Tampere University

MINNA PIHLAJAMÄKI

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ACADEMIC DISSERTATION
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Dedication

To all stakeholders involved in supporting employees' ability to work, irrespective of the science field.

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This dissertation is a result of a curiosity and desire to learn something new.

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Minna Pihlajamäki

ABSTRACT

Preventing work disability (WD), which presents as temporary (TWD) or permanent disability (PWD) is important for the individual and for society. Screening questionnaires are often used within the context of health surveillance to identify employees at WD risk at occupational health services (OHS) in Finland. Some of them, such as the Health Risk Appraisal (HRA) and the Subjective Cognitive Complaints (SCC) questionnaires, have indicated predictive value for identifying employees at an increased risk of TWD in smaller settings and selected occupational groups in earlier studies.

The objective of this thesis was to study whether the HRA and SCC questionnaire predict TWD, defined as sickness absence (SA), and PWD, defined as disability benefit (DB) that includes rehabilitation subsidy and disability pension, among employees in different industries like the HRA cohort and among knowledge-intensive sedentary occupations like the SCC cohort. TWD lasts under one year, while PWD is defined as work disability that lasts over one year.

In the present study, we used the HRA and the SCC questionnaires, which in the earlier studies with smaller study sample sizes were able to identify employees with temporary WD risks. The HRA identifies "high risk" subgroups based on self-reported health problems and SCC based on cognitive complaints. In the present study with a larger study population than in the previous studies, we evaluated the predictive value of these classifications among employees from different industries.

We collected the data from screening questionnaires from one national occupational OHS provider's register. The study participants were working-age employees from different industry sectors.

We combined the results of the HRA and SCC with the registry data on SAs and DBs. We used a Hurdle model with a negative binomial response to analyze zero-inflated count data of SA. Cumulative incidence (CIF) function was used to illustrate the differences between the HRA risk groups and SCC categories in the accumulation of DBs, respectively. We used the Fine-Gray model to estimate the predictors for DB occurring over time.

Self-reported health problems within the “WD risk” category in the HRA predicted future SA in both genders, regardless of occupational grading among over

22,000 employees from different industries. Subjective cognitive complaints predicted a higher total count of SA days among employees from knowledge-intense occupations. Belonging to the “WD risk” category in the HRA and the “abnormal SCC score” category predicted permanent WD in both genders in both the unadjusted and adjusted models.

In the HRA cohort, the ratio of the means of SA days varied between 2.7 and 4.0, depending on gender and occupational group. The lower limit of the 95% confidence interval (CI) was 2.0 at the lowest. The most common primary reasons for permanent WD were musculoskeletal (39%) and mental disorders (21%). In addition to age and prior sick leave days, the “WD risk” category in the HRA predicted DB in the Fine-Gray Model. Hazard ratios (HR) were 10.9 or more, with the lower limit of the 95% confidence interval being 3.3 or more among those with two simultaneous WD risk factors.

In the SCC cohort, the ratio of the means of SA days in the abnormal SCC category was higher than 2.8 as compared to the reference group (no findings) with the lower limit of the 95% confidence interval being 2.2. The most common primary reasons for permanent WD were mental (36%) and musculoskeletal (20%) disorders. SCC predicted DB in both genders when controlling for age and prior SA in the Fine-Gray Model. Hazard ratios were 2.9 at the lowest, with a 95% confidence interval of 1.4–6.0. The overall annual DB incidence was 0.15%: 0.18% among the females and 0.12% among the males.

Belonging to the “WD risk” category as defined in the HRA or to the abnormal SCC score category predicted the number of accumulated SA days during the 12-month follow-up and DB during a follow-up of six and eight years, respectively, irrespective of the other predictors or confounding factors.

These findings have implications for targeting preventive occupational health care actions toward those in need to prevent SA and DB. The HRA and the SCC questionnaire are potential tools for recognizing employees who are at an increased risk of WD regardless of the occupational group, as in the case of the HRA, and among knowledge-intensive workers as in the case of the SCC questionnaire.

Keywords: occupational health care, work disability, sickness absence, disability benefit, questionnaires

TIIVISTELMÄ

Työikäisten työkyvyttömyyden ehkäisy on inhimillisesti ja yhteiskunnallisesti tärkeää toimintaa. Työterveyshuollossa käytetään usein erilaisia seulovia kyselyjä osana suunnattuja terveystarkastuksia työkykyriskissä olevien työntekijöiden tunnistamiseen. Aiemmissa tutkimuksissa pienemmillä otannoilla ja valikoituneilla työntekijäryhmillä on todettu, että terveysperusteinen terveysriskien arviointilomake (HRA, Terveyskysely) ja psykososiaalista kuormitusta mittaava kyselylomake (SCC, Voimavarakysely) tunnistavat työkykyriskissä olevat työntekijät.

Väitöskirjatutkimuksessa tutkittiin ennustavatko Terveyskysely eri toimialojen työntekijöiden ja Voimavarakysely tietointensiivisten toimialojen työntekijöiden työkyvyttömyyttä. Työkyvyttömyys operationalisoitiin ohimeneväksi työkyvyttömyydeksi eli sairauspoissaoloksi sekä pysyväksi työkyvyttömyydeksi eli työkyvyttömyysetuudeksi. Pysyvä työkyvyttömyys kattaa kuntoutustuet ja työkyvyttömyyseläkkeet. Määritelmä huomioi työkyvyttömyyden pituuden, ohimenevä työkyvyttömyys kestää alle vuoden, kun taas pysyvä työkyvyttömyys on yli vuoden kestävä, jolloin etuuden maksaminen siirtyy työeläkevakuutusyhtiölle.

Tässä tutkimuksessa käytettiin Terveyskyselyä ja Voimavarakyselyä, jotka aiemmissa pienemmän otoskoon tutkimuksissa pystyivät tunnistamaan työntekijät, joilla oli ohimenevän työkyvyttömyyden riski. Terveyskysely tunnistaa ”korkean riskin” ryhmän itse ilmoitettujen terveysongelmien perusteella ja Voimavarakysely itse ilmoitettujen kognitiivisten ongelmien perusteella. Väitöskirjassa arvioitiin suuremmassa otoskoossa luokittelun ennustearvio eri toimialojen työntekijöillä.

Kyselylomakkeiden tieto kerättiin yhdeltä työterveyshuollon palveluja tuottavalta yritykseltä. Tutkimukseen osallistuvat olivat työikäisiä eri toimialojen työntekijöitä.

Terveyskyselyn ja Voimavarakyselyn tulokset yhdistettiin sairauspoissaolojen ja työkyvyttömyysetuuksien rekisteripohjaiseen dataan. Sairauspoissaoloja tutkittiin Hurdle -mallilla, jossa huomioidaan myös ne henkilöt, joilla ei ole sairauspoissaoloja. Hurdle -mallissa tarkasteltiin erikseen osajoukkoa, joka sisälsi kaikki sairauspäivät sekä osajoukkoa, josta oli poistettu sairauspoissaolopäivien nollapäivät. Työkyvyttömyysetuuksien ilmaantuvuutta tutkittiin kumulatiivisen insidenssifunktion ja Fine-Gray -mallin avulla.

Terveyskysely ja Voimavarakysely ennustavat tulevia sairauspoissaoloja sekä työkyvyttömyysetuuksia. Terveyskyselyn itsearvioidut terveysongelmat työkyvyttömyyskategoriassa ennustivat sairauspoissaoloja naisilla sekä miehillä riippumatta työntekijäluokasta eri toimialojen työntekijöillä. Voimavarakysely ennusti sairauspoissaoloja naisilla ja miehillä tietointensiivisillä toimialoilla. Terveyskyselyn "työkykyriski" luokka sekä poikkeava Voimavarakysely ennustavat tulevia työkyvyttömyysetuuksia.

Terveyskysely -kohortissa sairauspäivien keskiarvon vaihtelu oli välillä 2.7-4.0 riippuen sukupuolesta ja ammattiryhmästä. 95%:n luottamusvälin (LV) alaraja oli alimmillaan 2.0. Yleisimmät ensisijaiset syyt pysyvään työkyvyttömyyteen olivat tuki- ja liikuntaelimistön (36%) sekä mielenterveyden ja käyttäytymisen häiriöt (21%). Terveyskyselyn työkykyriskikategoria, ikä ja aiemmat sairauspoissaolot ennustivat myönnettyjä työkyvyttömyysetuuksia. Vaarasuhteet (Hazard Ratio, HR) olivat 10.9 tai yli ja 95%:n LV:n alaraja oli 3.3 tai suurempi niiden joukossa, joilla oli kaksi samanaikaista työkyvyttömyysriskiä.

Voimavarakysely -kohortissa tietointensiivisillä toimialoilla poikkeavan löydöksen työntekijöillä sairauspäivien keskiarvo oli yli 2.8 riippuen sukupuolesta vertailuryhmään (ei-löydöksiä) verrattuna. 95%:n LV:n alaraja oli alimmillaan 2.2. Yleisimmät ensisijaiset syyt pysyvälle työkyvyttömyyseläkkeille olivat mielenterveys- (37%) ja tuki- ja liikuntaelinsairaudet (20%). Voimavarakysely ennusti työkyvyttömyysetuuksia molemmilla sukupuolilla. Vaarasuhde (HR) oli 2.9 alhaisimmillaan, 95%:n LV oli 1.4-6.0. Vuotuinen DB-esiintyvyys oli 0,15%: 0,18% naisilla ja 0,12% miehillä.

Kuuluminen Terveyskyselyn ja Voimavarakyselyn työkykyriskiluokkaan ennusti sairauspoissaoloa 12 kuukauden seurannassa ja työkyvyttömyysetuutta kuuden ja kahdeksan vuoden seurannan aikana.

Näiden löydösten perusteella kyselyjä voidaan toteuttaa löytämään ne työntekijät, jotka ovat riskissä menettää työkyvyn toimialasta riippumatta kuten Terveyskyselyn kohdalla tai tietointensiivisillä aloilla Voimavarakyselyn kohdalla. Tämän perusteella voidaan suunnata työterveyshuollon resursseja kohdennetusti niille, jotka tarvitsevat tukitoimia.

Avainsanat: työterveyshuolto, työkyvyttömyys, sairauspoissaolo, työkyvyttömyys-etuus, kyselylomakkeet

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ABBREVIATIONS

BMI	Body Mass Index
CIF	Cumulative Incidence Function
DB	Disability Benefit
ETK	the Finnish Centre for Pensions
ERI	Effort-Reward Imbalance Model
HRA	Health Risk Appraisal
HW(H)/(S)E	Healthy Worker (Hire) / (Survivor) Effect
ICF	International Classification of Functioning, Disability, and Health
JDSC	Job Demand-Control-Social Support model
Kela	Social Insurance Institution of Finland
LTSA	Long-term Sickness Absence
PWD	Permanent Work Disability
OHS	Occupational Healthcare Service
RCT	Randomized Controlled Trial
SA	Sickness Absence
SCC	Subjective Cognitive Complaints
STSA	Short-term Sickness Absence
TE	Public Employment and Business Services (TE Services)
TWD	Temporary Work Disability
WA	Work Ability, the ability to work
WAI	Working Ability Index
WLC	Work-life conflict
WD	Work Disability

ORIGINAL PUBLICATIONS

Publication I — Self-reported Health Problems and Obesity Predict Sickness Absence During a 12-month Follow-up: A Prospective Cohort Study in 21608 Employees from Different Industries. Pihlajamäki M, Uitti J, Arola H, Ollikainen J, Korhonen M, Nummi T, Taimela S. *BMJ Open. 2019;9(10):e025967.*

Publication II — Self-reported Health Problems in a Health Risk Appraisal Predict Permanent Work Disability: A Prospective Cohort Study of 22023 Employees from Different Sectors in Finland with up to Six-year Follow-up. Pihlajamäki M, Uitti J, Arola H, Korhonen M, Nummi T, Taimela S. *International Archives of Occupational and Environmental Health. 2020;93(4):445-456.*

Publication III — Subjective Cognitive Complaints and Sickness Absence: A Prospective Cohort Study in 7059 Employees in Primarily Knowledge-intensive Occupations. Pihlajamäki M, Arola H, Ahveninen H, Ollikainen J, Korhonen M, Nummi T, Uitti J, Taimela S. *Preventive Medicine Reports. 2020;19:101103.*

Publication IV — Subjective Cognitive Complaints and Permanent Work Disability: A Prospective Cohort Study. Pihlajamäki M, Arola H, Ahveninen H, Ollikainen J, Korhonen M, Nummi T, Uitti J, Taimela S. *International Archives of Occupational and Environmental Health, Submitted. 2020*

1 INTRODUCTION

Occupational health surveillance focuses on either specific exposures prescribed by legislation (hazard surveillance) or on promoting wellbeing and wellness (health check-ups) (1). They focus on either reducing the incidence of occupational diseases and accidents, as in hazard surveillance, or on promoting work capacity and assessing fitness for work as in the case of health check-ups (2).

The Finnish OHS is unique in many aspects as compared to other countries. Most Finnish employees use OHS for both preventive and curative health care (3). In 2018, approximately 1.9 million Finnish employees (91% of the employed workforce (4)) were covered by OHS, according to official statistics of Finland. Voluntary curative health care covers 94% of the workforce (5). Study settings outside of Finland are not comparable with Finnish OHS practices as such. Occupational health surveillance in Finland has focused mainly on health and lifestyle issues (2,6). In 2018, there were 1.4 million occupational health check-ups focusing on health and lifestyle issues, of which 303,200 were based on a specific exposure (hazard surveillance) (5).

Occupational health surveillance is conducted in Finland from two different perspectives: to support the health and safety of the entire work community and all employees to prevent work-related diseases, and to support individual employee's ability to work. Since the 1990s, the focus of occupational health check-ups has gradually shifted towards supporting ability to work, which enables it to target interventions for those in need and promote employee work ability. Besides focusing on health complaints due to a specific hazard, screening questionnaires are increasingly used in preventive OHS as part of a targeted health check-ups to identify employees at risk of losing the ability to work. They measure e.g. health complaints or psychosocial non-illness–related outcomes. Screening questionnaires can be combined with occupational health check-ups (7), which focuses on the health risks of particular work tasks, and to supplement and systemize the identification of other non-work related health risks that might increase work disability risk.

The use of validated questionnaires can be expected to improve the quality and cost-effectiveness of health check-ups. Use of structured questionnaires may help to identify the threat of latent work disability (WD) in the future. Based on these risk factors, OHS may direct the preventive actions towards those in need at the individual and work community levels. An interview based on structured response options should provide more reliable information than an unstructured one. The use of questionnaires to identify potential WD risk is becoming more common.

OHS collects information on the health of employees, which gives an overview of a work community, i.e., how the employees' health develops. The goal of screening questionnaires is to identify WD risk at such an early stage that treatment and rehabilitation changes the prognosis. If OHS health check-ups include screening questionnaires, it is important to define the health objectives of the screening and to find evidence of the possibilities of achieving them through screening as well as the best tools for the screening. Screening questionnaires should be safe, accepted, and cost-effective. The care pathway from the screening questionnaire onward must be clear.

Early identification of WD risks and early management of the illnesses may potentially reduce sickness and sick leave days. In the long term, they also may prevent absenteeism, early retirement, and social exclusion. The predictive validity of different screening questionnaires used in clinical practice and in OHS surveillance to identify employees at WD risk should be properly evaluated.

Validated screening questionnaires have not been implemented in broader clinical use, nor has validation been performed among the public sector, specific industries, occupational groups, or in smaller sample sizes. The sample size affects the accuracy of the estimators. However, in studies with a larger sample size among different industries, we get statistical power and accuracy of the estimates.

In the present study, we evaluated whether two questionnaires commonly used in the clinical OHS practice, the health risk appraisal (HRA) and subjective cognitive complaints (SCC) questionnaire predict SA and permanent WD. We hypothesized that self-reported health problems predict future SA, irrespective of gender and occupational group and that these complaints have also an independent predictive effect on permanent WD. We also evaluated whether SCC predict SA and permanent WD among respondents from various knowledge-intensive occupations.

2 REVIEW OF THE LITERATURE

Ability to work (work ability, WA) and work disability (WD) describe the same complex phenomenon from the opposite sides. Modern occupational healthcare directs its resources towards supporting remaining WA rather than pointing out dysfunction and disability. Still, to support WA, we need to identify WD risk factors. The definitions of WA and WD are used in the context of assessing and promoting employees' capability of remaining at work, which makes the terms difficult to define without ambiguity.

In the present study, the review of the literature focuses on the definition of work disability (WD) and introduces the relevance of WD for society and at the individual level. The review also introduces the predictors of WD, such as sociodemographic predictors, health-related and lifestyle issues, and non-illness related predictors. Finally, the review of the literature gives a description of some tools to prevent WD. Occupational health check-ups are often supplemented by questionnaires. Their development should be based on scientific research, in which the predictive value for relevant outcomes, like work disability, is proven.

2.1 Definition of work disability

The conceptual definition for work disability (WD) is diverse among researchers, and there is no common understanding of how to handle it across the various research questions. WD can be understand as an umbrella concept consisting of several definitions such as temporary and permanent WD.

But first, it is important to understand the more universal and complex concepts of disability.

There are many different models for disability; the United States of America and Europe have developed disability models independently from each other (8-10). The International Classification of Functioning, Disability, and Health (ICF) was published in 2001 by World Health Organization (WHO), which integrates the major two models of disability, the medical model and the social model, as a "bio-psycho-social synthesis". The model recognizes the role of environmental factors in the formation of disability, as well as the role of underlying health conditions(10) (Figure 1).

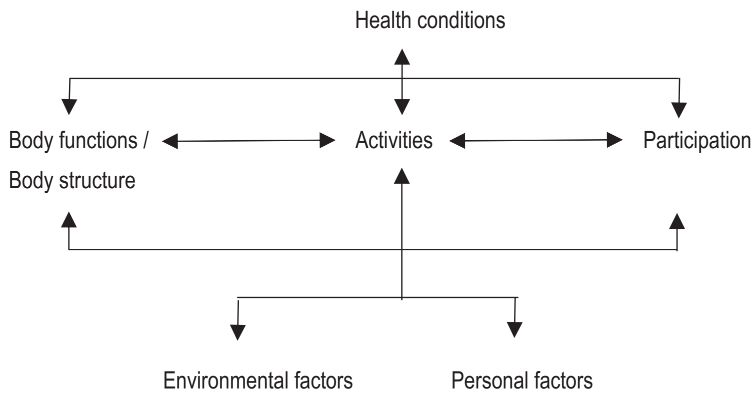

Figure 1. International Classification of Functioning, Disability, and Health (ICF) (WHO 2001).

This WD model does not seem sufficient enough in the context of OHS because it does not take organizations and workplaces into consideration. Therefore, it is not ideal in explaining why employees are pulled in or pushed out from the workforce, for example, in the case of sickness, and why some organizations have low sickness absence rates while others have high rates of absence due to illness.

Professor Patrick Loisel and his colleagues introduced a framework for WD that covers causes of disability due to a patient's personal characteristics (physical and psychosocial) and environmental factors, such as their workplace, social security system, and even healthcare system (11) (Figure 2).

The concept of WD and its counterpart work ability (WA) describe the same phenomena on the opposite sides: how employees can manage in the workforce with their current capabilities and how the environment such as the job itself (e.g. work has a protective effect on depression and general mental health), peers, and the close ones may influence their capabilities and motivation. It is difficult to find an interpretation of working capacity that encapsulates the perspectives of all stakeholders, such as employers, occupational health services (OHS), tertiary care, and different scientific disciplines. The ambiguity of working capacity should be based partly on the fact that the concepts of WD and WA are used in two different contexts in the assessment and promotion of working capacity (12).

