocial factors. The physical risk factors concerned the regular presence of manual materials handling such as lifting and carrying materials, awkward back postures in which the back is bent or twisted, static work postures, repetitive movements, and bending &/or twisting. A four-point scale was used with rating 'seldom or never', 'now and then', 'often', and 'always' during a normal workday. The answers 'often' and 'always' were classified as high exposure.[17]

Psychosocial risk factors were measured according to the demand-control model defined by Karasek.[18,19] The three dimensions job control (5 items), skill discretion (3 items), and work demands (5 items) were assessed by an abbreviated version of the original questionnaire(Cronbach's alpha = 0.73)[20]. Questions on job control concerned influence on the planning of tasks, influence on the pace of work, decision about the carrying out the tasks, interruption of work if necessary, and having a say on completion deadlines. Skill discretion concerned creativity, varied work, and required skills and abilities. Work demands related to excessive work, working hard, working fast, insufficient time to complete the work, and conflicting demands. For each questions, a four-point scale was used with ratings 'seldom or never', 'now and then', 'often', and 'always' during a normal workday. The sum score was calculated for each dimension separately and workers with a median sum score or higher were regarded as exposed to the psychosocial risk factor.

Health problems

We used the work ability index (WAI)[20] questionnaire to assess the workers' health. This questionnaire consists of seven dimensions with a final index score ranging from 7-49, and divided into four work ability categories as poor (7-27 points), moderate (28-36 points), good (37-43 points), and excellent (44-49 points. Data were collected for each dimension separately. Dimension 3 and 4 of the WAI are health related questions. Dimension 3 is a limitative list of 13 broad categories of diseases, ever diagnosed by a physician, with dichotomous answers. Dimension 4 addressed current functional limitations due to health problems, based on an ordinal scale. Based on these dimensions, health was considered as: (1) number of reported diseases by workers, with categories of no disease, one disease, and more than one disease, and (2) currently present impairment at work due to diseases with categories no impairment, moderate impairment, and severe impairment. The workers were also asked about injuries due to accidents at work or in leisure time.

Individual characteristic and lifestyle factors

Data on age, job type, height, and weight were collected by a questionnaire. Age was divided into three categories: 18 - 39, 40 - 49, and 50 - 65 years. The information on job type was used to classify subjects as either blue-collar or white-collar workers. The Body Mass Index (BMI) was calculated by dividing body weight in kilogram by the square of body height in meters and used to define subjects as normal (BMI < 25 kg/m^2), overweight (BMI 25 – 30 kg/m^2), or obese (BMI >30 kg/m^2). The lifestyle factors of interest concerned smoking and physical activity during leisure time. Subjects were divided in non-smokers and current smokers. They also were asked about their leisure time physical activity by a single yes/no question on the frequency of physical activities for at least 30 minutes during leisure time. Those who reported physical activity for 30 minutes per day on at least 5-day per week were considered in agreement with the recommendation on moderate physical activity.[22]

Statistical analysis

For the main variables we generated descriptive statistic such as numbers and percentages. Logistic regression analysis was used to explore the associations between work demands, health problems, individual characteristics and lifestyle factors with the occurrence of productivity loss at work. The Odds Ratio (OR) was estimated as the measure of association. For the initial selection of relevant variables, all variables with a P value less than 0.20 were selected in univariate analyses. Subsequently, all variables selected in the univariate analyses were investigated in a multivariate analysis and retained in the multivariate analysis when statistically significant at $p < 0.05$. In the analysis age and sex were considered to be potential confounders and included in each multivariate model. Other variables were also considered as potential confounders and included in the multivariate model when introducing a change by ≥ 15% in the coefficient of other risk factors in the model. The chi-square statistics was used to find interactions terms between work-related factors and health problems, by calculating the differences between the overall Wald test in models with interaction and models without, taking into account the differences in degree of freedoms. All analyses were carried out with the statistical package SAS version 8.2.[23]

Population Attributable Risks were calculated for significant determinants of productivity loss, using the formula PAR = Pe (OR-1)/ (1+ Pe (OR-1)).[24,25] Pe in this formula represents the prevalence of exposure in the study population.

RESULTS

Data on descriptive characteristics of the workers in the study are presented in table 1. The mean age of the study population was 43 years, ranging from 18 to 65 years. The mean BMI of the respondents was 25.5 (± 4.1). About 45 % of the workers reported some degree of productivity loss on the previous workday, with an average loss of 11% compared with a regular workday. The mean work ability among the study population was 41 (± 5). The odds ratios and 95 % confidence intervals (CI)

Table 5.1 Baseline characteristics of workers (n = 2252) in 25 companies in the Netherlands

	N	Percentage
Individual characteristics		
Age category		
18 - 39 Yr	753	33
40 - 49 Yr	696	31
50 - 65 Yr	803	36
Female (%)	697	31
White-collar	1038	46
Life style factors		
Normal weight	1,105	49
Overweight	921	41
Obese	226	10
Current smoker	518	24
Sufficient physical activity in leisure	1,321	60
Work-related factors		
Physical factors		
Manual materials handling	201	9
Awkward back postures	335	16
Static working postures	930	41
Repetitive movements	930	41
Bending &/or twisting upper body	751	33
Psychosocial factors		
Lack of job-control	1,016	54
Poor skill-discretion	1,601	71
High work-demand	1,377	61
Health problem		
Number of diseases diagnosed		
0	612	27
1	609	27
2 and more	1031	46
Work impairment due to health problems		
No impairment	1443	64
Moderately-impaired	575	26
Severely-impaired	234	10
Productivity loss	1018	45

Table 5.2 Univariate odds ratios (OR) and 95% confidence intervals (CI) of history of accident and different diseases for productivity loss among workers in different companies in the Netherlands (n= 2252)

	N	Percentage**	OR	95% CI
Accident	275	7	1.51	1.17 - 1.94*
Musculoskeletal disease	1,007	21	1.15	0.98 - 1.36
Cardiovascular disease	330	7	1.09	0.86 - 1.37
Respiratory disease	369	8	1.14	0.91 - 1.43
Psychological disease	248	6	1.27	0.97 - 1.65
Neurological disease	359	8	1.35	1.08 - 1.69*
Digestive system disease	220	5	1.27	0.96 - 1.67
Genitourinary disease	153	3	1.03	0.74 - 1.43
Skin disease	401	8	0.99	0.80 - 1.23
Tumor disease	68	1	1.09	0.67 - 1.77
Endocrine disease	136	3	0.96	0.98 - 1.36
Blood disease	73	1	0.95	0.60 - 1.53

*P value<0.05

** Percentage of exposed workers with productivity loss

for the likelihood of productivity loss were 1.63 (1.35 - 1.97), 2.66 (2.05 - 3.46), and 4.08 (2.36 - 7.07) for a good, moderate, and poor work ability, respectively, compared with an excellent work ability.

The most prevalent disease in the study population was musculoskeletal disease (45%). In the univariate analyses 9 out of 12 health problems showed an elevated odds ratio, but only the occurrence of an accident and neurological problem showed statistically significant associations with productivity loss at work (table 2).

In the univariate analyses female and white-collar workers have a lesser chance for productivity loss than males and blue-collar workers (table 3). Although job type was significantly associated with productivity loss at work, it became non-significant (OR 0.96, 95 % CI 0.74 – 1.25) when adjusted for health problems, lifestyle factors, and work-related factors. Smoking showed a significant association with lower productivity loss in both the univariate and multivariate analyses. Among physical work factors bending and/or twisting upper body was significantly associated with productivity loss in the univariate analyses, but after adjustment for other variables this association became non-significant (OR 0.96, 95% CI 0.74 – 1.25). Poor skill discretion and lack of control showed significant association with productivity loss in the univariate analyses, but after control for other risk factors skill discretion became non-significant (OR = 1.20, 95% CI 0.98 – 1.46). Both health indicators (number of diseases diagnosed, and work impairments due to health) showed a positive association with productivity loss at work, but after adjustment only impaired workers showed a statistically significant association with productivity loss whereas number of diagnosed disease was of borderline significance (OR = 1.24, 95% CI = 0.99 – 1.54) (table 3). When introducing interaction terms between health problems

Table 5.3 Univariate and multivariate odds ratios (OR) and 95% confidence intervals (CI) of individual characteristics, life styles factors, work-related factors, and health indicators for productivity loss among workers in different companies in the Netherlands (n=2252)

	Univariate analyses		Multivariate analysis	
	OR	95% CI	OR	95% CI
Age category				
18 - 39	1	-	1	-
40 - 49	0.93	0.76 - 1.14	0.90	0.73 - 1.10
50 - 65	0.81	0.67 - 1.00	0.78	0.64 - 0.97*
Sex	0.90	0.75 - 1.07	0.87	0.72 - 1.05
White-collar worker	0.73	0.62 - 0.86*		
Lifestyle factors				
Normal weight	1	-		
Overweight	1.14	0.96 - 1.36		
Obese	1.02	0.76 - 1.36		
Current smoker	0.78	0.64 - 0.95*	0.73	0.60 - 0.90*
Sufficient physical activity in leisure time	0.86	0.72 - 1.02		
Work related factors				
Physical factors				
Manual materials handling	1.03	0.77 - 1.38		
Awkward back postures	1.05	0.84 - 1.32		
Static working postures	1.07	0.90 - 1.26		
Repetitive movements	0.95	0.80 - 1.12		
Bending &/or twisting upper body	1.21	1.01 - 1.44*		
Psychosocial factors				
Lack of job control	1.35	1.15 - 1.60*	1.36	1.14 - 1.63*
Poor skill discretion	1.21	1.00 - 1.45*		
High work-demand	1.17	0.98 - 1.39		
Health problem				
Number of diseases diagnosed				
0	1	-		
1	1.31	1.04 - 1.64*		
2 and more	1.35	1.10 - 1.66*		
Work impairment due to health problems				
No impairment	1		1	
Moderate –impairments	1.26	1.04 - 1.53*	1.28	1.05 - 1.56*
Severe impairments	1.58	1.19 - 2.08*	1.63	1.22 - 2.17*

*P value < 0.05

and work-related factors in the logistic regression model, the fitness of the model did not improve statistically significant.

The population attributable risks for moderate and severe functional limitations due to health problems were 7% and 6%, respectively. The population attributable risk for lack of job control was 16%.

DISCUSSION

This study showed significant associations between health problems and subsequent impairments with productivity loss at work among workers in different companies in the Netherlands. Among work-related risk factors, job control was the most important factor associated with workers' productivity loss at work.

Some limitations must be considered in this study. First of all, the cross-sectional design of the study does not permit further explanation of the causal relationship between these factors and productivity loss at work. Secondly, there may have been some reluctance among participants to report symptoms and subsequent reduced productivity at work due to fears that if the employer would receive this information it could affect salary and employment. Although participants were informed that this information on productivity loss would remain strictly anonymous, it cannot be disregarded that some information bias might have occurred. Thirdly, the low response may also be associated with the presence of productivity loss. Unfortunately, we do not have information on response at company level, since companies hired the occupational health organization as external consultancy through different acquisition routes. Hence, it is not known whether these companies represent a random sample of the workforce in the Netherlands with respect to working conditions, health status, and work ability aspects. Within each company, it may be possible that workers with productivity loss have had less interest in participating in the study. In order to investigate the presence of potential selection bias in our study, the same analyses were done in 1014 workers of 16 companies with a response of 80% and more. Since the results were almost the same, we think that this source of selection bias will not have influenced the results to a major extend. Finally, although another study has emphasized the effect of education and income on productivity loss [26], the available data did not allow investigating the effect of these factors on productivity loss.

