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Predictors of Early Retirement

A Population-Based Study in Men From Eastern Finland

Doctoral dissertation

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ABSTRACT

The present study cohort included 1,755 men from eastern Finland who were followed-up from 1984 to
2000. At baseline, the subjects answered a questionnaire about physical loading at work, psychological
factors and perceived health. Maximal oxygen uptake was measured by respiratory gas analysis during
a bicycle ergometer test. Pension records were obtained from the Social Insurance Institution of
Finland and the Finnish Centre for Pensions. During the follow-up 861 (49.1%) disability pensions and
331 (18.9%) non-illness-based early pensions were awarded. Only 273 (15.6%) men reached the old-
age pension age without being awarded early pension. The main reasons for disability retirement were
musculoskeletal disorders (n=342, 39.7%), cardiovascular diseases (n=236, 27.4%), mental disorders
(n=118, 13.7%) and other diseases (n = 165, 19.2%). Maximal oxygen uptake and the duration of the
exercise test were inversely associated with the risk of all disability pensions combined. Standing,
lifting, static muscular loading at work and uncomfortable working positions as well as a heavy
physical workload were associated with an increased risk of early retirement. A high depression score
and a poor perceived health predicted both illness-based and non-illness-based early pensions.

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To Vesa, Joona, Sofia, Eemil and Matilda

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ABBREVIATIONS

BMI   Body mass index

CI   Confidence interval

CVD   Cardiovascular disease

ECG   Electrocardiogram

ICF   International Classification of Functioning, Disability and Health

KIHD   Kuopio Ischaemic Heart Disease Risk Factor Study

OR   Odds ratio

RR   Relative risk

SD   Standard deviation

SII   The Social Insurance Institution of Finland

TEL   The Employees' Pensions Act

WHO   World Health Organization

VO_2max Maximal oxygen uptake

LIST OF ORIGINAL COMMUNICATIONS

This dissertation is based on the following original communications referred to in the text by their Roman numerals I-IV:

I.   Karpansalo M, Lakka TA, Manninen P, Kauhanen J, Rauramaa R, Salonen JT. Cardiorespiratory fitness and risk of disability pension: Prospective population-based study in Finnish men. Occup Environ Med 2003 60;765-9.

II.   Karpansalo M, Manninen P, Lakka TA, Kauhanen J, Rauramaa R, Salonen JT. Physical workload and risk of early retirement: a prospective population-based study among middle-aged men. J Occup Environ Med 2002 44;930-9.

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IV.   Karpansalo M, Manninen P, Kauhanen J, Lakka TA, Salonen JT. Perceived health is a strong predictor of early retirement. Scand J Work Environ Health. 2004 30;287-92.

CONTENTS

1. INTRODUCTION

During the past few decades Finnish society has gone through enormous structural changes just like many other Western societies. While agriculture employs fewer people than ever, more and more people work in the service industry and information technology (Myllyntaus 1992).

At the beginning of the 1900s Finland was an agricultural society. Over two-thirds of the Finnish population of 2.7 million people made their living through agriculture, and farmers worked as entrepreneurs. When they became old or disabled, they left their farm to their children, who in turn took care of their parents until they died. There was no pension security at all.

At the beginning of industrialisation there was only so-called poor-ware to take care of disabled or old workers, if there were no relatives to take care of them. Thus, it was necessary to create some kind of a social security system to support living after work life. At first employees founded various funds themselves, but later the idea of a good employer spread from Central Europe. Moreover, employers wanted to create factory funds. Later, also the State and municipalities joined in to build up pension systems (Niemelä 1988).

In Finland the change from a rural to an industrialised society and further to an information technology society may have happened faster than anywhere else in the world. Finnish people reconstructed the country after the Second World War, and in the 1970s and 1980s the pension systems were improved to help these feeble people to retire flexibly. Due to this, even though the working age population grew by 13%, the number of people retiring at working age grew by 62% during 1970-1995 (Hytti 1998). As a result, most people left working life through early pension systems by the beginning of the 1990s. Only 10% of working age people retired normally on the old-age pension. It means that the common pensionable age, 65 years, lost its meaning (Hytti 1998).

After the deep recession of the early 1990s, companies strengthened their financial basis by raising their productivity. Costs were also cut, which meant, among other things, that the amount of labour was reduced or kept low in order to accomplish the same or even better results than earlier. This tendency seems to have continued. This is one of the reasons why employers want to encourage older and handicapped employees to retire and to hire younger and healthier workers instead. Handicapped workers may also feel inadequate and stressed in this more intense working atmosphere, and many workers want to leave working life before the normal retirement age. This has been possible because it has been relatively easy to retire, particularly after the age of 60.

Monitoring the retirement age started with the work of the Pension Committee in 1990. The Committee set the aim of rising the mean retirement age by one or two years per decade from 58 years in 1990 until 2020 (Eläkekomitea 1991). The same committee discussed whether the retirement age should be calculated using the mean or median. Depending on the method of calculation, the retirement age has varied between 58 and 60 since the 1990s (Hytti 1998). Many factors have an effect on the retirement age, and it is not a very good indicator of whether people stay in working life longer. For example, if employees are ageing, the mean retirement age will increase even if the number of people wanting to retire remains the same in age cohorts. The mean retirement age may also be influenced by legislation, such as the legislation regarding new pensions and new age limits for pensions (Hytti 1998).

At the time this study was started there was wide-spread discussion about the so-called pension bomb. Education takes more time than it has previously taken and young adults start their working life later than before. The age cohorts reaching working life are smaller than before. At the same time, older workers disappear from the labour market before the age of 60 on average. Perceived health is better than ever among retiring Finns. Even though life expectancy has increased, active time has not increased (Hytti 1998). Instead, retirement is longer. In 2003 only 14.9% of all retirees stayed in working life until the age of 65 years or more in Finland (Finnish Centre for Pensions 2005). The large age cohort born after the Second World War will retire during the next few years. Thus, there will be fewer working people than before in the near future. All this has prompted wide discussion about the possibilities and necessities of controlling early retirement.

There are many possibilities for solving this problem. One of them is a pension reform that took effect in 2005 in Finland. Nowadays it is possible to retire flexibly after the age of 63, while working longer has been made more tempting. In addition, various vocational rehabilitation methods and activities supporting work ability have been created. However, early retiring is a multietiologic phenomenon; individual, social and work-related risk factors are involved. It would be important to recognise and control the risk factors for early retiring. There are few longitudinal studies that deal with the individual and work-related risk factors of early retiring. The purpose of the present study was to find out such modifiable risk factors in a follow-up study among middle-aged men.

2. REVIEW OF THE LITERATURE

2.1 Pension system in Finland

There are two complementary pension systems in Finland: earnings-related pensions linked to past employment and the national pension linked to residence in Finland. Both systems include a wide range of retirement benefits for specific contingencies. All Finnish citizens over 16 years of age who live permanently in Finland are insured by the national basic pension system. It is granted not only for those who are Finnish by birth but also to foreigners who have lived in Finland for at least five years after the age of 16 years. The employee's pension scheme is for those who have either been in an employment relationship or have had a civil service post. The Employees' Pensions Act (TEL) insurance is arranged with a pension insurance company, an industry-wide pension fund or a company pension fund. Insurance must be arranged immediately when the employee comes within the scope of the TEL or within a period of three months from the start of employment. A new contract of employment is also regarded to have started after an employee returns to work after unpaid leave that has lasted for more than a year. There are specific insurance institutions for state and municipal employees. There are some differences in the bases of pension legislations between these companies, but the main principles are the same.

The old-age pension, disability pension, unemployment pension and widows'pension are paid from the basic pension system. The common age of old-age pension in Finland is 65 years. The pension age is lower in some occupations. The old-age pension can be granted as an early old-age pension at the age of 60 to 64, but the pension is smaller and remains smaller even after the age of 65. In 2004 only 14.9% of all retirees stayed in working life until the age of 65 or more in Finland (SII 2000).

Disability pension is granted if an illness, defect or injury causes a decrease in earnings or prevents the person from working. A disability pension can be either a full or part-time pension. The full disability pension is granted if the working capacity is reduced by at least three-fifths and by two-fifths for the part-time disability pension. After sick-

leave for a single disease has reached 300 days the disability pension should be applied. Disability pension can also be granted as a temporary pension, a rehabilitation subsidy, if it is reasonable to assume that rehabilitation would improve working capacity. It is granted during rehabilitation or the treatment of an illness.

In pension insurance companies, disability pension applications are settled mainly on the basis of a statement made by a team of multidisciplinary experts in insurance medicine. The assessment of working ability is based not only on the medical clarification but also on the information concerning the applicant's working history and social matters. The final pension decision is made at the pension insurance companies, pension divisions, or by the boards of the pension foundations or funds (Finnish Centre for Pensions 2004).

Until the end of 2004, it was possible to apply the disability pension as an individual early pension if a person was 58 to 64 years old and had worked for a long time and working capacity had been reduced to the point that it was not appropriate to continue working. This system was established in 1986 to facilitate the retirement of incapacitated persons who were born after the Second World War and helped rebuild our country. After the beginning of 2005, the individual early retirement pension is intended only for employees and self-employed persons who were born before 1944 and who have had a long history of work.

At the end of the 1970s and the beginning of the 1980s, there was powerful growth in the public economy and it was thought to be possible to let older workers retire. The unemployment pension for employees who were 60 or older came into force in 1971. At the end of the 1970s the age limit for the unemployment pension was lowered first to 58 and later to 55 years. When the economic depression and unemployment hit at the beginning of the 1990s, the age limit was raised back to 60 years and the requirements were further tightened after that. The unemployment pension is granted to the applicant if he or she has been unemployed for 500 days and is 60 to 64 years old. He or she must have worked at least five years during the last 15 years.

There have been some changes to Finnish pension security during the course of this study and further changes happened during 2004 and 2005 (Table 1). The most

important changes that took place during the present study were the implementation of an individual early retirement pension and the possibility to retire on an old-age pension predated in 1986. A part-time pension also became valid in 1987. The age limit for the unemployment pension was raised gradually from 55 to 60 years during 1986-1990. The age limit for the part-time pension was lowered from 60 to 58 in 1994 and further to 56 years in 1998. The age limit for the individual early retirement pension was 56 years to begin with, but it was raised to 58 in 1994 and to 60 in 2000. After the follow-up of the present study, the age limit of the part-time pension has risen from 56 back to 58 years in 2003. Meanwhile also the financial losses in the part-time pension also became greater.

The extensive pension reform took place in 2005, when several changes came into effect. An earnings-related pension accrues on all earnings between the ages of 18 and 68. A pension also accrues on the basis of earnings-related social security benefits, parenthood allowance, child home care allowance and periods of study. The amount of the earnings-related pension is affected by annual earnings and the age-related pension accrual rate. The accrual rate is a figure that indicates the amount of pension accruing from the wage or the earnings from self-employment. The main rule is that the earnings-related pension accrues at a rate of 1.5 per cent of the annual earnings. The pension accrual increases as the employee or self-employed person grows older. A person who has reached the age of 53 accrues a pension at the rate of 1.9 per cent of his or her annual earnings, and a person who has turned 63 accrues a pension at the rate of 4.5 per cent. The pension accrues at a rate of 1.5 per cent a year on the earnings on which social security benefits are based. If a person has earnings in addition to the old-age pension, new pension rights accrue on the basis of these at a rate of 1.5 per cent regardless of the person'age. There is no upper limit for the earnings-related pension. If the pension starts as a disability pension and the pension component for projected pensionable service is included, less pension will accrue than while working. The pension accrues on the basis of the earnings for projected pensionable service as follows: by 1.5 per cent a year up to the age of 50, and by 1.3 per cent between the ages of 50 and 63. In some situations, the pension accrual rates in the public sectors differ from those in the private sectors. Pension accrual rates may also be different in the maritime sector.

In 2005 one of the disability pensions, the former individual early retirement pension was abolished. Individuals aged 60 or 61 are no longer entitled to this pension, but they can seek disability pension on relaxed vocational criteria. Unemployment pension for those born in or after 1950 was also abolished. This will be compensated by daily unemployment benefit. To summarise, retirement benefits have been cut to some extent, but the system is trying to reward those who stay in working life longer.

Table 1. Current pensions, changes in pensions during 2004 and 2005 and changes during the follow-up in Finland.

Pension	Until the end of 2004	Since the beginning of 2005	Changes during the follow-up (year)
Old-age pension	Full pension at the age of 65 years Early old-age pension at the age of 58/60-65 years - pension is permanently reduced by 0.4% per month Old-age pension after 65 years of age - pension is permanently increased by 0.6% per month	Full pension at the age of 63 years Early old-age pension at the age of 62-63 years - pension is permanently reduced by 0.6% per month Old-age pension after 63 years of age - pension accrues by 4.5% per year at the age of 63-68 years and by 0.4% per month thereafter	Predated old-age pension - Age limit 60 years (1986) - Age limit 58 years (1989)
Individual early retirement pension	- 60-64 years of age - permanently reduced working capacity - long work history - reduced ability to cope with work demands - working hours are already reduced to minimum	- became obsolete	- Age limit 55 years (1986) - Age limit 58 years (1995), gradually - Age limit 60 years (2000)

Part-time pension	- 56/58 years of age
	- Old-age pension accrues during part-time pension:
	  • <60 years of age 1.5% per year
	  • 60 or more years of age 2.5% per year
	- Old-age pension accrues based on the reduction of the income was 1.5% per year.
		The change came into effect in 2003 (old terms are still valid for those born in 1946 or before).
		- 58-64 years of age.
		- Old-age pension accrues during part-time pension until the age of 63 years:
		  • <63 years of age 1.9% per year
		  • 63-68 years of age 4.5% per year
		- Old-age pension accrues based on the reduction of the income is 0.75% per year.
			- Age limit 60 years (1987)
			- Age limit 58 years (1989)

		- Age limit from 55 to 60 years gradually (1986) - Age limit 60 years (1990)
Unemployment pension	- Between 60 and 64 years - Unemployment allowance for at least 500 days - In employment for at least 5 years out of the previous 15 years	- Pension will not be awarded to those born in 1950 or before. It will be compensated by the daily unemployment benefit.

Disability pension	The amount of the pension is calculated based on
	- Previous income starting from 23 years of age (pension salary)
	- Projected pensionable service is taken into consideration if employment did not end more than 360 days before being disabled. It is calculated as follows:
	   • At the age of < 50 years 1.5%
	   • At the age of 50-60 years 1.2%
	   • At the age of > 61- 65 years 0.8%
		The amount of the pension is calculated based on
		- Previous income if there is no right for projected pensionable service. The pension salary will be taken into consideration until the end of 2009.
		- Projected pensionable service is taken into consideration if income is at least € 12,566.70 during previous 10 years. It is calculated based on the income 5 years before becoming disabled as follows:
		   • At the age of < 50 years 1.5%
		   • At the age of 50-63 years 1.3%

2.2 Pension system in other countries

Pension security in industrialised countries is very similar although the structure of the systems varies a lot (Table 2). In most countries the pension system is divided into three parts: Minimum pension security, employee pension security and an additional pension security. There are a few countries, such as Austria, Germany, Greece, Luxembourg, Switzerland and the United States, where there is no statutory minimum pension security at all. In these countries pension provision is based on employment and basic security is handled by social security. Canada, Great Britain, Japan, New Zealand and the Nordic countries, except Iceland, have a national basic pension system, but the payable pensions vary by country. Employee pension security is usually more comprehensive than the minimum pension security. Only Austria, Israel and New Zealand have no work-based pension system at all. However, additional pensions are possible in all countries. The common pensionable age in most countries is 65 years (Table 2), but in many countries the pension age is lower for women. The age limit for women is expected to be raised to the same level as it is for men during the following 15-20 years.

It is evident that Sweden and Norway, for example, have tried to achieve full employment. When ageing employees start to find it difficult to cope at work, they are encouraged to choose part-time work, society-financed retraining, or subsidised or sheltered work whereas in Central Europe the alternative has quite exclusively been either pension or unemployment security (Kohli 1991; Wadensjö 1991; Hytti 1993). In this regard, Finland belongs to the same group as the countries in Central Europe (Kangas 1992).

Table 2. Pension system in different countries (Laitinen-Kuikka and Bach 1999).

	Minimum pension security						Employee pension security								
	National basic pension system	Old-age pension	Disability pension	Family pension	Additional pension	Living support	Old-age pension	Disability pension	Family pension	Early or part-time pensions	Obligatory additional pension security	Voluntary insurance	Pension system for entrepreneurs	Additional pension security for statutory employee pension security	Common pensionable age in 1999 (men/women)
Australia		x	x	x			x	x	x	x		x	x		65/61
Austria						x									65/60
Belgium		x	x				x	x	x	x		x	x		65/61
Canada	x	x		x			x	x	x	x					65/65
Denmark	x	x					x		x	x					67/67
Finland	x	x	x	x			x	x	x	x	x		x		65/65
France		x	x				x	x	x	x	x	x	x		60/60
Germany						x	x	x	x	x		x	x		65/65
Great Britain	x	x	x	x	x		x	x	x	x				x	65/60
Greece						x	x	x	x	x	x	x	x		65/65
Ireland		x	x	x			x	x	x	x		x			65/65
Island		x	x	x			x	x	x	x	x	x			67/67
Israel		x	x	x											70/65
Italy		x	x				x	x	x	x		x	x		64/59 [1]
Japan	x	x	x	x			x	x	x				x		65/65
Luxembourg						x	x	x	x	x		x			65/65
New Zealand	x	x	x	x											62/62
Norway	x	x	x	x			x	x	x	x					67/67
Portugal		x	x	x			x	x	x	x		x			65/65
Spain		x	x				x	x	x	x		x	x		65/65
Sweden	x	x	x	x			x	x	x	x		x			65/65
Switzerland						x	x	x	x	x	x	x	x		65/62
The Netherlands		x	x	x	x			x		x					65/65
United States						x	x	x	x	x		x			65/65 [2]

1) Common pensionable age rose to 65 years (men) and 60 years (women) in 2001.