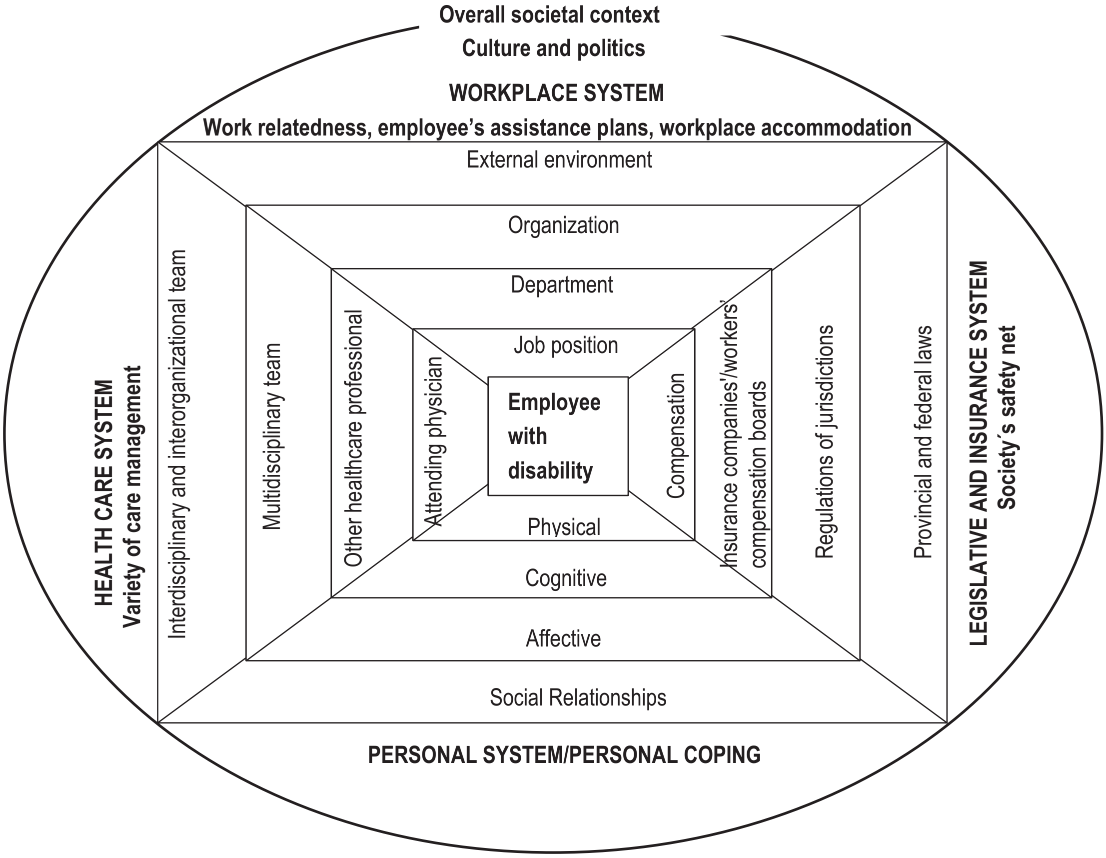

Figure 2. The Sherbrooke model or the arena of work disability (Loisel et al., 2001).

WA and WD assessment should be based on both objective findings and on employees' subjective estimations of their resources in relation to work demands (13). WA and a work ability index (WAI) was constructed in 1981 (13,14). Professor Juhani Ilmarinen and colleagues developed a WA house model based on a series of follow-up studies on the model in 2006 (Figure 3). In short, WA is recognized as a complex issue covering the employees' physical, mental and societal capacities as well as aspects like education, knowledge, skills, experience and motivations in this model (15).

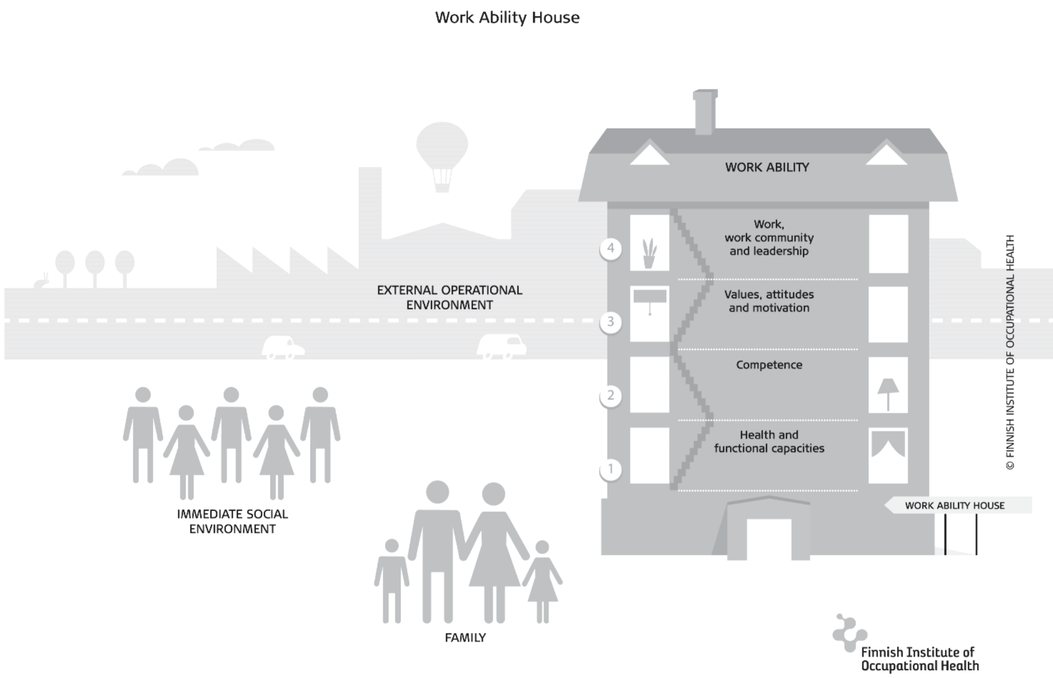

Figure 3. The "house of work ability" (Ilmarinen et al., 2006).

A systematic literature review introduces WA research and identifies eight different models to define WA in Finland (12): 1) medical model, 2) WA as a social construction, 3) the balance model, 4) psychosocial WA model, 5) employability-oriented model, 6) integrated "individual in work community" model, 7) bio-psycho-social model, and 8) other WA models. In this thesis, findings rely on the ICF framework, i.e., the bio-psycho-social model, because the study theses are evaluated, employee-derived variables (health-related and not health-related issues) rather than occupational healthcare itself.

In the context of WD is essential to understand that the definition is also associated with social security programs. In most Europe countries have three separate programs that differ according to WD causes and permanency: 1) short-term sickness, sickness benefits, sickness absence; 2) work-related injuries and diseases; and 3) diseases or non-work–related long-term disabilities, referred to as disability benefits, disability pensions or ill-health retirement (16).

In Finland, WD means that an employee is not able to work and earn money to cover living costs. WD is a medicolegal concept that always involves a medical evaluation as defined in Section 8, Paragraph 4 of the Health Insurance Act

(1224/2004) and in Section 3, Paragraph 35 of the Employees Pensions Act (395/2006) (17,18). In most industrialized countries, it is the physician's task to assess WA and be closely involved in the issuance of WD benefit (19-22). WD typically begins with the onset of one or more health conditions that may limit the employee's ability to perform specific tasks that they would otherwise normally perform (9).

WA and WD might be associated with absenteeism from work (11,23), but this is not always the case. Presenteeism is defined as decreased work performance due to the presence of health problems while the employee is working (24,25). There are two main scientific frameworks for understanding presenteeism as a phenomenon: as the loss in work productivity due to an employee's health problems or as subjective job insecurity when employee health status gives a legitimate reason to stay home (25). Based on this criterion, WD can be categorized into four different types: 1) employee is working but experiencing health-related work limitations, called presenteeism; 2) employee is off work due to health conditions; 3) employee returned to work with work limitations; and 4) employee is withdrawn from the active labour force (26). An accepted definition of absenteeism is "employees that do not present themselves at their place of work when management says they should be present" (27).

In conclusion, WD can be defined as a general inability to perform one's job due to a problem in bodily function, difficulties executing tasks, or problems experienced during tasks or social relations at the workplace (28).

In the present study, we focus on absenteeism due to ill health, that is, a phenomenon where the employee is temporarily or permanently out of the workforce due to health-related reasons.

2.1.1 Temporary work disability

Temporary work disability (TWD) is operationalized as sickness absence (SA) in the present study. SA is a complex and a multifactorial phenomenon determined by personal, sociodemographic, and lifestyle- and health-related factors, physical and psychosocial work-related risk factors, and health care system and/or OHS and legislation. Therefore, the international comparison is limited because analyses of temporary WD depend largely on health insurance systems and related requirements on medical certification in individual countries (11,29,30). Also, SA terminology and measures used have varied in different studies (9,31).

In Finland, SA is granted as a full or partial sickness allowance during which the physician is always assessing the remaining capacity to work. The partial sickness allowance helps a sick person keep their job until they are able to return to full-time work (32).

Literature considering SA can be divided into two strands. One strand of literature originated from neo-classical economic theory and considers SA to be a manifestation of employees' labor supply decisions, while another strand is called the epidemiological perspective, which views SA as being caused by ill health and work disability (33). In this summary of the thesis, the point of view is based on the epidemiological perspective.

SA means non-attendance at work when attendance was scheduled and expected (27). It is also defined as absenteeism from work, sick leave, sick days, sickness absence or sickness certification in the previous literature.

SA is considered integral to the medical management of illness and is an important administrative service to the business community (21,33,34). In most countries, general practitioners grant the most of SA days (35). In Finland, SA days are typically prescribed either by a general practitioner or by an OHS physician (36-38). A SA certificate, by legislation, is based on the medical facts known to the prescribing doctor and should outline the functional limitations that result from the medical condition only (34). Based on an earlier survey, OHS physicians prescribe simple certificates such as SA certificates (approximately 3.5 certificates/day) more frequently than general practitioners (approximately 1.9 certificates/day) (37). Another Finnish survey-based study concluded with hypothetical cases that OHS physicians prescribed shorter SAs than physicians in hospitals or in primary health care (36).

The model of illness flexibility emphasizes the choice an employee must make between being sick and going to work when they feel ill (23). SA can have causes other than ill health (11,23,29). In the literature, distinctions have been made between several types of absenteeism from work, such as excused and unexcused, voluntary and involuntary, or legitimate and illegitimate absenteeism (23,39). SA can be defined as one form of excused absence when it is medically proven (39).

SA is also defined as short-term (STSA) and long-term (LTSA), depending on the length of the sickness allowance. There is no universal definition of the LTSA; it depends on the study question, design, setting and operationalization of the variables.

In summary, temporary WD is a complex and multifactorial medico-legal phenomenon. In different studies terminology has varied and due to differences in the medico-legal settings, international comparisons must be done with caution. In the present study, we have assessed the predictive validity of two different questionnaires on temporary WD.

2.1.2 Permanent work disability

Because of the complex nature of WD, there is no self-evident criterion for determining a permanent WD, which usually manifests as a granted disability benefit (DB) (40). DB is usually caused by chronic disease, which reduces functional capacity and, hence, reduces ability to work. The synonyms for DB are disability pension, disability retirement, invalidity pension, and ill health retirement, which all are defined as a permanent exit from the workforce due to a medical cause. Terms like disability pension, invalidity pension, or ill-health retirement are all used to describe the specific kind of social security program that supports individuals who, due to long-term disabilities, cannot support themselves through work (16).

After sickness allowance has been paid for 60 days in Finland, the Social Insurance Institution of Finland (Kela) informs the employee about various rehabilitation options and providers. An OHS physician must evaluate the remaining capacity for work and the possibility to return to work after sickness allowance has been paid for 90 working days at the latest. After sickness allowance has been paid for 150 days, Kela sends a letter explaining the rehabilitation options and how to claim DB. In case sickness absence continues further and the employee submits a DB application, Kela and the pension insurance companies assess the possibilities of returning to work with the help of medical rehabilitation and/or vocational rehabilitation, which are primarily offered to an employee at risk. The DB ceases if the receiver returns to work or old-age pension begins (at 63–68 years of age), depending on the year of birth. In Finland, a DB is granted as a full-time benefit if the remaining maximum working capacity is 40% (2/5) and the respective figure for a partial benefit is 60% (3/5). The duration of the granted DB can be until further notice, as in the case of granted disability pension, or for a temporary fixed-term period, as in the case of a granted rehabilitation subsidy (41,42). TWD benefit is granted by Kela lasts under one year, while PWD is granted by pension insurance company and it lasts over one year.

Identifying PWD is not straightforward, and work disability is rather the degree of disabilities than dichotomous presence of ill-health status (43). The legal implementation varies among countries (43,44). The operationalizations of the legal criteria could be grouped into three categories according to their emphasis on a medical condition (disease, symptoms, impairments), functional status (limitation of activities) and/or required rehabilitative efforts (44). In Finland, receiving a DB is by legislation based on objectively determined decrease in functional and work capacity due to illness (45).

With a validated prediction model, it would be possible to target OHS resources to those in need to prevent permanent WD. In the present study, we have assessed the predictive validity of two different questionnaires on permanent WD.

2.2 Relevance of work disability

Many Organization for Economic Cooperation and Development (OECD) countries face challenges with the decline of the labor supply due to the aging population (46,47). Declining birth rates combined with longer life expectancy are increasing the ratio of old working-age persons (48). Work disability is a significant phenomenon. Across the OECD, one in seven people of working age regard themselves as having a chronic health problem or disability that hampers their daily life (49). However, the different definitions and measurement methods of WD make international comparisons difficult (27).

The costs of different types of WD are recorded with mixed methods, and rates between different countries are not comparable (27). Costs are commonly classified as direct or indirect. Direct costs may include the salary of the absent employee and replacement and overtime costs, and indirect costs may include the effects on productivity, administration, quality of service, social security contributions and the hiring of replacement workers (27). The approach to calculating the costs of social security systems is also variable in terms of the scope and details of information recorded (27).

There is limited comparable knowledge about the extent, causes and costs of WD across countries (27). According to an OECD report, temporary and permanent WD generate considerable public finance costs to society. On average, OECD countries spend 1.2% of the Gross Domestic Product (GDP) on DBs alone, and this figure reaches 2% when including SA (43).

In 2017 according to the Kela statistics, there were a total of 291,000 (of which 173,000 were female) individuals on sickness allowance in Finland (51). However, the Kela statistics do not include the first nine days of SA. The proportion of the

Kela sickness allowance recipients was 12% among the 2.47 million working-age population (50).

In 2019, 20,300 new disability pensions were granted and 65,000 people retired on an earnings-related pension (51). Incidence rates of DB due to different diseases from 1988 to 2009 has decreased from 13% to 7% in Finland (52). The largest decrease in granted DB occurred in ten years, between 2008 and 2017; in 2017, 27% fewer DBs were granted than in 2008 (53). At the same time, the retirement of large age groups increased the old-age pensioner population under the earnings-related pension system. Also, due to changes in legislation, work-life has become more attractive, which has led employees to stay in the workforce longer. The incidence of granted DBs may still have slightly increased since the end of 2017. From the beginning of January 2018, more DBs have been granted per month than in the same month in 2017 (54).

In 2014, the Finnish Ministry of Social Affairs and Health estimated the cost of lost work productivity due to WD based on the 2012 Kela SA registry data and Statistics Finland's 2012 Labor Force Survey, using expert-opinion-based estimates for the cost of productivity loss. The cost of WD due to SA was estimated to be 3.4 billion euros at the societal level, which is approximately 1590 euros per employee. The cost of WD due to DB was estimated to be 8.0 billion euros (55). However, these estimates must be interpreted with caution, since the largely rely on economic costs. Economic cost differs from accounting cost because it includes opportunity cost.

Because the definitions of WD, SA and DB vary, the exact costs of health-related absenteeism are difficult to quantify. Nevertheless, one of the key reasons for the present study is the burden of social costs of WD, although we did not study these direct or indirect costs.

2.3 Predictors of work disability

The previous literature has identified many predictors for WD. This review of the literature will focus on the sociodemographic, health and lifestyle factors, and non-illness–related predictors are defined as psychosocial risks and subjective cognitive complaints.

In this section, subheadings are based on topics in the questionnaires used in this thesis.

2.3.1 Sociodemographic characteristics

In WD research studies, socioeconomic differences have been handled as descriptive variables or as confounders to control for socioeconomic status (56). There is also a discussion about whether sociodemographic issues influence health or whether health influences sociodemographic issues such as a change in occupational level (57). Sociodemographic predictors might also be clustered (58-60). Socioeconomic status should be considered in statistical analyses.

2.3.1.1 Age

Age is a well-known predictor for WD (48,59,61). A systematic review found evidence that older age is associated with SA (OR 2.2 or over with 95%CI 1.3 or over) (61). The aging of employees might influence labor productivity by following two mechanisms: 1) employees' ill-health status and 2) decline of job productivity and performance due to degenerative processes of the human body (62-64) that might also be the risk factors for WD. Older employees generally have poorer health than younger employees, which might be due to both lifestyle-related and degenerative diseases (57). A cohort study suggest that physical and cognitive limitations at age 53 were associated with WD defined as early retirement (63). On the other hand, more and more diseases are being treated with costly advanced medicine, and the aging population is on the average in better condition than in the past (48). The relationship of ill-health status and productivity loss goes in both directions. A cohort study found that poor general health is indeed associated with productivity loss, and that health-related factors were more strongly associated with SA (OR 2.62; 2.11–2.93) than with low performance (OR 1.54; 1.38–1.71) (64). A later cross-sectional study found that age is negatively associated with the ability to work ($t= -0.34$, $p<0.001$) measured by work ability index (WAI) (62).

Age is associated with temporary work disability (TWD) (61,65) and permanent work disability (PWD) (66,67) by influencing both of the reasons for and duration of WD. Generally, the underlying diagnosis for WD varies by age: young employees tend to have relatively more mental disease diagnoses and older employees are more likely to have more musculoskeletal issues (67-69). A cohort study found that TWD diagnoses differed among age groups: younger employees have more mental diseases than older employees (those aged 20–29 had a mental disease incidence of 5.8/1000 person-years for males and 6.5 for females, and those in the 60–64 age range have corresponding figures of 0.5 and 0.0), while older employees have more musculoskeletal diseases than younger employees (0.4/1000 person-years for males and 0.2 for females aged 20–29 years, and those aged 60–64 have corresponding figures of 0.9 and 0.5) (68). This was later found in another cohort study that found that PWD diagnoses differed among age groups: younger (<35 years) people have more mental diseases (57%) than older employees (55+ years) (19%), and older employees have more musculoskeletal diseases (30%) than younger employees (19%) (67). The prevalence of musculoskeletal and mental health disorders in the general population also varies by age. The prevalence of musculoskeletal problems increases with age due to degenerative diseases (70), while the prevalence rates of common psychiatric disorders are substantially higher in younger than in older age groups (71).

The duration of SA spells also varies by age, depending on the diagnosed underlying disease (69,72-75). Older people have more prolonged SA than the younger ones (in the 55–62 age group, 40 days among males and 37 days among females, while in the 25–34 age group, 33 days among both males and females) (72), and younger people have more frequent SA spells than the older ones (73,74), but the overall accumulated number of SA days is higher among older employees (60,76,77). The cohort study conducted among employees of the City of Helsinki suggested that younger employees had shorter SAs but fewer long SAs than older employees (73). Another cohort study suggested that of propensity of having any SA was higher among the 18–29 age group (OR 1.17; 95%CI 0.48–2.86) than among the 55–61 age group (OR 0.51; 95%CI 0.26–1.01), while the duration of SA was higher in the 55–61 age group (MR 1.18; 95%CI 0.84–1.66) than in the 18–29 age group (MR 1.05 95%CI 0.72–1.52) (74). A Finnish register-based case-control study suggested more disability retirees among the 55–64 age group (N=27) than among the 25–34 age group (N=21) (60). A Swedish cohort study shows a similar association: the HR of disability pension among the 30–39 age group was 2.5 (95%CI 1.9–3.3) among males and 2.7 (95%CI 2.2–2.4) among females, and irrespective figures among the 50–59 age group was 19.5 (15.0–25.4) and 10.3 (8.3–12.7) (76).

Age does not have a direct causal mechanism to WD. Indeed, interpretation needs careful insight, and age alone cannot be used as a predictor of WD.

2.3.1.2 Gender

Females are at higher risk of WD than males. Researchers have searched for potential sources and reasons for the gender difference. These might be a) a labor market segregation into male- or female-dominated occupations, including differences in industries and working conditions, different types of work, and different occupational classes and unequal clustering into workplaces (78-82); b) biological (e.g., endocrinological and neurological) differences (39,83); c) cultural, societal and structural barriers (79,84-87); or d) a statistical approach (39,82,88). A systematic review gives some support that work-family conflict is associated with later SA and may contribute to the gender gap in SA (89).

In the given literature, it is well-known that females have higher TWD rates than males (39,90). A longitudinal study found that females were on SA more than males (mean of 22 days and 14 days, respectively) (t-test -5.43, $p<0.001$) (90). A similar association was found in Finnish observational studies (87,91). The gender gap tends to be larger for STSA and tends to narrow with LTSA (87,91-93). STSA rates might reflect more cultures and norms (87), i.e., women tend to stay home more often than males, for example, for their child's illness.