Work productivity can be related to a variety of factors such as work related factors, and health problems.[26] Productivity is most likely related to the physical work environment such as thermal climate and lighting condition and to regular disturbances in the logistics of the production process.[27,28] Although in the present study available data did not allow investigating the influence of these factors on productivity loss directly, the influence of most important physical work-related factors was investigated. Our results showed that psychosocial factors at work played a more important role on decreased productivity at work than physical load factors. The most prominent psychosocial factor was lack of control on the job with an OR of 1.36 (1.14 - 1.63). This association remained unchanged when adjusted for other significant variables. Other studies have also reported a positive association between productivity loss at work and a reduced job control.[4,16] Under the assumption of a causal association between work related factors and productivity loss, we estimated that about 16% of productivity losses were attributable to lack of control on work. One has to bear in mind, however, that a change in the cut-off value of this dichotomized factor might change the prevalence of exposure as well as the odds ratio and, thus, lead to a different population attributable risk. It is hypothesized that workers with a high job control are more likely to be able to work with health problems, because they may be able to adapt their pace of work to their current state of health. Control over the pace of work enables the individual to adapt the task performance to his or her physical and mental condition "on the day". It is also possible that workers with better control on their job may compensate the productivity loss in overtime.

The Health status of workers is an important underlying factor in enhancing or maintaining productivity in the labor force.[29] We observed that health problems per sé had a lesser importance than the presence of impairments due to these health problems. Although in the univariate analyses both indicators of health - number of disease and work impairment due to health - were positively associated with productivity loss, in the multivariate analysis only work impairment remained significant, although number of diagnosed disease was of borderline statistical significance. Under the assumption of a causal relationship between health problem and productivity loss, approximately 7% of productivity loss was attributed to moderate functional limitation due to health problems. The population attributable risk of productivity loss for severe functional limitation due to health problems was 6%. It should be noted that the number of diseases in the WAI questionnaire refers to diseases diagnosed in the past without a clear definition of the recall period, whereas work impairment was defined as an experienced hindrance in the current job. Therefore, this difference in recall period may explain why impairments were more important than the occurrence of specific diseases. This finding suggests that coping mechanisms with health at the work place is likely to play an important role in maintaining a good productivity at work. In addition of maintaining productivity, it has been shown that a positive coping mechanism also prevented withdrawal from the labor force in patients with rheumatoid arthritis (RA).[30,31]

Musculoskeletal problems were the most common disease among the study population (45%). Our result showed a comparable finding as Hagberg and colleagues who reported a mean reduction of productivity about 15% for women and 13% for men due to musculoskeletal disease, but this effect in our analysis was of borderline significance (OR = 1.15, 95% CI 0.98 – 1.36).[5] Meerding and co-workers also reported an average productivity loss of 7% for industrial workers and 25% for construction workers with musculoskeletal disease.[4] It has been also shown that pain from arthritis, back pain and other musculoskeletal problems caused productivity loss among 13% of US workers.[32] A possible explanation for the non-significant finding in our study is that the majority of musculoskeletal symptoms were not present on the previous workday or may have had no relation to work activity. The latter is suggested by a population survey where a wide variety of musculoskeletal symptoms were unrelated to work activity.[33] Secondly, in various jobs productivity at work may have been influenced more by external factors, such as characteristics of the production process, most notably working in teams or in process that are not machine-paced. Since about 50% of our study populations were blue-collar workers, it was hypothesized that work-related physical load in combination with musculoskeletal problems would influence productivity loss. The lack of a statistically significant interaction suggests that these musculoskeletal problems only influenced productivity when there is no possibility to adjust work activities, as was demonstrated by the importance of lack of control.

The individual characteristics included in the analysis - age and gender- had no associations with productivity loss at work. A study on determinants of presenteeism, the phenomenon that workers turn up at work despite health problems,[35,35] also showed no significant influence of these individual characteristics.[16]

Although in the univariate analysis white-collar workers had less productivity loss than blue-collar workers, after adjustment for other determinants, this association became non-significant. One previous study showed that blue-collar workers have a somewhat higher presenteeism than white-collar workers, but this finding could not be corroborated in our study.[36] Since the occurrence of health problems was higher among blue-collar workers, after adjustment for health status, the independent effect of job type disappeared. Although one study found that the moderate and vigorous exercise levels are associated with important work outcomes[37] the relationship between productivity loss and physical activity in leisure time was not statistically significant. Another study also failed to show a significant relationship between physical activity and productivity loss at work.[11] A surprising finding in our study was that smokers reported less productivity loss at work (OR 0.73, 95% CI 0.60-0.90). This contradicts the finding of Bunn et al. who reported that current smokers incurred the highest health related productivity losses when compared with non-smokers and former smokers,[38] although in their study productivity losses comprised both absenteeism and productivity loss at work. Our result might be partly due to reporting bias. Due to legislation in all workplaces a stringent smoke free policy has been adopted in the past few years in the Netherlands. In the debate on this legislation potential productivity loss at work among smokers played a substantial role and, hence, this may have biased the answers.

We found that productivity loss was associated with sick leave (data not shown). In the Netherlands everyone on sickness absence will be paid a full salary for the first 12 months of sickness absence. Therefore, financial pressure cannot be an explanation for productivity loss while at work. Since in the workers with reduced productivity, sick leave will provide scope for physical and psychosocial recuperation following strain or disease,[36] it can be expected that workers with productivity loss at work are at higher risk for future sick leave.[39]

In conclusion, this study demonstrated that productivity losses at work frequently occurred and were partly related to health problems and subsequent impairments. This loss of productivity will substantially contribute to indirect costs of work-related diseases and may prompt for interventions at the workplace. Among work related risk factor job control was important in maintaining good productivity. Hence, health management at the workplace should consider interventions that increase the possibilities for workers with health problems to continue working according to their abilities.

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Part 3

CHAPTER 6

Impact of work, lifestyle, and work ability on sickness absence among Dutch construction workers

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Impact of work, lifestyle, and work ability on sickness absence among Dutch construction workers
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ABSTRACT

Objective The objective of this study was to analyze the relative contribution of individual and life style characteristics, work related factors, and work ability on short, moderate, and long spells sickness absence.

Methods Altogether 5,667 Dutch construction workers with complete sick leave registration were followed from the day of medical examination in 2005 until the end of the year 2006. The main outcome of the study was the occurrence and duration of the first sickness absence, as registered by an occupational health service. Independent variables consisted of individual and life style characteristics, work related factors, and the work ability index. Poisson regression analysis was used to calculate rate ratios and 95% confidence intervals of each independent variable for occurrence of sick leave.

Results Important predictors for sick leave were older age, obesity, smoking, manual materials handling, awkward back postures, lack of control at work, lung restriction, and a less than excellent work ability. For most predictors a significant trend was observed with higher RR values for longer duration of sickness absence. The influence of work-related risk factors and life style factors was of comparable magnitude. Work and lifestyle also had an indirect influence through its associations with work ability.

Conclusion The study showed that physical and psychosocial work related factors and workers' work ability as well as life styles factors were important determinants of prolonged duration of sick leave, emphasizing the multifactorial background of absenteeism.

INTRODUCTION

Sickness absence is an expression of the complex relation between health and work characteristics[1] and is thought to have a multifactorial etiology.[2] Individual characteristics, job type, seniority, physical and psychosocial work-related factors, lifestyle factors, as well as health problems have been reported as important determinants of sickness absence.[2-4]The association between age and sickness absence has been shown in previous studies.[5-7] Short periods of sick leave are more common among younger and longer periods among older workers[8]. Blue collar workers have a higher level of sickness absence than white-collar workers.[3,8-10] High physical load and psychosocial demands at work, especially lower decision latitude have been associated with reported short and long spells sick leave.[2,11,12]

There is ample evidence that construction workers have a higher risk on health problems that may lead to sickness absence and subsequent work related disability.[13,14] A prospective study among construction workers showed that physical load was a risk factor for sickness absence.[15] The high physical load in construction industry is largely determined by manual material handling and repetitive awkward postures.[13,16]

The work ability index has been promoted in recent years as a valuable tool in occupational health programs dedicated to decrease early exit from the work place.[17] Although the relationship between work-related factors, individual health and work ability index is well-known[18], there is limited information on its predictive value of future sickness absence. One study by Kujala et al showed that a lower work ability among young employees had a predictive value for long-term sickness absence.[19]

The aim of the study was to analyze the relative contribution of individual characteristics, life style, working conditions, and work ability to the occurrence of sickness absence and to investigate whether these risk factors differed for the occurrence of short, moderate, and long spells sick leave among Dutch construction workers.

MATERIAL AND METHODS

Study population and design

The study population consisted of workers in the construction industry in the Netherlands who participated in the voluntary periodic medical examination in 2005. In general, about 60% of all construction workers participate annually in this examination, which is offered about every 4 years. In the Netherlands, the periodic examination is offered by over 20 different occupational health services with local branches, and it consists of a questionnaire and physical examination. Among 19,753 workers, complete registration of sickness absence was available from one large occupational health service for 5,677 workers. Sickness absence registration for other workers was done by companies themselves, was incomplete, and not available for analysis. The workers were followed from the day of medical examination until the end of the year 2006. The mean follow-up time until first sick leave was 369 days with maximum 699 and minimum 11 days.

Given the very small number of female workers (n = 245), the analysis was limited to male construction workers. Complete data on lifestyle, health and sickness absence was available for 5677 workers

Sickness absence

During the follow-up period, the sickness absence register was kept by one occupational health service, which recorded the occurrence and duration of every absence episode. The first sickness absence period during the follow-up was categorized as at short duration (less than 14 days), moderate duration (more than 2 weeks and less than 3 months), and long duration (more than 3 months).