2) Common pensionable age will rise to 67 years during 2000-2022

2.3 Retirement in Finland between 1984-2000

Disability and unemployment pensions in Finland during the follow-up period of the present study are shown in Figure 1. Granting individual early pensions began in 1986, which explains the increased number of all disability pensions. Figures from 1996 to 2000 are not quite comparable with those before, because in 1996 the national pension became limited by the employee pension. After this, nearly half of the retirees were not granted a pension from the Social Insurance Institution of Finland and mainly had pensions from employee pension institutions — not all the details for these statistics are available yet. The first proper general statistics, which cover all new disability pensions in Finland after this change, appeared in 2000. Due to the differences in compiling statistics, the numbers are still not directly comparable with the former period. The figures after 1995 are estimates calculated by the Finnish Centre for Pensions, which is the central body of the Finnish statutory earnings-related pension scheme and an expert in pension provision.

Figure 1. Unemployment, disability, and individual early pensions during 1984-2000 in Finland (SII 1985-2000).
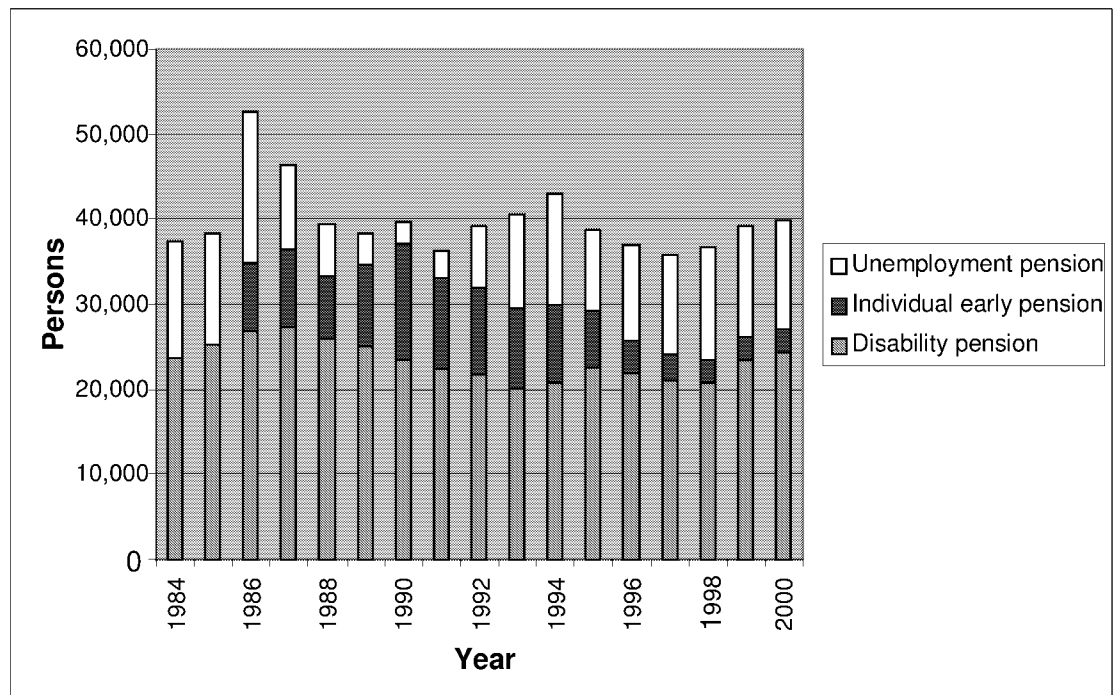
Figure 2 shows the primary diagnoses for disability pensions in the whole of Finland during the follow-up period of the present study. The reasons for granting disability pensions have changed quite a lot and the most significant change is an increase in the proportion of mental disorders. The relative proportion of musculoskeletal disorders and cardiovascular diseases has decreased to some extent.

Figure 2. Diagnostic reasons for disability pensions in Finland in 1985, 1990, 1995 and 2000, mean of these values and retirement of the study population during the same period (SII 1985-2000).
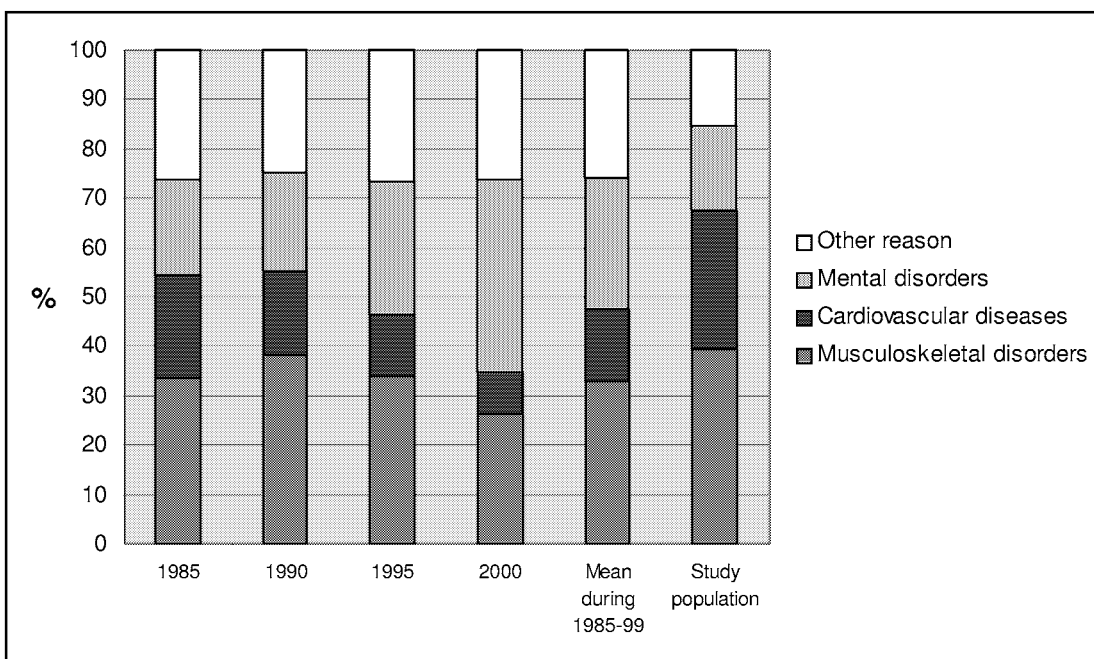
2.4 Definition of disability

Diseases cause impairment in the human body and lead to a decrease in functional capacity (disability), which can also handicap an employee depending on their occupation (WHO 1980). After 2001 the International Classification of Functioning, Disability and Health (ICF) framework views disability and functioning as outcomes of interactions between health conditions (diseases, disorders and injuries) and contextual factors. These contextual factors include external environmental factors and internal personal factors. In the ICF framework, disability involves dysfunction at one or more of three levels: body or body part, whole person or person in a social context (WHO 2001). The medically similar impairment in functional capacity can result in different degrees of handicap depending on the person's occupation or work tasks. Work ability is the sum of many factors. It is based on an individual's physical, psychological and social ability, which should be in harmony with the demands of the work. Work disability can develop if either the individual's work ability worsens or the demands of the work increase (Gould et al. 1991). If we think about retirement from the viewpoint of the insurance system, disability is not just an individual event; it changes dynamically over the course of the time and social development (Hännikäinen 1989).

2.5 Assessment of disability and work disability in epidemiological studies

Disability and work disability are complex phenomena and thus difficult to assess. In order to receive services from many programmes (federal, state and private) it is often necessary to meet some kind of eligibility criteria. Sometimes this is financial, other times it is medically based on how significantly the health issues or disability have an impact on daily life, and sometimes it is both. A person with a disability is generally defined as someone who has a physical, mental or social impairment that substantially limits one or more major activity in life. In literature the term disability has various meanings, but in this study a person with a disability means a handicapped person while work disability is used to mean incapacity for work. In some studies work disability has been measured by the number of sick leave days (Nygård et al. 1991; Tuomi et al.

1997), some studies have used self-administered questionnaires (Nygård et al. 1991; Kouzis and Eaton 1997; Tuomi et al. 1997; Armenian et al. 1998), while others have assessed various physical factors to find out deficiencies in working ability (Nygård et al. 1991; Ormel et al. 1999; van Heuvelen et al. 2000). In questionnaires, subjects have been asked, for example, to estimate their present working ability compared with their personal best and in relation to both the physical and mental demands of the work. Questions asked may also deal with disability in daily activities, for example in getting in and out of bed, dressing and undressing, taking a bath or a shower, using a toilet, or using a knife and a fork (Armenian et al. 1998). Some studies have included specific questions on musculoskeletal (Nygård et al. 1991) or psychological disability (Kouzis and Eaton 1997). In Finland, a specific work ability index has been widely used since 1981 to estimate an employee's working ability particularly in the occupational health field both in research and clinical practice (Ilmarinen 1999). It is not used, however, in pension insurance companies when they are deciding whether to accept or refuse a pension application.

Disability pension is used much less as a measure of work disability, even if it is a purely social endpoint and thus could be more reproducible and comparable internationally despite the differences in pension systems. The studies on disability pension are based on self-assessed questionnaires (Krause et al. 1997) or pension records obtained from official pension institutions (Tuomi et al. 1991c; Manninen et al. 1996; Manninen et al. 1997; Biering-Sørensen et al. 1999).

2.6 Risk factors for early retirement

Reasons for taking early retirement have only been studied more intensively since the 1990s. Not much is known of the factors underlying early retirement. The complexity of the concept of disability does not make understanding the phenomenon any easier. Varying legislation also make it difficult to compare the situation in different countries.

However, the risk factors of early retirement can be classified into three groups. First, social decisions, such as pension legislation, common social politics and labour force policy are the basis on which everything is founded (Hytti 1998). Second, working life

itself partly determines whether people continue working or leave work. The third factor is the actual individual who alone is a rather complex entity.

According to Gröhn, working life and conditions are the cornerstones in the retirement process (Gröhn 1991). It is not the attitude to work but the quality and benefits associated with the work, which have an effect on the process. Many work tasks, working environment, and working hours create stress (Gröhn 1991). Gould showed that one third of early retirees would have continued working if their working conditions had been made more convenient or if their health had been improved by rehabilitation (Gould et al. 1991). The factors that kept employees in working life were clarity of tasks and responsibilities, use of automation, learning the new things that were necessary at work as well as the possibility to regulate tasks and to participate in planning them. In a long prospective study by the Finnish Institute of Occupational Health, older employees' subjective work ability was reduced by work demands which were too great, a heavy and dangerous working environment, and poorly organised work (Tuomi et al. 1991a). Instead, minimising work-related psychological stressors improved working ability.

Disability itself has been studied a lot, but not many studies have been carried out on risk of having to take disability pension (Table 3). Moreover, the actual reasons for disability can only be clarified in a prospective study setting. Individual factors that lead to taking an early pension are still largely unknown. Even if illness is the essential factor (Gould et al. 1991), the final decision for applying for disability pension is based on other factors too. In many studies concerning the early retirement of chronically ill people, factors other than medical reasons have explained working disability better than the illnesses (Mitchell et al. 1988; Milhous et al. 1989; Pincus et al. 1989; Mark et al. 1992). These factors include age (Verbrugge et al. 1991; Biering-Sørensen et al. 1999; Sorvaniemi et al. 2003), being male (Nagi 1976; Pincus et al. 1989; Hytti 1993), being overweight or obese (Rissanen et al. 1990a; Mäkelä et al. 1993; Månsson et al. 1996; Narbro et al. 1999a), smoking (Biering-Sørensen et al. 1999; Krokstad et al. 2002), alcohol consumption (Månsson et al. 1999; Upmark et al. 1999b), physical inactivity (Biering-Sørensen et al. 1999; Krokstad et al. 2002), low educational level (Nagi 1976; Mäkelä et al. 1993; Krokstad et al. 2002) or socioeconomic status (Månsson et al. 1998; Månsson and Merlo 2001) and physically and mentally demanding work or poor

working postures (Bongers et al. 1988; Tuomi et al. 1991b; Vingård et al. 1992; Mäkelä et al. 1993; Krause et al. 1997; Holte et al. 2000). Poor self-reported general health, which is not exactly a medical condition either, has been shown to be one of the most important predictors of taking an early pension (Biering-Sørensen et al. 1999; Månsson and Merlo 2001; Månsson and Råstam 2001; Krokstad et al. 2002; Månsson et al. 2002). Longitudinal studies concerning risk factors for disability pension are shown in Table 3.

Table 3. Prospective studies on disability pension (+ risk of disability pension is increased, - risk of disability pension is decreased).

Authors	Study subjects	Age at baseline	Follow-up time	Objective measurement	Predictor for disability pension
Appelberg et al. 1996	15,348 Finnish subjects (8,021 men, 7,327 women)	24–65 years	6 years	Official pension registers	(+) Interpersonal conflict
Biering-Sørensen et al. 1999	892 Danish subjects (442 men, 450 women)	30, 50 or 60 years	15 years	Peak flow and isometric endurance of the back muscles, official pension registers	(+) Age, various illnesses, self-reported poor general health in last year, low general health risk-score by a doctor, unemployment, sick leave, low physical activity in leisure time, self-reported worse physical condition than those at the same age, smoking
Bongers et al. 1988	743 Dutch male crane operators with more than 5 years of exposure to vibration	20-60 years	10 years	Measurement of vibration, systematic coding of all disability pensions by the same (social insurance) physician	(+) Vibration increases the risk of disability pension due to intervertebral disc disorders. Combination of unfavourable postures and climatic conditions also involved.

Borg et al. 2001	213 Swedish subjects (84 men, 129 women)	25-34 years	11 years	Official pension registers	(+) 20 days or more sick leave owing to neck, shoulder or back diagnoses
Borg et al. 2004	213 Swedish subjects (84 men, 129 women)	25-34 years	11 years	Official pension registers	(+) 90 days or more sick leave owing to neck, shoulder or back diagnoses. Risk was higher in women.
Gamperiene et al. 2003	12,802 Norwegian women	20-49 years	10 years	Official pension registers	(+) Disability pension rates were higher among cleaners than among other women in unskilled occupations (+/-) The risk of disability pension did not increase with increased exposure to cleaning
Gjesdal and Bratberg 2003	10,077 Norwegian subjects (4,432 men, 5,645 women)	< 60 years	3 years	Official pension registers	(+) Age, part-time employment, duration of absence from work > 197 days, illnesses (-) Higher education, having children <11 years (women)

Goine et al. 2004	2,461 Swedish subjects: Plant A: 918 subjects (821 men, 97 women) Plant B: 1,543 subjects (1,317 men, 226 women)	16-64 years	10 years	All sick leaves and disability pensions were monitored at plant	(+) The size of financial investments in rehabilitation programmes has no significant impact
Hagen et al. 2002	34,754 Norwegian subjects (men and women)	25-29 years	7 years	Official pension registers	(+) Physically demanding work, poor general health, feeling of being worn out, current smoking and high body mass index predicted disability pension due to back pain.
Holte et al. 2000	Norwegian subjects First period: 154,711 men and 82,889 women Second period: 121,614 men and 85,824 women	50-56 years	Two 9-year periods	Official pension registers	(+) Manual work is a risk factor for becoming a disability pensioner due to osteoarthritis

Husemoen et al. 2004	9,053 Danish subjects (5,623 men and 3,430 women)	30-66 years	5 years	Official pension registers	(+) Smoking
Koivumaa-Honkanen et al. 2004	22,136 Finnish twins (11,037 men, 11,099 women)	18-54 years	11 years	Official pension registers	(+) Life dissatisfaction
Krause et al. 1997	1,038 Finnish men	42-60 years	4 years	Maximal oxygen uptake measured during exercise test, retirement status was ascertained by questionnaire	(+) Heavy work, uncomfortable working positions, long working hours, noise at work, mental and physical job strain, musculoskeletal strain, repetitive or continuous muscle strain, job dissatisfaction (−) The ability to communicate with fellow workers, social support from supervisors
Krokstad et al. 2002	62,369 Norwegian subjects (32,194 men, 30,175 women)	20-66 years	10 years	Official pension registers	(+) Low level of education, poor self-perceived health, long-standing health problem, low job control, manual work, unemployment (young men), separation/divorce (young men), loneliness (young men), subjective general dissatisfaction (men), smoking, physical inactivity (at the age of 50-66 years)

		Mean age from 39 to 62.2 years	2½ years	Retirement status was ascertained by questionnaire	(+) Disability pension: Low skill discretion, prevalent diseases, being underweight, smoking, Early retirement pension: Extreme bending of back, marital status
Lund et al. 2001	2,618 Danish male waste collectors and municipal workers				
Manninen et al. 1996	6,647 Finnish farmers (3,051 men, 3596 women)	40-64 years	10 years	Official pension registers	(+) Osteoarthritis in the knees due to excess weight
Manninen et al. 1997	8,655 Finnish farmers (4,118 men, 4,537 women)	18-64 years	10 years	Official pension registers	(+) Psychological distress
Månsson et al. 1996	5,926 Swedish men	55-60 years	11 years	Official pension registers	(+) Being underweight, overweight, obesity
Månsson et al. 1998	5,782 Swedish men	55-60 years	11 years	Official pension registers	(+) Low socio-economic status (as defined by occupation)
Månsson et al. 1999	3,751 Swedish men	55-60 years	11 years	Official pension registers	(+) Excess consumption of alcohol or being teetotal (-) Moderate alcohol intake
Månsson and Råstam 2001	5,932 Swedish men	48-52 years	11 years	Official pension registers	(+) Poor self-rated health

Månsson and Merlo 2001	5,313 Swedish men	48-52 years	11 years	Official pension registers	(+) Low socioeconomic status, obesity
Månsson et al. 2002	5,932 Swedish men	16-64 years	11 years	Official pension registers	(+) Poor self-rated health associated with use of analgesics and hypnotics
Narbro et al. 1999b	369 surgically treated obese Swedish patients (252 men, 117 women), 371 matched controls	47-60 years	5 years	Official pension registers	(+) Obesity (-) Surgical treatment of obesity
Rissanen et al. 1990b	31,129 Finnish subjects (19,076 men, 12,053 women)	25-64 years	11 years on average	Official pension registers	(+) Being overweight
Sorvaniemi et al. 2003	213 Finnish adult psychiatric outpatients	18-64 years	2 ½ years	Official pension registers	(+) Age, comorbidities, lowered self-esteem
Tuomi et al. 1991b	6,165 Finnish municipal employees (men and women)	44-58 years	4 years	Official pension registers	(+) Disability was more linked to individual factors (age, dissatisfaction with life, smoking) rather than work-load

Tuomi et al. 1991c	6,257 Finnish municipal employees (2,797 men, 3,460 women)	44-58 years	4 years	Official pension registers	(+) Poor index of work ability, work-related stress reactions, poor work postures, poor physical climate, age (-) Possibilities for development at work
Upmark et al. 1999a	8,122 Swedish conscripts	18-20 years	22 years	Official pension registers	(+) Excess consumption of alcohol, drink-driving and criminality
Upmark et al. 1999b	All 49,285 Swedish conscripts in 1969/1970	18-22 years	23 years	Official pension registers	(+) Psychiatric diagnosis at conscription
Upmark et al. 1999c	1,855 Swedish subjects (870 men, 985 women)	20 to 52 years	7 years	Official pension registers	(+) Excess consumption of alcohol

2.7 Cardiorespiratory fitness, health and risk of work disability

Regular physical activity has a number of favourable cardiovascular, musculoskeletal, metabolic, hormonal, neurological, respiratory and mental effects and it delays many physical ageing processes and it also improves functional capacity (Lakka et al. 1994; Vuori 1995; Fletcher et al. 1996; Biering-Sørensen et al. 1999; Laukkanen et al. 2001; Linton and van Tulder 2001). Physical activity and good cardiorespiratory fitness have been associated with a reduced risk of cardiovascular diseases (Lakka et al. 1994; Blair et al. 1996; Sesso et al. 2000; Laukkanen et al. 2001). As far as musculoskeletal diseases are concerned, physical activity or good physical fitness have been observed to prevent osteoporosis (Lee 1994; Kujala et al. 2000; Vuori 2001) and they may also reduce the risk of low back and neck and shoulder disorders (Leino and Magni 1993; Vuori 1995; Hildebrandt et al. 2000; Linton and van Tulder 2001; Vuori 2001). High doses of physical activity may promote the degeneration process of injured joints for patients with osteoarthritis (Buckwalter and Lane 1997; Lequesne et al. 1997; Vuori 2001). However, moderate physical activity seems to prevent the development of osteoarthrosis (Arokoski et al. 2000; Manninen et al. 2001). Physical activity has also been associated with reduced symptoms of depression (Sexton et al. 1989; Dunn et al. 2001), agonism (Petruzzello and Landers 1994), and anxiety (Sexton et al. 1989), but the evidence for these favourable effects is relatively weak. Depression in older women has also been found to be associated with decreased physical functioning as well as impaired physical fitness due to lower levels of exercise (Hollenberg et al. 2003).