In Finnish municipal employees, a cohort study found that females had a 54% higher age-adjusted occurrence of self-certified SA than men, and when controlling for occupation, this explained half of the gender difference; controlling for workplace explained the difference, and controlling for the occupation and workplace combined had almost the same effect as controlling for occupation only (91).

Because there are typical female and male occupations, the work-related risk factors may differ between genders (79,94), meaning that females and males have different types of work, or within the same employer, they have dominated different occupational classes. A systematic review found that jobs held by males are generally more physically demanding, have less support but higher levels of effort-reward imbalance and job status, were more exposed to noise and worked longer hours than females, while females had more job insecurity, lower control and worse contractual working conditions than males (79). A cohort study (78) as well as a longitudinal study (142) have a similar association that female excess of psychosocial risks explains over 20% of the TWD.

Findings on PWD, i.e., granted DBs, are controversial (92). On the other hand, there are more females on PWD (52,66,95), but the risk of getting PWD after LTSA is higher in males than in females (92). A prospective study shows that the annual cumulative incidence of LTSA was 6.5% for women and 4.9% for men, while 10.3% of the females and 12.1% of the males received DB after three years (92). The causal reason based on ICD classification for granted DBs differs among genders: males with mental and females with musculoskeletal disorders had the highest risk for DB (76).

In summary, the following conclusion can be drawn from the literature review. Females tend to have more SA and permanent WD than males. Reasons for the gender differences are many such as work and occupation, biological, social, and cultural reasons.

2.3.1.3 Occupational status (group)

As we can see, age, gender and a combination of both are important psychosocial risks that influence the risk of WD (96). Occupational status also influences many risk factors and WD. Different occupational groups are facing different exposures at work and tend to have different lifestyle choices. The higher occupational group, i.e., white-collar workers, seem to be at lower risk, while the lower occupational group, i.e., manual workers, are at higher risk for WD (97-101).

Occupational affiliation is a predictor for TWD (102-107) and PWD (59,95,97,98,108). These findings have also been studied in Finland, and a similar association has been found in observational studies (59,97,98,103,107).

A cohort study formed among Helsinki municipal employees found that high occupational group was associated with a low level of SA (manual worker OR was 1.67 at the lowest with a 95% CI of 1.65 or over, while the respective figure for semi-professionals was 1.23 with 95% CI 1.22 or over) (103).

Another cohort study shows an association with PWD and occupational group as follows: the hazard ratio was 1.41 (95% CI 0.84–2.33) in the routine non-manual group, 1.87 (95% CI 1.07–3.27) in the skilled manual group, and 2.12 (95% CI 1.14–3.95) in the unskilled manual group, the reference group was professional/manger (fully adjusted model), while work-related factors mediated the impact of occupational group on a subsequent PWD with 5% in the routine non-manual group, 26% in the skilled manual group and 24% in the unskilled manual group (the gender and health-adjusted model) (108). Employees in higher occupational groups are two times more likely to continue working beyond retirement age compared to those with lower occupational groups (109).

A Finnish cohort reveals that hospitalization showed a slightly more increased risk of PWD in the lower-ranking occupational group (110). Hospitalization among women for mental disorders showed a more increased risk in the professional group (hazard ratio 14.73; 95% CI 12.67–17.12) compared to the routine manual class (hazard ratio 7.27; 95% CI 6.60 to 8.02) (110). Differences in occupational group were similar for men and women. The risk of DB among women increased most in the routine non-manual group after hospitalization for musculoskeletal disorders and injuries; in the professional group, the greatest increase was seen after hospitalization for cardiovascular diseases. The corresponding risks among men increased most in the two lowest-ranking groups after hospitalization for injuries (110).

The review indicated that the effects of an exit from work, or more specifically, the effects of early/statutory retirement on health, are different between high and low socioeconomic groups (111).

A multisite cohort study found that low occupational class is associated with increased risks of a health-related exit from work (112).

It is important to understand a "healthy worker effect" (HWE) (113-116) as an umbrella concept, consisting of a "healthy worker hire effect" (HWHE) (117,118) and a "healthy worker survivor effect" (HWSE) (119,120). In the literature, there is debate over whether health is a confounder, a selection bias or both. In the given literature, it is known that employees in the workplace are healthier than the average population. Healthy people find work more easily and they are more prone to be hired, while workers with health problems are more prone to leave the workplace (113). A "healthy worker hire effect" (HWHE) has been identified as a component of the overall HWE that involves the initial entry of healthy individuals into an occupation (117,118). A similar bias would potentially result from an HWSE, which means that only the healthiest and strongest will continue working, while unhealthy individuals tend to leave work earlier (119,121).

In summary, occupational status is an important predictor of WD through many different mechanisms and should be included when building the predictive model of WD and there seem to be complex interactions between occupational status, gender, and age.

2.3.2 Lifestyle

Unhealthy lifestyle behaviors such as obesity (122-126), smoking (127), alcohol (128) and lack of physical exercise (129) associate with risk of WD. Unhealthy lifestyle factors tend to cluster with each other (130-132).

A systematic review included 36 studies, of which eleven studies investigated obesity and frequency of SA and nine found associations compared with normal weight (ORs from 1.3 to 2.1), but the evidence of accumulated SA days was conflicting and lacked precision for the conclusions (125). Another systematic review with 27 studies concluded that overweight (HR/RR 1.13, 95%CI 1.07–1.17) and obese employees (HR/RR 1.52, 95%CI 1.36–1.71) were more commonly granted DB than normal-weight employees (126).

In a systematic review of 56 studies, 24 out of 43 studies reported clustering of alcohol with smoking, and 14 out of 28 reported clustering of smoking, nutrition, alcohol and physical activity (130). In Finland, the simultaneous occurrence of predictors has also been studied. In a cohort study, 2.5% of males and 0.9% of females in Finland had unhealthy behaviors such as smoking, excess alcohol consumption, physical inactivity and unhealthy dietary habits (133). A longitudinal study concluded that smoking seemed to have an essential role in the association between different health behaviors, and it was predictive of alcohol use (OR 1.9 (95% CI 1.6–2.3) for males and 3.7 (95% CI 3.0–4.5) for females), physical inactivity (OR 2.0 (95% CI 1.6–2.4) for males and 1.8 (95% CI 1.5–2.2) for females), and unhealthy diet (OR 1.7 (95% CI 1.4–2.1) for males and 1.4 (95% CI 1.1–1.7) for females) (134).

Clustered health-related behaviors predict SA (122,135-137). Previously, there have been two different studies from the Helsinki Health Study cohort, in which findings are in line with each other, i.e., smoking and obesity are associated with SA (122,135). The RR for smoking was 1.2 with a 95% CI of 1.1 at the lowest; for obesity, it was 1.3 with a 95% CI of 1.1 at the lowest with self-certified SA, and the association was stronger with medically confirmed SA (135). Among women, there was a joint association with self-certified SA (obese smokers RR 1.81; 95% CI 1.59–2.07). Among both genders, smoking and obesity were jointly associated with medically certified SA (for obese smoking women, the RR was 2.23; 95% CI 1.93–2.57; for obese smoking men, the RR was 2.69; 95% CI 2.03–3.55) (122).

There is also evidence that clustered health-related behaviors predict DB. An association has been found between cigarette smoking and alcohol use and DB (138,139) but also in the transition out of work (140). A Finnish cohort study found an association between smoking and physical inactivity: OR was 1.9 at the lowest, with a 95% CI of 1.3 or over for a physically inactive heavy smoker compared to a physically inactive non-smoker, for which OR was 1.3 with a 95% CI of 0.9 or over for DB (127).

In summary, lifestyle factors are strongly associated with WD, and they should be included in the multivariate model of predicting WD.

2.3.3 Health

The association between work and perceived health is complex, and a multidisciplinary approach is needed to understand the complexity. Interdisciplinarity is needed to combine the following information: sociological information describing the work setting or environment, psychological information describing employee-related characteristics such as skills, coping process, etc., and biological or medical information describing the effects of underlying health conditions and the effects of work on health.

Work can be both detrimental and health-promoting (141). A systematic review of prospective studies concluded that work has a protective effect on depression and general mental health (142).

Self-rated health, (45,143,144), chronic health conditions (145) and the use of medication (145) are known predictors for WD. The most common reasons for STSA are infectious diseases, while the reasons for LTSA are musculoskeletal and mental health issues (146). A Finnish cohort study also found that self-rated less-than-good health predicted DB due to all causes among both women (HR 4.60; 95% CI 3.84–5.51) and men (HR 3.83; 95% CI 2.64–5.56), as well as due to musculoskeletal diseases (HR 5.17; 95% CI 4.02–6.66) and mental disorders (HR 4.80; 95% CI 3.50–6.59) (143).

In most countries, musculoskeletal (76,95,147-149) and psychiatric (43,60,150-154) disorders are the two diagnostic groups that most often legitimate LTSA and DB.

SA could be seen as a measure of perceived health (155,156). Earlier SA from work is also a predictor for future WD as it was described in earlier studies (43,61,72,156-162). There is some evidence that the risk of transition from SA to DB differs with age and geographic region. A cohort study found that SA is a risk marker for future DB (163). A cohort study from Sweden (61) and Finland (158) further supports a previous systematic review that STSA may have consequences for future SA beyond the effect of ill-health status (159). A cohort study from Norway supports the idea that LTSA increased the risk of obtaining DB (160). A study of OECD countries found a statistical correlation (R=0.6) between SA levels and DB inflow rates (43).

Generally, health affects working capacity in many ways. On the one hand, work that is adjusted to individual work capacity supports functional and remaining work ability. On the other hand, poor health potentially leads to WD and is also a risk factor for social exclusion. In summary, health status is a strong predictor of WD.

2.3.4 Earlier sickness absence

Previous studies suggest that earlier SA predicts future TWD (61,144,159,164,165) and PWD (72,76,163,166-169). This phenomenon is also known in Finland. A cohort study among City of Helsinki employees suggests that preceding SA increased the risk of new SA episodes; for example, among women, the risk of experiencing a new short absence spell was HR 1.29 (95%CI 1.39–1.60) among those who had already experienced one previous SA compared with those with no previous absence spells (162). A ten-town cohort study among Finnish municipal employees shows HRs for long spells to be 15.1 (95%CI 10.6–21.4) for psychiatric disability pension and 19.4 (95%CI 12.2–30.6) for musculoskeletal disability pension (163). A Finnish nationwide cohort drawn from Kela and ETK suggests that a long SA over 180 SA days was a predictor of disability retirement (HR 7.26 [95%CI 6.16–8.57) for upper non-manual employees and HR 3.94 (95%CI 3.60–4.30) for manual employees] (72).

A correlation has been shown between health and work status (170). There is a two-way causal relationship, i.e., health status influences the probability of being employed, and working status affects health through work conditions due to specific exposures (170). SA is a predictor of adverse health outcomes (155,171), but work can support employees' better health. In 2015, 12% of workers in the EU28 self-reported that their work positively affects their health, and 25% report that it affects their health negatively (49). In shorter spells, the influence of work satisfaction is an important factor along with health status (171). The Whitehall study among British public servants concluded that the risk factors differ for short and long spells due to different diagnostic patterns (171). In shorter spells, the influence of infectious diseases is large, while in longer spells, the influence of musculoskeletal and psychiatric diseases and accidents increases (31,171,172). This is also the case in Finland (173). The macroeconomic situation also influences the behavior of SA so that SA rates usually increase during periods of economic growth (172).

Longitudinal studies have revealed that once a person commences with certified SA, they commonly start down a slippery slope that leads to long-term worklessness; i.e., earlier SA is a precursor to permanent WD depending on the underlying diagnosis (34). TWD rates correlate with PWD rates (43).

Earlier SA and health have a two-way causal relationship. Both are predictors of WD.

2.3.5 Psychosocial predictors

Non-illness–related predictors (28), i.e., those with no ill-health context, are important to understand the full picture of WD risk factors and underlying determinants. Psychosocial risks have been recognized as a potential cause of poor health and subsequent WD (29,174-176), which is also supported in the Finnish review of the literature (177-183).

There are different models and theories explaining how psychosocial risk factors influence the risk of WD. Here are just a few of these models and theories: the job demand-control (-social) support (JDC(S)) model, the effort-reward imbalance (ERI) model, recovery theory, work-life conflict theory, and the concept of executive function. The most widely used theoretical frameworks in modelling WD are the JDC (28,181,183-185) and ERI models (28,186-188), and some also emphasize recovery theory (189-193).

The JDC model was developed in the late 1970s to explain the association between job strain and cardiovascular diseases (184,194) (Figure 4). In the JDC model, job demands and control together determine the effects of work on health and well-being of the employee. A systematic review found evidence for the role of low control (RR was 1.40, 95%CI 1.21–1.61) and for the combination of high demands and low control (RR 1.45, 95%CI 0.96–2.19) as predictors of DB (28).

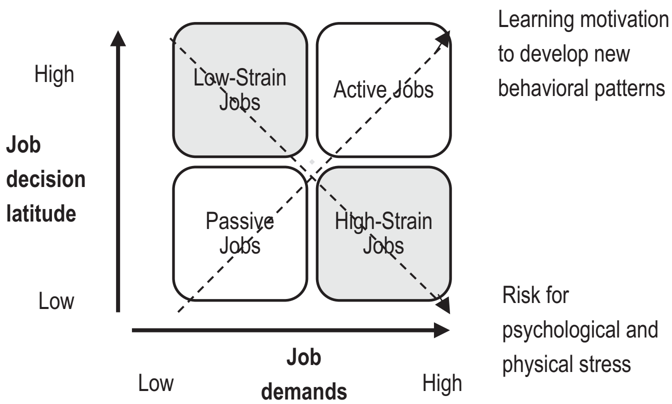

Figure 4. Job Demand control model by Karasek (Karasek 1979).

In addition to the person-environment fit model (195) and the JDC model (184), a third theoretical concept originating from medical sociology was introduced to assess the adverse health effects of stressful experiences at work (186). The focus of the effort-reward imbalance model (ERI) is on high-cost and low-gain conditions, which are considered particularly stressful (186) (Figures 5 and 6). High-effort variables are categorized as extrinsic factors such as work pressure (quantitative workload and time pressure) and intrinsic factors such as an employee's own personal coping pattern. ERI increases the risk of several disease outcomes as shown in different prospective studies (196,197), including cardiovascular disease (198,199) and poor mental health (200,201). There is evidence that ERI increases the risk of SA (29,201-206) and DB (28,187,207,208). However, the results of previous studies concerning the relationship between ERI and SA are not consistent (201-203,205,209).

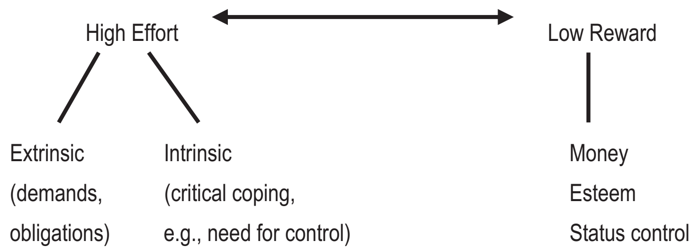

Figure 5. Effort-reward imbalance model at work (Siegrist 1996).

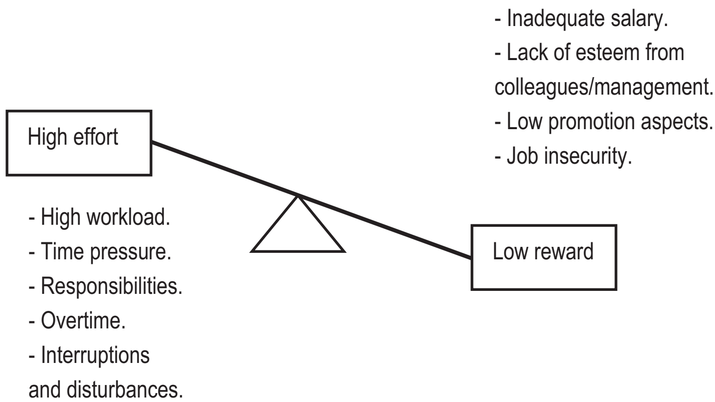

Figure 6. High efforts and low rewards of the ERI model.

The recovery theory (193) and the role of recovery can be understood from the perspective of the effort-recovery (210) and conservation of resources (211) theories (Figure 7). Recovery from work plays an important role in predicting individual health and well-being. Empirical studies have shown that recovery activities such as recovery experiences, which means psychological detachment from work and physical exercise are negatively associated with strain symptoms (e.g., exhaustion) and positively associated with positive well-being indicators (e.g., vigour) (212-215). There is some support to the idea that employees with limited recovery opportunities may have an increased risk for SA for (189). However, to the best of our study group knowledge, there is no previous literature on the association between recovery and PWD.

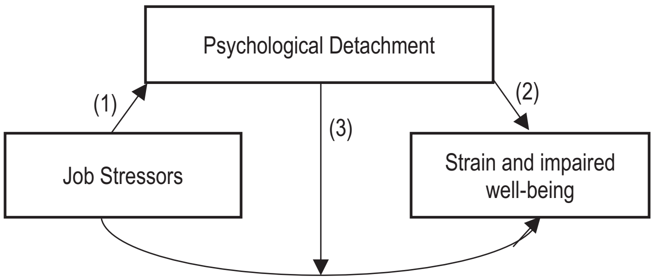

Figure 7. Basic stressor-detachment model (Sonnentag 2015). Paths 1 and 2 show the mediating process, and Path 3 shows the moderating process.

Work-life conflict theory was originally conceptualized as an inter-role conflict between work and family (216-218). There are studies linking the work-life conflict theory with poor self-rated health (209,219-223). Meta-analyses have pointed out that it is important to distinguish the direction of the conflict (220,224,225). A systematic review gives further support to work-family conflict being associated with later SA (89).

The executive function model affect four phases of problem-solving, which are representation, planning, execution, and evaluation, and it has been associated to development of attention, rule use, working memory and theory of mind (226). The executive functions allows for us purposeful and intentional interactions with the attention and focus, impulse control, decision-making and working memory, and they have been correlated with academic outcomes as well as quality of life and are impacted by environmental factors throughout the life (227). In occupational healthcare, we need to understand the mechanism that contributes to age-related changes in cognition as the elderly population in workforce is increasing by time (228). A case-control study suggest that task-switching with infrequent and unexpected transitions from one task set to another, is particularly difficult for ageing older adults (228). Cognition could be impaired due to chronic health issues (229,230) such as depression (231), bipolar disorders (232), strokes (233-236) and head injuries (237,238), but it could also be due to non-health–related factors like aging (239) or stressful situations (240,241).

Subjective cognitive complaints (SCC) can be understand as difficulty with concentration, memory, clear thinking and decision-making (242,243). SCC comprehends problems with mental executive capacity to monitor multiple sources of data, prioritize competing tasks, switch between tasks and resist distraction from the task, which are also associated with poor work ability (WA) (244). SCC have comorbidity with other common psychological problems such as chronic stress, exhaustion, sleeping problems and depression (242). The prevalence of SCCs increases among older age groups (245), as older employees contributes to cognitive decline include disease burden, e.g., depressive symptoms and poor sleep quality (246) as well as age-related cognitive declining (226). It has also been suggested that SCCs reduce WA in phases that are not yet characterized by clinical illness (247), but compelling evidence is scarce.

In summary, psychosocial predictors and subjective cognitive complaints play a role in well-being at work. Hence, we need to understand the mechanism of why and how they affect absenteeism.

2.4 Prevention of work disability

As we have learned previously, even the definitions of WD vary in the scientific literature and the risk of WD is multifactorial and complex. Prevention of WD obviously requires a multidisciplinary approach by different stakeholders. Essential stakeholders include employers, employees, society as the provider of funding, and healthcare systems, especially OHS in Finland.

It is important to keep in mind that the macroeconomic fluctuation, i.e., earning opportunities, affects the desirability of a DB. In many OECD countries, WD prevention policies are still predominantly focused on preventing work injuries and occupational accidents and diseases (43). Different social security programs, which are based on the legislation, are provided to prevent WD.

The multifactorial nature of WD, especially PWD, is approached through an analytical distinction between push (constraints such as perceived health) and pull (incentives, leisure time) explanations (24,248,249).