Work related factors

The work related factors in this study consisted of items on physical and psychosocial work related factors. Physical load concerned the regular presence of manual materials handling, awkward back postures, static work postures, repetitive movements, exposure to whole body vibration, and hand arm vibration ascertained by dichotomized questions.[17] Psychosocial work characteristics were assessed by means of an abbreviated Dutch version of Karasek's job content questionnaire[20], which included two yes/no questions on job demands and on job control. In addition, dichotomized questions on supervisor and co-worker support, and job satisfaction were asked.[17]

Individual characteristic and lifestyle factors

Data on age, job type, height, and weight were collected by the questionnaire during the medical examination. The Body Mass Index (BMI) was calculated by dividing body weight in kilogram by the square of body height in meters and used to define subjects as normal (BMI below 25), overweight (BMI from 25 to 30), or obese (BMI above 30). The lifestyle factors of interest concerned smoking, and alcohol drinking. Subjects were divided in current smokers and non-smokers. An open question on average number of alcoholic drinks per week was used to define problematic alcohol drinkers as those who consumed 15 units of alcohol or more per week.[21] Subjects were asked about their leisure time physical activity by a single open question on the frequency of physical activity for at least 30 minutes per day and a single question with 5 answer categories on frequency of strenuous physical activity making someone sweating. Those who reported physical activity for 30 minutes per day on at least 5 days per week were considered in agreement with the recommendation on moderate-intensity physical activity, and subjects with vigorous exercises at least 3 times per week were considered in agreement with the recommendation on vigorous-intensity physical activity.[22]

Health

Total blood cholesterol and high-density lipoprotein (HDL) cholesterol were measured in venous blood samples. Spirometry was conducted to measure forced expiratory volume (FEV1) and forced vital capacity (FVC). The FEV1 and FVC were expressed as percentages of the predicted values, based on reference equations [23]. Based on the spirometry findings, workers were divided into normal, obstructive and restrictive lung diseases, according to the American Thoracic Society criteria.[24]

Age, total blood cholesterol, HDL cholesterol, smoking habits, and systolic blood pressure of each participant were used to calculate the Framingham Risk Score (FRS) for the 10-year risk for coronary heart disease events (coronary heart disease death and myocardial infarction).[25] The 10-year risk prediction was dichotomized into no risk (0-9%), and cardiovascular risk (more than 10%), on coronary heart death and myocardial infarction.[26]

Work ability

Work ability was measured by the work ability index (WAI), consisting of an assessment of the physical and mental demands of an individual in relation to his work, diagnosed diseases, limitations in work due to disease, sick leave, work ability prognosis, and psychological resources. The WAI is constituted of seven dimensions and the index is derived as the sum score of the ratings on each dimensions. The range of the summative index is 7-49, which is classified into poor (7-27), moderate (28-36), good (37-43), and excellent (44-49) work ability.[27]

Statistical analysis

All descriptive data are given as mean ± standard deviation, and percentage when appropriate. In this study short, moderate, and long spells sick leave were analyzed separately with workers without sick leave as reference group. Poisson regression analysis was used to describe the effects of covariates on the sickness absence rate through relative effect estimates, referred to as rate ratios. In this model unequal follow-up time is a typical situation, and the logarithmic value of the actual follow-up time was included as offset variable. For Poisson distributed data the variance is equal to the mean, but for sickness absence data the variance was substantially larger than the mean. A scale parameter was therefore estimated for each model, by dividing the residual deviance by the number of the degree of freedom. In such a case, the parameter estimates are not affected, but the confidence interval are.[28,29] For the initial selection of relevant variables all significant variables with p-value< 0.10 were selected in a univariate Poisson model. Subsequently, all these variables were investigated in a multivariate analysis separately for individual and lifestyle factors, work-related factors, and health indicators. Finally, backward selection was used to retain important variables with a significant effect ($p < 0.05$) in the final multivariate Poisson model, considering significant changes in the likelihood ratio between the full model and the reduced model.

The one-sided P value of Cochrane-Armitage test was used to test the hypothesis of a trend between the dependent variable and explanatory variables. All analyses were carried out with the statistical package SAS version 9.13.[30]

RESULTS

Table 1 shows the baseline characteristics of the study population in the construction industry in the Netherlands, stratified by duration of sickness absence during follow-up. The incidence of sickness absence in the study population was 0.31 per person year. The mean age of the workers was 44 ± 11, ranging from 16 to 62 years old. Most workers had a blue-collar job (80.5%). The mean BMI for the study population was 26.2 ± 3.6, and 48.0 % were overweight and 13.1% were obese. The distribution of excellent, good, moderate, and poor work ability was 32.3%, 49.8%, 16.0%, and 1.9%, respectively.

Table 2 shows the influence of individual characteristics, lifestyles, and health indicators on sickness absence on the univariate models. White-collar workers had a lesser chance on sick leave compared with blue-collar workers. Smoking and high BMI were risk factors for moderate and long spells of sickness absence. Trend test for RR were significant for job type and spirometry abnormalities. The p values for trend test in obese workers, workers aged between 40 – 50 years, and workers older than 50 years were 0.07, 0.08, and 0.1 respectively.

Table 6.1 baseline characteristic of individual, lifestyles, health indicators, work related factors, and work ability index in a longitudinal study among 5677 male construction workers in the Netherlands.

Sick-leave	N	No N = 3882	Short spell < 14 days N=1320	Moderate spell 2 weeks – 3 months N = 353	Long spell > 3 months N = 112
Individual characteristics					
Age (mean ± SD)	5667	44.0 ± 11.1	43.2 ± 11.30	46.62 ± 10.00	54.4 ± 9.8
BMI (mean ± SD)	5667	26.2 ± 3.6	26.1 ± 3.5	26.5 ± 3.7	27.3 ± 4.7
White-collar job (%)	1105	21.3	18.0	9.1	6.3
Life styles					
Smoker %	1857	32.2	32.7	37.7	39.30
Problematic alcohol drinker %	813	14.6	13.0	17.0	15.2
Normal physical activity %	3174	68.4	70.6	74.7	69.4
Vigorous physical activity %	1102	20.438	20.41	19.435	22.7
Health indicator					
Lung obstruction %	119	1.7	3.1	2.0	6.3
Lung restriction %	50	0.5	1.4	1.7	4.5
Cardiovascular risk %	1714	29.8	29.6	37.1	33.0
Work-related physical factors					
Manual material handling %	2811	47.8	50.9	58.9	66.1
Awkward back postures %	1448	24.0	27.4	32.9	36.6
Static work postures %	2143	36.0	40.7	44.8	44.6
Repetitive movement %	1256	20.9	23.5	27.5	34.8
Whole body vibration %	875	14.8	16.4	16.3	20.2
Hand arm vibration %	966	16.8	18.4	21.1	21.8
Work-related psychosocial factors					
Lack of job control %	1976	33.2	37.1	43.3	39.3
High work demand %	3417	60.2	61.1	59.2	58.9
Lack of support at work %	713	12.3	13.7	15.6	17.6
Satisfaction with work %	5299	96.0	94.2	93.1	91.8
Work ability index					
Excellent %	1829	34.7	29.5	20.1	18.8
Good %	2822	48.9	51.6	54.7	43.8
Moderate %	905	14.4	17.5	22.7	31.3
Poor %	109	1.9	1.4	2.6	6.3

Among life style characteristics, physical activity (RR 1.12, 95% CI 0.98 – 1.28) and problematic alcohol drinking (RR 0.99, 95% CI 0.84 – 1.15) showed no significant association with sickness absence (data not shown).

Table 3 shows the crude impact of work-related factors on sick leave. All physical and psychosocial factors were associated with the occurrence of sick leave, expect

Table 6.2 Crude rate ratios (RR) and 95% confidence intervals of individual and lifestyle characteristics, and health indicator for prediction of sickness absence in a longitudinal study among 5677 male construction workers in the Netherlands

Sick-leave						
	Short spell < 14 days N = 1320		Moderate: 2 weeks – 3 months N = 353		Long spell > 3 months N = 112	
	RR	95 % CI	RR	95 % CI	RR	95 % CI
Age						
< 40 years	1.00	Reference	1.00	Reference	1.00	Reference
40 – 50 years	0.92	0.78 – 1.07	1.65*	1.31 – 2.09	1.86*	1.43 – 2.41
>= 50 years	0.85*	0.73 – 0.98	1.97*	1.58 – 2.46	1.51*	1.16 – 1.96
BMI (kg/m^2)						
Normal weight	1.00	Reference	1.00	Reference	1.00	Reference
Overweight	0.94	0.83 – 1.07	1.10	0.92 – 1.30	1.22	0.98 – 1.51
Obese	0.91	0.75 – 1.10	1.30*	1.02 – 1.65	1.82*	1.39 – 2.38
White-collar[a]	0.83*	0.72 – 0.97	0.39	0.30 – 0.51	0.30*	0.21 – 0.42
Smoker[a]	1.02	0.90 –1.15	1.24*	1.06 – 1.43	1.32*	1.09 – 1.60
Health indicators						
Lung obstruction[a]	1.19	0.97 – 1.55	1.15	0.65 – 2.05	3.50*	2.34 – 5.24
Lung restriction[a]	1.54*	1.12 – 2.11	2.78*	1.50 – 5.16	7.06*	4.41 – 11.32
Cardiovascular risk	0.99	0.87 – 1.12	1.37*	1.17 – 1.62	1.16	0.95 – 1.42

* P value < 0.05

[a] significant trend

Table 6.3 Crude rate ratios (RR) and 95% confidence interval of work related factors for sickness absence in a longitudinal study among 5677 male construction workers in the Netherlands

Sick-leave						
	Short spell < 14 days N = 1320		Moderate: 2 weeks – 3 months N = 353		Long spell > 3 months N = 112	
	RR	95 % CI	RR	95 % CI	RR	95 % CI
Work related factors						
Physical factors						
Manual material handling[a]	1.13*	1.00 – 1.27	1.53*	1.31 – 1.80	2.05*	1.68 – 2.49
Awkward back posture[a]	1.19*	1.05 – 1.36	1.53*	1.29 – 1.81	1.96*	1.62 – 2.37
Static postures[a]	1.20*	1.07 – 1.35	1.42*	1.21 – 1.67	1.45*	1.20 – 1.75
Repetitive movement[a]	1.15*	1.00 – 1.32	1.43*	1.20 –1.71	2.04*	1.67 – 2.48
Whole body vibration[a]	1.11	0.95 – 1.30	1.12	0.91 – 1.39	1.45*	1.14 – 1.83
Hand arm vibration[a]	1.11	0.95 – 1.29	1.33*	1.09 – 1.61	1.42*	1.13 – 1.79
Psychosocial factors						
Lack of control [a]	1.17*	1.03 – 1.32	1.50*	1.28 – 1.76	1.31*	1.08 – 1.59
High work demand	1.03	0.92 – 1.16	0.97	0.82 – 1.31	0.96	0.79 – 1.16
Lack of support at work[a]	1.31	0.95 – 1.34	1.35*	1.08 – 1.68	1.62*	1.26 – 2.06
Not satisfied with work[a]	1.41*	1.01 – 1.82	1.75*	1.28 – 2.39	2.16*	1.53 – 3.04

* P value <0.05

[a] significant trend

for high work demands. There were significant increasing RRs with longer duration of sick leave for manual materials handling, awkward back postures, static work postures, repetitive movements, lack of control, and being not satisfied with work. The univariate analysis on WAI showed that workers with good and moderate work ability had higher risks for taking sick leave than workers with excellent work ability (RR 1.30, 95% CI 1.15 – 1.48 and RR 1.60, 95% CI 1.36 – 1.87, respectively). The result was non-significant for poor work ability index (RR 1.33, 95%CI 0.90 – 1.96) (data not shown).

Table 4 shows the multivariate analyses of relevant variables for sickness absence. Short duration sickness absence occurred more often among younger workers,

Table 6.4 Adjusted rate ratios (RR) and 95% confidence interval s of individual, lifestyle and work related factors and health indicator for prediction of sickness absence in a longitudinal study among 5677 construction workers in the Netherlands.