Although there is a great deal of evidence on the favourable health effects of regular physical activity and good physical fitness, there are no previous prospective population-based studies on the association between cardiorespiratory fitness and the risk of disability pension. However, low leisure time physical activity and a poor self-reported physical condition have been associated with an increased risk of having to take disability pension (Biering-Sørensen et al. 1999). Physical activity also improved subjective working ability in a follow-up study by the Finnish Institute of Occupational Health (Ilmarinen et al. 1995). However, even though rehabilitation had helped to improve the muscle strength of patients suffering back pain, disability could not be prevented (Härkäpää 1992). It is not known, whether there is an association between

physical activity and psychological factors or whether these factors have an effect on work ability or the risk of disability pension.

2.8 Work-related stress and risk of work disability

It is known that a heavy physical workload is associated with an increased risk of disability retirement (Hasle and Jeune 1989; Vingård et al. 1992; Krause et al. 1997; Lund et al. 2001; Hagen et al. 2002) and that disability pensions are more often awarded to blue-collar than white-collar workers (Heliövaara et al. 1986; Bongers et al. 1988; Hasle and Jeune 1989; Månsson et al. 1998). Prospective studies on single physical risk factors of disability determined by disability pensions provide a scarce and fragmented overview. Earlier studies have shown that such factors include vibration (Bongers et al. 1988), manual work (Holte et al. 2000), monotonous work (Appelberg et al. 1996), a too fast pace and a long series of unpleasant working conditions (Hasle and Jeune 1989; Tuomi et al. 1991b; Tuomi et al. 2001), poor physical work environment, lack of freedom and muscular work, disturbing temperatures at the workplace, role conflicts, poor working postures (Tuomi et al. 1991b; Tuomi et al. 2001), long working hours, noise at work, job dissatisfaction and mental job strain (Krause et al. 1997). A few of the earlier studies in this field are longitudinal (Bongers et al. 1988; Tuomi et al. 1991b; Appelberg et al. 1996; Krause et al. 1997; Månsson et al. 1998; Holte et al. 2000; Lund et al. 2001; Tuomi et al. 2001; Hagen et al. 2002).

2.9 Depression, health and work disability in epidemiological studies

Relatively little is known about the complex temporal relationships between behaviour, effect, motivation, and pathophysiology, which account for the association of depression with morbidity and mortality. Difficulties to express one's feelings, known as alexitymia (Kauhanen et al. 1996), and negative affect, especially internally experienced distress (Wilson et al. 1993) and depression (Fu et al. 2003) have been associated with increased all-cause mortality. Hopelessness (Everson et al. 1996) and cynical hostility (Julkunen et al. 1994; Barefoot et al. 1995; Everson et al. 1997) have been associated with an increased risk of cardiovascular diseases. There is also some

evidence that depression is a risk factor for the development and progression of coronary artery disease (Prescott et al. 2003; Lett et al. 2004). Mortality after acute myocardial infarction (Carney et al. 2003) and sudden cardiac death (Luukinen et al. 2003) is higher in depressed than in non-depressed patients, although this association has not been found in all studies (Stewart et al. 2003). An association between impaired physical fitness and depression in older women (Hollenberg et al. 2003) could partly explain increased levels of cardiovascular mortality in depressed people. In addition to cardiovascular diseases, depression has also been found to have a connection with the severity of diabetes and its complications (Black et al. 2003). This may be explained by diminished motivation for self-care. In any case, the psychic component is an important factor in rehabilitation after illness (Milhous et al. 1989; Härkäpää 1992). Cancer surveillance is also thought to be connected with depression (Brown et al. 2003; Spiegel and Giese-Davis 2003). This is probably due to immune function disorders, dysregulation of the hypothalamic-pituitary-adrenal axis, especially diurnal variation in cortisol and melatonin, caused by depression (Spiegel and Giese-Davis 2003). Psychic factors are also very important predictors for back and neck disorders (Bongers et al. 1993).

Little is known about the role of depression as a risk factor for early retirement even if mental disorders, particularly depression, are the leading cause for early retirement in Finland nowadays. The association between depression and early retirement has been studied in only a couple of population studies. In a Finnish 10-year follow-up study, psychological distress was found to be an independent risk factor for disability (Manninen et al. 1997). In another study, personal conflicts at work among women, and dissatisfaction for life in both genders predicted early pension (Appelberg et al. 1996).

2.10 Self-assessed health and risk of work disability

Perceived health, also called self-rated or self-assessed health, seems to be a strong indicator of health. It is considered to be a useful component in evaluating health and predicting behaviour (Linn et al. 1980b; Hunt et al. 1984; Bue-Bjørner et al. 1996). Poor perceived health has been associated with older people, men (McDonough and Amick 2001), the white race (McDonough and Amick 2001), depression (Kivinen et al. 1998),

use of cardiac and antihypertensive medication, hypnotics or analgesics (Månsson and Råstam 2001), alcohol consumption (Månsson and Råstam 2001), being underweight (Månsson and Råstam 2001), obesity (Månsson and Råstam 2001), decreased physical activity (Leinonen et al. 2001), low level of education (McDonough and Amick 2001; Månsson and Merlo 2001), low socioeconomic status (Månsson and Merlo 2001), myocardial infarction (Månsson and Råstam 2001), coronary heart disease (Kivinen et al. 1998), mental disorders (Månsson and Råstam 2001), hypertension (Månsson and Råstam 2001), overall morbidity (Aro and Hasan 1987; Barsky et al. 1992; Bue-Bjørner et al. 1996; Møller et al. 1996), and overall mortality (Mossey and Shapiro 1982; Kaplan and Camacho 1983; Aro and Hasan 1987; Idler and Angel 1990; Ostlin 1990; Wannamethee and Shaper 1991; Idler and Benyamini 1997; Miilunpalo et al. 1997; Sundquist and Johansson 1997; Yu et al. 1998; Lee, Y 2000; Månsson and Råstam 2001).

Three earlier studies have shown self-assessed poor health to be associated with disability pension (Table 3) (Biering-Sørensen et al. 1999; Månsson and Råstam 2001; Krokstad et al. 2002). In the first study (Biering-Sørensen et al. 1999) the adjusted risk of disability pension was 3.4 (CI 95% 2.1–5.5) among those who considered their health to be poor in the previous year. In Månsson's study the adjusted risk of disability pension was 3.3 (CI 95% 2.8–3.8) among those who considered their health to be less than perfect last year (Månsson and Råstam 2001). In Krokstad's study the adjusted risk of disability pension among men aged 50-66 was 1.9 (CI 95% 1.7–2.1) if the self-assessment of their health was fair or bad.

3 AIMS OF THE STUDY

The general purpose of this present doctoral thesis was to study the predictors of early retirement in a middle-aged male cohort and to focus on potentially modifiable risk factors which could prevent early retirement in the future.

The specific aims were:

1. To investigate whether good cardiorespiratory fitness predicts early retirement.

2. To study whether physically demanding work predisposes a person to take early retirement and to assess the importance of single work tasks in relation to early retirement.

3. To investigate whether feelings of depression predict early retirement.

4. To find out the risk factors of poor perceived health and to evaluate whether perceived health predicts early retirement.

4 SUBJECTS AND METHODS

4.1 Study design and study population

The Kuopio Ischaemic Heart Disease Risk Factor Study (KIHD) is an ongoing population-based cohort study which began in 1984. The purpose of the study is to investigate risk factors of cardiovascular diseases and other chronic diseases (Salonen 1988). The study population comprises two randomly-selected samples of men living in the town of Kuopio and neighbouring rural communities, a geographically defined area in eastern Finland, and who are aged 42 to 60 years at the baseline examination (Figure 3).

Cohort 1 included 54-year-old men. Of those chosen, 1,399 were alive and living in the defined area, and thus eligible, and 1,166 (83.3%) of them agreed to participate. The baseline examination date for each individual was selected near his 54th birthday. All baseline examinations were conducted between March 1984 and June 1986. Cohort 2 was an age-stratified sample of 42-, 48-, 54-, and 60-year old men, who were examined between August 1986 and December 1989 near their birthday. A total of 1,836 men were eligible for the study and 1,516 (82.6%) of them participated.

Of the 3,235 eligible men, 84 were excluded due to death, 65 because of a serious disease, and 49 due to migration. Thus, the final KIHD study sample included 2,682 participants (82.9% of these eligible). The percentages of those participating out of the total number of eligible men aged 42, 48, 54, and 60 were 81.9%, 85.6%, 83.7%, and 78.7%, respectively. Of the participants, 55.6% lived in the town of Kuopio. The respective proportion of the non-participants was 51.9%.

In this study, men who died during the follow-up (n=29) or had retired before the beginning of the follow-up (n= 898) we excluded. Thus, the final study population of the present study included 1,755 men. Of the excluded men who had retired before the follow-up, 67% had retired on disability pension, 19% on non-illness-based pension and 14% on an old-age pension.

Figure 3. Study population.

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                    ┌─────────────────────┐      ┌─────────────────────┐
                    │ Cohort 1 in March   │      │ Cohort 2 in August  │
                    │ 1984-August 1986:   │      │ 1986-December 1989: │
                    │ 1,399 eligible      │      │ 1,836 eligible 42-, │
                    │ 54-year old men     │      │ 48-, 54-, and       │
                    │                     │      │ 60-year old men.    │
                    └─────────────────────┘      └─────────────────────┘
                              │                            │
                              └──────────┐      ┌──────────┘
                                         ▼      ▼
                    ┌───────────────────────────────────────────┐
                    │          Eligible men (n = 3,235)          │
                    └───────────────────────────────────────────┘
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Died (n = 84)

Serious disease (n = 65)

Migration (n = 49)

Did not want to participate (n = 355)

Participants (n = 1,166, 83.3% of eligible) from cohort 1 and (n = 1,516, 82.6% eligible) from cohort 2.

KIHD population (n = 2,682, 82.9% of eligible men)

Retired before baseline (n=898)

Died before retirement (n=29)

Study population n = 1,755

Did not proceed to cycle ergometer test (n = 117) or retired on non-illness-based pension (n = 331)

Did not answer the question concerning the perceived health (n = 7)

Did not answer the question concerning the depression (n = 29)

Subjects for study of heavy work (n = 1,755)

Subjects for study of depression (n = 1,726)

Subjects for study of physical fitness (n = 1,307)

Subjects for study of perceived health (n = 1,748)

Baseline

Register linkage

Follow-up 1984-2000

Invitations to attend the first study visit and written instructions on how to complete the self-administered questionnaire were mailed four weeks in advance. Fifteen men were examined each week on Tuesdays, Wednesdays, and Thursdays. During the first study visit, a trained nurse checked the completed questionnaire, including questions relevant to the present study such as age, education and occupation. Height and weight were measured and body mass index was computed as the ratio of weight to the square of the height (kg/m^2). The subjects were instructed to complete a 12-month leisure-time physical activity questionnaire for the year before the second visit and to keep a 24-hour total physical activity diary carried out the day before the second visit and a four-day food diary recorded on the days following the first visit. During the first visit, the subjects also performed a maximal exercise test.

Subjects returned their 12-month leisure-time physical activity questionnaires, 24-hour total physical activity diaries, and their four-day food diaries on the second study visit seven days after the first visit, on the same day of the week. Subjects had the same interviewer on both visits. Intake of alcohol was assessed using both the four-day food diary (g/day) and the self-administered questionnaire (g/week). A subject was also defined as a smoker if he had ever smoked regularly and had smoked cigarettes, cigars, or a pipe within the past 30 days. The current number of cigarettes, cigars, and pipefuls of tobacco smoked daily as recorded using the self-administered questionnaire. A seven-day recall of leisure-time physical activity recall over the days between the two visits was taken and an occupational physical activity interview was performed. Blood samples were also collected for laboratory determinations during the second visit.

Histories of disease and disability caused by chronic disease were recorded using the self-administered questionnaire. A physician reinterviewed the subjects regarding their medical history.

4.2 Assessment of cardiorespiratory fitness

Cardiorespiratory fitness was assessed using a maximal symptom-limited exercise tolerance test on an electrically-braked bicycle ergometer. The exercise test was performed on 2,361 (88.0%) of all 2,682 men and for 1,619 (92.3%) men in the present

study. The proportions of disability pensioners, non-illness-pensioners and those who retired on an old-age pension or were still working at the end of the follow-up who performed the exercise test were 91.8% (n = 790), 91.8% (n = 517) and 94.3% (n = 312), respectively. For the 459 men who were examined before June 1986, the testing protocol comprised a three minute warm-up of 50 Watts followed by a step-by-step increase of work-load by 20 Watts per minute (Tunturi EL 400 bicycle ergometer, Turku, Finland). For the remaining 1,160 men, most of whom were examined after August 1986, a linear increase of workload by 20 Watts per minute (Medical Fitness Equipment 400 L bicycle ergometer, Mearn, Netherlands) was used.

Respiratory gas exchange was measured for 472 men using the mixing chamber method with a Mijnhardt Oxycon 4 Analyzer (Gebr. Mijnhardt B.V., Netherlands) and with the breath-by-breath method using a MGC 2001 Analyzer (Medical Graphics Corp., St.Paul, Minnesota, U.S.A.) for 1,290 men. The Mijnhardt Oxycon 4 Analyzer measured the VO_2max as the average value over 30 seconds, whereas the MGC 2001 Analyzer measured it as the average value over eight seconds. The VO_2max was defined as the highest value, or the plateau, in oxygen uptake. The mean VO_2max was 2.3 l/minute (30.1 ml/kg/minute) measured with the Mijnhardt Oxycon 4 Analyzer and 2.6 l/minute (32.4 ml/kg/minute) measured with the MGC 2001 Analyzer. The Pearson's correlation coefficient between simultaneous Mijnhardt Oxycon 4 and MGC 2001 measurements was 0.97 in 13 men, indicating a close correlation.

The most common reasons for having to stop the exercise test were leg fatigue (n = 696), exhaustion (n = 210), breathlessness (n = 118), and pain in the leg muscles, joints, or back (n = 50). The test was discontinued for cardiorespiratory symptoms of abnormalities in 183 (13.3%) men. These included arrhythmias (n = 37), dyspnea (n = 46), a marked change in systolic or diastolic blood pressure (n = 35), chest pain (n = 30), dizziness (n = 6), and ischaemic electrocardiographic changes (n = 20).

4.3 Assessment of work-related factors

Work-related factors were assessed using a self-administered questionnaire at baseline. Subjects were asked to select one of the following categories to describe their physical workload: 1) sedentary, 2) moderate physical, 3) heavy physical and 4) very heavy physical work. In the analyses, categories 3 and 4 were combined as heavy physical work.

The amount of sitting, standing and walking at work was elicited using a Likert scale (0 = not at all, 1 = a little, 2 = quite a lot, and 3 = very much). For the analyses, categories 2 and 3 were combined (= a lot). The proportion of lifting, static muscular loading and uncomfortable work positions required in the work were elicited with the question "How much (0 = not at all, 1 = quite a little, 2 = to some extent, 3 = quite a lot, and 4 = very much) harmful strain do the following details cause in your work? 1) muscular action such as heavy lifting and continuous moving (= lifting and moving heavy pieces); 2) continuous muscle contraction such as holding up heavy pieces or squeezing (= static muscular loading); or 3) work in uncomfortable positions?". For the analyses, the categories were reclassified as follows: 1 = 0 and 1 (not at all), 2 = 2 (a little), and 3 = 3 and 4 (a lot).

The subjects were also asked how much (0 = not at all, 1 = a little, 2 = moderately, 3 = quite a lot, and 4 = very much) loading different body parts such as fingers, wrists, arms, ankles, knees, the lower extremities, back and neck or shoulders experienced at work. The subjects were regarded to be exposed to risk if they selected either three or four in answer to any of these questions. Loading of fingers, wrists and arms was combined to cover strain in the upper extremities. Loading of ankles, knees and the lower extremities was generally combined to cover strain in the lower extremities. Strain in the neck or shoulder region was examined separately and added to the strain in the upper extremities. The reference categories in each of these variables were those with moderate strain, no strain or a little strain at work.