Figure 8 illustrates different stakeholders of WD and at which level they can be of influence.

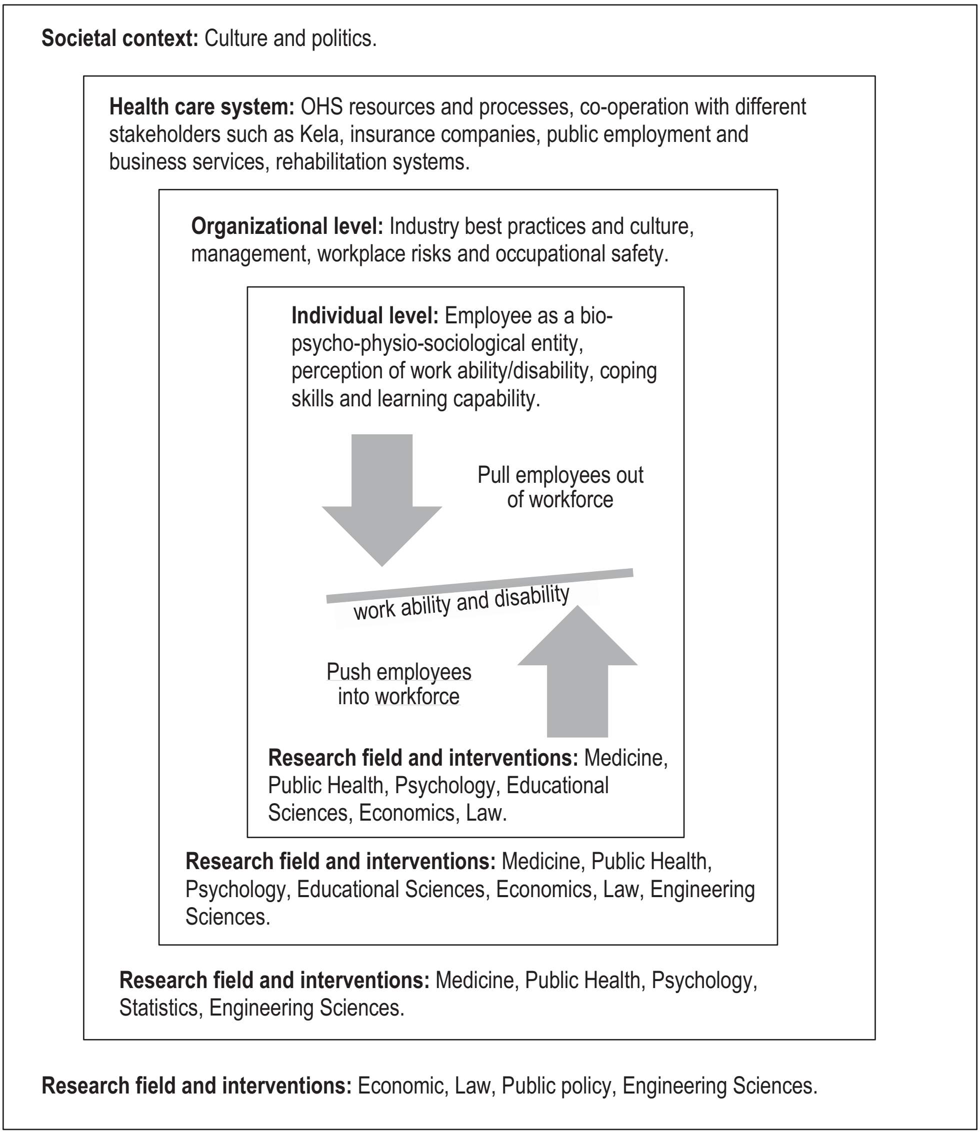

Figure 8. Stakeholders for the prevention of work disability.

2.4.1 Health check-ups in occupational health service

As described in the earlier chapters of the literature review, prevention of WD requires participation of many stakeholders at different levels.

In Finland, periodical health check-ups, as a part of health surveillance, include elements of strengthening employee resources at the aggregate level, facilitates work management's capability on early detection of WD risk and proper actions thereof, and identification of individual risk factors for WD and chronic long-term diseases at OHS. In Finland, OHS increasingly focuses on supporting employees' remaining work capacity, which is also supported by legislation such as the Government Decree on the principles of good occupational health care practice, the content of occupational health care and the qualifications of professionals and experts (708/2013). A simple classification of working capacity can be used as a tool to evaluate the individual needs for interventions. Category 1: good work ability, no need for treatment, interventions, or rehabilitation; Category 2: a threat of work disability, without proper treatment, interventions or rehabilitation; Category 3: imminent risk of work disability that requires treatment, intervention or rehabilitation.

Nowadays, data can be collected, interpreted, and analyzed in many different ways, including the help of digital algorithms (artificial intelligence); the results can then be disseminated to those who need to know, i.e., in a cost-effective way of handling data (250). Within occupational health check-ups, it is possible to get data concerning the employee-level WD risks as well as the organizational-level hazards. However, the screening questionnaires that feed in the data for the algorithms must be properly validated on their predictive ability.

2.5 Work disability risk assessment using questionnaires

The tables below summarize the previous literature on the predictors of work disability with different questionnaires based on self-reported health issues and subjective cognitive complaints.

Based on the given literature, eleven questionnaires have been used as a WD risk assessment tool to predict SA (Table 1); three were used to predict DB (Table 2) due to health issues, and there were seven psychosocial questionnaires (Table 3) and one cognitive one (Table 4).

A Finnish public sector study (ongoing survey) suggests that SA can be predicted with a model consisting of socioeconomic (HR 1.13, 95%CI 1.12–1.14), self-rated health (HR 1.10, 95%CI 1.01–1.20), previous SA (HR 1.56, 95%CI 1.51–1.60), chronic diseases (HR 1.15, 95%CI 1.12–1.18), and lifestyle factors such as smoking (HR 1.10, 95%CI 1.06–1.16), sleep (HR 1.0038, 95%CI 1.0022–1.0055), and obesity (HR 1.0002, 95%CI 1.0002–1.0003) (164). A multifactorial prediction model for LTSA was properly validated externally among occupational groups in both sexes. The survey is used in the Finnish public sector, and it must be generalized cautiously among private sector employees due to different legislative backgrounds.

The 12-item short form (SF-12) measures general health, and results are summarized using two scores: the Physical Health Component Summary (PCS) score and the Mental Health Component Summary (MCS) score. A longitudinal survey among nurses suggests an association between PCS (OR 2.16, 95%CI 1.28–3.63), MCS (OR 3.15, 95%CI 2.01–4.93) and LTSA (251). A prospective cohort study showed an association with general health perceptions (RR 1.73, 95%CI 1.64–1.82), PCS (RR 1.53, 95%CI 1.48–1.59), MCS (RR 1.30, 95%CI 1.24–1.37), and SA (252). The prediction model has been tested among Norwegian nurses (251) and the Finnish public sector (City of Helsinki employees) (252). The SF-12 is mostly used by researchers, and it is not widely accepted in clinical practice.

A cohort study among former employees of the U.S. Department of Energy introduced a Total Worker Health program and web-based screening questionnaire, which used algorithms to find occupational and non-occupational health conditions (253). The study was descriptive, and no statistical analyses were conducted.

Based on the given literature, there are two different health risk assessment tools, the one used in Netherlands (254) and the one used in Finland and the Netherlands (74). The Prevention Compass measures self-rated health, physical activity, weight, smoking and alcohol consumption, stress, working ability, and previous SA (254). In the present thesis, we are focusing on the HRA used in Finland and the Netherlands, which measures body anthropometrics, physical activity, alcohol consumption, smoking, pain, impairment due to musculoskeletal problems, depression, stress and fatigue, sleep disturbances, daytime sleepiness, and future working ability (74). An earlier study suggests that the HRA was able to identify WD risk group employees with a high number of SA days (74) among the study population (N=1341) from the construction industry, which included mainly blue-collar (61%) males (88%). A randomized trial within the high-risk group shows the difference in SA days between the targeted intervention group and the control group, which was 10.6 days in favor of the intervention during the 12-month follow-up (255). The total cost of healthcare, on average, was 180 euros per person less in the intervention group than in the usual care group (256). The HRA used in the present thesis seems to focus on essential health problems and is able to identify employees at WD risk (255).

Another WD screening instrument, the Balansmeter, includes questions on demographics, work environment, private situation, health, and earlier SA. (257). A cohort study showed predictive values for SA over 28 days in males (internal validation RR 4.69, 95%CI 2.74–8.02; external validation RR 2.90, 95%CI 2.35–6.45) and females (internal validation RR 4.16, 95%CI 2.05–8.43, external validation RR 2.62; 95%CI 1.44–4.77) (257). The Balansmeter is not used in Finland. Validation has been done in the Netherlands.

A previous cohort study suggests an association with poor general health (OR 1.54, 95%CI 1.38–1.71) and SA (64). A cohort study shows an association with SA and earlier SA (frequency and length), chronic disease, weight, and smoking (7). The cohort might have a strong bias (HWE) because the study group was a survivor population. Employees who left the trust during the study period were excluded.

A descriptive report introduced a screening instrument, the World Health Organization Health and Work Performance Questionnaire (HPQ), as a prediction tool for future SA (258). The questionnaire includes questions on health status, smoking, alcohol consumption, sleep difficulties, and work. The HPQ questionnaire is not used in the context of Finnish OHS.

A cohort study introduced HRA, the StayWell HealthPath, to collect self-reported health risk and SA data (137). The StayWell HealthPath asks about variety of topics such as chronic disease, health status, demographics, and lifestyle. The screening questionnaire is used in the U.S.

The Working Ability Index (WAI) has been used in the Finland OHS and other European countries as a predictor of SA and DB. A cohort study found an association between WAI and the risk of future SA episodes over 28 (OR 0.80, 95%CI 0.77–0.83), over 42 (OR 0.80, 95%CI 0.77–0.83), and over 60 days (OR 0.80, 95%CI 0.76–0.83) (259). An earlier Finnish register-based cohort study shows that the incidence of LTSA were RR 3.08 (95%CI 2.19–4.32) for poor WAI, and the HR of DB were 9.84 (95%CI 6.68–14.49) for poor WAI (260). Another cohort study among Finnish municipal employees suggests that a single-item WAS (HR 3.70, 95%CI 3.33–4.11) could be an alternative to a seven-item WAI (HR 5.30, 95%CI 4.81–6.07) in describing the risk of DB and as a prognostic tool for OHS (261). WAI is time-consuming to fill out and is not attached systematically to broader clinical use. During OHS health check-ups, the nurse or physician asks about "present work ability compared to the lifetime best" in an unstructured way.

A cohort study suggested an association with self-rated health and DB among females (HR 4.60, 95%CI 3.84–5.51) and males (HR 3.83, 95%CI 2.64–5.56) (143). The study combined survey data and register data with a reasonably large cohort of employees. However, the study was conducted among municipal employees and generalization must be done carefully.

Table 1. Screening questionnaires used to identify employees with an increased risk of temporary work disability, i.e., sickness absence due to health issues

Instrument	Survey issues	Study design and setting	Population: N, gender, age	Outcomes/findings
The Finnish Public Sector (FPS) survey. (164)	FPS is an ongoing survey that is part of the sickness absence research collaboration (SARC). Follow-up will continue until 2020.	The study design was a longitudinal survey cohort study, and the setting was a Finnish municipal OHS.	The FPS survey: Employees from the municipal service of 10 Finnish towns and 21 public hospitals working during 2000–2002 or 2004.	A multifactorial prediction model for SA lasting 90 days or more includes predictors such as self-rated health (HR 1.10; 1.01–1.10), depression (HR 1.15; 1.08–1.22), sex (HR 1.00; 0.96–1.05), age (HR 1.00; 0.96–2.05), socioeconomic position (HR 1.13; 1.12–1.14), previous SA (HR 1.56; 1.51–1.60), chronic diseases (HR 1.15; 1.12–1.18), smoking (HR 1.10; 1.06–1.16), shift work (HR 1.09; 1.04–1.14), working night shift (HR 1.02; 096–1.08) and quadratic terms for BMI (HR 1.00; 1.00–1.00) and the Jenkins Sleep Scale (HR 1.00; 1.00–1.00).
SF-12 (12-item short form). (251)	Survey is a generic measure of health status (physical functioning, role limitations due to physical health problems, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems, and mental health).	A longitudinal Survey of Shift work, Sleep and Health (SUSSH), follow-up during 2008–2010, study setting is Norway.	Female nurses working at least 50% of a full-time position, N=1381, mean age without SA 32.5 (SD 8.2) and with SA 34.1 (SD 8.8).	The SF-12 dimensions predicted mental (OR 3.45; 2.25–5.27) and musculoskeletal (OR 1.98; 1.03–3.7) SA, but they did not identify nurses at high risk of SA.
SF-12 (12-item short form). (252)	SF-12 survey is a generic measure of health status (physical	Prospective cohort study during 2000–2002, mean	Employees of the City of Helsinki, N=6934, 72% of	All eight SF-36 subscales and the two component summaries predicted the occurrence of SA over the

	functioning, role limitations due to physical health problems, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems, and mental health).	follow-up time 2.7 years. Study setting is Finland OHS.	females, aged 40–60 years old.	follow-up period. In both genders, the area under the ROC curve was largest for bodily pain (RR 1.65; 95% CI 1.45 at the lowest), general health (RR 1.64; 95% CI 1.44 at the lowest), and physical functioning (RR 1.53; 95% CI 1.48 at the lowest) and lowest for mental health (RR 1.29; 95% CI 1.14 at the lowest) and role limitation due to emotional problems (RR 1.29; 95% CI 1.13 at the lowest).
Health risk questionnaire as part of a Total Worker Health ™ approach. (253)	Health screening and work exposure questionnaire.	A cohort study with completed initial NSSP medical screening between 2005 and 2013. The study setting is a DOE former worker program (FWP).	U.S. Department of Energy (DOE) former employees, N=12000, 24% females 22–94 years old, average age for females was 61 years and for males, it was 65 years.	The NSSP identified potential occupationally related health conditions in 40.5% of those screened. Notably, 85.8% of participants with addressable non-occupational health conditions were identified, many of which were previously undiagnosed.
WAI (Work Ability Index). (259)	The WAI index is formed by questions that consider the demands of work, the employees' health status and resources.	Prospective cohort study among employees participating in OHS surveys between 2010 and 2012 in the Netherlands.	Employee from a steel mill, N=3049 (1710 manual and 1339 office), 7% females, mean age (SD) among manual workers was 44.7 (12.3) and office workers 47.8 (9.3).	The WAI could be used to screen manual and office workers for their risk of SA lasting over 28 (AUC=0.80; 0.77–0.83), over 42 (AUC=0.81; 0.78–0.85), and over 60 days (AUC=0.81; 0.79–0.87).
WAI (Work Ability Index). (260)	The WAI index is formed by questions that consider the demands of work, the employees' health status and resources.	Cohort study among those who respond to the Finnish Quality of Work Life survey (FQWLS) of 1997, 2003 and 2008.	Finnish employees, N=11131, 54% females, 42% of the participants 35–49 year old.	Compared with those with good/excellent work ability scores, the hazard ratios of disability pension after adjusting for all covariates were 9.84 (95% CI 6.68–14.49) for poor and 2.25 (CI 95% 1.51–3.35) for moderate work ability scores. For future work ability, the hazard ratio was 8.19 (95% CI 4.71–14.23) among those with poor future work ability.

Web-based HRA (health risk assessment). (254)	Computerized algorithms, which are formed based on ill-health status and unhealthy behavior.	Prospective cohort study in the Netherlands, survey completed between 2007 and 2009.	Employees from a large Dutch financial service company, N=3826, 50% females, mean age 41.4 (SD 9.9).	20.3% reduction in absenteeism was shown among voluntary participants in a web-based worksite health promotion program, when comparing their absenteeism rates to those of nonparticipants.
Screening questionnaire for health- and work-related factors. (64)	Questions concerning physical force, job autonomy, job demands, workplace violence or harassment, and health status.	Cross-sectional study, The Netherlands Working Conditions Survey (NWCS), 2007.	Dutch workforce, N=22759, 46% female, 15–64 years old (mean age 40; SD 12).	SA was associated with poor health (OR 2.62; CI 2.33–2.93), more than 1 health condition (OR 2.47; CI 2.21–2.75), and job autonomy, job demands (OR 1.09; CI 1.03–1.17) or emotionally demanding work (OR 1.09; CI 1.02–1.16).
Balansmeter. (257)	Questions assessed prolonged fatique, work environment, mental health status, demographic variables and characteristics of the private situation.	Maastricht Cohort Study (MCS), prospective survey study, follow-up 1998–2001.	Netherlands employees from 45 companies with an office work environment, N=5601, 30% females, 18–65 years, mean age 42 (SD 8).	The Balansmeter has predictive value for future SA, internal validation RR 4.16; 2.05–8.54 for female and RR 4.69; 2.74–8.02 for male, external validation RR 2.62; 1.44–4.77 for female and RR 3.90; 2.35–6.45 for male.
Pre-placement assessment with a questionnaire. (7)	Questions measured current SA (spells and duration), back pain, depression, ischemic heart disease, smoking status, weight, knee pain.	Retrospective cohort study, follow-up 1998–2003, study setting is a British OHS.	Employees commencing employment at a National Health Service (NHS), N=400, 85% females, mean age 42.8 years.	Gender, age, smoking, history of at least 2 previous low back pain episodes, previous SA, predicted SA.
HRA (health risk appraisal). (74)	Question topics are body anthropometrics, physical activity, alcohol consumption, smoking, pain, musculoskeletal impairment, depression, stress and fatique, sleep disturbances, daytime sleepiness, future working ability.	Cross-sectional survey study. Cohort was formed from one corporation in Finland and study was conducted in 2004.	Finnish permanent employees in one construction field corporation, N=1341, 12% females, 19–61 years (average age 44 years), 61% blue-collar.	Self-reported health problems predicted SA in a dose-related manner. Propensity for being susceptible to SA (OR 3.51; 1.35–4.68) and duration of SA (OR 3.41; 2.64–4.40) in two or more health problems group.

WHO-HPQ (World Health Organization Health and Work Performance Questionnaire). (258)	The HPQ was developed as an expansion of the work role module in the WHO Disability Assessment Schedule.	A prospective cohort study in four different occupations and industry fields in UK.	Employees from airline reservation agents, customer service representatives, automobile company executives, railroad engineers. N=6335, 80% females, working-age population (18–67).	Good concordance is found between the HPQ and the archival measures in occupations; OR 2.5; 95% CI 2.8 at the lowest.
StayWell HealthPath. (137)	Questionnaire topics are chronic disease, health status, demographics, lifestyle and absenteeism.	A cohort study among the US workforce.	Employees from 28 organizations from the public and private sectors, N=35452, average 41 years old, 47% females.	High (4 or more risks) OR 1.8 for absenteeism.

Table 2. Screening questionnaires used to identify employees with increased risk of permanent work disability, i.e., a granted DB due to health issues

Reference	Survey issues	Study design and setting	Population; N, gender, age	Outcomes/findings
WAI (Work Ability Index). (260)	The WAI index is formed by questions that consider the demands of work, the employees' health status and resources.	Cohort study among those who respond to the Finnish Quality of Work Life survey (FQWLS) of 1997, 2003 and 2008.	Finnish employees, N=11131, 54% females, 42% of the participants 35–49 years old.	The incidence rate ratios of accumulated LTSA days were 3.08 (95% CI 2.19–4.32) and 1.59 (95% CI 1.32–1.92) for poor and moderate WAS and 1.51 (95% CI 0.97–2.36) for poor future work ability.
WAI (Work Ability Index) and its first ítem, WAS (Work Ability Score). (261)		Finnish Longitudinal Study of Ageing Municipal Employees (FLAME). Data collection began in 1981, follow-ups carried out in 1985, 1992, 1997 and 2009.	Finnish municipal employees, N=5251, 56% females, 44–58 years.	Compared to those with good/excellent WAI, the hazard ratio (HR) for DP related to moderate and poor WAI was 2.0 (95% CI 1.8–2.2) and 5.0 (95% CI 4.4–5.6). For WAS, the HRs were 1.8 (95% CI 1.6–2.0) and 3.4 (95% 3.0–3.8).
Self-rated health. (143)	Questions concerning self-rated health, diseases, illness, common mental disorders, working conditions, work contract, shift work, working overtime, hazardous exposures at work, physical work load, computer work, job demand and control and social support at work.	Finnish cohort study, Helsinki Health Study (HeSSup), 2000–2002.	The baseline survey was sent to the employees of the City of Helsinki, aged 40, 45, 50, 55 and 60 years, and it was conducted in 2000, 2001 and 2002. N=8960, response rate 67%, 80% female.	Less than good self-rated health predicted DB for women (HR=4.60, 95% CI=3.84–5.51) and men (HR=3.83, 95% CI=2.64–5.56), as well as due to musculoskeletal diseases (HR=5.17, 95% CI=4.02–6.66) and mental disorders (HR=4.80, 95% CI=3.50–6.59) among women and men pooled.