Sick-leave						
	Short spell < 14 days N = 1320		Moderate: 2 weeks – 3 months N = 353		Long spell > 3 months N = 112	
	RR	95 % CI	RR	95 % CI	RR	95 % CI
Age						
< 40 years	1.00	Reference	1.00	Reference	1.00	Reference
40 – 50 years	0.91	0.78 – 1.05	1.54*	1.21 – 1.96	1.64*	1.26 – 2.13
>= 50 years	0.83*	0.71 – 0.97	1.80*	1.43 – 2.27	1.17	0.89 – 1.54
BMI (kg/m2)						
Normal weight	1.00	Reference	1.00	Reference	1.00	Reference
Overweight	0.96	0.84 – 1,10	0.98	0.84 – 1.19	1.11	0.89 – 1.38
Obese	0.92	0.75 – 1.12	1.10	0.86 – 1.41	1.61*	1.22 – 2.11
Smoker	0.96	0.84 – 1.09	1.23*	1.04 – 1.45	1.28*	1.05 – 1.55
Physical work-related factors						
Manual material handling[a]	1.03	0.90 – 1.18	1.34*	1.13 – 1.41	1.61*	1.29 – 2.00
Awkward back posture[a]	1.09	0.94 – 1.26	1.10	0.91 – 1.32	1.23*	1.00 – 1.52
Whole body vibration	1.02	0.85 – 1.20	0.89	0.72 – 1.12	0.86	0.67 – 1.11
Psychosocial work-related factors						
Lack of control[a]	1.11	0.98 – 1.26	1.33*	1.13 – 1.61	1.13	0.94 – 1.38
Lack of support at work	1.08	0.90 – 1.28	1.14	0.91 – 1.41	1.23	0.97 – 1.58
Health indicators						
Lung restriction[a]	1.48*	1.07 – 2.03	2.34*	1.27 – 4.32	5.16*	3.07 – 8.66
Work ability index						
Excellent	1.00	Reference	1.00	Reference	1.00	Reference
Good	1.21*	1.05 – 1.40	1.65*	1.33 – 2.04	1.43*	1.10 – 1.85
Moderate[a]	1.39*	1.15 – 1.69	2.00*	1.54 – 2.59	2.90*	2.16 – 3.89
Poor[a]	0.91	0.55 – 1.53	1.51	0.88 – 2.61	3.18*	1.95 – 5.19

* P value <0.05
[a] significant trend

workers with lung restriction and workers with a less than excellent work ability. For sick leave between 2 weeks and 3 months older age, being a smoker, manual materials handling, lack of job control, lack of support at work, lung restriction, and lower work ability were important risk factors. Sick leave prolonging over 3 months was influenced by comparable risk factors as sick leave of moderate duration, as well as an additional effect of obesity and awkward back postures. The physical and psychosocial work factors as well as life style factors were associated with a lower work ability.

The analyses of the separate WAI dimensions showed that the most important predictor for sick leave, especially moderate and long spells were the number of current diseases diagnosed by a physician (dimension 3) and the reported work impairments due to disease (dimension 4). (Data not shown)

DISCUSSION

This study showed that the sickness absence among Dutch construction workers is a multifactorial phenomenon with individual, lifestyle and work related factors as important predictors of sickness absence, especially absence with prolonged duration. It also showed that for most of these determinants, there were trends of higher RRs with longer duration of sick leave. The work ability index was a good predictor of sickness absence, especially for longer duration of sickness absence.

Some limitations must be taken into account in this study. First of all, the data were drawn from the voluntary medical examination of workers and information on non-respondents was not available. It was estimated that about 60% of the invited workers took part in the examination. Therefore, we do not know whether unhealthy workers took part more in the physical examination or not. A selective participation may have influenced the results of our study, but the potential effect of this source of differential bias is unknown. Secondly, it is known that there is a substantial variation in quality of laboratory tests and spirometry measurements among the different occupational health services. A large measurement error will lead to a substantial underestimation of the importance of these measurements on future sickness absence.

While the association between overweight and sickness absence was non significant, obesity was associated with sickness absence longer than 3 months. In a literature review, Aldana and Pronk[31] showed that excessive body weight had the strongest association with absenteeism. It has also been shown that obese employees were 1.74 and 1.61 times more likely to experience high and moderate levels of absenteeism, respectively.[32] The association between smoking and increased risk of sickness absence confirms previous studies.[33,34] Contrary to the observed lack of an association between physical activity in leisure time and absenteeism in our study, other studies have shown a positive effect of physical activity on reducing sick leave over a period of four years.[35] There is also an inverse dose-response relationship between the frequency of vigorous physical activity and sick leave.[36]

Although job type had a significant influence on sick leave, we did not include this variable in the multivariate model, since job type was strongly associated with the occurrence of work related factors, especially physical work factors. The univariate analysis showed that the workers with white-collar jobs had fewer sick leaves than blue-collar workers (RR 0.72 CI 0.62 – 0.83) and this effect seems mainly caused by differences in physical workload.

The most common work factors that determined sick leave were manual materials handling and lack of control in moderate duration, and manual materials handling and awkward back postures in long duration sick leave. The effects of physical work on moderate and long spells of sickness absence were consistent with previous reports.[37] Uncomfortable working conditions, such as heavy physical work, monotonous movements, and high physical demanding job were found to be associated with sickness absence.[3,38-42] Finding from other prospective studies showed that stressful working conditions, such as low decision latitude, high job demands, and low work social support are related to sickness absence.[43-45] Despite the fact that several studies have investigated the effects of physical and psychosocial factors on absenteeism separately, only a few studies have analyzed the effects of psychosocial and physical exposure simultaneously on sickness absence.[38,46,47]

The restrictive pulmonary abnormality based on spirometry finding was a predictor of sickness absence. The Framingham risk score did not show any significant effect on absenteeism. Since the Framingham Risk Score has no obvious effect on worker's health, it may be expected that no association was observed.

Several studies have investigated the predictive value of WAI on early exit from the work force.[17,19,48] The result of this study showed that the WAI is a good predictor of sickness absence. These results are consistent with a previous study that suggested that work ability index is a predictor of long-term sickness absence.[19] Entering the WAI in the model has reduced the influence of physical and psychosocial work related factors on sick leave. Since it has been shown that up to 22% of variance in work ability can be attributed to physical and psychosocial factors, these factors have also an indirect effect on sick leave through their influence on WAI.[18] In long duration sick leave all dimension of WAI were important, and the health related dimensions (dimensions 3 and 4) showed higher RRs for sickness absence. For short duration sick leave the mental resources dimension showed a significant effect on absenteeism. Therefore, for long-term absence involvement of a disease is only one factor in the decision making process for taking sick leave. The "illness flexibility model” [49,50] clarifies the complicated relationship between different factors and the decision for taking sick leave or staying at work despite of illness. All of these factors have prompted many work places to create their own procedures to diminish lost work time due to sick leaves.[51] In this regard, it is of interest to note that for most predictors a significant trend was observed with higher RR values for longer duration of sickness absence and for sick leave over 3 months the influence of work-related risk factors and life style factors was of comparable magnitude.

CONCLUSION

This cohort study showed that physical and psychosocial work related factors and workers’ work ability as well as lifestyle factors were important determinants of sickness absence of longer duration. This multifactorial background of absenteeism asks for a variety of preventive activities at the workplace, aimed at life styles, working conditions, and workers’ work ability, in order to diminish sick leave and its subsequent burden.

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CHAPTER 7

Determinants of work ability and its predictive value for disability among Dutch construction workers

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Determination of work ability and its predictive values for disability among Dutch construction workers.
Submitted: Occupational Medicine

ABSTRACT

Aims: To analyze the effects of work-related physical and psychosocial factors and individual characteristics on work ability and to determine the predictive value of work ability and its underlying dimensions for future work-related disability.

Methods: A longitudinal study was conducted among 1154 construction workers of 40 years and older (response 74%, n=850) with 3 consecutive questionnaires on work-related risk factors, mental and physical health, and work ability, which was measured with the work ability index, based on 7 subscales on worker's capabilities, job requirements, and health. Disability was defined by receiving a disability pension that is granted to workers on sick leave after 52 weeks and who are unable to continue working in their regular job. A regression model was used to evaluate the effects of work-related factors and individual characteristics on work ability at baseline. A Cox regression analysis was conducted to evaluate the predictive value of work ability for entering the disability scheme and to determine which aspects of work ability contributed most to the predictive value of work ability.

Results: Several physical and psychosocial factors at work were associated with a lower work ability at baseline, together explained 15% of the variance, but had little prognostic value for future work disability during the average follow-up of 23 months. The hazard ratios for disability among workers with a moderate and poor work ability at baseline were 8 and 32, respectively. All separate scales in the work ability index had predictive power for future disability with the highest influence of current work ability in relation to job demands and lowest influence of diseases diagnosed by a physician.

Conclusion: Among construction workers a moderate or poor work ability was highly predictive for receiving a disability pension. Preventive measures should facilitate a good balance between work performance, health, and mental resources in order to prevent quitting labor participation.

Key words: work ability, construction, disability

Key messages

1. Among construction workers self reported work ability proved to be a strong risk factor for future work-related disability.
2. Current work performance, health problems and associated consequences for functioning and sick leave, and mental resources were important prognostic factors for future disability

3. Work-related physical and psychosocial factors were associated with a lower work ability at baseline but had little predictive power for future disability.

Policy statement

1. Occupational health measures aimed at preventing work-related disability should be tailored to workers with a reduced work ability, since they are at highest risk.
2. Preventive measures should facilitate a good balance between work performance, health, and mental resources in order to prevent quitting labor participation.

INTRODUCTION

There is ample evidence that construction workers have a higher risk of work-related disability than workers in less physically demanding jobs.[1-4] Manual materials handling, awkward postures, and repetitive movements are core determinants of physical load in the construction industry. Musculoskeletal disorders, cardiovascular diseases, and accidents represent the main causes of disability.[1,4-6] With an ageing work force, the proportion of construction workers at risk for disability is expected to increase in the near future.[7] Therefore, prevention of disability will become even more important in the construction industry.

In order to prevent workers from quitting the workforce due to (work-related) disability, the concept of measuring work ability has been developed as a valuable tool to tailor interventions at individual level. Work ability is described by the available resources in relation to work demands throughout an individual's working life.[7] In order to assess work ability, Finnish researchers have constructed the so-called work ability index (WAI), that combines subjective experiences of one's ability to cope with physical and mental requirements at work (performance at work) with information on diseases and consequent functional limitations and sick leave (health), and information on mental resources at work. The index is sensitive to changes in work conditions, health status, and physical fitness.[8] In a 4- year follow-up study construction workers a poor and moderate work ability were predictive for disability with relative risks of 10.7 and 5.4, respectively.[9]

Several studies on work ability have demonstrated clear effects of work-related physical and psychosocial factors and individual characteristics on work ability.[8,10,11] However, these studies have not addressed the important question which aspects of work ability are affected most by work-related risk factors and individual characteristics. In addition, the relative contribution of performance, health, and mental resources in the predictive power of work ability for future disability is largely unknown. This is clearly important for prioritizing interventions at the workforce. Thus, the aims of this study were to analyze the effects of work-related physical and psychosocial factors and individual characteristics on work ability and to determine the predictive value of work ability and its underlying dimensions for future work-related disability.

MATERIAL AND METHODS

Study population

A longitudinal study was performed among male Dutch construction workers who had participated in a voluntary periodic occupational health examination and were not (partially) disabled, retired or working outside the construction industry at the time of the examination. The initial selection started with a random sample of 1,000 workers aged 40 years and over who had participated in the examination during a 3-month period from September 2002 until November 2002. An additional selection of 195 workers was based on workers who started in an education program during the period April – December 2002, aimed at enhancement of work capabilities towards jobs inside or outside the construction industry.[12] From this initial study population of 1195 subjects, subjects were removed due to an incomplete medical examination (n=2), receiving a partial disability pension (n=8), or being woman (a too small group for analysis) (n=31), resulting in 1154 eligible participants.