4.4 Assessment of depression

The subjects filled in several psychological questionnaires at baseline. We used the HPL (Human Population Laboratory) depression score (Appendix 1) that has been previously used in the longitudinal Alameda County Study in the assessment of depressive symptoms (Kaplan et al. 1987). A set of 40 items that are ostensibly related to depression (mood disturbance, negative self-concept, loss of energy, problems with eating and sleeping, trouble with concentration, psychomotor retardation, agitation) were selected from a larger pool of questionnaire items dealing with varied aspects of psychological distress to make up the HPL depression score (Kaplan et al. 1987). These 40 items were then rated independently by 10 clinical researchers (psychiatrists and psychologists) in terms of their presumed usefulness in ascertaining whether a subject was depressed. From these ratings, half of the items were eliminated. The homogeneity of the remaining set of items was then assessed by item-total correlations and measures of internal consistency and a further two of the 20 items were then eliminated. A score is generated by assigning one point for each "often" or "never" response (whichever is appropriate). The remaining 18 items inquired, whether a subject felt depressed or very unhappy, lonely or remote from other people, on top of the world, too tired even to do things he normally enjoys, pleased about accomplishing something, bored, too restless to sit still for long, left out even when in a group, excited or interested in something, vaguely uneasy without knowing why or if subject finds it hard to feel close to others. Subjects were also asked whether they had poor appetite, trouble getting to sleep or staying asleep, fun in their leisure time, satisfaction with performance, difficulty relaxing, concerns about getting tired in a short time or less energy than other people. These items have item-total correlations ranging from 0.18 to 0.45 and acceptable internal consistency reliability. Coefficient alpha was 0.71. The HPL 18-item index showed a correlation coefficient of 0.66 with the Beck Depression Inventory (Beck et al. 1961) in an outpatient clinical population (Kaplan et al. 1987). This correlation is about as high as can be expected based on the reliability of these two instruments. After the sum score of items was calculated, the score was categorised into thirds (low, medium, high) for further analysis.

4.5 Assessment of perceived health

Perceived health at baseline was assessed using a self-administered questionnaire. The first question was: How is your present health? The alternatives were 0 = very good, 1 = pretty good, 2 = average, 3 = pretty poor, 4 = very poor. The second question asked the subject to compare his own health with that of other men of the same age with the question: When you compare your health with other men of your age, do you consider yourself to be 0 = much healthier than others, 1 = little healthier than others, 2 = just as healthy as others, 3 = little less healthy than others or 4 = much less healthy than others? For the analyses, the variables in both questions were categorised into three classes by combining alternatives 0 and 1 (good/better than the other men of same age), by keeping alternative 2 as such (average/the same as the other men of same age), and by combining alternatives 3 and 4 (poor/worse than the other men of same age).

4.6 Assessment of education and occupation

Education and occupation were assessed with a self-administered questionnaire. The subjects were asked to choose one of the following alternatives to describe their educational level: 0. completed part of elementary school, 1. elementary school or completed part of middle school, 2. elementary school and some occupational education, 3. middle school and completed part of high school, 4. middle school and some occupational education, 5. high school examination, 6. high school examination and some other examination, 7. academic examination. Alternatives 0, 1 and 2 were united as elementary school or less, alternatives 3 and 4 as middle school and alternatives from 5 to 7 as high school or above.

The subjects were asked what kind of work they had done for most of their life and the alternatives were as follows: 1. farming or cattle breeding, 2. forestry, 3. factory work, mining, building work or something comparable, 4. office work, intellectual work or work in the service sector. Alternative 1 was classified as farming, alternatives 2 to 3 as blue-collar work and alternative 4 as white-collar work.

4.7 Assessment of lifestyle factors and body mass index

The current number of cigarettes, cigars, and pipefuls of tobacco smoked daily and the duration of the regular smoking in years were recorded using a self-administered questionnaire. A self-reported quantity-frequency questionnaire was used to record the level of alcohol use. The average weekly consumption of alcohol in pure ethanol (g/week) was calculated based on the known alcoholic content of each beverage type and the reported doses and frequencies of the drinking sessions (Kauhanen et al. 1997).

Body weight was measured at the baseline using a balance scale. The subject wore light clothing and no shoes. Body mass index was calculated by dividing body weight in kilograms by the square of body height in metres.

4.8 Assessment of diseases

Prevalent diseases were assessed using a self-administered questionnaire. A physician reinterviewed the subjects regarding their medical history. In the questionnaire, the subjects were asked whether a physician had ever diagnosed them as having any of the listed diseases (yes/no). The diseases and their classification used in this study are shown in Table 4.

Table 4. Classification of baseline illnesses.

Cardiovascular diseases
Myocardial infarction
Chest pain (angina pectoris)
Coronary artery bypass surgery
Other coronary disease
Cardiomyopathy
Cardiac failure
Cardiac nerve failure (functional)
Hypertension or high blood pressure
Ischaemic or haemorrhagic stroke
Obstruction of arteries of lower extremities (claudication)
Other cardiovascular diseases

Musculoskeletal disorders
Osteoarthritis
Back disease or problem

Mental disorders
Mental problem or disorder

Other diseases
Chronic bronchitis or emphysema
Pulmonary asthma
Pneumoconiosis
Pulmonary tuberculosis
Neurological disorder
Difficult psychiatric illness resulting in hospitalisation
Migraine or persistent headache
Epilepsy
Hyperthyreosis or thyroidism
Gastric or duodenal ulcer or gastritis
Biliary or gall-stone disease
Inflammation or irritation of large intestine
Rheumatoid arthritis or other rheumatoid disease
Chronic urinary infection
Kidney stones
Chronic liver or pancreatic disease
Serious injury
Milk sugar (lactose) intolerance
Other chronic diseases

4.9 Follow-up of early retirement

The cohort was linked to the pension registers of the Social Insurance Institution of Finland and the Finnish Centre for Pensions covering all the pension information of these subjects from the baseline up to the 31st of May 2000. The Social Insurance Institution of Finland is responsible for providing every Finnish citizen from the age of

16 up to 65 years with basic social security to cover disability. The Finnish Centre for Pensions is an expert on earnings-related pension provision and the central body of the Finnish statutory earnings-related pension scheme.

In the present study, disability pension and non-illness-based pension are referred to as an early pension. Disability pensions include both the normal disability pensions and the individual early retirement pensions. Non-illness-based pensions include the unemployment pension, early pensions for farmers, and part-time pensions. A comprehensive medical certificate written by a physician and ascertained by an expert medical adviser on behalf of the Social Insurance Institution of Finland and the Finnish pension institutions is required in order to assess eligibility for pensions based on disability. The diagnosis which is the main cause of the disability stated on the medical certificate made by an attending physician or an expert medical adviser of the pension insurance company was regarded as the main cause of disability. The diagnoses were categorised into three main groups: musculoskeletal disorders, cardiovascular diseases, and mental disorders. Minor illness groups were categorised as one group. More detailed disease-specific analysis could not be made due to a low number of cases.

4.10 Statistical methods

The endpoint for the follow-up was defined as the date when the early pension was awarded or when a person began to receive old-age pension or the end of the follow-up on 31st May 2000, whichever came first. Follow-up time was calculated in days. A death was regarded as a censored case. The association between the variable of the interest and the risk of early retirement was performed using logistic regression or Cox regression modelling adjusted for possible confounders. Men in the higher categories were compared with men in the lowest category. The results were expressed as risk ratios (RR) and their 95% confidence intervals (Rothman and Greenland 1998). SPSS 10.0 for Windows was used for statistical analyses.

Age, education, maximal oxygen uptake, alcohol consumption, smoking, body mass index and the most prevalent baseline diseases (musculoskeletal disorders, cardiovascular diseases, mental disorders, and other chronic illnesses) were included

into all models as potential confounding variables. Age, maximal oxygen uptake, alcohol consumption, smoking, and body mass index were used as continuous variables and other confounders were categorised.

5. RESULTS

5.1 Characteristics of subjects

The baseline characteristics are shown in Table 5. Disability retirees were older, their body mass index was slightly higher and they had lower maximal oxygen uptake and their exercise test was shorter ($p < 0.001$) than that of old-age pensioners or those who were still working at the end of the follow-up. They also had more musculoskeletal disorders and cardiovascular diseases at the baseline. Moreover, they were more likely to be blue-collar workers or farmers and less educated than the old-age pensioners or those who were still working. Their work also involved more physical loading, they felt less healthy and their depression score was higher (Table 5).

The comparison of non-illness-based pensioners to old-age pensioners or those who were still working at the end of follow-up gives results that are quite similar to those presented above for disability pensioners. Non-illness-based pensioners had higher levels of other chronic illnesses at baseline than the old-age pensioners or those who did not receive any pension during the follow-up. As far as the body mass index was concerned there was no difference between non-illness pensioners and the men who kept working until 65 years of age or those who were still working at the end of the follow-up (Table 5).

There were few statistically significant differences between the disability pensioners and the non-illness-based pensioners. At the baseline, the disability retirees were younger than the non-illness-based pensioners. They also were less likely to be farmers than the non-illness-based pensioners. Disability retirees had a slightly higher prevalence of cardiorespiratory diseases at baseline and on average they perceived their health to be worse (Table 5). Interestingly, there was no difference in cardiorespiratory fitness, lifestyle factors (smoking, alcohol consumption, body mass index), baseline illnesses (apart from cardiorespiratory diseases), workload or depression between these two groups even though only disability pensioners had retired due to a medical reason.

Before the baseline, 108 men had been unemployed for 0 to 12 years (mean 1.4, SD 1.9). Of these 108 men, 51.9% (n = 56) retired on non-illness-based pension (unemployment pension), 36.1% (n = 39) retired on disability pension, 8.3% (n = 9) continued working and 3.7% (n = 4) stayed in working life until they received old-age pension. Of the 108 men, 57.0% were blue-collar workers, 24.3% white-collar workers and 18.7% were farmers.

Table 5. Baseline characteristics.

	Disability retirees (n = 861)	Non-illness-based retirees (n = 331)	Working men and old-age retirees (n = 563)	Difference between the groups
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**p-value**
Age (years)	52.5 (4.1)	53.9 (3.0)	49.4 (6.3)	< 0.001
Body mass index (kg/m^2)	26.9 (3.6)	26.6 (3.5)	26.4 (3.1)	<0.05
Alcohol (g/week)	76.4 (121.8)	72.0 (155.5)	77.1 (120.6)	0,831
Smoking (cigarettes/day)	5.7 (9.9)	5.1 (9.5)	5.1 (9.9)	0.449
Maximal oxygen uptake (l/min)	2.4 (5.8)	2.5 (5.4)	2.7 (6.3)	< 0.001
Duration of the exercise test (min)	11.0 (2.4)	11.1 (2.1)	12.4 (2.4)	< 0.001
Depression score	1.9 (2.1)	1.8 (2.0)	1.4 (1.8)	< 0.001
Illness at baseline	**Percent**	**Percent**	**Percent**	
Musculoskeletal[1] (n = 757)	49.0%	43.5%	33.9%	< 0.001
Cardiovascular[2] (n = 883)	58.1%	51.7%	37.7%	< 0.001
Mental[3] (n = 68)	4.4%	3.9%	3.0%	0.411
Other chronic illness (n = 588)	34.4%	37.2%	30.0%	0.069
Education				
High school or above (n = 147)	5.7%	5.4%	14.2%	< 0.001
Middle school (n = 661)	36.0%	33.2%	42.9%	
Elementary school or less (n = 946)	58.3%	61.3%	42.9%	
Occupation				
Farming (n=342)	19.4%	27.4%	15.7%	< 0.001
Blue-collar (n=642)	39.9%	39.2%	31.5%	
White-collar (n=745)	40.7%	33.4%	52.8%	
Work				
Heavy physical (n = 793)	50.8%	55.2%	33.9%	< 0.001
Light physical (n = 360)	18.5%	20.7%	25.0%	
Sedentary (n = 564)	30.7%	24.1%	41.2%	
Perceived health				
Poor (n = 162)	12.8%	10.3%	3.2%	< 0.001
Average (n = 849)	53.5%	48.6%	40.7%	
Good (n = 741)	33.7%	41.1%	56.1%	

Values are means (standard deviations) or percentages.
[1] Includes back problems and osteoarthritis.
[2] Includes coronary heart disease, cardiac insufficiency, hypertension, claudication and stroke.
[3] Includes all mental disorders.

5.2 Maximal oxygen uptake and other risk factors at baseline

VO_{2max} had a strong inverse association with age ($p < 0.001$), body mass index ($p < 0.001$), smoking ($p < 0.001$) and the prevalence of cardiovascular diseases at baseline ($p < 0.001$). Moreover, the subjects with a low VO_{2max} were less likely to have high school or middle school education than those with a high VO_{2max} ($p < 0.001$). The duration of the exercise test was inversely associated with age ($p < 0.001$), smoking ($p < 0.001$), body mass index ($p < 0.05$) education ($p < 0.05$) and the prevalence of cardiovascular diseases ($p < 0.05$).

5.3 Physically heavy work and other risk factors at baseline

Men who carried out physically heavy work were older ($p < 0.001$), less educated ($p < 0.001$), smoked more ($p < 0.05$), their exercise test was shorter ($p < 0.001$), and they had more musculoskeletal disorders ($p < 0.001$) than those whose work was lighter. Farmers were older ($p < 0.001$) and less educated ($p < 0.001$), smoked more ($p < 0.05$) and drank more alcohol ($p < 0.05$), their exercise test was shorter ($p < 0.001$), and had more musculoskeletal disorders ($p < 0.05$) than white-collar workers. Blue-collar workers were less educated ($p < 0.001$) and they smoked more ($p < 0.001$) than white-collar workers. Their exercise test was shorter ($p < 0.001$) and they suffered more musculoskeletal disorders ($p < 0.05$) and cardiorespiratory illnesses ($p < 0.05$) than white-collar workers.

5.4 Depression and other risk factors at baseline

Depression was directly associated with age ($p < 0.05$), body mass index ($p < 0.05$), smoking ($p < 0.001$), alcohol consumption ($p < 0.001$) and the prevalence of cardiovascular diseases, musculoskeletal disorders, mental disorders and other chronic diseases ($p < 0.001$). It was inversely associated with maximal oxygen uptake ($p < 0.001$), the duration of the exercise test ($p < 0.001$) and education ($p < 0.001$). Blue-

collar workers had a higher depression score than farmers or white-collar workers ($p < 0.05$).

5.5 Perceived health and other risk factors at baseline

Men who considered their health to be poor were older ($p < 0.001$), had a higher body mass index ($p < 0.001$), were more likely to be smokers ($p < 0.001$), drank more alcohol ($p < 0.001$), had lower maximal oxygen uptake ($p < 0.001$), carried out physically more demanding work ($p < 0.001$), and were more depressive ($p < 0.001$) than those with good perceived health (Table 6). They also suffered from more musculoskeletal disorders and cardiovascular as well as other chronic illnesses at baseline ($p < 0.001$) than the others. They did not, however, differ in prevalence of mental disorders, except depression.

Most of the white-collar workers assessed their health to be good (53.2%) whereas most blue-collar workers (51.3%) and farmers (59.4%) perceived their health to be average ($p < 0.001$). A total of 60.5% of those with high school education and 52.4% of those with middle school education considered their health to be good, while 55.6% of those who had elementary school education or less considered it to be average ($p < 0.001$). The associations of perceived health compared with the men of same age and background factors were in line with the results of perceived health.

Table 6. Perceived health and confounding factors at baseline.

	Perceived health		
	Poor	**Average**	**Good**
Age			
> 54.4 years	3.29 (2.08-5.22)	1.65 (1.31-2.06)	0.43 (0.34-0.53)
49.1 – 54.3 years	2.73 (1.67-4.44)	1.68 (1.32-2.14)	0.45 (0.36-0.58)
< 49.0 years	1.00	1.00	1.00
Body mass index			
> 27.7 kg/m^2	1.65 (1.11-2.43)	1.23 (0.98-1.55)	0.68 (0.54-0.86)
< 25.04 kg/m^2	1.02 (0.67-1.56)	0.80 (0.64-1.01)	1.22 (0.97-1.54)
25.05 – 27.65 kg/m^2	1.00	1.00	1.00
Alcohol consumption			
> 69.65 g/week	1.66 (1.12-2.45)	0.90 (0.71-1.13)	0.95 (0.75-1.19)
12.6 – 69.59 g/week	1.10 (0.72-1.67)	0.85 (0.68-1.01)	1.17 (0.93-1.48)
< 12.59 g/week	1.00	1.00	1.00
Smoking			
>20 cigarettes/day	2.25 (1.55-3.26)	1.75 (1.36-2.26)	0.37 (0.28-0.49)
1-19 cigarettes/day	1.18 (0.69-2.02)	1.67 (1.22-2.27)	0.55 (0.40-0.76)
Non-smoker	1.00	1.00	1.00
Maximal oxygen uptake			
<28.35 ml/kg/min	6.57 (3.86-11.2)	2.46 (1.93-3.14)	0.21 (0.16-0.28)
28.36 – 34.47 ml/kg/min	2.13 (1.18-3.85)	1.74 (1.36-2.21)	0.51 (0.40-0.65)
> 34.48 ml/kg/min	1.00	1.00	1.00
Work			
Heavy	2.12 (1.42-3.15)	2.17 (1.74-2.71)	0.35 (0.28-0.43)
Average	1.01 (0.65-1.86)	1.08 (0.82-1.41)	0.90 (0.69-1.17)
Sedentary work	1.00	1.00	1.00
Depression score			
High	8.22 (4.74-14.3)	1.91 (1.48-2.45)	0.27 (0.20-0.35)
Average	3.40 (1.94-5.95)	1.62 (1.30-2.02)	0.49 (0.39-0.61)
Low	1.00	1.00	1.00

Values are odds ratios and their 95% confidence intervals from logistic regression analysis.