Based on the given literature, there are more health-related questionnaires than those with psychosocial and cognitive questions. However, it is important to understand the modern-day work life and uprising risks concerning cognitive overloading.

The COPSOQII questionnaire includes questions about job demands, task resources, interpersonal resources, leadership resources, strain symptoms, positive work attitudes, and health-related work ability. A previous cohort study supported an association with a psychosocial working environment and WA (262). Another cohort study suggested that SA was predicted by high levels of cognitive demands (HR 1.31, 95%CI 1.10–1.56), high levels of emotional demands (HR 1.26, 95%CI 1.07–1.48), low levels of influence at work (HR 1.30, 95%CI 1.03–1.64), and high levels of role conflicts (HR 1.34, 95%CI 1.09–1.65); DB was predicted by low levels of influence at work (HR 2.73, 95%CI 1.49–5.00) and low levels of recognition from management (HR 2.04, 95%CI 1.14–3.67) (263).

The Brief Job Stress Questionnaire (BJSQ) is used in Japan to screen high psychosocial stress in workplaces with 50 or more employees and includes questions on job stressors, psychological and physical stress responses, and buffering factors (264). A cohort study suggested that employees with stress measured by BJSQ had elevated risks for SA (HR 6.59, 95%CI 3.04–14.25 for males and HR 2.77, 95%CI 1.32–5.83 for females) (264). The study population was adequate and large enough (N=14,686). However, generalizability must be done carefully due to the cultural context (Japan), and the study was conducted in a single company with mostly white-collar employees.

The non-illness predictors of sickness absence (NIPSA) scale contains questions concerning the perception of the psychosocial work environment, perceived vulnerability, rest-focused attitude toward recovery, and attitudes toward work (265). A cohort study suggested an association with SA ($p<0.05$) (265). One strength of the NIPSA questionnaire is that it is quick and easy to fill out. On the other hand, a short questionnaire might lack information that needs to be asked. Another limitation is the lack of knowledge concerning causality and the mechanism behind non-illness–related SA.

A cohort study introduced the Four-Dimensional Symptom Questionnaire (4DSQ) to identify mental health symptoms among postal workers who were at risk of SA (ORs 1.5 or over, 95%CI 1.04 or over) (266).

In the present thesis, we are focusing on the SCC used in Finland. A previous study showed that the SCC questionnaire found employees who are incapable of planning and organizing work and predicted subjective memory complaints (267). The questionnaire had no specific commitment to any particular theoretical model such as the JDC or the ERI. The questionnaire has shown predictive value for SA in previous preliminary studies (267–269). In an earlier cohort study (N=180), 42% of those in an abnormal SCC category among professional/managerial employees had later long-term SA (>30 days) after the baseline survey (267). Another cohort study (N=2898) found that an abnormal SCC category associated with an increasing number of SA compared to those with a normal SCC category (13.9 vs. 5.3 SA days/employee/year) (269). The aim of the questionnaire is to provide an extensive early-phase screening to assess mental and cognitive function at work among employees without medical complaints or illnesses.

A cohort study evaluated whether the Maslach Burnout Inventory (MBI-GS) and the Utrecht Work Engagement Scale (UWES) can be used to screen for SA: total MBI-GS scores (OR 1.54, 95%CI 1.14–2.06), but not UWES scores (OR 0.76, 95%CI 0.55–1.03), were associated with SA (270). The study stetting was the Dutch national OHS, and generalization must be done carefully in the Finnish OHS context.

A cohort study investigated the psychometric properties of scales in the General Nordic Questionnaire for Psychological and Social Factors at Work (QPS) and suggested that organizational variables predicted SA (271). The QPS consists of 118 work-related items (task module, organizational module, individual module).

Table 3. Screening questionnaires used to identify employees with increased risk of temporary work disability, i.e., sickness absence due to non-health issues (psychosocial and cognitive issues)

Reference	Survey issues	Study design and setting	Population; N, gender, age	Outcomes/findings
COPSOQII (Copenhagen Psychosocial Questionnaire). (262)	Generic questionnaire that covers the seven theories of psychosocial factors at work: the job characteristics model, the Michigan organization stress model, the job demands-control model, the sociotechnical approach, the action-theoretical approach, the effort-reward imbalance model and the vitamin model.	Cross-sectional cohort, data collection during 2014–2015. Study setting is Sweden.	Public dental organization employees in four regions in Sweden. N=1345, 90% females, mean age 48.5, SD 11.3 years.	Leadership had a direct, weakly negative effect on workability (β was ±0.17, p<0.01). Job demands had a weakly positive effect on work ability (β was 0.24, p<0.001). Nomological validity of COPSOQ was supported as the JD-R model can be operationalized by the instrument**.**
BJSQ (the Brief Job Stress Questionnaire). (264)	Questions are divided into three domains: 1) factors believed to cause stress, such as qualitative and quantative workload; 2) mental and physical responses triggered by stress, such as fatique, depressed mood, anxiety and irritation; 3) other factors affecting stress responses, such as levels of support from supervisors, colleagues and family members.	Cross-sectional survey study. Cohort was formed from one corporation in Japan in 2015.	Employees in one financial services industry, N=14686, 50% females, 20–66 years.	Employees identified as high stress had significantly elevated risks for SA. Hazard ratios (HR) for females was HR 2.77; 1.32–5.83, and for males, HR was 6.59; 3.04–14.25. The corresponding population's attributable risks for high stress were 21% for female and 24% for male.
NIPSA (Non-Illness Predictors of Sickness Absence). (265)	Questionnaire measures a broad range of individual and work-related factors that have been suggested to predict occupational health outcomes: perceived	Part of The South East London Community Health (SELCoH) study, 2011–2013.	Households' working-age inhabitants in communities in the south London boroughs of Southwark and	Perception of psychosocial work environment, perceived vulnerability and rest-focused attitude toward recovery factors showed significant associations with LTSA measures (p<0.05).

	vulnerability, attitude toward employment, the psychosocial work environment, relationship with employer, coping style at work and response to symptoms.		Lambeth. N=682, 59% females, aged 16–65 years.	
A three-item screener derived from 4DSQ. (266)	Screening questionnaire for mental health symptoms.	Prospective cohort study in Dutch, 2-year follow-up, 2010–2012.	Employees working in distribution and transport. N=4877 52% females, mean age 47 (SD 12) years.	The three-item questionnaire identifies non-sicklisted employees at risk of future mental SA, area under curve (AUC) 0.72; 0.6–0.8.
SCC (subjective cognitive complaints). (267)	Topics of the questionnaire are Workload, Resource balance and Recovery. The sum score is calculated from all questions.	Prospective cohort study in Finland OHS.	Employees in one information technology company, N=133, 50% females, age: working-age 18–64 years.	An unfavorable questionnaire sum score was associated with SA, visits to the OHS, incapability of planning and organizing work and the need to recover from work. In addition, the sum score predicted subjective memory complaints in the at-risk, high-risk and exhausted groups within the following 1.5 years.
The vitality check. (270)	Survey issues including MBI (Maslach Burnout Inventory) and UWES (Utrecht Work Engagement Scale).	Prospective cohort study in the Netherlands during 2008–2010, 1-year follow-up.	Dutch national OHS (ArboNed) customers, 58 companies, N=4894, 48% females, mean age 37.0 (SD 10.6)	The MBI and UWES predicted future mental LTSA in non-sicklisted employees (MBI OR 1.55; 1.07–2.25 and UWES OR 0.67; 0.45–0.99), but discrimination was not practically useful for identifying employees at high risk of LTSA (MBI AUC=0.60 and UWES AUC=0.70).
QPS Nordic (General Nordic Questionnaire for Psychological and Social Factors at Work). (271)	Psychological and Social Factors at Work.	Cross-sectional cohort study in Sweden, 2002.	Employees working or a county council in southern Sweden (Kalmar), N=3976, 83% females.	Psychometric testing of the QPS Nordic so far suggests that it is a good instrument for assessing health-related factors at work.

Table 4. Screening questionnaires to identify employees with increased risk of permanent work disability, i.e., a granted DB due to non-health issues (psychosocial and cognitive issues)

Reference	Survey issues	Study design and setting	Population; N, gender, age	Outcomes/findings
COPSOQII (Copenhagen Psychosocial Questionnaire). (263)	Generic questionnaire, which covers the seven theories of psychosocial factors at work: the job characteristics model, the Michigan organization stress model, the job demands-control model, the sociotechnical approach, the action-theoretical approach, the effort-reward imbalance model and the vitamin model.	Prospective follow-up study CAMB (Copenhagen Aging and Midlife Biobank). Baseline measurements in 2009–2011, follow-up in 2015.	CAMB contains data on biological, psychological and social factors, N=5076, 30% females, 49–63 years old.	Disability pension was predicted by low levels of influence at work (HR 2.73; 95% CI 1.49–5.00, p=0.001) and low levels of recognition from management (HR 2.04; 95% CI 1.14–3.67), p=0.017).

In summary, screening questionnaires have been used mostly in scientific studies but many of them have not been implemented in broader clinical use. Many questionnaires are time consuming to fill out, and they are detached from occupational health surveillance as OHS main process, which is an instrument that leads employees' to targeted interventions. Most of the previous studies have been performed among public sector employees or in specific industries or occupational groups.

3 AIMS OF THE STUDY

The study questions and hypothesis:

Study question 1. *What is the predictive value of the HRA results on SA among respondents from various industries and occupations? How the potential additive roles of self-reported health problems, occupational well-being and obesity affect the results?*

Hypothesis: Self-reported health problems and occupational well-being independently predict future SA irrespective of gender and occupational status, and obesity has an independent additive effect.

Study question 2. *Do self-reported health problems in the HRA predict WD? If so, does the WD risk increase by the number of self-reported health problems?*

Hypothesis: Self-reported health problems in the HRA predict WD and the higher the number of WD risk factors, the higher the WD risk. In addition, earlier SA plays an independent role as a predictor for the future absence from work.

Study question 3. *What is the predictive value of the SCC questionnaire results on SA among knowledge-intensive sedentary occupations?*

Hypothesis: SCC, comprehended as difficulties of concentration, memory, clear thinking, and decision making, which potentially hamper work ability, predicts SA.

Study question 4. *What is the predictive value of the SCC questionnaire results on WD among respondents from various knowledge-intensive sedentary occupations?*

Hypothesis: Self-reported subjective cognitive complaints predict permanent WD.

The aim of the study was to find out whether a health risk appraisal (HRA) and a subjective cognitive complaints (SCC) questionnaire predict work disability (WD). The WD was operationalized as a sickness absence (SA; TWD) and a granted disability benefit (DB; PWD). The thesis is based on four studies. Both questionnaires formed separate cohorts. The first cohort was formed by the HRA responses and included two studies (I and II). The second cohort was formed by the SCC questionnaire responses and included two studies (III and IV). Figure 9 shows the numbering of studies

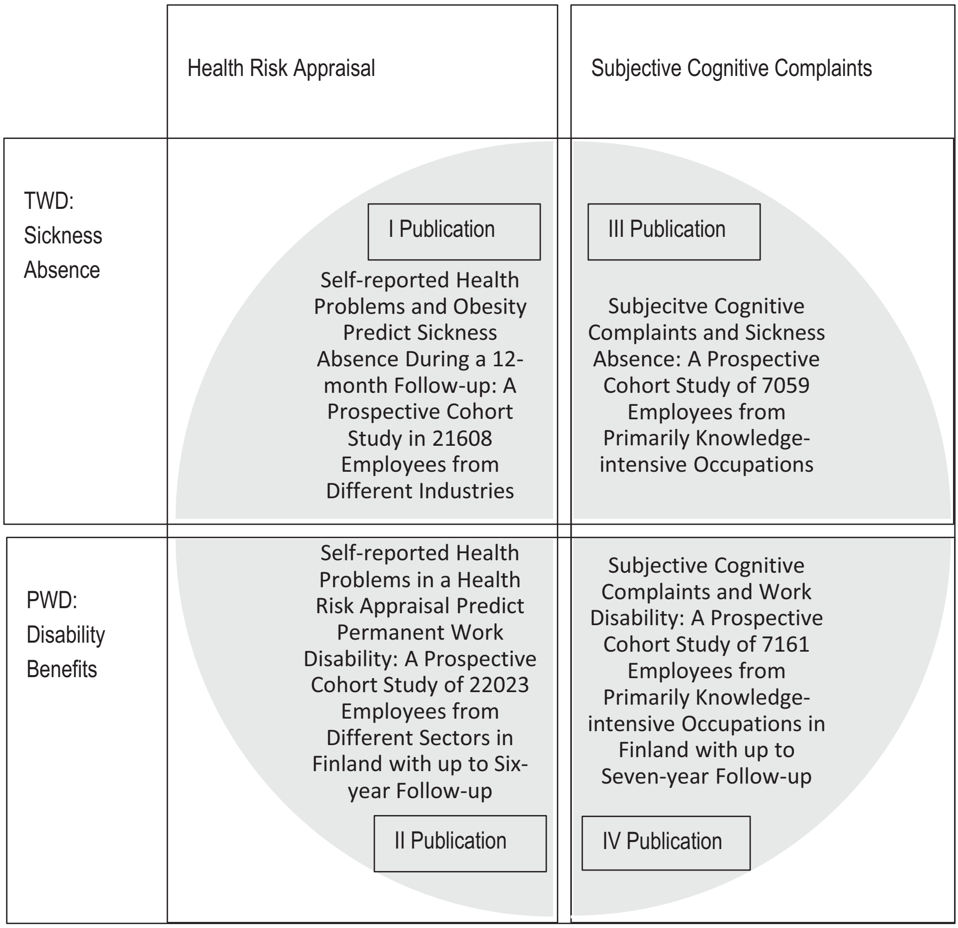

Figure 9. Numbering of studies.

4 MATERIALS AND METHODS

In all four studies, the study design was a register-based cohort study, and the setting was the Finnish preventive OHS in the context of Finnish DB legislation.

The Tampere University Research Ethics Board approved the study (ETL code R16074), and it was performed according to the Declaration of Helsinki. Data privacy was strictly followed.

4.1 Study populations and data collection

We collected the data from screening questionnaires from one national occupational OHS provider's register (Terveystalo Oyj), which offers services to a variety of industries and different sizes of companies, including governmental and municipal employees. This national OHS provider keeps separate registers for the screening questionnaires, so the HRA and SCC registers were handled as two separate cohorts. The participants of the study were working-age Finnish residents, aged 18–68 years, who had completed the HRA or SCC.

SA register data were also collected from the same OHS provider's registers. Information on the archival data of DB was retrieved from the national register of the Finnish Centre for Pensions (ETK), which had complete information on all DB events, including their primary and secondary diagnoses based on the International Classification of Diseases, the 10th Revision.

The response rate in the HRA cohort was 66% (an invitation to the HRA had been sent to N=33,990 employees, of which 11,475 had not responded). The response rates were almost identical among blue-collar workers (65%), clerical employees (67%), and experts/managers (66%). The study I exclusion criteria were over 150 SA days in the 12 months before the HRA (N=119), granted DB (N=689), missing data concerning the occupational group (N=79), or loss to follow-up (N=77). The study II exclusion criteria were previously granted DB (N=415), or data concerning the occupational group were missing (N=79). The average age of the participants was 45 years, of which 59% were female (31% blue-collar workers, 55% clerical employees, 14% professional/managers). The non-respondents were slightly younger than the respondents, with an average age of 44 years, of which 71% were males. We used HRA results collected as part of preventive OHS in 2012–2015 and the archival data of SA covering 2011–2016, and the data on DBs from the ETK national register covered years 2012–2017 (Figure 10). The participants were mainly from (O) the public administration and defense, compulsory social service (21%); (G) wholesale and retail trade and (H) transportation and storage (18%); and (P) education (14%). The corresponding figures in Finland, according to Official Statistics are (O) 5%, (G+H) 17% and (P) 7% (272).

We do not know the exact response rate of the cohort formed by the SCC questionnaire results because it is not known how many invitations were sent out. The unique identifier for combining the questionnaire results and the SA registers was the respondent's email address. The study III exclusion criteria were unknown identification code (N=3343), other than the first response (N=2087), previously granted DB (N=81), or an occupational group other than a professional/manager (N=462). The study IV exclusion criteria were unknown identification code (N=3343), other than the first response (N=2117), an occupational group other than a professional/manager (N=462), or previously granted DB (N=98). The average age of participants was 47 years, of which 45% were female. The excluded respondents were slightly older than participants, with an average age of 52 years, of 67% of which were males. The participants had completed the SCC questionnaire during 2010–2016, and the archival data of SA covered 2009–2017 (Figure 11). The information on the archival data of DB covered the years 2010–2017. The participants were mainly from (J) the information and communication industries (47%); (M) professional, scientific and technical activities (23%); (O) public administration; defense, and compulsory social security (9%); and (P) education (7%) (273). The corresponding figures in Finland, according to Official Statistics, are (J) 4%, (M) 11%, (O) 5% and (P) 7% (272).

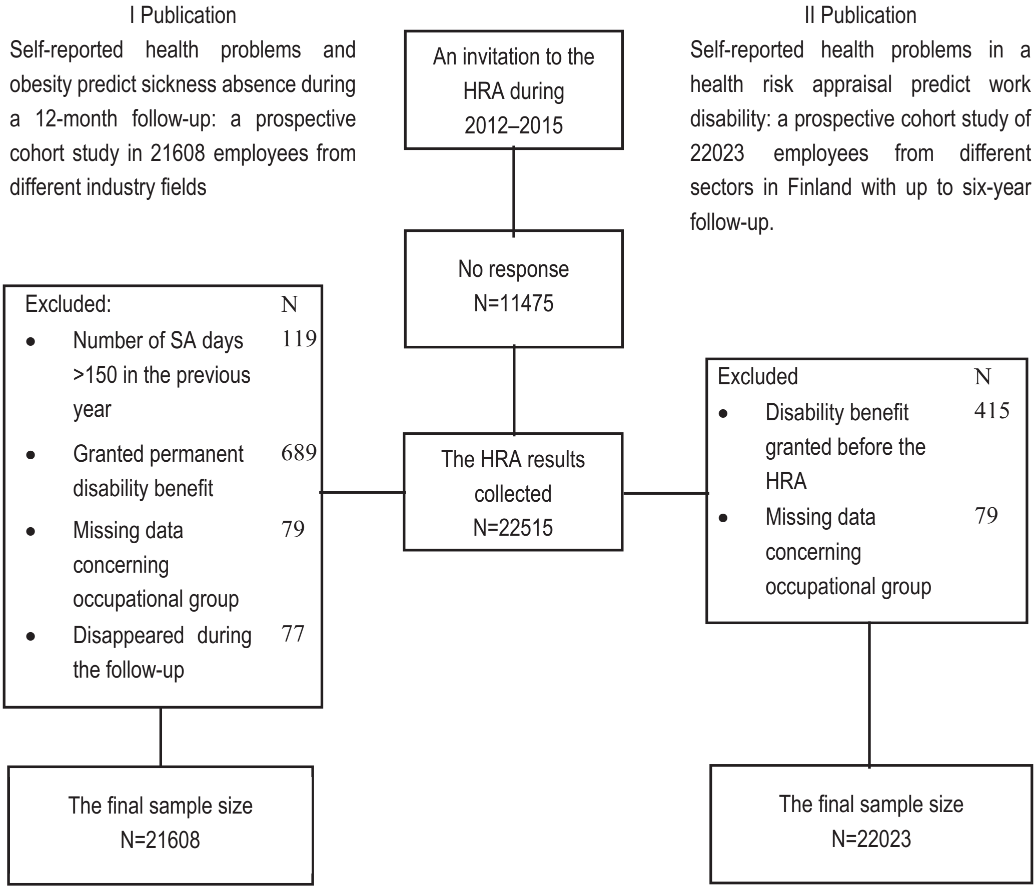

Figure 10. Study flow of the HRA cohort including the first and second publication.