During this medical examination a questionnaire was filled out on individual characteristics, working conditions, health problems, and work ability. In February 2003, workers were mailed a first follow-up questionnaire at their home address, on average about 5 months after attending the periodic health examination (follow-up 1). Respondents on this first questionnaire were sent two other follow-up questionnaires at fixed time intervals of approximately 9 months (follow-up 2 and 3), resulting in an average follow-up period of approximately 23 months. All questionnaires contained questions on work ability as well as work status: change of job to a job outside the construction industry, partial and full disability pension, or (early) retirement.

The annual participation in the regular medical examination in the construction industry in the Netherlands is estimated to be around 60% and it is expected that the participation in the current sample closely resembled the overall participation. The response on first follow-up questionnaire was 74% (n=850), with non-response (n=303) partly due to 41 (14%) incomplete questionnaires. The response to the second and third questionnaires, relative to response on the first follow-up questionnaire, was 70% (n=592) and 69% (n=583). In total, 450 workers completed all three questionnaires. Loss-to-follow-up (n=267) was partly determined by workers changing job towards other branches of industry (n=30) and workers taking (early) retirement (n=13).

Disability

In each questionnaire workers were asked about their current economic status with five mutually exclusive categories: paid work, retired, unemployed, disabled, or other. During the study period disability was defined by receiving a formal disability pension which is granted to a worker who has been on sick leave for 52 consecutive weeks and whose functional limitations are too severe to be able to continue in his regular job. The eligibility criteria for such a disability pension, as stated in national legislation, further stipulated that a substantial loss of income must be demonstrated as a result of the fact that the worker cannot perform paid employment at all or holds a new, less strenuous job with a much lower salary.

Work ability index

The work ability index (WAI) was measured during the medical examination as well as determined in each follow-up questionnaire.[9,11] The WAI consists of an assessment of the physical and mental demands of the individual in relation to his work, diagnosed diseases, functional limitations due to disease, sick leave, own prognosis of work ability, and mental resources.[9,13] The answers on each scale were translated into a weighted score and the index was derived as the sum of these scores. The range of this summative index is 7-49, which is classified into poor (7- 27), moderate (28-36), good (37-43), and excellent (44-49) work ability.[9] For the purpose of this study the original 7 scales were also used as separate dependent variables in the analysis.

Work-related factors

The questionnaire during the medical examination comprised questions on physical load and psychosocial factors at work. Physical load at work was determined by dichotomous questions on regular exposure to awkward postures, kneeling or squatting, manually handling of materials, whole-boy vibration, and hand-arm vibration.[14] A sum score across these 5 questions was also calculated (0-5) in order to dichotomize around the median value the study population into high and low physical load. Psychosocial factors were measured according to the demand-control model defined by Karasek on job demands, skill discretion, and job control.[15] An abbreviated version of the original questionnaire was used and job demands were assessed by means of a 7-item sum score, skill discretion by a 6-item sum score, and job control by a 5-item sum score. The median of each sum score was used to dichotomize the study population into workers with a high and a low psychosocial load at work.

Individual characteristics

During the medical examination information on age and job title was collected by questionnaire. The information on job title was used to categorize subjects into white and blue-collar workers. The questionnaire during the medical examination also consisted of questions on mental and physical health. Mental health problems were asked by 11 questions on the presence (yes/no) of fatigue, sleep disturbance, gloomy feeling, nervousness, irritability, stress, being exited, memory and concentration problems, and depression. These questions were largely similar to the EURO-D scale for depression diagnosis which defines a clinically relevant depression by a sum score greater than 3.[16,17] The sum score was used to dichotomize subjects to poor (more than 3 positive answers) and good mental health. Aspects of physical health were ascertained by dichotomous questions on the presence of regular chest pain, regular shortness of breath, and 4 questions on regular pain in back, neck, upper and lower extremities. The latter 4 questions were used to define the presence of musculoskeletal problems.

Statistical analysis

With respect to the first aim of the study, multiple linear regression models were used to analyse the associations between individual characteristics and work-related risk factors with work ability at baseline and with its separate scales. In each model a backward selection approach was used with a p-value of 0.10 or less for the initial selection of relevant variables, and only variables statistically significant at $p < 0.05$ were retained in the final models.

With respect to the second aim of the study Kaplan-Meier curves were produced to describe the trend over time in proportion of workers without a disability pension relative to the time since inclusion in the cohort. The analysis was stratified by a poor, moderate, and good/excellent work ability measured at baseline. A Cox regression analysis was performed with the Hazard Ratio (HR) as measure of association to study the relation between work ability and disability. Disability pension, loss to follow-up because of early retirement, and moving to another job outside the construction industry were considered censoring. All statistical analyses were carried out with SAS 8.2 statistical software package.

RESULTS

Table 1 shows the baseline characteristics of the study population. The cohort consisted of 17% white collar and 83% blue-collar workers. The average age was approximately 48 years. The mean work ability index was 38.7 and the proportion of workers with a poor or moderate work ability was 5% and 24%, respectively. The seven scales within the work ability index were highly correlated, with highest associations between scales 1 and 2 (Pearson's correlation coefficient 0.59), scales 2 and 7 ($r = 0.43$), scales 1 and 4 ($r = 0.41$), and scales 2 and 6 ($r = 0.41$). The average score on the scale on current diseases was 56% of the maximum score, whereas on all other scales the average score varied from 73% to 86% of the maximum score.

The loss-to-follow-up during the consecutive measurements was not related to work ability, but respondents in the first and second follow-up reported a slightly higher physical load, lower work demands, lower job control, and less skill discretion than construction workers who dropped out of the study.

Table 7.1 Characteristics of a cohort of 850 construction workers who participated in a voluntary medical examination at the start of the study

	Mean ± SD	Median
Individual characteristics:		
Age	48.4 ± 7.2	
White collar job	142 (17 %)	
Work-related factors		
Often awkward postures	234 (28%)	
Often kneeling and squatting	182 (21%)	
Often manual materials handling	398 (47%)	
Regular exposure to whole-body vibration	103 (12%)	
Regular exposure to hand-arm vibration	136 (16%)	
Work demand (0-7)	2.81 ± 1.84	3.00
Job control (0-5)	4.20 ± 1.23	5.00
Skill discretion (0-6)	4.35 ± 0.96	5.00
Work ability index	38.73 ± 5.75	
Excellent / Good	606 (71%)	
Moderate	204 (24%)	
Poor	40 (5%)	
Work ability index scales		
1: Current work ability relative to lifetime best (0-10)	7.7 ± 1.5	
2: Work ability in relation to demands at work (2-10)	7.9 ± 1.0	
3: Current diseases diagnosed by physician (1-7)	4.4 ± 1.8	
4: Work impairment due to diseases (1-6)	5.1 ± 1.2	
5: Sick leave in past year (1-5)	4.1 ± 1.1	
6: Prognosis of work ability 2 years from now (1-7)	6.2 ± 1.6	
7: Mental resources (1-4)	3.4 ± 0,7	

Table 7.2 Effects of work-related risk factors and individual characteristics on the work ability index in a cohort of 850 construction workers at the start of the study

	Univariate		Multivariate	
Variables	β	se	β	se
Intercept	–	–	41.98	0.43
Age (y) 45 and less	Reference		Reference	
45 - 50	-0.27	0.56	-0.65	0.53
Over 50	-1.26*	0.44	-1.48*	0.42
White-collar job	+2.23*	0.52		
Often awkward postures	-3.81*	0.42	-1.86*	0.54
Often kneeling and squatting	-3.54*	0.47	-1.41*	0.55
Often manual material handling	-2.70*	0.38	-1.25*	0.42
Regular exposure to whole body vibration	-3.53*	0.59	-1.59*	0.60
Regular exposure to hand-arm vibration	-3.35*	0.53		
High work demands	-1.69*	0.39		
Lack of job control	-1.57*	0.40	-0.85*	0.38
Lack of skill discretion	-1.66*	0.39	-0.92*	0.38
Total explained variance	–	–	15%	

*P< 0.05

Table 2 shows the effect of age, white-collar work, and work related risk factors on work ability at baseline. In the univariate analyses, all work related factors were significantly associated with a lower work ability at baseline. In the multivariate model all factors except job type remained statistically significant, albeit with a

Table 7.3 Univariate and multivariate Cox regression analysis on prognostic factors for becoming work disabled, expressed by hazard ratios (HRs) and 95%-confidence intervals, during an average follow-up period of 23 months among construction workers

	Univariate		Multivariate	
Factor	HR	95% CI	HR	95% CI
Age (y) 45 and less	1		1	
45 - 50	2.75*	1.14 – 6.63	3.11*	1.28 –7.53
Over 50	1.76	0.77 – 4.04	1.64	0.71 – 3.79
White collar work	1.54	0.55 – 4.36		
Often awkward postures	1.70	0.90 – 3.19		
Often kneeling and squatting	1.69	0.87 - 3.27		
Often manual material handling	0.66	0.35 - 1.26		
Exposure to whole body vibration	1.15	0.48 - 2.74		
Exposure to hand-arm vibration	1.15	0.53 - 2.51		
High job demands	1.24	0.66 - 2.32		
Lack of job control	0.85	0.45 - 1.64		
Lack of skill discretion	1.63	0.85 - 3.14		
Good/excellent work ability	1		1	
Moderate work ability	7.97*	3.35 – 18.98	8.09*	3.38 - 19.34
Poor work ability	32.39*	13.02 – 80.56	34.16*	13.73 – 85.00

* P<0.05

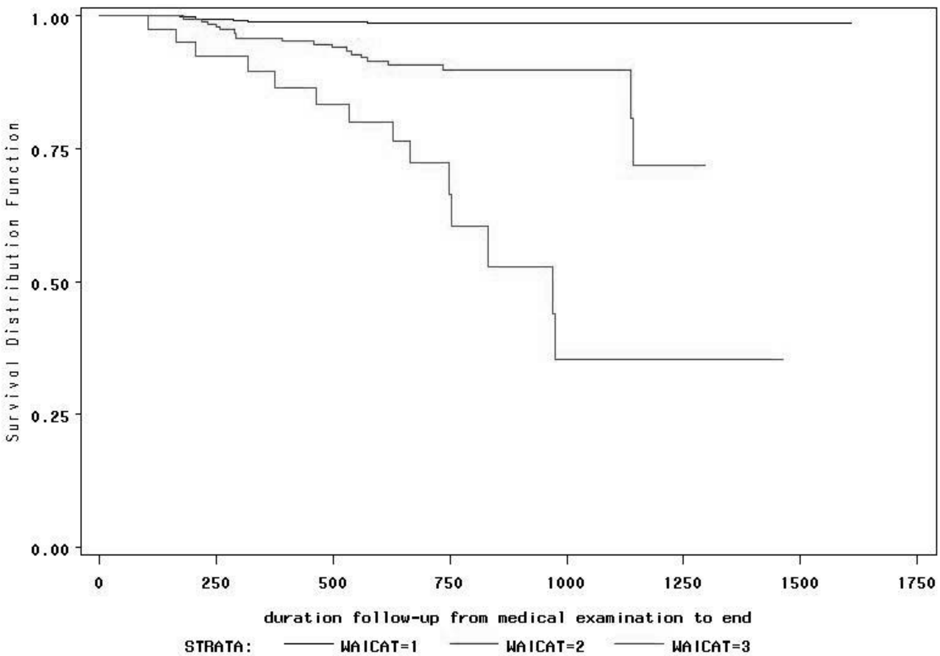

Figure 7.1 Survival time to becoming partially or fully disabled among construction workers, stratified by category of workability index

lower magnitude of the regression coefficient. These factors were explained 15% of the variability in the work ability index at baseline. Similar analyses for each separate scale showed that the highest age group had statistically significantly lower scores on all scales, except sick leave and mental resources. Work related risk factors were more strongly associated with the three scales on work ability and with mental resources compared with the three scales on health (data not shown).