5.6 Risk of early retirement

5.6.1 Retirement during the follow-up

During the follow-up, 861 (49.1%) men were awarded a disability pension (Figure 4).
Of them, 67% (n = 577) had an ordinary disability pension, 2.7% (n = 23) had a
temporary disability pensions and 30.3% (n = 261) had an individual early retirement
pension. The reasons for disability retirement were musculoskeletal disorders (n=342,
39.7%), cardiovascular diseases (n=236, 27.4%), mental disorders (n=118, 13.7%), and
other diseases (n = 165, 19.2%). The mean age of retirement for disability retirees was
58.2 (SD 3.88) (Table 7). During the follow-up, 331 (18.9%) men were awarded a non-
illness-based pension. All non-illness-based pensions were unemployment pensions,
and no part-time pensions were awarded. Only 273 (15.6%) out of 1,755 men retired on
an old-age pension. Of all men, 3.4% (n = 59) retired predated on old-age pension, and
only 0.1% (n = 1) delayed his retirement. 78.0% (n = 213) of the men who took old-age
pension waited until they reached the pension age which is only 12.1% out of 1,755
men. At the end of the follow-up, 290 (16.5%) men out of 1,755 were still working.
These numbers vary a little in different analyses, because some subjects were excluded
from the analyses due to missing values (Figure 3). The cumulative incidence of
retirement during the follow-up is shown in Figure 5.

Figure 4. Retirement during the follow-up and disability pensioners according to the cause of disability.

Retiring during the follow-up

Men still working at the end of follow-up
17 %
(n = 290)

Old age pension
16 %
(n = 273)

Disability pension
48 %
(n = 861)

Non-illness based pension
19 %
(n = 331)

Disability pensioners according to the cause of disability

Other reason
19 %
(n = 165)

Mental disorder
14 %
(n = 118)

Musculo skeletal disorder
40 %
(n = 342)

Cardiovascular disease
27 %
(n = 236)
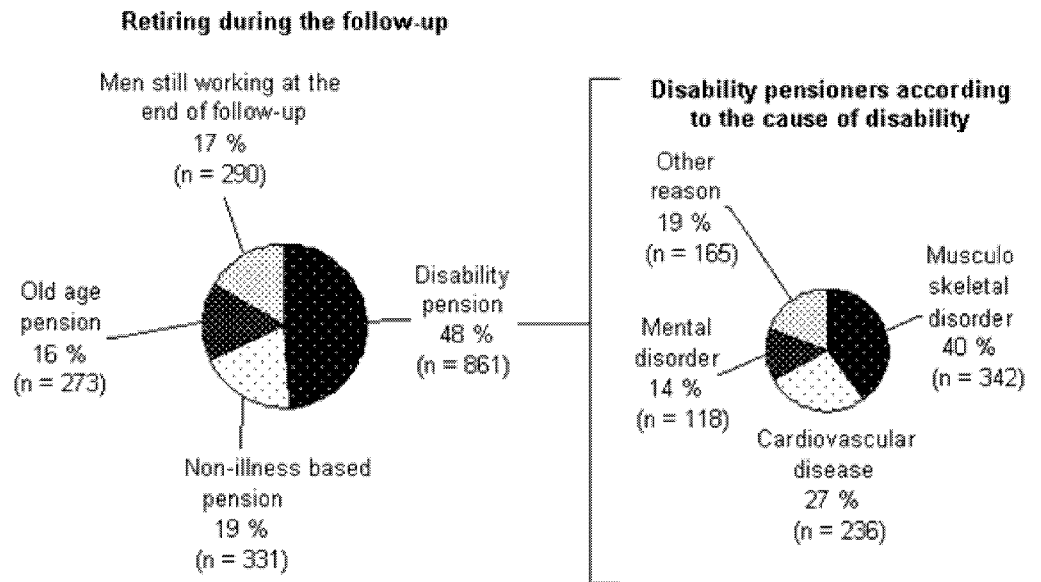
Figure 5. Study population during the follow-up.
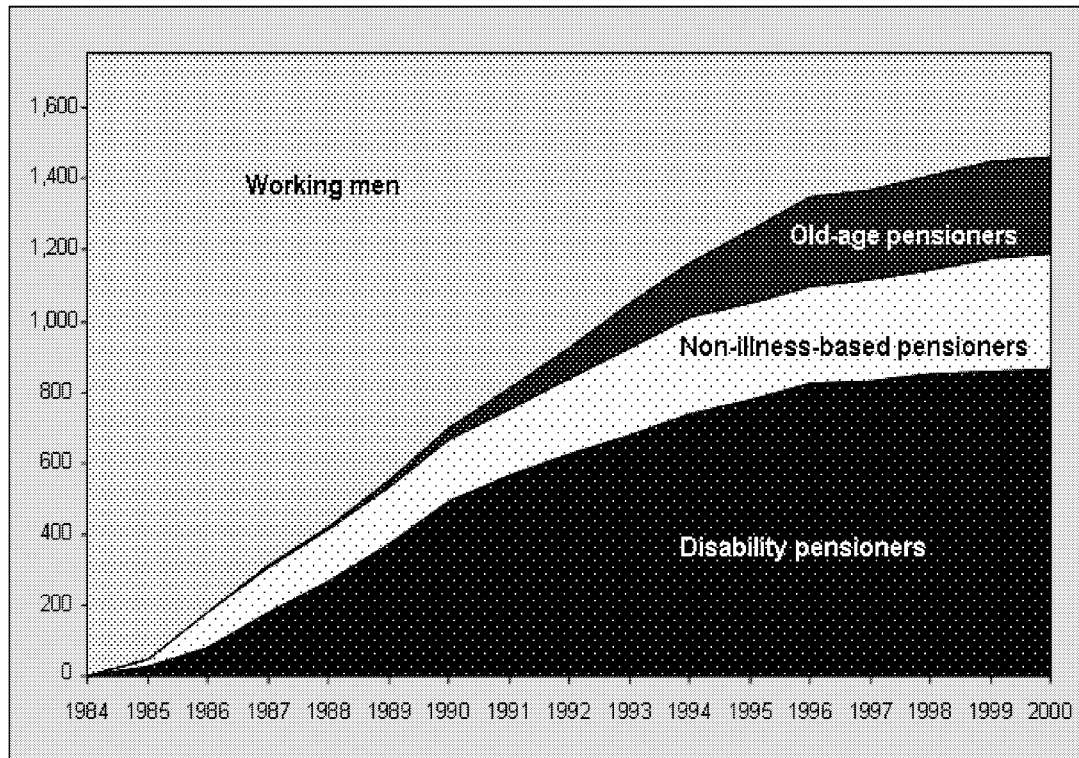
Table 7 shows mean retirement ages by different risk factors, pension type and disease

category. Of the single risk factors of early retirement, poor perceived health decreased

the mean retirement age most. There were 28 subjects in the cohort who had a low

maximal oxygen uptake, carried out physically heavy work, had a high depression score

and poor perceived health. Twenty of them (71.4%) were retired on disability pension,

seven (25.0%) on non-illness-based pension and one (3.6%) subject was still working.

The mean age of retirement was 56.6 years (SD 3.34) (Table 7).

Table 7. Age of retirement in men with different risk factors, diseases causing disability and pension types.

	MEAN	SD
All early retirees (n=1,192)	58.8	3.91
Disability pensioners (n=861)	58.2	3.88
Non-illness pensioners (n= 331)	60.3	3.59
Disability pension due to cardiovascular disease (n= 243)	58.2	4.02
Disability pension due to musculoskeletal disorder (n= 340)	58.4	3.72
Disability pension due to mental disorder (n= 146)	57.8	4.06
Disability pension due to other reason (n= 563)	58.2	3.82
Subjects with low maximal oxygen uptake (n=539)	59.3	4.19
Subjects carrying out heavy physical work (n=793)	59.0	4.38
Subjects with high depression score (n= 446)	58.6	3.98
Subjects with poor perceived health (n= 165)	57.3	3.28
Subjects with low maximal oxygen uptake, heavy physical work, high depression score and poor perceived health (n= 28)	56.6	3.34

5.6.2 Maximal oxygen uptake and retirement (Study I)

After adjustment for age, education, occupation, alcohol consumption, smoking and prevalent diseases at baseline, maximal oxygen uptake and the duration of the exercise test both had an inverse association with the risk of all disability pensions combined (Figure 6). Lower maximal oxygen uptake and a shorter exercise test were the most strongly associated with the risk of disability due to cardiovascular diseases (OR 3.58, 95% confidence interval 1.91-6.70 and OR 4.56, 95% CI 2.40-8.65, respectively). Poor cardiorespiratory fitness was also associated with an increased risk of having to take disability pension due to musculoskeletal disorders, and showed a weak inverse association with disability due to mental disorders. No association was found between maximal oxygen uptake or the duration of the exercise test and the risk of retiring on non-illness-based pension.

Figure 6. Odds ratios for disability pension and different causes for disability in fifths of maximal oxygen uptake and duration of exercise test. Adjusted for age, education, occupation, body mass index, alcohol consumption, smoking, oxygen uptake and chronic diseases at baseline (*) p < 0.05, **) p < 0.005, ***) p < 0.001).
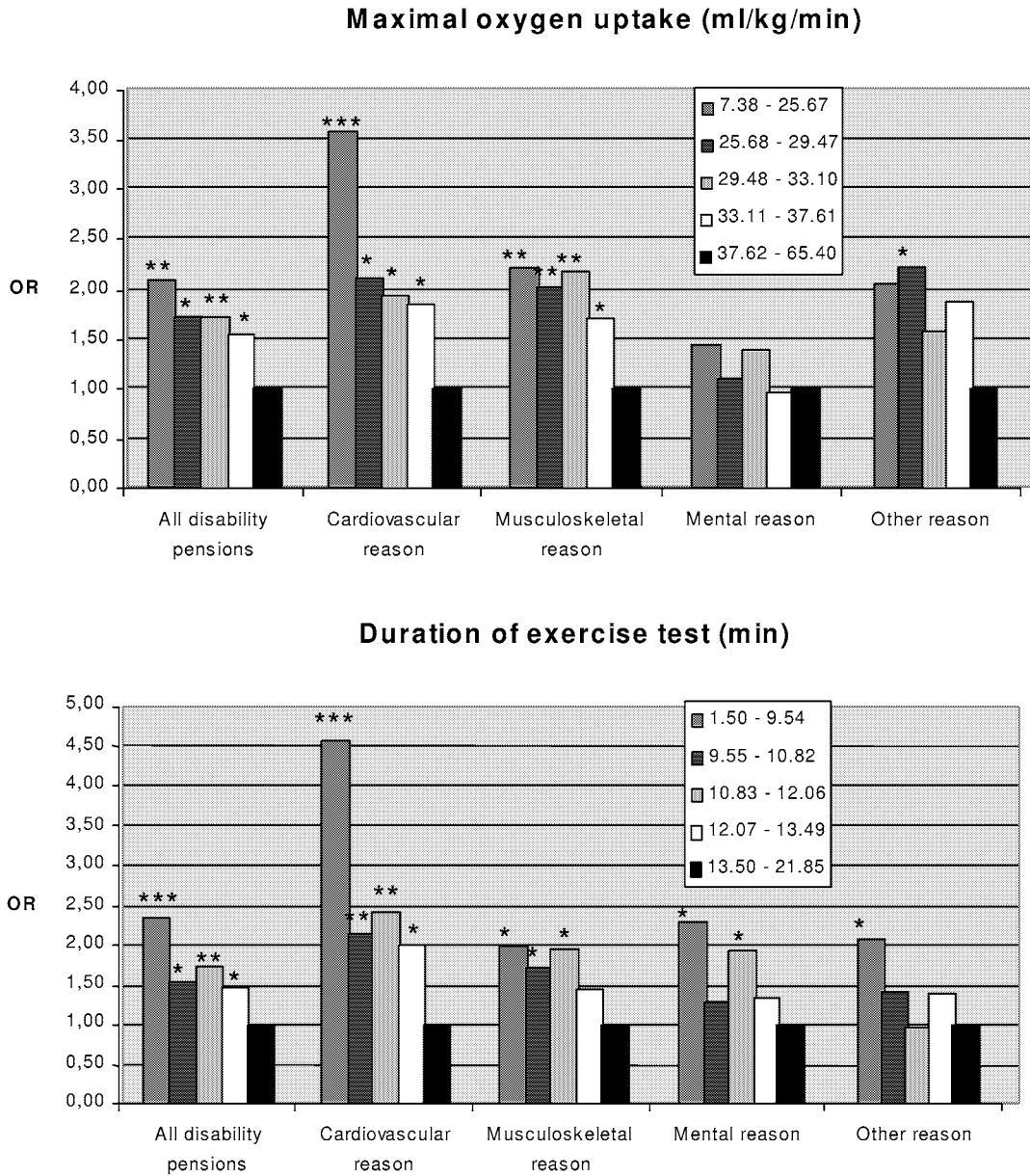
5.6.3 Physically heavy work and retirement (Study II)

Sitting down a lot at work was associated with a decreased risk of early retirement whereas standing, lifting, static muscular loading, and uncomfortable working positions and a heavy physical workload were associated with an increased risk (Figure 7). A high self-estimated physical workload was associated with an increased risk of early retirement. A high self-estimated physical workload was associated with an increased risk of disability due to musculoskeletal disorders, cardiovascular diseases, and other chronic diseases, but not due to mental disorders. The loading of the upper extremity and neck and shoulder region had direct associations with the risk of having to take any one of the disability pensions and with musculoskeletal and cardiovascular reasons in particular, but not mental disorders. The loading of the low back or lower extremity also had a direct association with retirement due to musculoskeletal disorders. The risk of ending up to non-illness pension seems to decrease if the work contains a lot of sitting. However, the risk appears to increase if physical loading, especially in the upper extremity, increases.

A heavy physical workload and a low maximal oxygen uptake were also associated with an increased risk for having to take disability pension, particularly due to musculoskeletal and cardiovascular reasons. Good physical fitness prevented retirement due to cardiovascular disorders, but not retirement due to musculoskeletal disorders. A person who has good physical fitness and carried out physically loading work is more likely to have a non-illness-based pension rather than a disability pension (Figure 8).
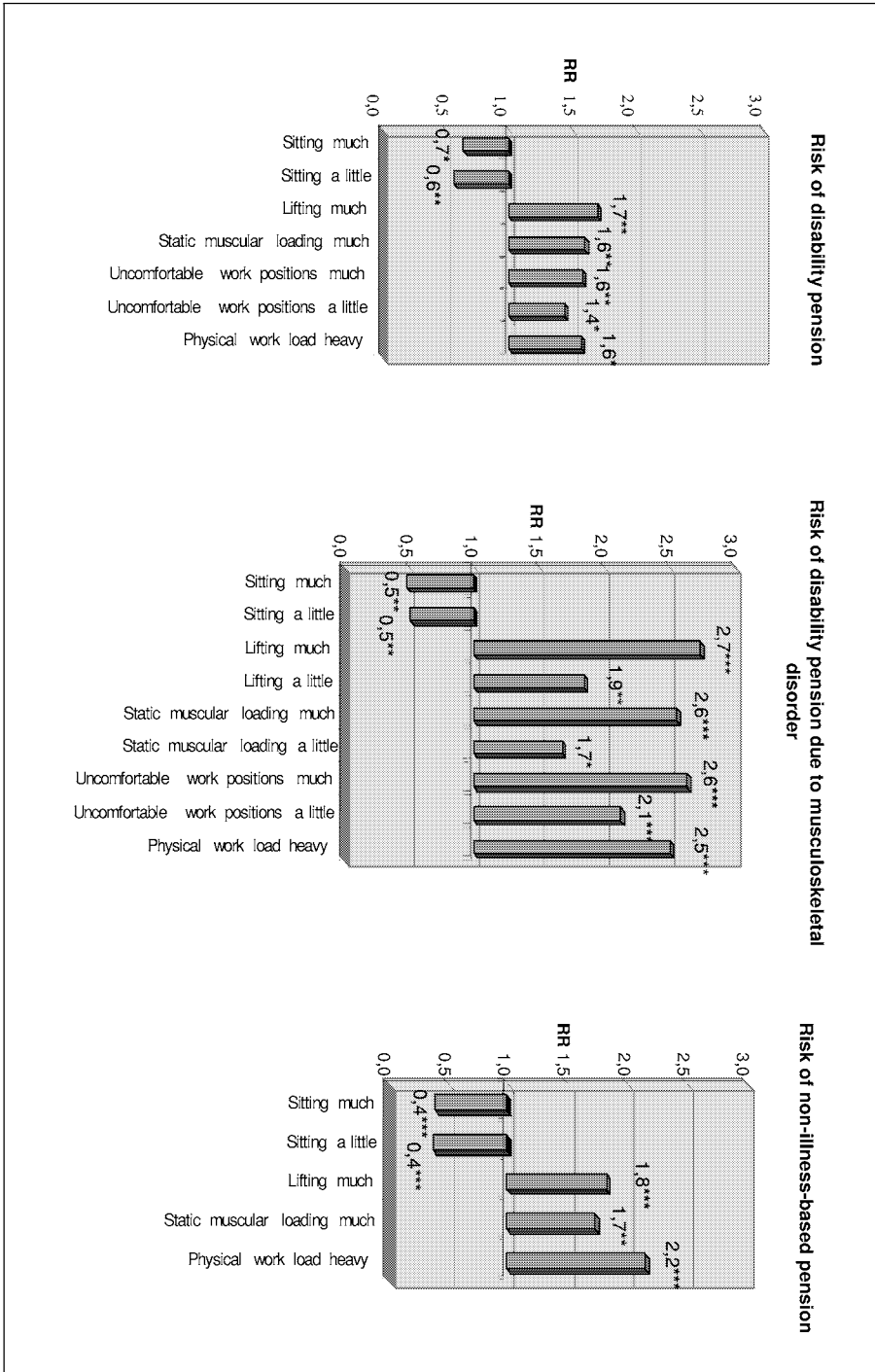
Figure 7. Relative risks (RR) of disability pension according to physical loading at work. Adjusted for age, education, body mass index, alcohol consumption, smoking, oxygen uptake and chronic diseases at baseline. Logistic regression modelling. Low physical loading in each category as the reference (RR = 1.0) (*) $p < 0.05$, (**) $p < 0.005$, (***) $p <$