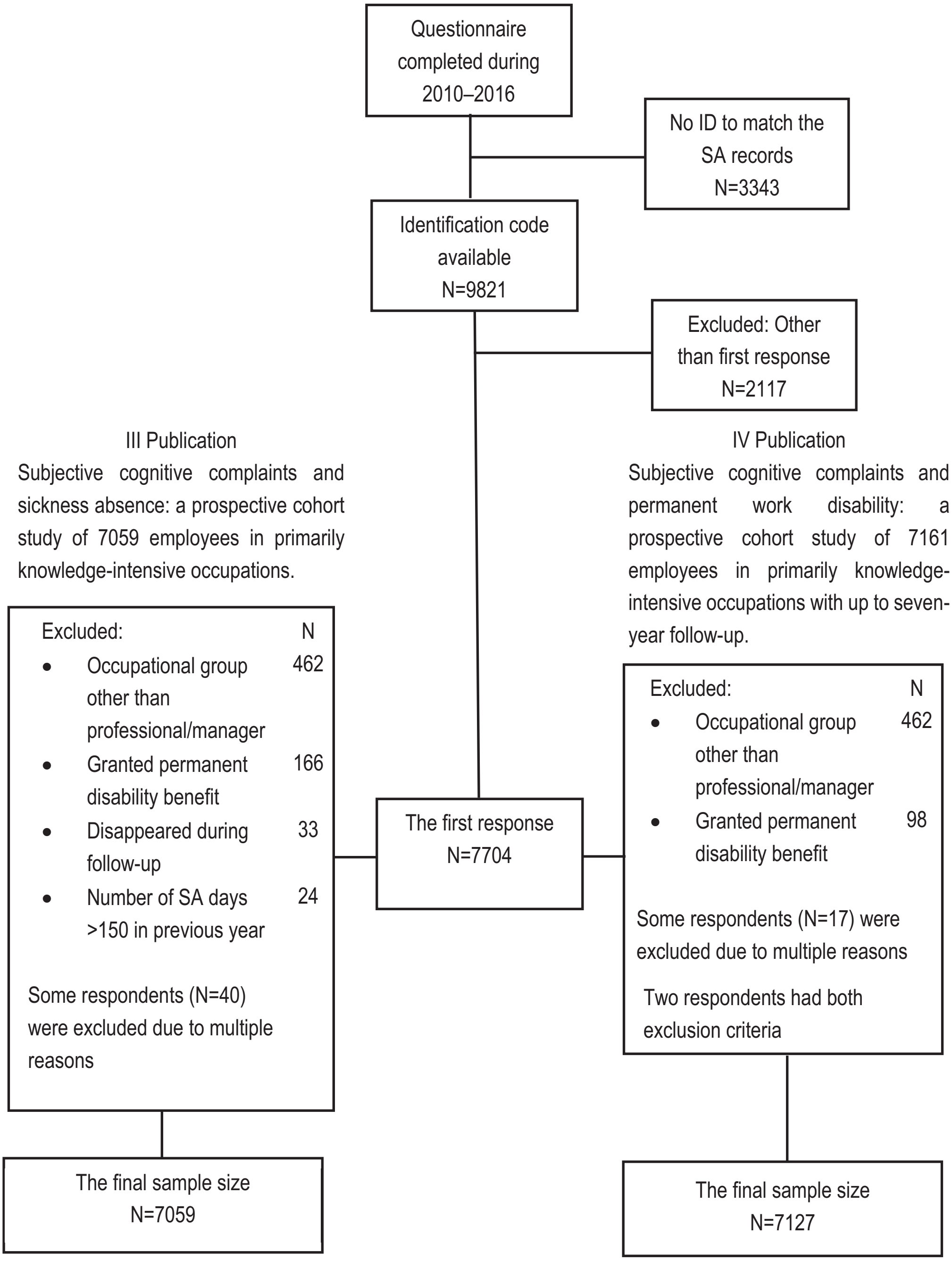

Figure 11. Study flow of the SCC cohort including the third and fourth publication.

4.2 Health risk appraisal

The online HRA is used in Finland and the Netherlands. Different occupational health service (OHS) providers used questionnaire to recognize employees at WD risk to target interventions for those in need.

The classified results of the HRA were used as the primary exposure variable in Studies I and II. Other exposure variables included problems with occupational well-being and obesity (only in Study I). Gender, age, occupational group, and earlier SA were treated as confounding variables in Studies I and II.

The HRA categories in the present study: 1) work disability risk, 2) health risk, 3) some symptoms, 4) lifestyle issues and 5) no findings (Table 5). The first category, labeled as "WD risk," includes the following self-reported health problems: musculoskeletal problems, depressive symptoms, sleep problems, constant stress and feeling of exhaustion, and doubts about work ability. The results were further subdivided within the "WD risk" category (1 and 5) by the number of risk factors. We combined the "lifestyle issues" and "no findings" categories as the reference class and included the result of the HRA (six categories) as a covariate in the statistical models.

HRA included a dichotomous variable, "problems with occupational well-being," based on modified questions from the JDCS model, the ERI model, the WLC theories, and the presence of constant stress or dissatisfaction (Table 6) (274-276). If the criteria were met, the respondent was classified as having a problem with occupational well-being.

In Study I, BMI was categorized as underweight (<18.5), normal weight (18.5–25.0), overweight (25.0–30.0), and obese (>30). Normal weight was chosen as the reference class in the statistical model. The occupational group was defined as blue-collar workers, clerical employees, and professionals/managers. The number of SA days 12 months prior to the questionnaire was included as a continuous variable. The unadjusted model included the HRA categories of no findings as a reference, some symptoms, health risk, and WD risk, and the adjusted model was added with BMI categories, age groups, and problems in well-being and SA before the questionnaire.

In Study II, the unadjusted Fine–Gray model included the HRA categories of no findings as a reference, some symptoms, health risk, and WD risk. The crude model was added with age group, occupational status, and SA before the questionnaire.

Table 5. Description of criteria for classifying employees into health risk appraisal categories

Topic	Criteria
Work disability risk: at least one of topics below	
Impairment due to musculoskeletal problems at work, OR	Numerical rating scale (0–10) score ≥ 5
Pain hampers work	At least moderate pain that affects work ability at least three times a week
Depressive symptoms	Depression score DEPS ≥ 11
Sleep problems	Problems in falling asleep or night-time awakenings AND daytime sleepiness daily or almost daily
Work-related constant fatigue or	Feeling being squeezed empty
Work-related constant stress	Feeling tense, strained, nervous and/or anxious because work-related issues are constantly on one's mind
Doubt of work ability	Self-rated future working ability: uncertain of own ability ("uncertain") or quite sure ("not able") of not being able to continue in the current job due to health reasons
Health risks: at least one of points below	
Weight problems*	Body mass index (BMI) ≥ 30 or ≤ 18.5
Diabetes risk	Diabetes risk score ≥ 11
Excess use of alcohol	Males ≥ 350 ml/week, Females ≥ 240 ml/week (expressed as absolute alcohol)
Some symptoms: at least one of points below	
Impairment due to musculoskeletal problems at work	Numerical rating scale (0–10) score = 4
Some depressive symptoms	DEPS score between 8 and 10
Some sleep problems	Problems falling asleep or night-time awakenings AND daytime sleepiness 3 to 5 times a week
A chronic disease	Self-reported chronic diseases diagnosed by doctor
Symptoms	Self-reported symptoms
Lifestyle issues: at least one of points below	
Smoking	Smoking = Yes
Physical inactivity	No physical activity during leisure time nor while commuting to work
Overweight*	BMI between 25 and 30
No findings	
Previous criteria are not met	

*Overweight and weight problems were not included in the HRA category but were analyzed separately in the fully adjusted model in the first study question. BMI = body mass index; DEPS = depression scale; HRA = health risk appraisal.

Table 6. Description of criteria for classifying employees into the health risk appraisal category "problems with occupational well-being"

Feature	Criteria
Insufficient job control	High 'Job Demands' AND [Low 'Decision Authority' OR Low result concerning 'Job Contents'].
Work-life conflict	The low result in 'Work-Life Balance'
Strain due to rewarding	Any of the individual questions concerning rewarding (Meaningfulness of work; Appreciation; Income; Career opportunities) in a category "causes very much strain"
Lack of social support	Bullying at workplace OR [No support from line manager AND no teamwork]
Overloaded	Always feeling squeezed empty due to work OR Always feels stress
Dissatisfied	Seldom enjoys life OR never content with the present job

4.3 Subjective cognitive complaints

Ahveninen and Arola et al. developed the psychosocial and subjective cognitive complaints (SCC) questionnaire (Terveystalo, Voimavarakysely) in the late 2000s and published it in the Finnish Medical Journal in 2014 (267). The online questionnaire is used in Finland by one nationwide occupational health services (OHS) provider (Terveystalo) as part of preventive OHS to recognize employees at WD risk and to target interventions for those in need.

The questionnaire includes nine screening questions evaluating psychosocial workload and individual resources for coping. If the trigger questions indicate problems at work, seven questions concerning cognitive function are asked. Table 7 shows the topics and cut-off limits for the trigger questions.

Table 7. Subjective cognitive complaints questionnaire topics and cut-off limits for the trigger questions

Topic	Cut-off limits*
1. Duration of working hours per week.	≥ 45 hours/week.
2. Time pressure from workload and feeling of strain within the last two months.	Continuous perception of pressure and job strain.
3. Ability to achieve meaningful outcomes at work, which gives satisfaction.	Completely disagree.
4. Self-perception of overall resources.	With the current working tempo, individual resources remain adequate at the maximum for another 6 months.
5. Well-being and energy.	The last time when felt well and energized was already over 3 months ago.
6. Physical condition.	Poor.
7. Psychological resources.	Feeling overloaded, but able to cope.
8. Level of energy after a working day.	Three or less on a scale from 1-10 (1=extremely tired, 10=extremely energetic).
9. Sleep difficulties within the last three months.	At least three nights per week.

* If any of the trigger questions met or exceeded the cut-off, the additional seven questions concerning subjective cognitive complaints (SCCs) were asked.

Table 8 shows the seven questions used to formulate SCC score. The response options were 1) I strongly disagree, 2) I somewhat disagree, 3) I somewhat agree and 4) I strongly agree with the question. The average of the sum of the seven questions formed SCC score. The cut-off limit was chosen ≥2.4 for the abnormal SCC score based on a preliminary non-published study (N=30) in which participants responded to the SCC questions and conducted neuropsychological examinations. Cronbach's alpha for the SCC score was good in our data (0.98).

Table 8. Topics for questions that formed the subjective cognitive complaints (SCC) score

1.	Memory difficulties
2.	Difficulty planning and organizing one's own work tasks
3.	Forgetting agreed-upon issues and work tasks
4.	Difficulty concentrating
5.	Delays in recollection
6.	Disruptions in thinking
7.	Difficulty with recollection

The classified results of the SCC were used as the primary exposure variable. The respondents who did not indicate any problems with the psychosocial screening questions—and were therefore not asked SCC questions—were classified as belonging to the reference class. Second, we categorized the SCC score into normal or abnormal based on the a priori cutoff limit. Thus, the exposure variable (unadjusted model) consists of three categories: 1) reference (no psychosocial load); 2) some psychosocial load but normal SCC score; and 3) psychosocial load and abnormal SCC score. Age and earlier SA were treated as confounding variables, which were added to the adjusted model in Studies III and IV.

4.4 Outcome measurement

The outcome measurement was a sickness absence (SA) (studies I and III) as a proxy measure of temporary work disability and a granted disability benefit (DB) (studies II and IV) as a proxy measure of permanent work disability. The definition of the outcome measurement is determined by the Finnish medico-legal system.

4.4.1 Temporary work disability

Studies I and III had the outcome measure of sickness absence (SA). SA was operationalized as the accumulated number of days on sick leave during the 12-month follow-up after the survey, which includes the days and periods absent because of illness. We combined overlapping and consecutive SA. The SA did not include maternity/paternity leaves and absence from work to care for a sick child.

An SA is defined as non-attendance at work when attendance was expected (27). In Finland, sickness allowance is paid as compensation for loss of income due to the incapacity to work that lasts less than a year. Employee sickness allowance is qualified with medical certificate. The employer records when each sickness absence (SA) starts and ends. If the SA is prescribed by the other than occupational health care (OH) physician, the employer supplies the information of the SA to the OHS care. Usually permanent employees are paid a full salary during their SA from the first day, up to three months. The employer receives sickness allowance from Kela after ten working days, excluding Sundays and national holidays. Generally, blue-collar employees must provide a medical certification for any SA, while professional/managerial employees must provide a written explanation for short SA and a medical certification for SA longer than three days. An employee may receive sickness allowance from Kela for less than one year of work disability due to the same illness. If an employee is unfit for work because of an illness for more than a year, it is possible to claim a disability benefit and the evaluation of eligibility for WD benefits is transferred to the pension insurance companies.

4.4.2 Permanent work disability

Studies II and IV had the outcome measure of a granted disability benefit (DB) as a proxy measure of permanent work disability (PWD), and it was operationalized dichotomously: a granted DB, yes or no.

When assessing a reduced work ability, both medical and socioeconomic factors are assessed (18). The DB is granted if the ability to work has been reduced based on the examination of an attending physician and if it is objectively determined as a decrease in functional and work capacity due to illness (18).

In our study, DBs consist of four categories: 1) full and 2) partial disability pension or 3) full and 4) partial fixed-term rehabilitation subsidies (Table 9). Vocational rehabilitation is the primary alternative before the disability pension, and therefore, a pension provider and Kela will assess the rehabilitation criteria. The rehabilitation subsidy is granted only for a temporary period to ensure a return to work. A disability pension benefit continues until the old-age pension begins. The eligibility for the DB categories and distribution of DBs are shown in Table 9.

Table 9. Eligibility for the disability benefit categories (DBs) and the distribution of DBs in the final study samples

Disability benefit	HRA N	HRA %	SCC N	SCC %	Maximum capacity to work	Time for granting
Full disability pension	115	30	27	32	Ability to work 2/5 (40%)	Until further notice
Partial disability pension	138	36	24	28	Ability to work 3/5 (60%)	Until further notice
Full rehabilitation subsidy	73	20	24	28	Ability to work 2/5 (40%)	Temporary period
Partial rehabilitation subsidy	53	14	10	12	Ability to work 3/5 (60%)	Temporary period
TOTAL	379	100	85	100		

4.5 Statistical methods

The statistical methods used were dependent on the hypotheses and the outcome measurement, and they were the same for articles I and III (sickness absence) and for articles II and IV (granted disability benefit). The main explanatory variable was the classified results of either the HRA (studies I and II) or SCC (studies III and IV).

We used the multiple imputation method MICE software with predictive mean matching when missing values in the questionnaire-based variables were imputed (277), only testing the hypothesis of SA in the HRA cohort (study I).

We presented baseline characteristics using descriptive statistics. We calculated patterns with SA means (SD) and the ratio of means with 95% confidence intervals using the HRA results classed separately by gender and occupational group and the SCC results classed separately by gender. In the HRA, the combined group "No findings" and "Lifestyle issues only" was selected as the reference, and in the SCC, the group "Expected" was selected as the reference.

Modeling SA data is challenging because a large number of employees have no absenteeism due to sickness (74). Poisson or negative binomial regression models, as ordinary count data methods, are not suitable to analyze the excess count of zero days. Our approach was to try mixture regression, zero-inflated negative binomial regression, and the Hurdle model. The mixture regression and zero-inflated negative binomial regression approaches had problems when estimating the model's parameters. We chose the Hurdle model, which provides a combination of the two statistical models: a binary model determines whether the outcome is zero or positive (logistic regression), and a zero-truncated count model determines the positive part of the count data (truncated negative binomial regression). We used the truncated negative binomial regression model because it accounts for the overdispersion present in the count data. We used R library pscl (278) for the actual estimation of the model parameters. The estimated odds ratios based on the binary part and the estimated risk ratios based on the regression coefficients of the part of the count with the covariates are reported with 95% confidence intervals (95% CI).

The cumulative incidence function (CIF) was used to illustrate the difference between the HRA risk groups and the difference between the SCC categories. Over time, the graphic display of the cumulative incidence function, i.e., failure probabilities, is used in medical research (279). The Fine-Gray method was used to estimate how HRA categories and SCC categories, age and occupational group effect on the probability of events, i.e., the disability benefit, occurs over time (280). The Fine-Gray model gives hazard ratios (HR) to describe the relative effect of covariates, and they are interpreted as the probability of a DB occurring over time. In the present study, we used the Fine-Gray method, which is better than methods of standard survival analysis, such as the Kaplan-Meier method for estimation of survival function, the log-rank test for comparison of cumulative incidence curves, and the standard Cox model for the assessment of covariates, which are more likely to lead to incorrect and biased results (279).

Statistical analyses were performed using R 3.4.4 software.

5 RESULTS

5.1 Health risk appraisal (studies I and II)

The average age of the participants was 45 years and 59% were female (30% blue-collar workers, 55% clerical employees, and 15% professional/manager). The non-respondents were slightly younger (44.2 years, SD 12; t =-7.3; p<0.0001) than the respondents on average. Males were less likely to respond than females (response rates at 60% and 71%), (chi-square 425.5; p<0.0001). The response rates were almost identical among blue-collar workers 65%, clerical employees 67% and professional/managers 66%, (chi-square 14.3; p=0.0007).

5.1.1 Temporary work disability

A total of 172331 days of SA were recorded in the study population during the 12-month follow-up. The distribution was heavily right-skewed: 48% had not been on SA at all. The proportions of zero absences were 35% in blue-collar males and 29% in females, 65% in clerical males and 46% in females, and 68% in professional/manager males and 55% in females.

The mean number of daily absences among those with any SA were 18.2, 13.8 and 11.0 days in blue collars, clericals, and professionals/managers. An increasing trend of SA by age was seeing among those with any absence. In all occupational groups, females tended to have more SA days than males. 26% reported WD risk factors of the subjects, but their share of total SAs was 47%.

HRA category “health risk” or “work disability risk” predicted higher mean values of SA during the follow-up, regardless of the occupational group or gender. The ratio of mean SA days varied between 2.6 and 6.1 among those with WD risk factors and the reference category with no findings in the HRA, depending on gender and occupational group. The lower limit of the 95% confidence interval (CI) was 1.6 at the lowest (Table 10).

Table 10. Sickness absence by the health risk appraisal result categories in different occupational groups by gender. means and the ratio of means

	Male				Female			
Interpretation of the HRA	SA days (N; mean; SD)			The ratio of means (95% CI)	SA days (N; mean; SD)			The ratio of means (95% CI)
Blue collar workers								
No findings or lifestyle issues only	274	5.18	10.5	ref	198	6.95	17.83	ref
Some symptoms	1060	7.18	15.73	**1.39 (1.07-1.87)**	1471	9.31	20.24	1.34 (0.96-2.11)
Health risk	691	8.33	16.56	**1.61 (1.23-2.19)**	843	12.04	22.42	**1.73 (1.24-2.74)**
Work disability risk	672	19.88	41.05	**3.84 (2.91-5.23)**	1394	20.64	38.19	**2.97 (2.15-4.67)**
Clerical employees								
No findings or lifestyle issues only	532	2.43	12.2	ref	425	4.48	16.6	ref
Some symptoms	2198	3.1	10.61	1.28 (0.87-2.26)	3390	5.18	13.49	1.15 (0.84-1.80)
Health risk	953	4.08	11.57	**1.68 (1.11-3.00)**	1344	7.87	18.11	**1.75 (1.26-2.75)**
Work disability risk	872	9.8	25.2	**4.04 (2.69-7.19)**	2175	12.27	26.43	**2.74 (1.99-4.26)**
Professionals/managers								
No findings or lifestyle issues only	232	1.77	4.71	ref	95	2.00	3.76	ref
Some symptoms	913	2.86	11.39	**1.61 (1.06-2.60)**	774	4.15	12.73	**2.08 (1.38-3.48)**
Health risk	292	3.89	12.15	**2.20 (1.29-3.69)**	220	5.98	14.81	**2.99 (1.79-5.20)**
Work disability risk	232	5.4	17.07	**3.05 (1.68-5.23)**	358	7.82	18.14	**3.91 (2.55-6.59)**

The analyses from the Hurdle model were stratified by gender and occupational group due to complex interactions, and the results are displayed in unadjusted and adjusted model. Detailed results are shown in the first publication (281). The average number of SA days among those susceptible to any SA in both genders followed pattern as blue-collar workers > clerical employees > professionals/managers. We found some evidence of an overall decreasing trend in the susceptibility to SA with increasing age. In clerical and professional/managerial males, the number of SA days tended to increase by age. This trend was not seen in females or blue-collar males. An earlier SA predicted susceptibility for SA, and the number of SA days during the follow-up. The "WD risk" category predicted susceptibility to SA and the mean number of SA days in all occupational groups. Several "WD risk" factors increased susceptibility and/or the number of SA days. Problems with well-being at work predicted SA in the professional/managerial group in both genders. Overweight and/or obesity predicted SA in all professional groups in both genders. All these effects are additive.