During the follow-up period (with a mean of 22 months) 40 persons became partially or fully work disabled and were granted a disability pension. Figure 1 presents the Kaplan-Meier curve describing the proportion of workers without disability relative to time since follow-up for three categories of workability. In total, 7 of 606 (1%) workers with a good/excellent workability, 19 of 204 (9%) with a moderate workability, and 14 of 40 (35%) with a poor workability at baseline became disabled.

In the univariate and multivariate Cox regression analyses older age and a lower work ability index were significant prognostic factors for becoming disable during the average follow-up period of 23 months (table 3). A poor and moderate work ability score were highly predictive for becoming disabled with HRs of 32 and 8, respectively. Adjustment for age did not influence the predictive power to a large extent. None of the physical and psychosocial work related factors had a predictive value for becoming disabled. Interaction terms between work related factors and work ability score were not statistically significant. The analyses for each separate scale of the work ability index showed statistically significant HRs for all scales, with the highest predictive value for work ability in relation to demands at work (HR = 1.96 per point decrease) and the lowest predictive value for current diseases diagnosed by a physician (HR = 1.37 per point decrease).

DISCUSSION

This study found that the work ability of construction workers aged 40 and over strongly predicted receiving a disability pension during the 22 months follow-up period. Current work performance, health problems and associated consequences for functioning and sick leave, and mental resources were all important prognostic factors for future disability. Work related physical and psychosocial factors were associated with a lower work ability at baseline, but had limited predictive value for future work disability during the 28 months follow-up.

The strength of this study is its longitudinal design that enabled a Cox regression analysis to estimate the predictive power of the several risk factors and work ability index for work disability. However, a limitation of this longitudinal study is the substantial drop-out during the follow-up measurements, since only 49% of the selected construction workers had filled out the last questionnaire. The loss-to-follow-up during the consecutive measurements was not influenced by the magnitude of work ability, but respondents in the first and second follow-up reported a slightly higher occurrence of physical and psychosocial factors at work than construction workers who dropped out of the study. This differential selection in self-reported exposure frequency will most likely have had little impact on the predictive value of the work ability index for work-related disability during the follow-up, given the finding that the work-related factors were not statistically significant in the survival analysis. A second limitation of the study is the use of self-reported disability pension as proxy for work-related disability. The eligibility criteria for a disability pension only partly depend on a deteriorated health that has disabled the worker to perform his regular job. The assessment of loss of income associated with the level of disability is also part of the formal decision process and, thus, receiving a disability pension does not only reflect the incapability of performing work. In addition, in this study we were not able to analyse the effects of work, health, and work ability on other mechanisms of displacement from work in the construction industry, such as unemployment, retirement, or change of job towards other branches of industry due to the small number of these events in the study population.

At baseline age and physical and psychosocial work related factors determined 15% of the variation in work ability among workers (table 2). The importance of these determinants of workability have been reported in several occupational groups.[10,18-20] In another study in the construction industry work related factors explained 22% of the variability in work ability, but this study encompassed all age groups.[21] It has to be noted that in this study among construction workers the best part of the variability in workability could not be explained by physical and psychosocial work load. An important reason is most likely the crude assessment of work load based on dichotomous parameters. Another explanation is the importance of variables not accounted for in this study, most notably physical activity in leisure time [18,20], mental stress[19], and body mass index.[20,23]

During the average 23 months follow-up period the average work ability changed little and the duration of follow-up may have been too short to notice a substantial decrease in work ability. In a randomized controlled trial on a physical activity program the work ability also remained stable during the 24 months of follow-up.[24] In addition, Tuomi and colleagues have shown in a 11-year follow-up study that both the improvement and decline in work ability were associated more strongly with changes in work and lifestyle during the follow-up than with their initial variation.[25]

Our study has confirmed the finding that a poor or moderate work ability strongly predicts the risk of a work-related disability pension.[9,26] The fact that work-related risk factors were associated with work ability at baseline, but not predictive for disability during the follow-up period, suggests that physical and psychosocial factors at work are especially important in the balance between physical and mental requirements of the job and the capabilities of the worker. Within this regard, it was an important finding that every separate scale of the work ability index showed a statistically significant hazard ratio for future work ability. Hence, current work performance, health problems and associated consequences for functioning and sick leave, and mental resources were all important prognostic factors for future disability. The work ability index as combination of these aspects reflects the magnitude of personal balance between job requirements and capacities. The disbalance, as characterized by a moderate or poor work ability, was highly predictive for future work disability. Unfortunately, we did not gained access to the medical diagnosis underlying the work disability, thus, limiting the possibilities to evaluate the predictive power of work ability in relation to specific health problems for becoming disabled at work.

The work ability index was developed and applied to assess an individual's work ability.[7,8] Given its strong predictive power for future work-related disability, the concept of work ability offers a suitable framework for preventive intervention programs. These preventive programs should address the determinants of work ability, which include according to our study work-related physical and psychosocial factors at work, and the separate components of work ability reflecting performance at work, health, and mental resources. Other studies have also shown that lifestyle factors, most notably physical activity in leisure time, will influence work ability and, thus, could be address in preventive programs. However, the low explained variance in the analysis of determinants of work ability at baseline suggests that interventions on working conditions may have only a modest impact on work ability in the short term. As a consequence, interventions may need to focus more on the disbalance between health problems and associated functional limitations and an individual's capabilities to cope with the physical and mental requirements of work rather than addressing working conditions or health independently.

In conclusion, among construction workers a moderate or poor work ability was highly predictive for receiving a disability pension. Preventive measures should facilitate a good balance between work performance, health, and mental resources in order to prevent quitting labor participation.

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CHAPTER 8

General discussion

8.1. INTRODUCTION

There is ample evidence on the relation between unemployment and ill health, showing that unemployment may affect a person's health but also that health may determine the selection into and out of the workforce.[1] Education, sex, and lifestyle factors, such as alcohol consumption and obesity, are other important factors which are associated with early exit from work force.[2] Unemployment is only one mechanism of withdrawal from the labor force among elderly workers, since workers may also leave the workforce due to disability, or early retirement, partly depending on eligibility criteria and generosity of disability and retirement benefits.[3] Sickness absence, a multifactorial phenomenon, is an expression of the complex relationship between work characteristics and health.[4,5] Evidence is emerging that health problems with subsequent functional limitations may also cause a decreased productivity while at work .[6] Productivity loss at work, sickness absence, and displacement from the labor market are all signals of lack of sustainability of workers in the work force due to health problems.

In this thesis, first of all, we aimed to describe the association between perceived health and specific disease with early exit from work force. Secondly, we evaluated the relative influence of individual characteristics, health, life style factors, and physical and psychosocial work-related factors on work ability. Finally, the effect of a poor work ability on productivity losses at work, sickness absence, and permanent work related disability was evaluated.

In the first part of this thesis (chapter 2) the objective was to describe the effect of health on early exit from the work force in an aging population.

Since the work ability index (WAI) has been promoted in recent years as a valuable tool in occupational health programs, in the second part we focused on this index. The main aim in chapters 3 and 4 was to evaluate the effect of different individual characteristics, lifestyles and work related factors on worker's work ability.

In part 3 the specific contribution of a reduced work ability to productivity loss at work (chapter 5), sickness absence (chapter 6), and work-related disability (chapter 7) was investigated.

In last chapter, the results of the studies will be summarized and integrated, and some methodological issues will be discussed. The chapter ends with the main conclusions for practice and future research in this area.

8.2. MAIN FINDINGS

I. Association between health and early exit from the work force

The result from the SHARE (Survey on Health and Ageing in Europe) study showed that self-perceived poor health was associated with non-participation in the labor force. In a cross-sectional analysis among the study population of workers over age 50 in 10 European countries, 18% of employed workers reported a poor health, whereas this proportion was 37% in retirees, 39% in unemployed persons, and 35% in homemakers. It was also shown that, independent from self-perceived poor health, depression, stroke, diabetes, and musculoskeletal diseases were strongly associated with different types of non-participation in the labor force. A lower education, being single, obesity, and physical inactivity were significantly associated with any type of quitting work. These findings are of particular interest and have implications on policies and programs aiming at promoting healthy ageing by improving lifestyles behavior.

II. Relative influence of individual characteristics, lifestyles, and work-related factors on work ability

In chapter 3 it was found in a cross-sectional study that the work ability index among 19,753 Dutch construction workers was predominantly influenced by physical and psychosocial work-related factors. These work-related factors together explained 22% of variability in work ability. Individual and lifestyle characteristics and several physical health measures explained some variability in workers' work ability, but their contribution was low. It was concluded that in high physically demanding jobs, such as in the construction industry, psychosocial and physical work-related factors are the most important determinants of work ability.

Few studies have addressed determinants of work ability in occupational populations with predominantly mental demands at work. Results from chapter 4 showed that in a cross-sectional survey among white-collar workers in the commercial services industry psychosocial factors at work, stressful life events, lack of vigorous physical activity, and obesity were significantly related to a lower work ability. The influences of lifestyle factors on work ability were significant only for older workers. The strong associations between psychosocial factors at work and mental health and work ability suggest that in white-collar workers health promotion should address working conditions rather than individual life style factors.

III. Work ability as a determinant of productivity loss at work, disability, and sickness absence

A. Effect of poor work ability on productivity loss at work

The results of the cross-sectional study among 2,252 blue and white-collar workers from 24 different companies in 15 branches of industry in the Netherlands showed that about 45% of the workers reported some degree of productivity loss on the previous work day, with an average loss of 11% on a regular workday. In this study severe functional limitations due to health problems (one component of the work ability index) and lack of control at work were associated with productivity loss at work. About 10% of the productivity loss was attributed to health problems with limitations and 16% of productivity loss was attributable to lack of control. Therefore, based on finding of this study, health management at the workplace should consider interventions that increase the possibilities for workers with health problems to continue working according to their abilities.

B. Predictive value of the work ability index for sickness absence and permanent work disability

The follow-up study among Dutch construction workers in chapter 6 showed that sickness absence is a multifactorial phenomenon with individual, lifestyle, and work related factors as important predictors, especially absence with prolonged duration. The influence of work-related risk factors and lifestyle factors were of comparable magnitude. The results also showed that the work ability index was a good predictor of sickness absence, especially for longer duration of sickness absence. The multifactorial background of absenteeism asks for a variety of interventions at the work place in order to diminish sick leave and its subsequent burden.

The longitudinal study with 23 months follow-up showed that work ability of construction workers aged 40 and over strongly predicted receiving a disability pension. Work-related risk factors, health problems, and age were independent predictors of work-related disability in this study, but had limited additional predictive value for the decrease in work ability during the 28 months follow-up.