Figure 8. Odds ratios (OR) for disability pension according to physical work load (light, heavy) and oxygen uptake. Adjusted for age, education, body mass index, alcohol consumption, smoking, and respective reason for retirement (musculoskeletal disorders, cardiovascular diseases or mental disorders).
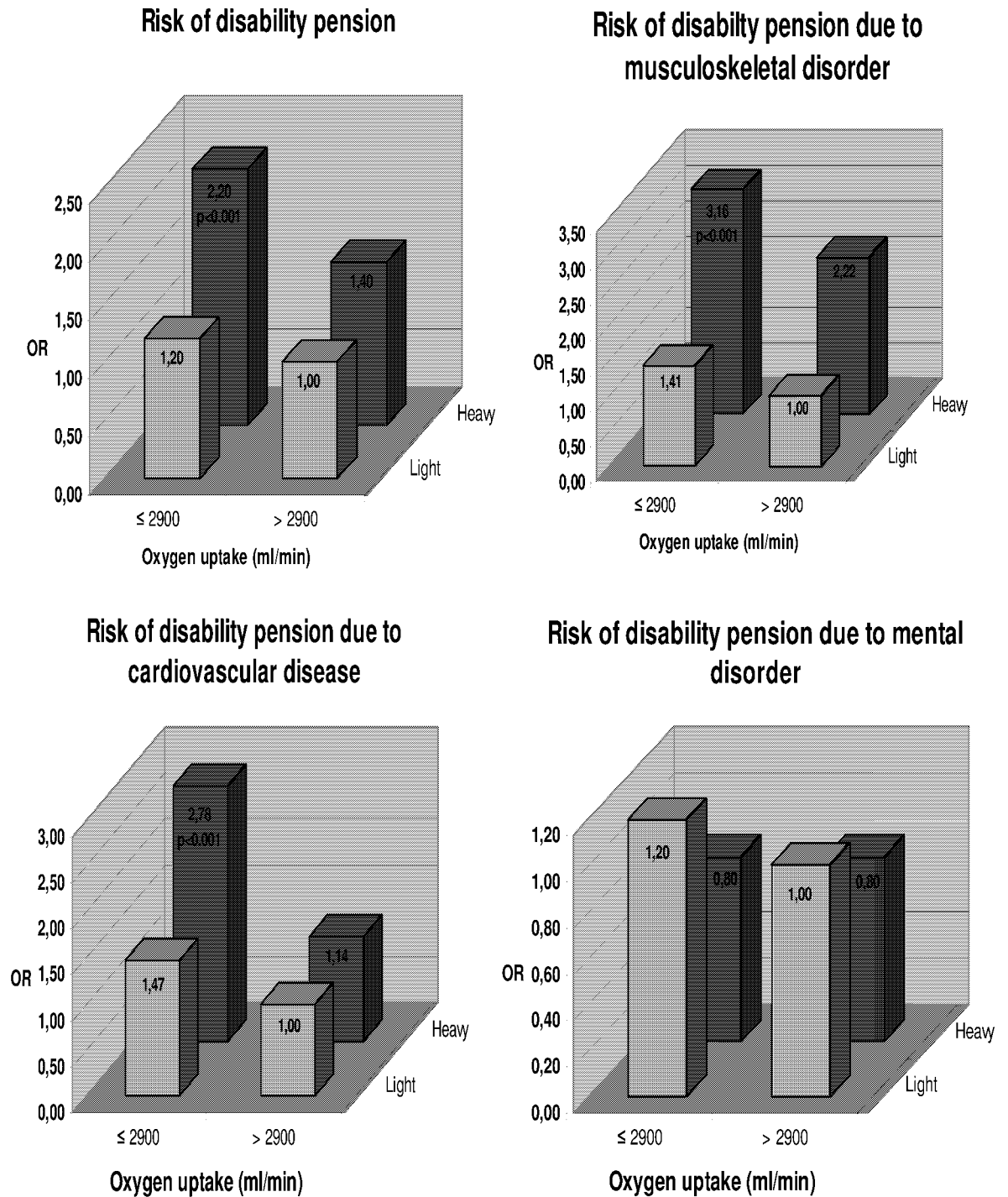
5.6.4 Depression score and retirement (Study III)

The depression score ranged from 0 to 13, and the mean score for the entire cohort was 1.71 (SD 1.98). The mean depression score was 1.91 (SD 1.98) among those on disability pension, 1.80 (SD 2.04) among those on non-illness-based pension, 1.29 (SD 1.75) among unretired men, and 1.40 (SD 1.78) among those on old-age pension. The mean age of retirement for those with a high depression score was 58.6 years (SD 3.98) and 59.4 years (SD 4.28) for those with a low depression score (p < 0.001 for difference). The mean retirement age was 57.8 (SD 4.06) among those men who retired due to a mental illness.

After adjustment for age, the men with a depression score placed in the highest third of the range of figures had a 1.8 times higher risk of having to take early retirement due to any reason than men in the lowest third. The men with highest depression score had a 2.2-fold risk of early retirement due to mental disorders, a 1.9-fold risk due to musculoskeletal disorders, a 1.9-fold risk due to cardiovascular diseases and a 2.4-fold risk due to other chronic somatic diseases. The risk of having to take disability pension due to mental disorders was also increased in the second third of the depression score range. After adjustment for potential confounders including age, education, occupation, body mass index, alcohol consumption, smoking, maximal oxygen uptake and chronic diseases at baseline, the risks of having to take disability pension were 1.5-fold due to any reason, 1.8-fold due to mental disorders, 1.7-fold due to musculoskeletal disorders, 1.4-fold due to cardiovascular diseases and 2.1–fold due to other chronic somatic diseases (Figure 9).

Men with a high depression score alone had a 1.53 (95% CI 1.27-1.85) times higher risk of having to take disability pension than other men. Men with a high depression score with a low maximal oxygen uptake had a 1.92 (95% CI 1.56-2.35) fold risk of receiving disability pension compared to the other men. Thus, poor cardiorespiratory fitness seems to increase the risk of having to take disability pension among depressive men (Figure 10). The same tendency was seen in all pension categories.

Figure 9. Relative risks (RR) of early pensions by depression score. Adjusted for age, education, body mass index, alcohol consumption, smoking, oxygen uptake and chronic diseases at baseline ($*^{)}$ p < 0.05, $**^{)}$ p < 0.005, $***^{)}$ p < 0.001).

Figure 10. Relative risks (RR) of having to take early pension in depressed men by poor cardiorespiratory fitness. Adjusted for age, education, body mass index, alcohol consumption, smoking, and chronic diseases at baseline.
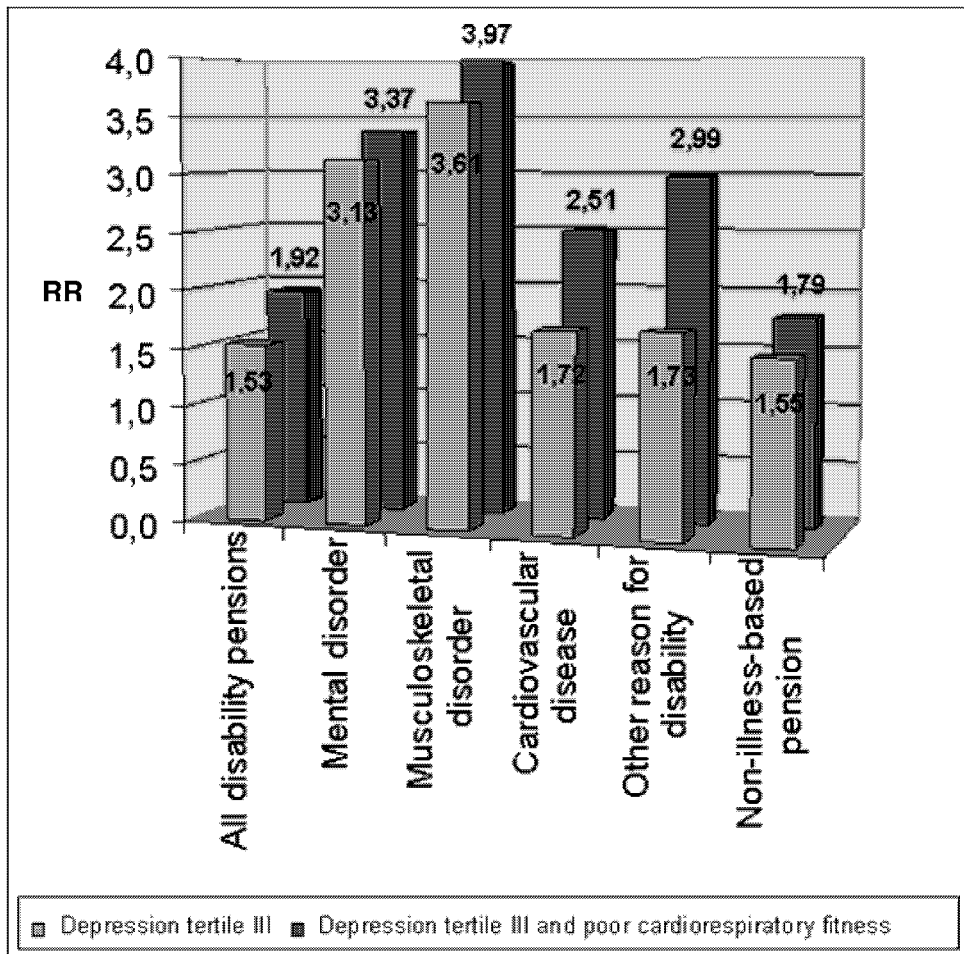
5.6.5 Perceived health and retirement (Study IV)

Poor perceived health at baseline was strongly associated with the risk of having to take both illness-based and non-illness-based pensions even after adjustment for baseline illnesses and other potential confounding factors (Figure 10). Of the separate disease categories, the association was strongest with the risk of disability pension due to mental illnesses (RR 4.13, 95% CI 2.04-8.37). A subjective feeling of suffering from poorer health was also a strong predictor for ending up to early retirement due to cardiovascular diseases (RR 3.25, 95% CI 2.02-5.23) and a non-illness-based pension (RR 3.36, 95% CI 2.20-5.13). Older men with poor perceived health seem to be more vulnerable than younger men. The risk of disability pension was clearly higher among men aged 55 or more (RR 4.78, 95% CI 2.605-8.78) than among men under 55 years of age (RR 1.93, 95% CI 1.51-2.48). The results were similar in other categories of retirement but analysis may not be entirely reliable, because there were only 20 subjects in the group of older men.

At baseline, the subjects compared their perceived health with other men of the same age. Self-assessed health compared with other men of the same age was also strongly associated with the risk of disability pension during the follow-up (Figure 11). Disability due to cardiovascular diseases was, however, the most common reason for retirement if a subject considered his health to be worse than that of other men of the same age (RR 3.60, 95% CI 2.22-5.85).

Figure 11. Relative risks (RR) of early pension by the level of self-assessed health. Adjusted for age, education, body mass index, alcohol consumption, smoking, oxygen uptake and chronic diseases at baseline (*[*)] p < 0.05, **[*)] p < 0.005, ***[*)] p < 0.001).
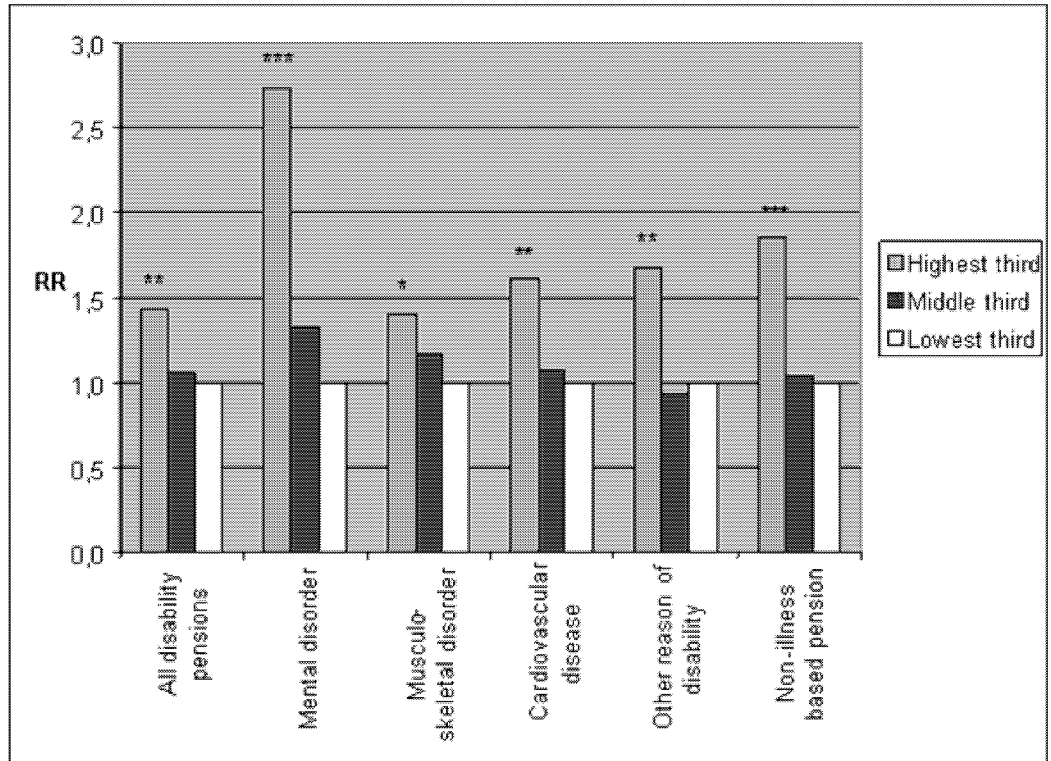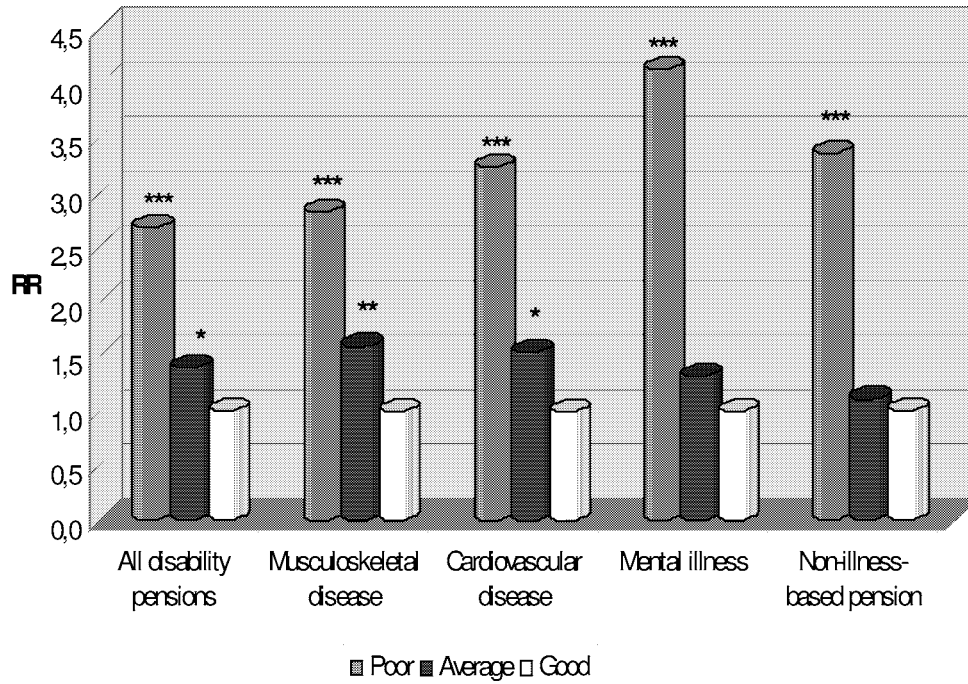
Figure 12. Relative risks (RR) of pension by perceived health compared with the other men of same age. Adjusted for age, education, body mass index, alcohol consumption, smoking, oxygen uptake and chronic diseases at baseline. Good perceived health as a reference (RR 1.00) (*) p < 0.05, **) p < 0.005, ***) p < 0.001).
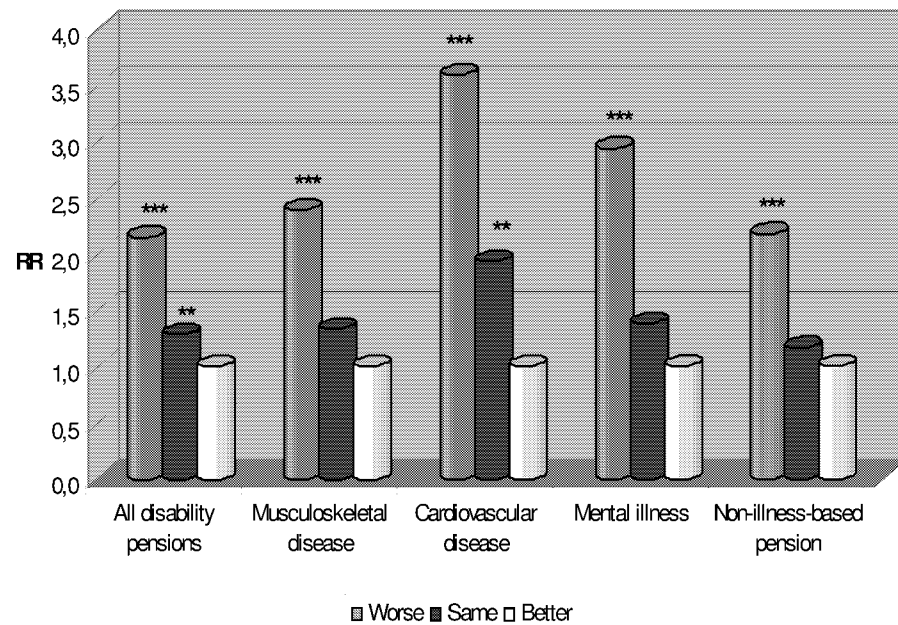
5.6.6 Lifestyle factors and retirement

The risk of disability pension was 1.20 (95% CI 1.10-1.42) among 484 smokers, 1.25 (95% CI 1.05-1.50) among 585 men who consumed more than 69.6g alcohol a week (highest tertile) and 1.61 (95% CI 1.32-1.95) among 302 men whose maximal oxygen uptake was under 2.0 litres per minute (lowest tertile) compared with men with no lifestyle risk factors. Among men (n = 94), who smoked, consumed alcohol (highest tertile) and had a low maximal oxygen uptake (lowest tertile), the risk of having to take

disability pension was 1.56-fold (95% CI 1.18-2.06). Finally, among 56 men who smoked, consumed alcohol, had a low maximal oxygen uptake and had a high body mass index ($<$ 27.7 kg/m^2, highest tertile) the risk of disability pension was 2.02-fold (CI 95% 1.27-3.22). The unadjusted and adjusted risks of disability pension and non-illness-based pension are shown in Table 8.