5.1.2 Permanent work disability

A disability benefit (DB) was granted for a total of 379 participants of two years on average (range from 3 days to 5.7 years) after the HRA. DB's overall annual incidence was 0.29% (0.33% among females and 0.23% among males, ($p=0.23$)). Of those who had received a DB, 149 (39%) participants were primarily diagnosed with a musculoskeletal disorder (M) and 80 (21%) with a mental or behavioral disorder (F), and 15 participants had both musculoskeletal and mental or behavioral diagnoses simultaneously (4% of all DBs).

The HRA "WD risk" category predicted DB. There was a dose-response relationship between the number of WD risk factors and the probability of ending up on DB. Figure 12 shows cumulative incidence of disability benefits.

The HRA "WD risk" categories, age, occupational group and earlier SA before the HRA questionnaire predicted the probability of DB for both genders in an additive manner in the fully adjusted Fine-Gray model. In the unadjusted model, the HR for the probability of a DB was 36.2 (8.8-148.4) for the females and 47.7 (14.4-158.1) for the males in the HRA "WD risk" categories with three and more risk factors. When all covariates were included, HR decreased among both genders, and was 17.3 (4.2-71.7) for the females and 18.2 (5.4-60.8) for the males. Detailed results are shown in the third publication (282).

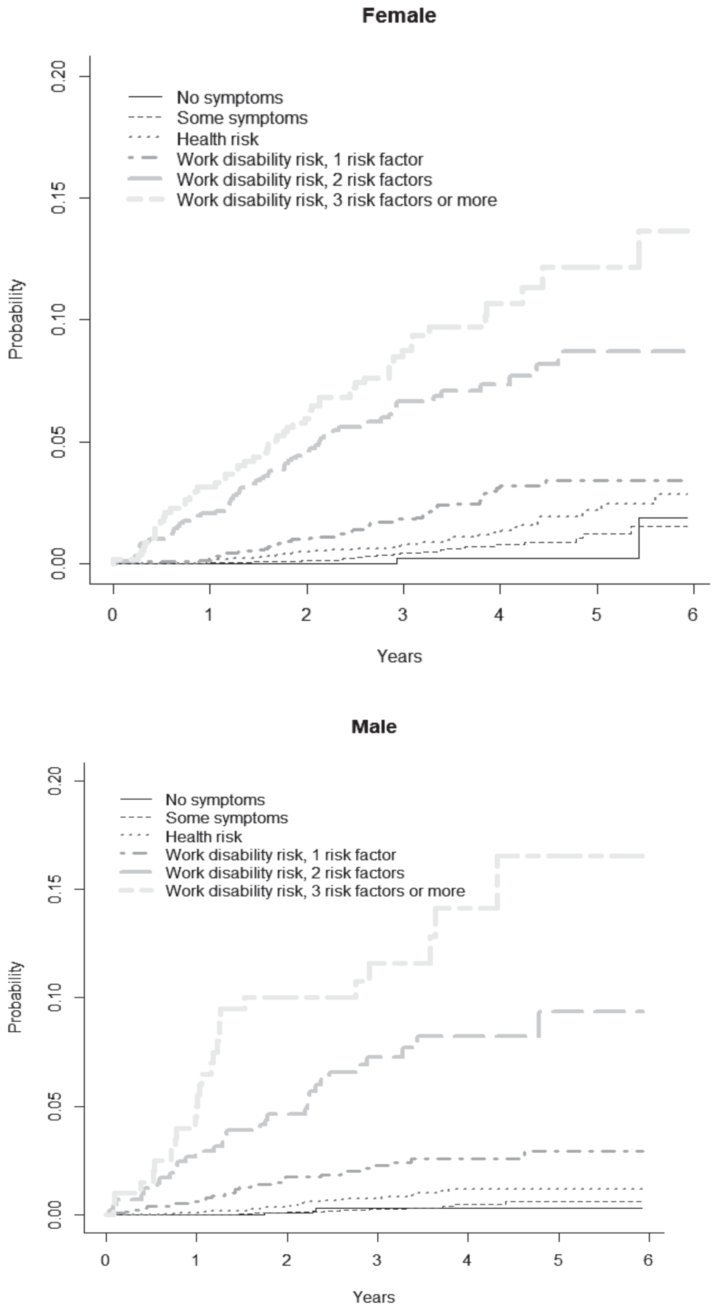

Figure 12. Cumulative incidence of disability benefits over the six-year follow-up period by different health risk appraisal groups among females and males.

5.2 Subjective cognitive complaints (studies III and IV)

The participants average age was 47 years in both studies. 45% of the respondents were female. The respondents excluded were slightly older on average (52 years, $p<0.005$), and a larger proportion of them were men (over 55%, $p<0.005$) than of the participants.

5.2.1 Temporary work disability

In the under-30 age group SCC results were classified less likely within the abnormal category than in the older age groups. 13% of males were classified into the abnormal SCC category, the respective figure for females was 15% (chi-squared 130.69, $p<0.005$). In the over 50 years age group, the proportion of respondents with zero SA days was higher than in the younger age groups for both genders. The females have higher average number of SA days than males among the group "susceptible to any SA".

The abnormal SCC category predicted higher mean SA values during the follow-up, regardless of gender. The ratio of mean SA days varied between 2.8 and 3.1 among those in the abnormal SCC category and the reference category, depending on gender. The lowest limit of the 95% confidence interval (CI) was 2.1 (Table 11).

Table 11. Sickness absence by the different subjective cognitive complaints (SCC) category and gender. means and ratio of means.

			SA days				
Psychosocial load §	SCC	Participants(N)	median	mean	SD	Ratio of means	95% CI
MALE							
No	N/A#	1215	0	3.5	9.6	ref.	
Yes	normal	2142	0	4.3	14.3	**1.2**	**1.0–1.5**
Yes	abnormal	497	2	10.6	30.4	**3.1**	**2.2–4.1**
FEMALE							
No	N/A#	648	1	5.2	14.2	ref.	
Yes	normal	1962	1	6.2	15.5	1.2	0.9–1.5
Yes	abnormal	595	3	14.5	31.2	**2.8**	**2.1–3.7**

Bold values denote statistical significance at the $p<0.05$ level.

§ Psychosocial load refers to the results of the screening questionnaire.

N/A indicates the group of participants who did not indicate any problems with the psychosocial screening questions, and therefore, they were not asked the SCC questions.

The results of fitting the Hurdle model are shown in Model 1 (the crude estimates), and in Model 2 (adjusted for age (five classes) and number of SA days during the 12 months preceding the questionnaire). We conducted the analyses stratified by gender. Detailed results are shown in the second publication (283).

The older age groups had higher likelihood of having zero SA than younger. But higher age predicted higher SA count, if there were any. Earlier SA prior to the questionnaire predicted both susceptibility to SA and the number of SA days during the follow-up.

5.2.2 Permanent work disability

A disability benefit (DB) was granter for a total of 85 participants of the average three years after filling out the questionnaire (range from 44 days to 7.2 years). The DB's overall annual incidence was 0.15% (0.18% among the females and 0.12% among the males (p=0.795)). Of the participants who received a DB, 31 (37%) had primary diagnoses of a mental disorder (F), and 17 participants (20%) had primary diagnoses of a musculoskeletal disorder (M), and 4 were given both musculoskeletal and mental or behavioral diagnoses simultaneously (5%). Figure 13 presents the cumulative incidence of DB.

In the Fine-Gray model, the unadjusted (Model 1) HR for DB in the abnormal SCC category was 3.3 (1.7–6.6) for the females and 4.1 (1.9–8.5) for the males. In the fully adjusted model (Model 2), the HRs decreased among both genders, being 2.9 (1.4–6.0) for the females and 3.7 (1.8–7.9) for the males. In the fully adjusted model, the HR for SA days before the questionnaire was 1.013 (1.010–1.017) for the females and 1.018 (1.014–1.021) for the males. In the fully adjusted model, the HR for DB by age was the highest in the 50- to 60-year age group for females 3.6 (1.2–10.5). Detailed results are shown in the fourth submitted publication.

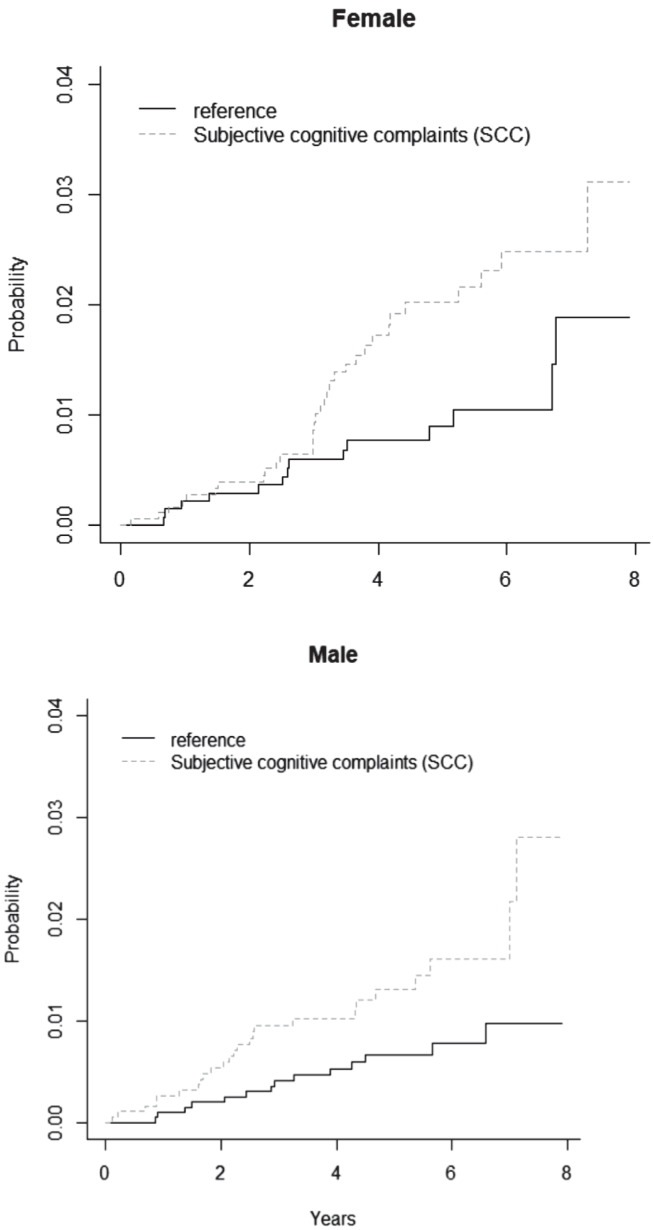

Figure 13. Cumulative incidence of disability benefits over an eight-year follow-up period by subjective cognitive complaints (SCCs) among females and males. Estimates are unadjusted crude values with no other explanatory variables. The reference category includes employees with no psychosocial load and those with some psychosocial load but a normal SCC score.

6 DISCUSSION

6.1 Main findings

Study question 1. What is the predictive value of the HRA results on SA among respondents from various industries and occupations? How the potential additive roles of self-reported health problems, occupational well-being and obesity affect the results?

Self-reported health problems within the “work disability risk” category in the HRA predicted future SA in both genders, regardless of occupational group. The larger the number of WD risk factors, the higher the odds for any SA and the larger the number of SA days, if any. Obesity and earlier sick leave days also predicted future SA in an additive fashion. Occupational well-being did not have an independent role in the results, against our initial hypothesis.

Study question 2. Do self-reported health problems in the HRA predict WD? If so, does the WD risk increase by the number of self-reported health problems?

Self-reported health problems within the “WD risk” category in the HRA predicted future DB for both genders. Age, occupational group, and earlier SA also predicted future DB in an additive manner.

Study question 3. What is the predictive value of the SCC questionnaire results on SA among knowledge-intensive sedentary occupations?

SCCs predicted both the likelihood of SA and the number of SA days, if any, in both genders in primarily knowledge-intensive occupations when adjusted for age and prior SA days.

Study question 4. What is the predictive value of the SCC questionnaire results on WD among respondents from various knowledge-intensive sedentary occupations?

SCC also predicted permanent WD in both genders when adjusted for age and SA days before the questionnaire.

6.2 Strengths and weaknesses of the study

A key strength of our study is that they include registry-based, prospectively collected data on WD in a large cohort of employees from various organizations. The studies I and III used sickness absence (SA) data. Recorded SA data have several advantages: its quality in terms of coverage, accuracy, and consistency over time is better than what is achievable with self-reports (284). The studies II and IV used disability benefit (DB) data. The Finnish Centre for Pensions archival DB data quality in terms of coverage, accuracy, and consistency over time is good, and no data were lost in the follow-up (5,285). ETK combines DBs under different pension act legislations into one that is linked to an employee's career, not to a particular employer, and the coverage of the register is practically 100%. We were also able to control key potential confounders, like age, gender, prior SA, and occupational group as a proxy for socioeconomic status.

The participants of the studies I and II came from a variety of industries and companies, including governmental and municipal workplaces, which we consider as a strength in the generalizability of the results. Previous WD studies in Finnish OHS settings have mainly focused on the public sector (164,205,252,260,286) or a specific industry or occupation group (74,267,287). In Finland, for example, there are different pension act legislations in the public and private sectors, for which reason generalization to the entire working life based on public sector studies should be done with caution. Also, working cultures vary by sector and industry, which is reflected, for example, in much higher SA rates in the public sector (11.5 days lost/employee/year) than in the private sector (9.7 days lost/employee/year) (288).

Another strength in the studies II and IV was the dichotomized outcome measurement of PWD, which was operationalized as DB. We combined all four DB categories as one for reliability (no lost data) and homogeneity in the amount of SA days. The follow-up period in both studies continued for at least two years after the questionnaire had been completed. Sickness allowance is paid for a maximum of one year after the onset of WD, and the DB decision is typically made soon after the sickness allowance period. Thus, the two-year follow-up period was long enough to detect all new potential DB receivers.

We used in the studies I and II a HRA that was shown earlier (74) to be able to identify employees with a high number of SA days, which we consider as a strength of the present study. Our results in a prospective setting in various industries were well in line with the earlier findings in the construction industry (74,255,256,289).

One limitation concerning SA registry data in all studies, but especially in the Studies I and III, should be considered. Short spells of sickness absence are not always registered in the OHS records, since they do not require a note from a physician, especially among white collar employees. This potential bias may result as underestimation of sickness absence days and inaccurate point estimates of the predictors of SA risk especially among experts and managers.

Another limitation of the studies III and IV is that SCC was previously only evaluated in a preliminary study using a small selected population from one information technology company without proper psychometric validation (267,269). However, Cronbach's alphas were at an acceptable level for the SCC score (0.98) in the present studies III and IV. Another limitation concerning only the SCC cohort is that we do not know the exact response rate.

"A healthy worker effect" (HWE) might be present in all studies if employees with worse health levels were less likely to be hired to work in the first place or had not responded to the questionnaire (290). This potential bias would underestimate the associations of the variables and WD as the respondents would be healthier, and possibly having less SA days than non-respondents. A "healthy worker survival effect" (HWSE) might result similar bias. HWSE means that only the healthiest and strongest will remain at work (118). Moreover, we did not include those on long-term sickness absence or those who had already been granted a disability benefit, such as disability pension or rehabilitation subsidy before the questionnaires. All this might underestimate the associations. It may also be possible that the healthiest employees might not respond to questionnaires, which would have an opposite effect than the healthy worker and healthy worker survivor effects on our estimates.

WD resulting from accidents at work, occupational diseases and traffic accidents are not included in this thesis because we did not have access to the statutory accident insurance data. Results of thesis can only cautiously be generalized to the entire working-age population because people outside of working life (e.g., due to unemployment) were not included.

An analysis of SA predictors and determinants in studies I and III is difficult with traditional statistical methods due to a substantial fraction is clustered at value zero. The residual variability in the nonzero part of the distribution exceeds that predicted by a Poisson model for counts. The Hurdle model (291) was perhaps not able to deal with all the complexity associated with this type of response variables, but it was clearly more appropriate than the simpler alternative models in dealing with both the extra-zero component and the overdispersion among computationally feasible approaches. However, the residual collinearity between age, weight, WD risk factors and problems with occupational well-being can cause imprecise estimates of the coefficient values, and therefore, the resulting out-of-sample predictions may also be imprecise.

We chose to use the Fine-Gray model in studies II and IV to estimate the effect of the covariates on the rate at which WD occurs. The Fine-Gray model was more appropriate than, e.g., the Kaplan-Meier survival analysis, which tends to overestimate the cumulative incidence of health-related events (292). Besides, to the Fine-Gray model was easier to add variables than to the Kaplan-Meier. In a conceptual way, we also prefer talking about cumulative hazards to "survival at work". Nevertheless, an interpretation of the HR estimates from the Fine-Gray model is not straightforward. We recommend interpreting the covariates as having an effect on the incidence of WD (i.e., on the CIF). The magnitude of the relative effect of the covariate on the subdistribution hazard function is different from the magnitude of the effect of the covariate on the CIF. Yet one can conclude that if a variable increases the subdistribution hazard function, it will also increase the incidence of the event. However, one cannot infer that the exact magnitudes of these two effects are the same (293).

Some WD criteria are comparable between countries, such as requirements for a health condition in relation to work and the permanence of the condition (44). The legislation varies between countries (43), and therefore, our results must be interpreted with caution in the international context.

Typical limitation of all register-based studies is that some information may be missing. We used multiple imputations to minimize bias due to occasional missing values in publication I. We performed the analyses separately for males and females due to interactions between gender and other covariates, as suggested earlier (81).

6.3 Comparison to previous studies

Self-reported health problems. In countries like Finland and other Scandinavian countries, the Netherlands and Germany (261,294), the Work Ability Index (WAI) (295) has been widely used to predict PWD. An earlier Finnish follow-up study has shown elevated incidence rate ratios of accumulated LTSA among those with poor future work ability (260). Earlier studies have provided evidence for the effectiveness of targeted health check-ups and subsequent measures carried out based on HRA results (253,256,289). The HRA used in the present study was able to identify a subgroup with "WD risk" in an earlier study (74), which found abundant health problems that were previously not known by the OH services. A randomized trial was carried out within the above-mentioned high-risk group, half of which received an invitation to OH services for targeted health check-ups and half of them received usual care. The difference between the targeted intervention group and the control group was 10.6 days in favor of the intervention during the 12-month follow-up (255). The total cost of healthcare was on average 180 euros per person less in the intervention group than in the usual care group (256). Thus, the HRA used in the present study seems to focus on the essential health problems (255). Two longitudinal studies have reported that the risk of a granted DB was higher among employees with poorer WAI scores (HR 7.8; 95% CI 2.6–23.4 (294), and HR 5.0; 95% CI 4.4–5.6 (261)). Our results provide further support for earlier studies that self-rated health and symptoms predict WD and granted DBs. The HRs in our study were exceptionally high among those reporting multiple health problems, which is line with earlier WAI studies. Other questionnaires than WAI, like the HRA in the studies I and II, have also good predictive value on SA and WD. It seems that self-rated health is strong predictor for future work ability. The higher the number of WD risk factors, the higher risk for WD.

Occupational well-being. Previous studies indicate that occupational well-being, described as psychological, social, and organizational factors at work contribute to SA (177,205,275) and DB (28,187). A previous Finnish public sector study shows that women and men in psychological high-strain jobs had 1.2-1.3 times higher rates of SA than those with low-strain jobs, respective figures in effort-reward imbalance were 1.2-1.4. (205). However, contrary to our hypothesis, there was no independent association between occupational well-being and SA in the Study I, but this seems to be due to strong collinearity with self-reported health problems (data not shown). Also, association between occupational well-being and health has been reported before (296). It seems that self-reported health is a stronger predictor for SA than occupational well-being based on our study results, although the causality might in both directions.