8.3. METHODOLOGICAL CONSIDERATIONS

I. General considerations

In the studies with cross-sectional design it is not possible to investigate the causality of the relationship between exposures and outcomes. For example, in chapter 2 further explanation of whether poor health determines labor force exit, or poor health is a consequence of becoming unemployed or retired is not possible. Previous studies have shown that both mechanisms are probably true.[1,7,8] Although the cross-sectional design of the study in chapter 3 does not allow an explanation of the causal relationship between work-related factors and work ability, similar effects of work-related factors on work ability were shown in a prospective study in chapter 7.

Given the low number of female worker in construction industry and consequently in our data on chapter 3, 6, and 7, the analyses was limited to male workers. Therefore, the effect of sex as a potential confounder was ignored in these studies. Several specific remarks concerning the validity of the studies have been made in this thesis. Below some general aspects of the internal and external validity of the studies are considered.

II. Work ability index

In the past decades the WAI questionnaire has been widely used in occupational health research as a method to evaluate the effects of intervention programs on work ability[9], and by occupational physician as a simple instrument to assess individual work ability in periodic health surveys. In order to fully appreciate the usefulness of the WAI aspects of reliability and validity need to be discussed.

A. Reliability

The reliability of a test refers to the degree to which the results obtained, can be replicated under identical conditions. There are four general classes of reliability, of which the two most important measures are discussed below:

Test-retest reliability: this method is used to assess the consistency of a measure from one time to another. The reliability of WAI was evaluated by means of the test-retest method over a 4 weeks interval, demonstrating an observed agreement of 66% with disagreement primarily a shift in 1 category .[10] The result of this study provides evidence of an acceptable reliability of the classification of a subject's work ability by means of this questionnaire.

Internal consistency: this method is used to assess the consistency of results across items within a test. Our results in the study population presented in chapter 6 showed that the Pearson correlation coefficients between WAI dimensions differed from 0.12 to 0.53. Only item 1 (subjective estimation of present work ability with the life time best) and item 2 (subjective work ability in relation both to physical and mental demands of work) were moderately correlated (Pearson's correlation coefficient = 0.53). The Cronbach's alpha across all 7 WAI dimensions was 0.7. With evidence for reliability[10] and internal consistency, the subjective assessment of work ability by WAI questionnaire seems to provide a good instrument.

B. Validity

The validity aspects focus on criterion validity, which refers to the extent to which the measurement correlates with an external criterion of the phenomenon under the study.

In chapter 7 it was shown that among those workers with a poor work ability 35% entered the disability scheme during the 2-year follow-up, whereas this proportion was much lower for those with a moderate work ability (9%) or a good work ability (1%). Disability was defined by receiving a formal disability pension which is granted to a worker who has been on sick leave for after 52 weeks and whose functional limitations are too severe to be able to continue in his regular job.

A Receiving Operator Characteristic (ROC) analysis was done to evaluate the most adequate cut-off point of the WAI score for predicting work-related disability as outcome (see figure 1). The WAI score of 36 yielded the highest sum of sensitivity and specificity and, thus, was regarded as the most appropriate cut-off point for screening susceptible workers for future work-related disability. This value of 36 coincides with the upper limit of the moderate work ability score. This cut-off point resulted in a sensitivity of 79% and specificity of 94%. The area under the cure was 0.894 (p<0.001).

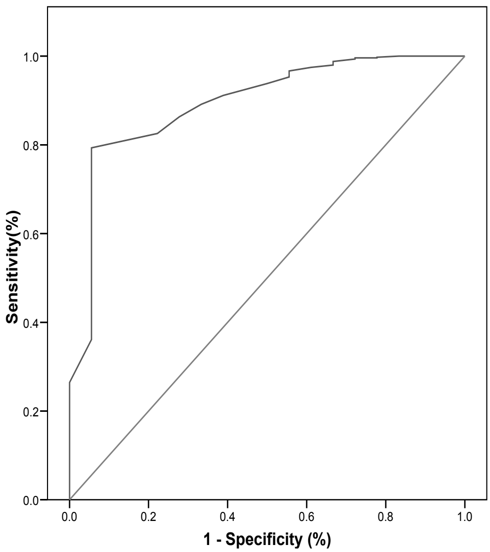

Figure 8.1 Receiver operator curve of the Work Ability Index for predicting work-related disability

Although the specificity of the outcome for 'poor work ability' as cut-off point was only moderate (33%), the WAI questionnaire can be regarded as a useful indicator for further diagnostic procedures since it identifies a reasonable proportion of those workers becoming fully or partially disabled in the next few years. Moreover, given the good specificity of a score as good/excellent work ability, when an expensive preventive intervention is to be implemented after screening a large group of workers, an instrument with a high specificity is preferred, to ensure that the intervention will be directed at individuals who will particularly benefit from it

Since our results from the Poisson model showed that the WAI is a good predictor for long duration sick leave (Chapter 6), a similar analysis was also conducted for sickness absence with a duration of 3 months or more (see figure 2). The ROC curve has an area under the curve of 0.649 ($p<0.001$), which illustrates that the Work Ability Index had limited power to adequately predict which workers were on sick leave longer than 3 months in the next 12 months. This is reflected in a low sensitivity (6%) and a low positive predictive value (9%) of a poor work ability for predicting sick leave lasting at least 3 months.

Additional analyses showed that the WAI dimensions 1, 2, and 4 were predictors of disability, whereas the WAI dimensions 3, 4, and 5 were determinants of long duration sick leave. The dimensions 1, 2, and 4 have a larger contribution to the total score of the WAI than the dimensions 3, 4, and 5 (maximum of 26 points versus 18 points, respectively). This difference in contribution to the total WAI score may partly explain why the WAI had a better predictive value for disability than for sickness absence.

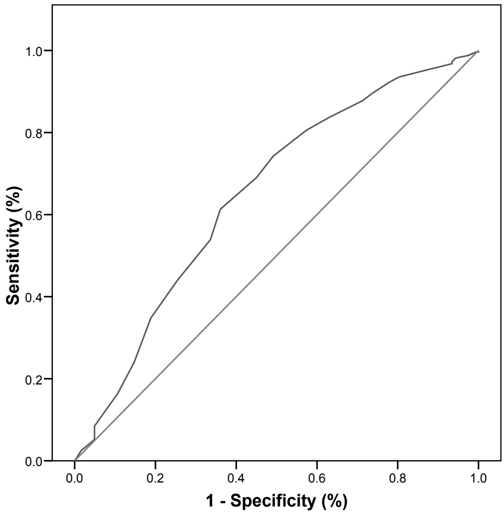

Figure 8.2 Receiver operator curve of the Work Ability Index for sickness absence lasting at least 3 months

In general, it could be concluded that especially the low sensitivity does not make the WAI a suitable test for identifying workers at risk for a longer duration of sickness absence. Again, it is implied that those workers with a poor work ability need to be investigated further before advising on a specific treatment or intervention.

III. Internal validity of epidemiological studies

Internal validity refers to the extent to which the results might be distorted by systematic errors. Three possible systematic errors are generally distinguished: selection bias, information bias, and confounding.[11]

For all of the studies in this thesis questionnaires were used. In chapter 2 the household response in the study population was 61.8%, with an additional response of 86.3% of members within a household. Since non-response bias depends on how much respondents and non-respondents differ with respect to the variables of interest, bias due to non-response could not be ruled out in this study. However, the overall response of SHARE was comparable with the response of the two official Europe-wide surveys (The European Community Household Panel, ECHP, and the European labor force survey, EU-LFP), but it was substantially higher than the response achieved by other cross-sectional community-based surveys on work and health in Europe.[12]

The study populations in chapter 3, 6, and 7 consisted of construction workers who participated in the voluntary periodic medical examination. In general, about 60% of all construction workers participate annually in this examination, which is offered about every 4 years. Therefore, we do not know whether the unhealthy workers took part more in the physical examination or not. A selective participation may influence the results of our study, but the potential effect of this source of bias is unknown.

The data on work-related risk factors, mostly dichotomous variables, were self-reported. This could bias the results, if there would have been a systemic difference in the answering of worker with outcome and them without outcome.

IV. External validity of epidemiological studies

The external validity of a study refers to generalizability of the study outcomes to people outside the study population, e.g. in another occupational group. Most of the studies in this thesis were conducted in occupational groups consisting of mainly blue-collar workers who experienced high physical work load.

Since the time that the concept of work ability originated, lifestyle factors, health and work management were considered important factors.[13,14] These factors were largely corroborated in the studies presented in this thesis. In the studies by Eskelinen et al.[15] and Nygård et al.[16] a good relationship was found between the subjective results of the WAI and the clinically assessed factors of health, including functional capacity. In our studies among construction workers and professionals the objective health measures, such as lung function and cardio-respiratory fitness, had little influence on the WAI when adjusted for physical and psychosocial working conditions.

Our study on the predictive value of WAI has also confirmed the finding that work ability strongly predicts the risk of disability.[17,18] The result of the follow-up study on determinants of sickness absence showed that the WAI is a good predictor for sickness absence. This result is consistent with a previous study that suggested that WAI is a predictor of long-term sickness absence.[19]

In concordance with our study on productivity loss (chapter 5) other studies have also reported a positive association between productivity loss at work and a reduced job control.[20,21] Therefore, in comparison with other findings we think that the external validity of our results in these studies is reasonable.

8.4. NEW INSIGHTS

Our results showed that in workplaces with high physical demands, psychosocial and physical work-related factors are the most important determinants of work ability. Among physical factors repetitive movements, static work postures, awkward back postures, and manual materials handling were the most important factors and among psychosocial factors, lack of support at work, high work demands and low job control had prominent effects on work ability. Although the important influence of work factors has been shown in other studies [22-26], it is the first time that physical and psychosocial factors were investigated together and, with mutual adjustment, showed a significant influence on work ability. We also found that in two occupational populations with great contrast, i.e. construction workers and professionals in commercial services, the lifestyle factors were less important than the work-related factors. Therefore, in these workplaces workplace interventions might have a great importance for maintaining the work ability among workers. Since perceived health and its consequences for functioning constitute a major part of the WAI, it is hypothesized that the improvement of work conditions may also contribute to workers' health. The finding in chapter 2 showed that for a sustained job, health per sè was important. Therefore, it might be assumed that, in addition to the direct effects on worker's health, improving work conditions can also prevent early exit from the work force.

Physical and psychosocial work-related factors and workers' work ability as well as lifestyle factors were important predictors of sickness absence of longer duration.

The new finding in the study of sickness absence was that for most of these indicators a significant trend was observed with higher RR values for longer duration of absenteeism. The fact that work-related risk factors after controlling for work ability index became non-significant suggests that the effect of these factors on sickness absence are partly mediated through work ability. This is also true for the relationships of lifestyles and individual characteristics with sickness absence. It seems that the WAI can be a suitable instrument in occupational health programs to monitor which workers may need additional investigation and guidance to maintain their performance at work and to prevent adverse effects in terms of sickness absence and long-term disability.

8.5. FINAL CONCLUSION ABOUT WAI

While the WAI index is a valuable and simple tool in occupational health research and practice nowadays, since it can subjectively evaluate the current balance between work demands and functional capacity of the worker, the disadvantages of this test should not be ignored. Within occupational health care one of the disadvantages is that the WAI measures the consequences of a reduced ability in terms of number of diagnosed diseases, and the health impairment due to these diseases (item 3 and 4). These dimensions could be poorly defined because of bias due to recall problems. To prevent this bias, based on our finding in chapter 2, one possible suggestion is to replace these dimensions with the questions on currently perceived health, since self-perceived poor health seems the most powerful predictor of work force exit. In conclusion, the WAI can be used in occupational practices at individual and group level. At individual level, workers who changed to a lower category of WAI need further investigation. A high prevalence of poor and/or moderate work ability in particular jobs can be an indicator of hazardous work place with high physical and psychosocial demands. Therefore, preventive measurements in these occupational groups for promoting work ability would prevent subsequent outcomes such as productivity loss at work, sickness absence, and work-related disability.