Table 8. Unadjusted and adjusted risks of disability and non-illness-based pensions.

	Risk of disability pension		Risk of non-illness-based pension	
	Unadjusted	Adjusted*	Unadjusted	Adjusted*
Age				
55 years or more (n=146)	1.72 (1.29-2.29)	1.30 (0.91-1.87)	2.90 (1.99-4.21)	2.45 (1.61-3.74)
< 55 years (n=1609)	1.00	1.00	1.00	1.00
Body mass index (m/kg^2)				
>27 (n=710)	1.28 (1.08-1.51)	1.31 (1.09-1.57)	1.15 (0.88-1.49)	1.02 (0.77-1.36)
25-27 (n=463)	1.05 (0.89-1.24)	1.15 (0.96-1.37)	0.89 (0.67-1.17)	0.80 (0.60-1.07)
< 25 (n=579)	1.00	1.00	1.00	1.00
Alcohol consumption (g/week)				
>70.0 (n=585)	0.95 (0.81-1.12)	1.05 (0.87-1.25)	0.84 (0.64-1.11)	0.94 (0.70-1.26)
12.6-70.0 (n=584)	0.90 (0.76-1.06)	1.09 (0.91-1.30)	0.89 (0.68-1.16)	1.04 (0.79-1.38)
< 12.6 (n=585)	1.00	1.00	1.00	1.00
Smoking				
Smoker (n=484)	1.22 (1.05-1.41)	1.06 (0.89-1.25)	1.16 (0.90-1.49)	1.03 (0.78-1.36)
Non-smoker (n=1271)	1.00	1.00	1.00	1.00
Education				
High school or above (n=147)	0.37 (0.28-0.50)	0.54 (0.38-0.86)	0.28 (0.17-0.45)	0.36 (0.20-0.64)
Middle school (n=655)	0.61 (0.53-0.71)	0.91 (0.77-1.07)	0.52 (0.41-0.66)	0.65 (0.50-0.85)
Elementary school or less (n=923)	1.00	1.00	1.00	1.00
Baseline illnesses				
Cardiovascular diseases (n=883)	1.93 (1.68-2.21)	1.35 (1.15-1.58)	1.75 (1.41-2.18)	1.32 (1.03-1.70)
Musculoskeletal disorders (n=757)	1.67 (1.46-1.91)	1.28 (1.10-1.49)	1.43 (1.14-1.78)	1.05 (0.83-1.34)
Mental disorders (n= 68)	1.41 (1.01-1.96)	1.36 (0.95-1.96)	1.26 (0.72-2.20)	1.35 (0.76-2.40)
Other chronic diseases (n=581)	1.25 (1.08-1.44)	0.95 (0.81-1.11)	1.27 (1.01-1.60)	1.07 (0.84-1.37)

Maximal oxygen uptake				
I tertile (low)	2.63 (2.20-3.13)	1.59 (1.05-1.58)	2.67 (2.01-3.55)	0.92 (0.68-1.24)
II tertile	1.51 (1.26-1.81)	1.10 (0.91-1.34)	1.61 (1.22-2.13)	1.01 (0.73-1.39)
III tertile (high)	1.00	1.00	1.00	1.00
Work				
Heavy (n=793)	2.01 (1.57-2.57)	1.45 (0.99-2.11)	2.65 (1.79-3.07)	1.33 (0.97-1.82)
Moderate (n=360)	0.99 (0.74-1.33)	0.79 (0.56-1.13)	1.35 (0.97-1.87)	1.04 (0.73-1.49)
Sedentary (n=564)	1.00	1.00	1.00	1.00
Depression				
III tertile	1.97 (1.65–2.34)	1.43 (1.21-1.79)	1.90 (1.43-2.53)	1.86 (1.37-2.51)
II tertile	1.26 (1.07-1.48)	1.06 (0.89-1.26)	1.25 (0.96-1.62)	1.04 (0.78-1.37)
I tertile	1.00	1.00	1.00	1.00
Perceived health				
Poor (n=162)	5.19 (4.15-6.50)	2.69 (2.04-3.56)	4.32 (2.93-6.38)	3.36 (2.20-5.13)
Average (n=849)	2.01 (1.74-2.34)	1.40 (1.18-1.66)	1.62 (1.28-2.04)	1.11 (0.86-1.44)
Good (n=741)	1.00	1.00	1.00	1.00
Self-assessed health compared with other men of the same age				
Worse (n=334)	2.93 (2.39-3.59)	2.15 (1.68-2.73)	1.83 (1.31-2.58)	2.18 (1.51-3.16)
Same (n=1012)	1.10 (0.92-1.32)	1.06 (1.06-1.57)	0.85 (0.66-1.10)	1.17 (0.89-1.55)
Better (n=405)	1.00	1.00	1.00	1.00

*Adjusted for age, education, body mass index, alcohol consumption, smoking and baseline illnesses.

6. DISCUSSION

6.1 Study design and methodological aspects

A principal objective in epidemiology is identifying alterable causes of endpoint in order to discover relationships that offer possibilities for preventing these endpoints (MacMahon and Trichopoulos 1996). It is important to note, however, that statistical associations are determined for categories, not for individual persons. The quality of an epidemiological study can be evaluated by study design, study population, exposure and outcome variables, assessment of confounding factors, inclusion and exclusion criteria and statistical methods used.

Longitudinal study design is notoriously slow and laborious. This is true especially when studying the incidence of cancer or other illnesses with a long incubation period or rare diseases. Prospective study design, however, is considered to yield causally stronger evidence than most other types of epidemiological study (Rothman and Greenland 1998). In studies on the incidence of disability pension, the follow-up should be long enough. Most of all, the time needed depends on the age of the subjects: the younger the study population, the longer the time needed to gather enough cases for analyses.

6.2 Study population

The study population provided a unique opportunity to investigate the risk of having to take disability pension. A strength of the present study is that it has a representative population-based sample of men at an age when the occurrence of disability pension is high. The follow-up time was fairly long. There were few losses to follow-up due to the low number of men migrating out of eastern Finland. The age structure of the cohort and the long follow-up made it possible for enough subjects to be classified into different pension groups. Extensive measurements of risk factors at baseline enabled us

to control for potential confounders. The results can be generalised for Finnish men, but not for women because the study sample included only men.

6.3 Methods

6.3.1 Assessment of retirement

The Social Insurance Institution of Finland maintains a national pension register, and all Finnish inhabitants are insured for disability. The information on pensions was ascertained using pension registers that include all Finnish citizens so the data on different pensions in this study can be considered reliable. Even though a person generally knows whether he has retired or not, the nomenclature of different part-time and limited pensions and rehabilitation subsidies is unclear and even the professionals make mistakes. The subjects were also asked about their retirement at baseline. A few subjects did not know or did not say whether they were retired, but after obtaining the pension registers we found that they actually were. These subjects were excluded from the analyses, because the pension had been awarded before the beginning of the follow-up.

The number of diagnoses in medical certificates depends on the attending physician and the severity of the major cause of disability, but only the main diagnosis and two following diagnoses are registered. In this study only the first diagnosis was used in the disability statistics. In most cases the attending physician lists the diagnoses in order, starting with the main reason for retirement. However, there may sometimes be some difference in opinion about what is the most important diagnosis. Of course, this is a matter of diagnostics as well. Psychiatric illnesses and particularly depression are under-diagnosed, and the main diagnosis may belong in this group even though it has not even been mentioned on a certificate. Based on this, there is room for some problems in validity concerning the assessment of disease-specific pensions.

Legislation concerning disability pensions did not change substantially during the follow-up period. Only flexible retirement possibilities improved in Finland after 1985.

Non-illness-based pensions, such as early old-age pension and part-time pension, as well as an individual early pension that is illness-based, were brought in and the individual early pension practically replaced part of the common disability pension (Figure 1 and Figure 5) (Hytti 1998). Because disability pension and individual early pension were combined in the analyses, the phasing in of individual early pension probably did not have a marked effect on the results. However, the risk factor profile among individuals with a normal disability pension or an individual early pension may vary, but it was not possible to study this issue due to the low number of cases. Thus, during the follow-up period admittance of disability pension and early retirement pension have not undergone significant changes.

6.3.2 Assessment of cardiorespiratory fitness

Cardiorespiratory fitness was assessed at baseline by a direct measurement of maximal oxygen uptake during a maximal symptom-limited exercise stress test on a cycle ergometer, which is also widely used in clinical practice. From the entire Kuopio Ischaemic Heart Disease study (n=2,682), the exercise test was performed for 2,361 (88.0%) men. The most common reason for not performing the test was the limited number of staff available for the supervision of the tests. The mean maximal oxygen uptake of middle-aged men in eastern Finland was similar to that of Finnish men of the same age in a previous study (Rusko et al. 1972) and the mean reduction of maximal oxygen uptake per year of age is of the same order as shown previously, 0.42 ml/kg/min (Shvartz and Reibold 1990). Maximal oxygen uptake is an accurate measure of cardiorespiratory capacity (Åstrand and Rodahl 1986) and reflects habitual physical activity quite well.

6.3.3 Assessment of work-related factors

Subjects were asked about physical loading at work at baseline. Their type of work and working conditions may have changed since then. Possible changes at work could not be determined, but another study concerning physical workload among subjects of the same age and from the same geographical area showed that people tended to stay in the

same occupations (Manninen et al. 2002). Some development and changes at work may have occurred but that could not be dealt with. Minor misclassifications in measuring physical risk factors may have occurred, because people experience physical workload differently or because the questions may not have been equally understood. Self-assessment is relatively inaccurate, even though it is feasible and useful in epidemiological studies (Wiktorin et al. 1993; Nordström et al. 1998; Torgren et al. 1999). It is also possible that the subjects with chronic diseases had chosen physically lighter work as compared to those who were healthier but this type of healthy worker effect would rather underestimate than overestimate the results.

6.3.4 Assessment of depression

Depression was measured with a questionnaire. We did not define depression as a clinical entity, or diagnosis in this study but rather as a dimensional characteristic. Despite this, our measurements were able to predict clinical depression, which accounted for a large proportion of disability pensions awarded due to mental disorders. However, self-reported mental disorders at baseline may not comprehensively include all psychiatric morbidity, and it is not possible to study this, so the adjustment for this variable may have left room for some residual confounding.

6.3.5 Assessment of perceived health

The assessment of perceived health is based on self-estimation. Although the measure provides fairly crude information about perceived health, it has been found to be useful in evaluating the risk of having to take disability pension (Biering-Sørensen et al. 1999; Månsson and Råstam 2001; Krokstad et al. 2002), evaluating the health status and predicting future health behaviour (Linn et al. 1980a; Hunt et al. 1984; Bue-Bjørner et al. 1996).

6.3.6 Assessment of confounding factors

Education, occupation, and lifestyle factors were recorded with a questionnaire. Body height and weight were measured with standard protocols by two trained nurses, one during 1984 to 1985 and another during 1986 to 1989. Body mass index was calculated as the ratio of weight to the square of height (kg/m^2). History of diseases was found out using a self-administered questionnaire and the subjects were reinterviewed by a physician regarding their medical history.

6.3.7 Statistical methods

We first used the multinomial regression analysis and logistic regression analysis. Multinomial regression analysis was technically more suitable for the data, because the outcome variable, disability pension had several categories. However, multinomial regression analysis is rarely used in epidemiological studies, and therefore we decided to use a commonly used logistic regression analysis. In further analyses, we preferred the Cox regression analysis, because it considers the follow-up time. It is worth mentioning, however, that the results were quite similar for all of these analyses.

Age, education, maximal oxygen uptake, alcohol consumption, smoking, body mass index and the most prevalent baseline diseases were added into the model as potential confounding variables. Occupation was also included in the model in analyses concerning cardiorespiratory fitness and the risk of disability pension. It was not used in further analyses though, because education already reflects social status. Use of maximal oxygen uptake makes the adjustment quite inclusive when compared with other studies concerning risk factors for retirement.

6.4 Results

6.4.1 Retirement during follow-up

At the beginning of the follow-up, 33.5% of all disability pensions granted for men in Finland were awarded due to musculoskeletal diseases, 20.7% due to cardiovascular diseases and 19.7% due to mental illnesses (SII 1985). Disability pensions granted to men at the end of 2000 in the same disease categories were 26.1%, 8.4% and 39.4% respectively (SII 2000). In our cohort the number of pensions for cardiovascular diseases was overrepresented. While the number of disability pensions for mental disorders has increased enormously in Finland, their number is still quite low in our cohort (Figure 2). The reason for overrepresentation of cardiovascular diseases as a cause of having to take a disability pension may be that at the start of the study eastern Finland used to have one of the highest incidences of cardiovascular diseases in the world. The subjects also worked in heavy occupations, which may explain quite a low level of disability pensions for mental disorders, while the number of disability pensions for musculoskeletal disorders is fairly high.

A total of 79% of men in the present cohort had at least one chronic disease at baseline, which provides one explanation for the high incidence of disability pensions during the follow-up. Previous studies have shown that the prevalence of chronic diseases in eastern Finland is higher than in most of the other parts of Finland (Salomaa et al. 1992). The incidence and mortality of coronary heart disease in Finland was among the highest in the world at the baseline of the present study (Uemura and Pisa 1988). The high prevalence of chronic diseases and the high incidence of disability pensions during the follow-up can also be partly explained by a low educational level and heavy occupations in the study sample.

Before baseline, while the subjects of our cohort were still working, 22.0% of the total KIHD study population had retired on disability pension and 4.8% on an old-age pension. Men who were already retired at baseline clearly differed from those who were

included in the present follow-up study. The subjects were 42-60 years old at baseline which meant that nobody had reached the official pensionable age of 65 years yet. There may have been some men, however, whose common pensionable age was lower than usual, some state or municipal employees for example.

6.4.2 Maximal oxygen uptake and retirement

The novel finding of this prospective population-based study is the strong association between poor cardiorespiratory fitness and an increased risk of having to take disability pension. A low maximal oxygen uptake and a short exercise test were associated with an increased risk of receiving disability pension particularly due to cardiovascular diseases, but also due to musculoskeletal disorders, when other potential risk factors were controlled for. It has been shown before that a low level of physical activity in leisure time and worse self-reported physical condition predicts disability pensions (Biering-Sørensen et al. 1999), but the association of the disability pension risk with maximal oxygen uptake has not been studied before.

The association of low maximal oxygen uptake with an increased risk of disability pension is partly due to a lower incidence of chronic illnesses among fit individuals. This finding suggests that carrying out regular physical activity improves cardiorespiratory fitness and helps preventing disability pension. Exercise testing is not feasible in all clinical practices, because a doctor is needed to supervise the test. Nevertheless, the present study suggests that the measurement of cardiorespiratory fitness during an exercise test is a useful tool for estimating the risk of work disability.

6.4.3 Physically heavy work and retirement

Physical load at work has been found to be associated with early retirement in several studies (Heliövaara et al. 1986; Hasle and Jeune 1989; Vingård et al. 1992; Krause et al. 1997; Månsson et al. 1998). However, only a few of these are longitudinal (Bongers et al. 1988; Tuomi et al. 1991a; Krause et al. 1997; Månsson et al. 1998; Tuomi et al. 2001). In these studies, either heavy physical workload (Tuomi et al. 1991b; Krause et

al. 1997) or a job involving heavy physical workload (Krause et al. 1997; Månsson et al. 1998) had the same degree of direct association with the risk of having to take early retirement. In this respect, our findings support the results of these previous studies.

Three earlier studies considered the effect of work-related physical risk factors on the risk of disease-specific reasons for disability (Bongers et al. 1988; Tuomi et al. 1991a; Holte et al. 2000). In this study, the effect of physical risk factors on the risk of disability retirement seemed to be rather closely related to the disease causing the disability. Physically loading work increases the risk of disability due to musculoskeletal and cardiovascular reasons, but retiring due to a mental disorder does not seem to be associated with physical strain at work. For individuals with physically heavy work a high maximal oxygen uptake appears to decrease the risk of having to take early retirement due to cardiovascular diseases, but does not decrease the risk of having to retire early due to musculoskeletal disorders very much. This finding is consistent with the notion that good cardiorespiratory fitness prevents cardiovascular diseases (Lakka 1994; Blair et al. 1996; Sesso et al. 2000; Laukkanen et al. 2001). A risk of fatal cardiac complications may partly explain the increased incidence of disability pensions due to cardiovascular diseases in men with a physically heavy work. Musculoskeletal disorders, in turn, may limit some work tasks, but staying at work is not life threatening.

Of single risk factors, lifting, static workload and uncomfortable working positions predicted an increased risk of having to take disability pensions whereas sitting a lot at work was associated with a reduced risk. The inverse association of sitting with disability pension has not been reported earlier. The present finding does not mean that sitting itself protects against having to take an early pension, but that even a disabled employee can continue working in a physically light job. Employees, whose work contains a lot of sitting, may exercise a lot during their spare time and that could partly explain the reduced risk of disability pension in these individuals. However, physically heavy work causes different stress injuries and degenerative problems, which may restrict work and cause disability.

Physically heavy work was associated with an increased risk of having to take a non-illness-based pension also among those with a high maximal oxygen uptake.

Continuous physical loading is extremely strenuous and coping with it may become very difficult. So, when working ability has not been reduced enough to gain a disability pension, a non-illness-based pension can be an alternative. In the present study, all of the non-illness-based pensions were unemployment pensions. It must be noted that there was an economic depression in Finland during the follow-up period. The unemployment that resulted concerned mostly blue-collar workers. This may partly explain the results.

It is known that static and dynamic loading of the upper extremities increases the risk of neck and shoulder pain (Bjelle et al. 1981; Hagberg and Wegman 1987; Holmström et al. 1992; Ekgerg et al. 1994; Viikari-Juntura et al. 1994; Ohlsson et al. 1995), but the direct association between upper extremity loading and risk of having to take disability retirement is a new finding. Loading of upper extremities and the neck and shoulder region was associated with an increased risk of disability due to musculoskeletal and cardiovascular diseases, but loading of the low back and lower extremity were associated only with disability due to musculoskeletal disorders. The findings concerning musculoskeletal diseases are as expected. What is surprising is that loading of upper extremities but not loading of lower extremities was associated with an increased risk of disability pension due to cardiovascular diseases. Employees whose lower extremities are loaded at work tend to have higher levels of physical activity at work and possibly a higher level of cardiovascular fitness than those whose upper extremities are loaded at work. It remains obscure, however, as to what kind of a loading of upper extremities is needed, and to what extent, to increase the risk of ending up to disability pension due to cardiovascular diseases. This issue has become quite important given the fast development of information technology. Is this kind of a loading a risk factor for receiving disability pension due to cardiovascular diseases? Or how to estimate the work ability of a worker who has a cardiovascular illness and carries out work that loads upper extremities? The explanation for this may also be too little exercise combined with sedentary work or other risk factors.

Carrying out heavy work was not associated with disability pensions for mental disorders. Instead, some physical factors, such as walking, static loading and physical workload, showed a weak inverse association with the risk of early retirement. Some physical loading at work may be even therapeutic for workers with a mental disorder.

In a previous study it has been shown that physical exercise is associated with good work ability in workers with musculoskeletal or cardiovascular disease (Tuomi et al. 1991a). In this study, the risk of disability pension was strongly associated with physically heavy work among those with a low maximal oxygen uptake. This is the case especially for musculoskeletal disorders and cardiovascular diseases. Workers with poor physical fitness should be identified and actions to improve fitness should be taken. Working conditions should also be monitored and the physical risk factors at work which increase the risk of disability should be controlled, especially in workers with musculoskeletal disorders. The tasks which involve loading of the upper extremities may constitute even more of a risk for having to take an early pension than loading of the low back and lower extremities.

6.4.4 High depression score and retirement

Based on this longitudinal study, it seems that depression plays a role in retirement due to any kind of somatic illness. This is a new finding. The question is whether the depression or the other disabling illness comes first. Baseline illnesses were taken into consideration in the analyses and so it is likely that depression preceded the chronic illnesses. Depression is likely to make it difficult to recover from an illness. It also easily remains undiagnosed when it is not so severe. It is natural, though, for the psychic component to always be present when a person gets ill. The situation may develop into a vicious circle when a primarily depressed person gets ill. Recovery slows down because of depression, and this in turn may worsen the depression. If depression remains undiagnosed and untreated then it may lead to early retirement.

It is logical for a high depression score to be associated with an increased risk of disability pension due to mental illnesses, but the increase in the risk of having to take a disability pension due to other chronic diseases and even the risk of having to take a non-illness-based pension further emphasises early diagnosis of depression. The increase of disability due to musculoskeletal disorders and other illnesses may point out that coping is difficult for a depressed person and willingness to retire instead of staying at work with some health problems will probably win. The relationships at work may be unsatisfactory and work may be uninteresting and heavy. In this kind of a situation, it

may be difficult for a depressed person to find the motivation to work. Occupational health experts may not recognise depression behind other symptoms, the person may not feel very depressed, and finally friends and relatives may also think that this person has always been a little bit melancholy. There may be multiple underlying mechanisms behind this, and further studies on this topic are needed.

6.4.5 Perceived health and retirement

A poor perceived health at baseline was strongly associated with the risk of having to take both illness-based and non-illness-based pensions even after adjustment for baseline illnesses and other potential confounding factors. This finding is in line with previous studies (Biering-Sørensen et al. 1999; Månsson and Råstam 2001). As depression is probably associated with perceived health, it should have been added into the analyses as a confounder. This was done afterwards though, and it slightly weakened the relationship between perceived health and early retirement, but the association remained statistically significant. Other potential confounders include the illnesses that make a subject assess his health as poor. As with depression, baseline illnesses were controlled for in the analyses, and the association remained unchanged.

As previously pointed out, perceived health has been shown to have an association with age, race, sex, body weight, physical fitness, education, socioeconomic status, life style factors and different illnesses. When thinking of ways to decrease early pensioning due to poor perceived health, age, sex and race are factors that can not be changed. Socioeconomic status may be changed by further education, but it is not so simple. When overall dissatisfaction prevails, it is not easy to find solutions for improving one's self-assessed health. Nonetheless, it is difficult to differentiate the effect of perceived health from true, underlying, symptomatic or unsymptomatic disease on the risk of early retirement.

However, perceived health turned out to be the strongest predictor of taking an early pension and it is not really that surprising. Self-assessed health is based on a person's comprehension of himself and his situation as a whole. If a person's physical condition is bad then it is important to motivate that person to exercise more and eat more

healthily. But it may be quite pointless to try to rehabilitate a person, whose mate is retired or severely ill. It may also be pointless to try and rehabilitate a person who began working at the age of 10 and is still working at the age of 60 while suffering from symptoms of degenerative arthritis and being paid an insignificant salary. The pension system does not consider that but takes the medical side of the applicant into account instead. The methods that occupational health professionals and pension institutions use to solve problems are also quite medical. More intense clarification of the person's situation and aligned measures of support provided early enough could perhaps be the answer for at least some of them. One simple question concerning perceived health could be quite predictive of early retirement and a useful tool for the personnel in occupational health services.

6.4.6 Other considerations

Unemployment grew explosively during the deep economic depression of the 1990s that was particularly severe in Finland, (Työministeriö 1991; Työministeriö 2004). While unemployment increased, retirement decreased and this trend continued until the end of the follow-up. This means that many of the potential early pensioners in our cohort probably became unemployed instead of retiring. Hytti (Hytti 1993) has showed that employees who have health problems and carry out physically heavy work and work in occupations that are sensitive to economic fluctuations become unemployed rather than retired due to disability during the economic depression. The unemployment trend was similar across Finland even though the unemployment level was slightly higher in eastern Finland during the last part of the follow-up. Thus, men in this study may not have differed greatly from the rest of the Finnish population in this respect. However, unemployment weakens rather than strengthens the power of our study due to the lower level of retirement.

Controlling for unemployment would have been important in our analyses, because the situation changed so much during the follow-up. This was not possible, however, because unemployment records were not available. There was a question about being unemployed in the questionnaire but it was asked at the baseline, when the unemployment level was quite low.

6.4.7 Practical implications

In this study, perceived health was the strongest predictor of early retirement. In this regard the State and municipalities should invest in the all-inclusive well-being of the population. Employers should also concentrate on a well-functioning working community instead of single exercise afternoons. More flexibility is sometimes needed in work arrangements considering the different life and health situations of employees. Also physically heavy work tasks should be modified more actively especially for those workers with some musculoskeletal disorder. The occupational health services should try to recognise and treat depression better and to motivate the employee to take care of his or her physical fitness. It is important to take the whole person into account, including social situation and support in difficulties. In this study two simple questions concerning perceived health were highly predictive for having to take disability pension. It might be worth considering using them instead of the work ability index.

7. SUMMARY AND CONCLUSIONS

We investigated the associations of cardiorespiratory fitness, work-related physical factors, depression and perceived health with the risk of early retirement. The present study is a part of the Kuopio Ischaemic Heart Disease Risk Factor Study (KIHD). The study population comprised 1,755 men aged 42, 48, 54, or 60 at the baseline examination living either in the town of Kuopio or one of six neighbouring rural communities.

We followed a cohort of 1,755 men from eastern Finland from 1984 to 2000. The subjects answered a questionnaire about physical loading at work, psychological factors, and perceived health at baseline. Maximal oxygen uptake was measured by respiratory gas analysis during a cycle ergometer test. The relevant pension records were obtained from the Social Insurance Institution of Finland and the Finnish Centre for Pensions. Logistic or Cox regression modelling was used in the statistical analyses.

During the follow-up 861 (49.1%) men were awarded a disability pension and 331 (18.9%) men were granted some non-illness-based early pension (unemployment pension). Only 273 (15.6%) men reached the old-age pension age without previously having to take an early pension. The diagnostic reasons for disability retirement were musculoskeletal disorders (n=342, 39.7%), cardiovascular diseases (n=236, 27.4%), mental disorders (n=118, 13.7%), and other diseases (n = 165, 19.2%).

Maximal oxygen uptake and the duration of the exercise test had an inverse association with the combined risk of any disability pension. A lower maximal oxygen uptake and a shorter duration of exercise test were most strongly associated with the risk of disability pension due to cardiovascular diseases. Poor cardiorespiratory fitness was also associated with an increased risk of disability pension due to musculoskeletal disorders, and showed a weak inverse association with disability due to mental disorders.

Sitting a lot at work was associated with a decreased risk of having to take early retirement whereas standing, lifting, static muscular loading and uncomfortable working positions as well as heavy physical workload were associated with an increased risk.

The risk of having to take disability pension was increased due to musculoskeletal disorders, cardiovascular diseases, and other chronic diseases, but not due to mental disorders. Loading of the upper extremity and neck and shoulder region, in particular, was directly associated with the risk of disability pensions due to musculoskeletal and cardiovascular reasons in particular. The loading of the low back or lower extremity also had a direct association with having to retire due to musculoskeletal disorders. The risk of non-illness pension seems to decrease if the work involves a lot of sitting. High maximal oxygen uptake seems to prevent early retirement in physically heavy work.

Men with a depression score in the highest third of the range of figures had a 1.5 times higher risk of having to take early retirement for any reason than men in the lowest third. The men with highest depression score had a 1.8-fold risk of having to take early retirement due to mental disorders, a 1.7-fold risk due to musculoskeletal disorders, a 1.4-fold risk due to cardiovascular diseases and a 2.1-fold risk due to other chronic somatic diseases. They also had a 1.6 times higher risk of having to take retirement due to other reasons than diseases. Poor cardiorespiratory fitness seems to increase the risk of disability pension among depressive men.

Poor perceived health at baseline was strongly associated with the risk of both illness-based and non-illness-based pensions. The association was strongest with the disability due to mental illnesses. Subjective feeling of poorer health compared with the other men of the same age was also a strong predictor of early retirement due to cardiovascular diseases and non-illness-based pensions. Older men with poor perceived health seem to be more vulnerable than the younger men with poor perceived health, because the risk of having to take disability pension was clearly higher among men aged 55 or more than in men who were less than 55 years of age.

In the present study, the risk of disability pension was strongly associated with the poor maximal oxygen uptake, heavy physical workload, high depression score and poor perceived health. Low maximal oxygen uptake still increased the risk of having to take disability pension among those whose work was physically heavy or whose depression score was high.

Based on this study, it can be recommended that different influencing parties such as State, municipality, employers and occupational health service affect the all-inclusive well-being of employees more than single individual health matters.

8. SUMMARY IN FINNISH - YHTEENVETO

Tutkimuksessa selvitettiin kardiorespiratorisen kunnon, työhön liittyvien fyysisten tekijöiden, masentuneisuuden ja koetun terveyden yhteyttä ennenaikaiselle eläkkeelle siirtymiseen. Tutkimus on osa Kuopion Sepelvaltimotaudin vaaratekijätutkimusta (KIHD). Otos koostui alkuvaiheessa 42, 48, 54 tai 60-vuotiaasta 1755 miehestä, jotka asuivat joko Kuopiossa tai jossain sen kuudesta naapurikunnasta.

Seurasimme 1755 itäsuomalaisen miehen kohorttia vuodesta 1984 vuoteen 2000. Henkilöt olivat vastanneet kyselylomakkeen kysymyksiin koskien työn fyysistä kuormittavuutta, psykologisia tekijöitä ja koettua terveyttä. Maksimaalinen hapenottokyky mitattiin hengityskaasuanalyysillä polkypyöräergometritestin aikana. Kattavat eläketiedot saatiin Kansaneläkelaitoksesta ja Eläketurvakeskuksesta. Tilastoanalyyseissä käytettiin Logistista tai Coxin regressiomallia.

Seurannan aikana 861 (49.1%) miestä jäi työkyvyttömyyseläkkeelle ja 331 (18.9%) ei-sairausperusteiselle eläkkeelle (työttömyyseläke). Ainoastaan 273 (15.6%) miestä jäi vanhuuseläkkeelle ilman edeltävää ennenaikaista eläkettä. Työkyvyttömyyden syyt sairausryhmittäin olivat tuki- ja liikuntaelimistön sairaudet (n=342, 39.7%), sydän- ja verisuonitaudit (n=236, 27.4%), mielenterveyden häiriöt (n=118, 13.7%) ja muut sairaudet (n = 165, 19.2%).

Maksimaalisella hapenottokyvyllä ja rasituskokeen kestolla on käänteinen yhteys työkyvyttömyyseläkkeelle jäämiseen. Matala maksimaalinen hapenottokyky ja lyhyt rasituskokeen kesto olivat yhteydessä työkyvyttömyyseläkkeelle siirtymiseen erityisesti sydän- ja verisuonitautien vuoksi. Huono kardiorespiratorinen kunto oli myös yhteydessä lisääntyneeseen työkyvyttömyyseläkeriskiin tuki- ja liikuntaelinsairauksien vuoksi, mutta näytti olevan käänteisesti yhteydessä mielenterveyden häiriöiden vuoksi eläkkeelle jäämiseen.

Runsaasti istumista sisältävä työ liittyi alentuneeseen eläkeriskiin, kun taas seisominen, nostelu, staattinen lihasjännitys ja epämukavat työasennot, kuin myös raskas ruumiillinen työ lisäsivät riskiä. Työkyvyttömyyseläkkeen riski oli lisääntynyt tuki- ja

liikuntaelimistön sairauksien, sydän- ja verisuonitautien ja muiden kroonisten
sairauksien, mutta ei mielenterveyden häiriöiden vuoksi. Erityisesti yläraajojen ja niska-
hartiaseudun alueen kuormittamisella sekä erikseen että yhdessä on suora yhteys
työkyvyttömyyseläkeriskiin erityisesti tuki- ja liikuntaelimistön ja sydän- ja
verenkiertoelimistön sairauksien vuoksi. Alaselän ja alaraajojen kuormitus oli suoraan
yhteydessä tuki- ja liikuntaelimistön sairauksien vuoksi eläkkeelle jäämiseen. Ei-
sairausperusteisen eläkkeen riski näytti vähenevän, jos työ sisälsi runsaasti istumista.
Hyvä maksimaalinen hapenottokyky näyttäisi suojaavan ennenaikaiselle eläkkeelle
siirtymiseltä fyysisesti raskaassa työssä.

Depressiopistemäärän ylimmässä kolmanneksessa olleilla miehillä oli 1.5-kertainen
ennenaikaisen eläkkeen riski verrattuna matalimman depressiopistemäärän ryhmän
miehiin. Korkeimpien depressiopistemäärien miehillä oli 1.8-kertainen riski jäädä
työkyvyttömyyseläkkeelle mielenterveyshäiriöiden vuoksi, 1.7-kertainen riski
eläköitymiseen tuki- ja liikuntaelinsairauksien vuoksi, 1.4-kertainen riski sydän- ja
verisuonitautien, ja 2.1-kertainen muiden kroonisten sairauksien vuoksi. Huono
kardiorespiratorinen kunto lisäsi työkyvyttömyyseläkkeen riskiä depressiivisillä
miehillä.

Seurannan alkuvaiheessa huonoksi koettu terveys oli vahvasti yhteydessä sekä sairaus-
että ei-sairausperusteisiin eläkkeisiin. Yhteys oli vahvin mielenterveyden häiriöiden
vuoksi myönnettyjen eläkkeiden kanssa. Subjektiivinen tunne huonosta terveydestä
verrattuna muihin samanikäisiin miehiin ennusti myös vahvasti eläkkeelle jäämistä
sydän- ja verisuonitautien vuoksi samoin kuin siirtymistä ei-sairausperusteiselle
eläkkeelle. Vanhemmat miehet, jotka kokivat terveytensä huonoksi näyttävät olevan
haavoittuvampia kuin nuoremmat, sillä työkyvyttömyyseläkkeen riski oli selvästi
korkeampi vähintään 55-vuotiailla, kuin alle 55-vuotiailla miehillä.

Tässä tutkimuksessa työkyvyttömyyseläkeriski oli vahvasti yhteydessä huonoon
maksimaaliseen hapenottokykyyn, fyysisesti raskaaseen työhön, korkeaan
depressiopistemäärään ja huonoksi koettuun terveyteen. Matala hapenottokyky edelleen
lisäsi työkyvyttömyyseläkkeen riskiä niillä, joiden työ oli fyysisesti kuormittavaa tai
joiden depressiopistemäärä oli korkea.

Tämän tutkimuksen perusteella voi suositella, että eri vaikuttajatahot kuten valtio, kunta, työnantajat ja työterveyshuolto panostaisivat yksittäisten terveysseikkojen lisäksi enemmän myös työntekijöiden kokonaisvaltaiseen hyvinvointiin.

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APPENDIX

Assessment of depression.

Thesis or question in a questionnaire	Score of an alternative		
	0	**1**	**2**
I often feel tired	Do not agree	Cannot say	Agree
I often feel insecure			
I feel I have problems I cannot solve			
I'm continuously worried about my health			
It's difficult to manage with demands that are made on me			
I often lose my temper			
I feel nobody can understand my innermost feelings			
I often think about death			
I often feel desperate			
I often get nervous because of work			
I often worry about my health			
I've sometimes felt unsuccessful			
I'm often dissatisfied with myself			
I feel frustrated			
My family does not understand me enough			
It is difficult to meet or visit people			
I often feel exhausted			
I think it's impossible to reach the aims that I would like to			
My future seems hopeless and I do not think it will change for the better			
I still enjoy sexual intercourse	Agree	Cannot say	Do not agree
I feel I am in the best condition of my life			
Have you been able to enjoy usual daily activities recently?	More or as much as usual	Less than usual	Much less than usual
Have you recently felt worthless?	Much more than usual	A little more than usual	Not at all or not more than usual
At the moment, do you consider your life	Very or quite happy	Quite unhappy or can not say	Very unhappy
At the moment, do you consider your life	Very or quite easy	Quite hard or can not say	Very hard
At the moment, do you feel	Not lonely at all	Quite lonely or can not say	Very lonely

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