Within occupational health research a clear disadvantage is that the WAI measures both the ability to work (item 1 and 2) as well as the consequences of a reduced work ability in terms of number of diseases, health impairment due to these diseases, and sickness absence (item 3, 4, and 5). A potential improvement could be obtained by leaving out the question on experienced sickness absence in the past year, since sickness absence should be regarded as a potential consequence of a decreased WAI, and hence, should not be incorporated in the index itself.

8.6. RECOMMENDATIONS FOR FUTURE POLICY, RESEARCH, AND OCCUPATIONAL HEALTH PRACTICE

I. Policy

A. In chapter 2 it was demonstrated that ill health is an important factor of early exit from work force. Hence, in social policies to encourage employment among older persons, the role of ill health and its influencing factors needs to be incorporated. Health management at the workplace should consider interventions that increase the possibilities for workers with health problems to continue working according to their abilities.

II. Research

A. The predictive value of the WAI for work-related disability was good, but for sickness absence at best very moderate. These findings were observed among construction workers and need to corroborate in other occupational populations.
B. Physical and psychosocial work-related factors had an important influence on the WAI. Intervention studies on these work-related factors are required to demonstrate that a reduction in exposure to physical load and psychosocial aspects at work will lead to an improvement in the WAI.
C. The effects of a low WAI on early exit from the work force other than receiving a disability pension are largely unknown. Given the observed influence of ill health on displacement from the labor market, studies are required on the impact of a reduced work ability on unemployment and early retirement.

III. Occupational health practice

A. A decreased WAI indicates that the individual worker is at increased risk for future sickness absence and disability. Hence, it is advised to include the WAI in the regular medical examination in order to identify the workers whose work ability category has changed to the lower categories and to investigate whether preventive measures are required.
B. The average WAI in particular jobs may present useful information on those jobs that need workplace interventions. Occupational groups with a high prevalence of a poor or moderate work ability may be targeted for preventive interventions at group level..

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SUMMARY

In many countries through the industrial world the population is aging. Despite an increased life expectancy, improved living conditions, and better health status, the average time people spend in paid work is decreasing **(chapter 1)**. There are two main reasons for this paradoxical development. The first reason is the delay of young people entering the labor market due to a prolonged education, but the more important reason is that older workers are exiting the labor market in great numbers. There are several mechanisms of withdrawal from the labor force among elderly workers. Workers may leave the work force due to disability, unemployment, and early retirement. Many health problems, work related factors, life styles and individual characteristics are involved with early leaving of the labor force. In recent years, promoting work ability has been considered as an affirmative means to decrease work-related disability and early retirement. The concept of work ability expresses the interrelations between the productive potential of a worker, the worker's individual characteristics, and physical and psychosocial work related factors. Therefore, assessment of work ability should measure the ability of a worker to perform his/her job, taking into account the specific work-related factors, mental and physical capabilities, and health. The work ability index (WAI), a questionnaire-based method, constructed by Finnish researchers to operationalize the concept of work ability, has been promoted in recent years as a valuable tool in occupational health programs dedicated to decrease an early exit from the work force.

The specific objectives of this thesis are:

4) To describe the associations between perceived health and specific diseases with early exit from the work force
5) To evaluate the relative influence of individual characteristics, health, lifestyle factors, and physical and psychosocial work-related factors on work ability.

To investigate the effect of a poor work ability on productivity losses at work, sickness absence, and permanent work related disability.

The thesis begins with a cross-sectional study **(Chapter 2)** across 10 European countries, based on the Survey on Health and Aging in Europe, to determine the association between different measures of health and labor market participation. A large variation across European countries was observed for the proportion of persons 50-65 years with paid employment, varying among men from 42% in Austria to 75% in Sweden and among women from 22% in Italy to 69% in Sweden. Among employed workers 18% reported a poor health, whereas this proportion was 37% in retirees, 39% in unemployed persons, and 35% in homemakers. The results showed that a perceived poor health was strongly associated with non-participating in labor force in most European countries. A lower education, being single, physical inactivity, and a high body mass index were also associated with withdrawal from the labor force. Long-term illnesses such as depression, stroke, diabetes, chronic lung disease, and musculoskeletal disease were significantly more common among those persons not having paid employment.

The study in **chapter 3** describes the relative impact of individual characteristics, health, and work related risk factors on the work ability index (WAI). The study population consisted of 19,753 Dutch construction workers who participated in the voluntary periodic medical examination in 2005, with complete information on laboratory tests and spirometry. We found that physical work load and, to a lesser extent, psychosocial factors at work together explained 22% of the variability in work ability. Age, physical activity in leisure time, and lung obstruction explained about 9.3% of workers' ability to work, but when adjusted for work related risk factors their effects became very small. Factors with the highest influence on work ability were awkward back postures, static work postures, repetitive movements, and lack of support at work. It can be concluded that in high physical demanding jobs such as in the construction industry, work-related risk factors were the most important determinants of work ability. Therefore, interventions aimed at preventing construction workers from dropping out of the work force should primarily focus on reducing physical and psychosocial load at work.

The association of psychosocial factors at work, life and stressful life events on health and work ability among white-collar workers was described in **chapter 4**. A cross-sectional survey was conducted among workers in commercial services (n=1,141). The main outcome variables were work ability, measured by the WAI, and mental and physical health, measured by the Short-Form Health Survey (SF-12). Individual characteristics, psychosocial factors at work, stressful life events, and life-style factors were determined by a questionnaire. Maximum oxygen uptake, weight, height, and biceps strength were measured during a physical examination. We found that a lower work ability of white-collar workers in commercial services industry was strongly associated with psychosocial factors at work such as poor teamwork, poor stress handling, and less self-development and, to a lesser extent, with stressful life events, lack of physical activity, and obesity. Determinants of mental health were very similar to those of work ability, whereas physical health was influenced primarily by life style factors. With respect to work ability, the influence of an unhealthy lifestyle seemed more important for older workers than for their younger colleagues. In conclusion, among white-collar workers mental and physical health were of equal importance to work ability, but only mental health and work ability shared the same determinants. The strong associations between psychosocial factors at work with mental health and work ability suggest that in this study population health promotion should address working conditions rather than individual and lifestyle factors.

In a study population (n=2,252) from 24 different companies in the Netherlands in 2005-2006 about 45% of the workers reported some degree of productivity loss on previous work day **(chapter 5)**. Self-reported loss of productivity on the previous workday was measured on a 10-point numerical rating scale. We found that moderate and severe functional limitations due to health problems (OR=1.22 and 1.54 respectively) and lack of control at work (OR=1.35) were associated with productivity loss at work. About 10% of productivity loss was attributed to health problems with limitations and 16% of productivity losses at work was attributable to lack of control. In conclusion, productivity losses at work frequently occur due to health problems and subsequent impairments, and lack of control over the pace and planning of work. This loss of productivity will substantially contribute to indirect costs of work-related diseases.

The aim of the prospective study in **chapter 6** was to analyze the relative contribution of individual characteristics, lifestyle, working conditions, and work ability to the occurrence of sickness absence and to investigate whether these risk factors differed for the occurrence of short, moderate, and long spells of sick leave. Altogether 5,667 Dutch construction workers with complete sick leave registration were followed from the day of medical examination in 2005 until the end of the year 2006. The mean follow-up time until first sick leave was 369 days with maximum 699 and minimum 11 days. Poisson regression analysis was used to calculate rate ratios (RR) and 95% confidence intervals of each independent variable for occurrence of sick leave. The results showed that important predictors for sick leave were older age, obesity, smoking, manual materials handling, awkward back postures, lack of control at work, lung restriction, and a less than excellent work ability. For most predictors a significant trend was observed with higher RR values for longer duration of sickness absence. The influence of work-related risk factors and lifestyle factors was of comparable magnitude. Work and lifestyle also had an indirect influence through its associations with work ability. This multifactorial background of absenteeism asks for a variety of preventive activities at the workplace, aimed at lifestyles, working conditions, and workers' work ability, in order to diminish sick leave and its subsequent burden.

In **chapter 7** the predictive value of work ability for permanent work-related disability, relative to the effects of work-related risk factors were assessed. In a cohort of 785 construction workers aged 40 years and over with an average follow-up of 23 months work-related risk factors, mental health and physical health problems, and the work ability index were measured by 4 repeated questionnaires. Disability was defined by receiving a disability pension that is granted to workers on sick leave for 52 weeks and unable to continue in their regular job. Cox regression analyses were performed to study the predictive value of work-related and individual factors on disability and whether the effects of work-related factors had separate effects from work ability on future disability. A mixed model with repeated measurements was used to investigate the work-related and individual determinants of changes in work-ability during the follow-up period. This study showed that work ability strongly predicted receiving a disability pension during the follow-up period. Although work related physical and psychosocial factors, health problems, and age were independent predictors of work-related disability, the effects of workload and health problems largely disappeared when adjusted for the work ability index. Work-related physical and psychosocial factors, health problems, and age were associated with a lower work ability at baseline, but had limited additional predictive value for the decrease in work ability during the 23 months follow-up.

Chapter 8 reflects on the main finding and methodological considerations with regard to the studies in this thesis. The implication of the WAI and its usefulness are addressed. Based on the studies in the thesis, this chapter ends with general recommendation for future research in this area, and policy measures for preventing an early exit from labor force.

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Finally, I would never forget my father heartedness. I know he is resting in peace and I am sure he is very proud of my success. God bless his soul.

CURRICULUM VITAE

Seyed Mohammad Alavinia was born on September 20th 1967 in Tehran, Iran. After his graduation at high school (Hassan-abadi, Bojnord, Iran), he started medical school at the Iran University of Medical Sciences (Tehran, Iran) in 1985, and graduated in 1992. After graduation he worked as a general practitioner in remote and poor provinces in Iran to provide primary medical care. From 1994 till 1998 he worked at the Sabzevar University of Medical Sciences as "director of the health service" of the university. In 1998 he started his Master of Public Health (MPH) at Tehran University of Medical Sciences. For his MPH thesis he studied "the knowledge, availability, and usage level of safety products in technical workers". After graduation he worked as occupational physician in the occupational clinic in Sabzevar. In 2003, he received a scholarship from the Ministry of Health and Education to continue his study to obtain a PhD degree in Clinical Epidemiology, and at the same time he moved in to Bojnord to work as a director in the Imam-Ali Hospital. In September 2004, he started his study in Erasmus MC, Rotterdam, to obtain a Master of Science degree of Clinical Epidemiology at the Netherlands Institute of Health Sciences (NIHES), which he finished in August 2005. His manuscript produced for his graduation was "Interleukin-4 promoter gene polymorphism-524 C/T and Type diabetes mellitus: the Rotterdam study". He started his research described in this thesis in September 2005 at the Department of Public Health (head Prof. Dr. J. P. Mackenbach) of Erasmus Mc University. In the future he plans to continue his research in the field of occupational as an epidemiologist.