Obesity. Our results in the study I provide further support to obesity as an independent risk factor for SA in line with other recent studies (125,297,298). In an earlier Finnish Public Sector study, BMI was one of 17 predictors for SA (164). A previous study based on the Helsinki Health Study cohort among employees of the city of Helsinki found that BMI was associated with all-cause DB among men and women, the highest risk being for the severely obese and the obese. The study I results are in line with these earlier findings among municipal employees. We found similar association among employees from various industries and occupations.

Subjective cognitive complaints. In an earlier preliminary cohort study among professional/managerial employees 42% of those in an abnormal SCC category had long-term SA (over 30 days) during follow-up (267). Another cohort study found that an abnormal SCC category was associated with an increasing number of SA days (13.9 SA days/employee/year) compared to those in a normal SCC category (5.3 SA days/employee/year) (269). Our study is in line with these earlier studies. Most studies focusing on the association between SCC and WD have included employees with health-related conditions, such as depression (299,300) or stress-related symptoms (burnout/exhaustion) (301). Obviously, these conditions are related to temporary and permanent WD as such (69,173,188,302,303), but we are not aware of other prospective cohort studies that focus on how SCC affects WD risk. Previous studies that have analyzed the relationships between SCC and permanent WD have focused either on a particular illness (304) or general aging (245). Psychosocial workload can affect concentration, memory, clear thinking and decision making, which might increase the risk of health complaints (296) and WD in the future. The causal and mediating pathways between psychosocial load, cognitive performance, SCC, ill-health status, and WD is not yet clearly understood.

Age. Age has been a predictor of future SA (305) and DB (66,76) in previous studies. Our results support this finding in all studies I-IV. A previous cross-sectional study proposed that older workers report prolonged SA more often, but less frequent SA than younger workers (305). Our results in studies I and III support this finding. The propensity to have zero SA days was higher in the over-50 age groups for both genders. The duration of SA varies by age (96), depending on the underlying diagnosed disease. The older employees seem to have longer spells of SA than the younger ones (61,72,305), but the younger set seem to have more frequent short spells of SA than the older group (73,74). This is also in line with our results: the propensity to have longer SA days was higher in the over-50 age groups for both genders (zero-truncated NB in Hurdle model). By age, the risk of prolonged WD was highest in the 50- to 60-year age group in our study population among study II and IV. This might be because of a "healthy worker survivor effect" (306), which means that only the healthiest and strongest remain at work, and those who became unfit during their employment tend to leave their working lives earlier (306). This effect was notable in our study, in which the over-60 age group had a lower rate of DBs than the 50- to 60- year age group.

Gender. There are conflicting reports about the role of gender in occupational groups (81,85,96). Anyhow, there seem to be differences in occupational exposure patterns between genders, and these disparities have been observed between and within occupations (94). In our study population among studies I and II, blue-collar workers and clerical employees were overrepresented by females. A previous prospective study found no overall gender difference in DB rates (66), whereas other studies have found gender differences. A Finnish register-based retrospective study found a gender difference between different SA trajectories, which led to DB (60). A Swedish twin cohort found that females are at higher risk of DB-than males (58). In our studies II and IV, the gender difference was not statistically significant in terms of the annual incidence of granted DB. The findings of previous studies in this respect are contradictory.

Occupational group. In the study I, Blue-collar workers had the highest levels of SA days and the professional/managerial employees had the lowest. SA rates have also varied largely by occupational group in earlier studies (102,103,105,107). The HRs for DBs were the highest among the blue-collar employees in the study II, which is in line with a previous study that was drawn from seven independent studies in Finland, France, the UK and the USA, which reported an association with a low occupational grade and increased risks of a health-related exit from work (112). A Finnish cohort study found that higher occupational groups are two times more likely to continue working beyond retirement age than lower occupational groups (109), while another cohort study found that hospitalization was slightly more associated with increased DB in the lower occupational classes (110). These studies indicate that lower occupational groups have poorer health. In our study population (studies I-IV), professionals/managers were predominantly occupied by males, who were also older than in the other occupational groups. Previous studies from several countries have shown that SA is consistently higher in lower occupational classes (107). The blue-collars and the clericals often have limited autonomy over their job tasks and limited power in decision-making, and job tasks are standardized (96). Employees at the professional and managerial level are typically older, male, often highly committed to their work, and have flexible working hours. These factors may partly explain the lower levels of SA among professionals/managers compared to other occupational groups. However, professionals/managers can be away from work for one to three days without a medical certificate in Finland, and therefore, SA days may be underestimated in this group.

Sickness absence. Our results also support a connection between prior and future SA, as reported earlier (162,307). In the present study, the earlier SA was strong predictor for the future SA among all age groups in studies I and III. We also found that earlier SA days predicted future DB in studies II and IV, which is in line with previous studies (60,72,163,308). Our results also agree with earlier findings that the two largest categories of the causes of DB are diseases of the musculoskeletal system (66,76,309), mental and behavioral disorders (58,66,76) and a combination of the two (149,310) in studies II and IV. Our results are in line with earlier findings that the accumulation of SA predicts DB (72,163) and that the main causes of DB in Finland are diseases of the musculoskeletal system and mental disorders (149,181,185,188,311-313).

6.4 Meaning of the study

The findings of our study are summarized in the figure 14 within the context of the ICF-framework (functioning, disability, and health, WHO 2001). The black bolded text indicates the independent predictors for work participation, i.e. absence of temporary (sickness absence) or permanent work disability (disability benefit) that were the outcome variables (underlined and bolded in gray). The light-gray text shows the variables without an independent predictive role for work disability in the present study.

The questions concerning psychosocial work factors in the HRA questionnaire – modified questions from the job-demand-control-social support model, the effort-reward imbalance model, the work-life conflict theories – were collinear with self-rated health problems, hence they did not show an independent explanatory role in the fully adjusted statistical models.

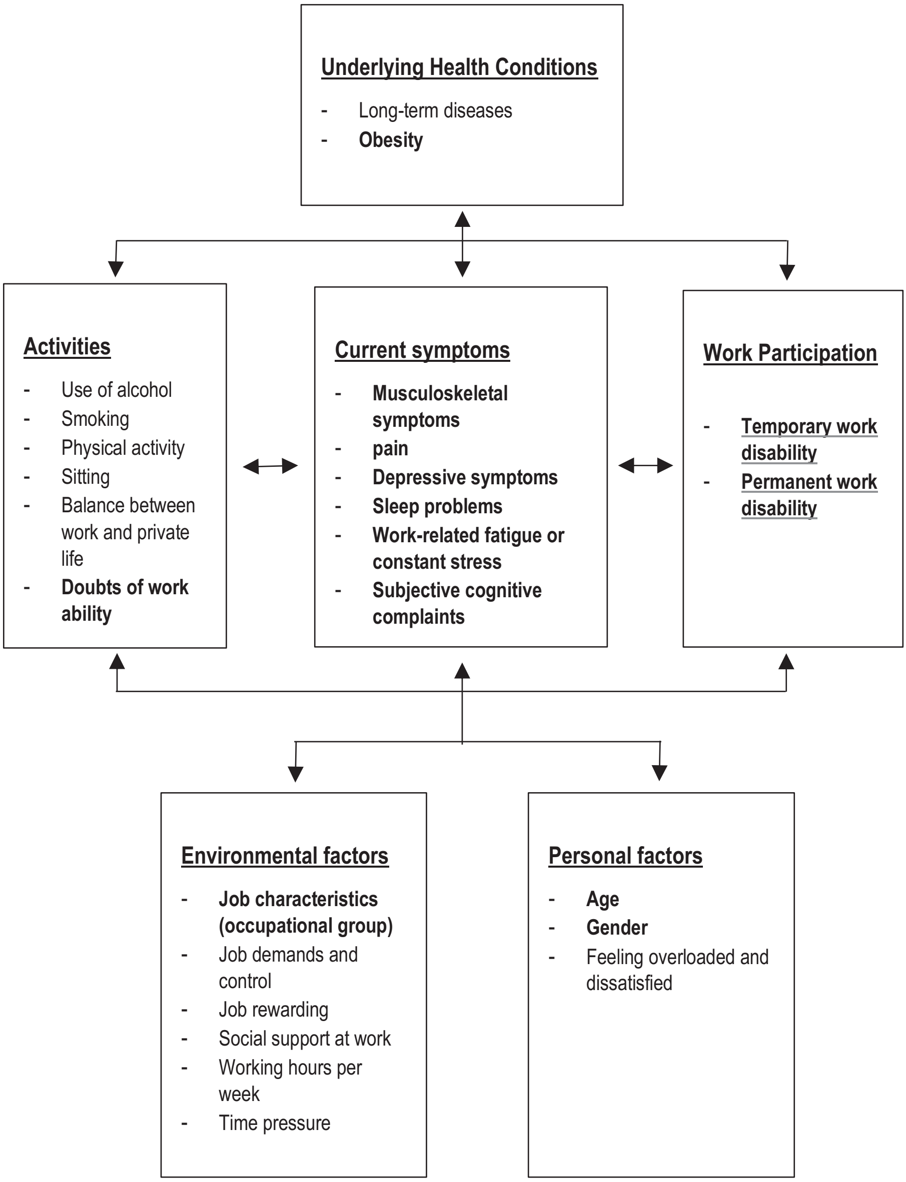

Figure 14. Summary of the findings of this thesis according to the ICF-framework: Biopsychosocial approach to work disability.

Self-reported health problems and obesity seem to predict TWD, irrespective of occupational status, gender, or age (Study I). In addition to self-reported health problems, prior absence from work, age, and participation in manual labor play an independent role in identifying employees who are at an increased risk of PWD (Study II). The hazard ratios of multiple simultaneous self-rated health problems were very high in predicting PWD in the fully adjusted model, indicating that the current burden of relevant symptoms strongly affects future work ability and that a simple questionnaire is a powerful tool in finding a subgroup at high risk of PWD.

The independent role of subjective cognitive complaints predicting TWD and PWD, irrespective of baseline sickness absence as a proxy measure of overall health status, is a novel finding in the international literature (studies III and IV). SCC - self-rated problems in concentration, memory, clear thinking, and decision making - seems to act as an early indicator of future WD risks in cognitively demanding occupations.

The outcome of interest in studies II and IV, i.e., DB, was rare in the entire population. However, since PWD is very costly for society (43), and the underlying diseases and disorders are a burden for disabled individuals in addition to their partially lost income, it is important to identify predictors of DB and to determine how to prevent WD.

Practical tools are needed to identify the risk factors for SA and WD and to target interventions for those in need. Our results provide further support that, in addition to job characteristics, age, and prior absence from work, self-reported health problems and psychosocial risks that can be identified with questionnaires play independent roles in identifying employees at increased risk of both TWD and PWD.

6.5 Implications and recommendations

Screening questionnaires with predictive validity seem appropriate for targeting OHS efforts to help employees in need. They seem useful in identifying symptoms and signs that predict both TWD and PWD, i.e., SA and DB. These findings have implications for both the occupational healthcare system management in the group level and the prevention of work disability at the individual employee level.

The HRA and SCC questionnaires seem useful in health surveillance within the OHS context: they can be used to target the OHS efforts like health check-ups and follow-up actions to those at need. Optimally, each participant in a health check-up should receive a personal health plan, which aims at improving work ability, including also targeted actions to prevent future WD risk. We assume that the use of questionnaires with predictive validity on WD will improve the quality of health surveillance at OHS. Moreover, once the WD risks have been identified, OHS interventions can be targeted not only for those in need at the individual level, but also for the larger groups (organizational prevention) based on the aggregated results of the questionnaires.

In the future, OHS will use validated screening questionnaires as part of health check-ups. Electronic health records use algorithms to select employees with WD risks for care pathways and rehabilitation in a cost-effective manner.

Several knowledge gaps remain after this thesis. First, further research is needed to understand the causal pathways between psychosocial load, occupational well-being, cognitive performance, symptoms, illnesses, and temporary and permanent WD. Second, there is an obvious knowledge gap concerning the (most) effective ways of intervening the WD risk factors that have been identified with the questionnaires. Third, cost-effectiveness and cost-benefit of the targeted interventions for the risk groups warrant further research. Fourth, as the aggregated results of the questionnaires can be used as a platform for group-level (organizational) interventions, there is a novel arena for studies on their effectiveness and cost-effectiveness.

6.6 Conclusions

The two screening questionnaires used in this thesis, addressing relevant topics on self-rated symptoms or cognitive complaints, predict both temporary and permanent work disability.

Belonging to the HRA questionnaire category "WD risk", based on self-reported health problems, predicts a higher total count of SA days regardless of industry and occupational group. Previous sickness absences and obesity also predict sickness absence in an additive fashion, besides self-rated symptoms. The larger the number of "WD risks", the higher were the odds for any SA and the larger the number of SA days. The presence of WD risk factors, especially the presence of multiple simultaneous "WD risks" predict also permanent work disability among both genders across occupational groups. However, we did not find an independent association between occupational well-being and SA, but this is probably due to the strong collinearity between WD risk factors and problems with occupational well-being.

Subjective cognitive complaints predict both temporary and permanent work disability in knowledge-intensive occupations, irrespective of gender, age, or general health.

Both instruments evaluated in this thesis – the HRA and the SCC questionnaire – seem suitable for being used in health surveillance within OHS within appropriate target groups.

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PUBLICATIONS

Publication I	Self-reported Health Problems and Obesity Predict Sickness Absence During a 12-month Follow-up: A Prospective Cohort Study in 21608 Employees from Different Industries. Pihlajamäki M, Uitti J, Arola H, Ollikainen J, Korhonen M, Nummi T, Taimela S. *BMJ Open. 2019;9(10):e025967.*
Publication II	Self-reported Health Problems in a Health Risk Appraisal Predict Permanent Work Disability: A Prospective Cohort Study of 22023 Employees from Different Sectors in Finland with up to Six-year Follow-up. Pihlajamäki M, Uitti J, Arola H, Korhonen M, Nummi T, Taimela S. *International Archives of Occupational and Environmental Health. 2020;93(4):445-456.*
Publication III	Subjective Cognitive Complaints and Sickness Absence: A Prospective Cohort Study in 7059 Employees in Primarily Knowledge-intensive Occupations. Pihlajamäki M, Arola H, Ahveninen H, Ollikainen J, Korhonen M, Nummi T, Uitti J, Taimela S. *Preventive Medicine Reports. 2020;19:101103.*
Publication IV	Subjective Cognitive Complaints and Permanent Work Disability: A Prospective Cohort Study. Pihlajamäki M, Arola H, Ahveninen H, Ollikainen J, Korhonen M, Nummi T, Uitti J, Taimela S. *International Archives of Occupational and Environmental Health, Submitted. 2020*

PUBLICATION
I

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Self-reported health problems and obesity predict sickness absence during a 12-month follow-up: a prospective cohort study in 21 608 employees from different industries

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ABSTRACT

Objectives To study whether self-reported health problems predict sickness absence (SA) from work in employees from different industries.

Methods The results of a health risk appraisal (HRA) were combined with archival data of SA of 21 608 employees (59% female, 56% clerical). Exposure variables were self-reported health problems, labelled as 'work disability (WD) risk factors' in the HRA, presence of problems with occupational well-being and obesity. Age, socioeconomic grading and the number of SA days 12 months before the survey were treated as confounders. The outcome measure was accumulated SA days during 12-month follow-up. Data were analysed separately for males and females. A Hurdle model with negative binomial response was used to analyse zero-inflated count data of SA.

Results The HRA results predicted the number of accumulated SA days during the 12-month follow-up, regardless of occupational group and gender. The ratio of means of SA days varied between 2.7 and 4.0 among those with 'WD risk factors' and the reference category with no findings, depending on gender and occupational group. The lower limit of the 95% CI was at the lowest 2.0. In the Hurdle model, 'WD risk factors', SA days prior to the HRA and obesity were additive predictors for SA and/or the accumulated SA days in all occupational groups.

Conclusion Self-reported health problems and obesity predict a higher total count of SA days in an additive fashion. These findings have implications for both management and the healthcare system in the prevention of WD.

Strengths and limitations of this study

- Our study is based on prospectively collected extensive data from various fields of industries and occupations.
- The coverage, accuracy and consistency of the registry-based sickness absence outcomes is superior to self-reports.
- Our advanced statistical model is able to control key potential confounders.
- Generalisations can only be made to a working population.

INTRODUCTION

The main goals of health surveillance are to prevent work-related illnesses, to support workers' health and work ability and to reduce absenteeism as defined in International directives (Council Directive 83/391/EEC) and International Labour Office's guidelines (ILO).[1] Screening questionnaires are used as a part of targeted health surveillance to identify workers at risk. Some screening questionnaires have shown predictive value for identifying individuals with an increased risk of sickness absence (SA) or work disability (WD) due to health issues.[2–5]

In the present study, we used a health risk appraisal (HRA), which is widely used in Finland and The Netherlands as a part of preventive occupational health services (OHS) to recognise employees at WD risk and to target interventions for those in need. The HRA was able to identify employees with a high number of SA days in an earlier study.[6] The previous study population (n=1341) were mainly blue collars (61%) and males (88%) from the construction industry. Age, gender, occupational grade and the self-assessment of future work ability were strong determinants of SA.[6]

SA is a complex and multifactorial phenomenon determined by personal, sociodemographical, lisfestyle-related and health-related factors as well as organisational determinants, healthcare management and legislation.[7 8] Self-reported health problems predict SA and prolonged return to work.[6 9] The key psychosocial predictors of SA include individuals' own perceptions of health and work ability.[10–13] On the other hand, SA serves as a measure of

Table 1 Criteria for classifying employees into the HRA categories

Topic	Criteria
Work disability risk: at least one of the topics below	
Doubt of work ability	Self-rated future work ability: uncertain of own ability ('uncertain'), or quite sure ('not able') not being able to continue in the current job due to health reasons.
Impairment due to musculoskeletal problems at work	Numerical rating scale (0–10) score ≥5.
Pain hampering work	At least moderate pain that affects working ability at minimum three times a week.
Sleep problems	Problems in falling asleep or night awakenings AND daytime sleepiness daily or almost daily.
Depressive symptoms	DEPS score ≥11.
Work-related constant fatigue	Feeling being squeezed empty.
Work-related constant stress	Feeling tense, strained, nervous and/or anxious because work-related issues are on one's mind all the time.
Health risks: at least one of the topics below	
Weight problems*	BMI ≥30 or ≤18.5.
Diabetes risk	Diabetes risk score ≥11.
Excess use of alcohol	Males ≥350 mL/week, females ≥240 mL/week (expressed as absolute alcohol).
Some symptoms: at least one of the topics below	
Impairment due to musculoskeletal problems at work	Numerical rating scale (0–10) score=4.
Some depressive symptoms	DEPS score between 8 and 10.
Some sleep problems	Problems in falling asleep or night awakenings AND daytime sleepiness 3–5 times a week.
A chronic disease	Self-reported chronic diseases.
Symptoms	Self-reported symptoms.
Lifestyle issues: at least one of the topics below	
Smoking	Smoking=yes.
Physical inactivity	No physical activity during leisure time nor while commuting to work.
Overweight*	BMI between 25 and 30.
No findings	
Previous criteria are not met	

*Overweight and weight problems were not included in the HRA category but analysed separately in the fully adjusted model.
BMI, body mass index; DEPS, Depression Scale; HRA, health risk appraisal.

health in the working population when health is understood as a mixture of social, psychological and physiological functioning.[14 15] Multiple studies have shown that psychosocial work factors and work characteristics predict ill health and eventually WD.[16] Therefore, besides questions related

Table 2 Criteria for problems with occupational well-being

Feature	Criteria
Insufficient job control	High 'job demands' AND (low 'decision authority' OR low result concerning 'job contents').
Work-life conflict	The low result in 'work-life balance'.
Strain due to rewarding	Any of the individual questions concerning rewarding (meaningfulness of work; appreciation; income; career opportunities) in a category 'causes very much strain'.
Lack of social support	Bullying at workplace OR (no support from line manager AND no teamwork).
Overloaded	Always feeling squeezed empty due to work OR always feels stress.
Dissatisfied	Seldom enjoys life OR never content with the present job.

to health and lifestyle risk factors, the HRA used in our study includes questions modified from the job demand-control-social support (JDCS) model, the effort-reward imbalance (ERI) model, the work-life conflict (WLC) theories, level of stress and work satisfaction.[17–19]

Recent studies have suggested that obesity may be a risk factor for SA,[20–22] and that prevention of obesity may be cost-effective.[23] In some studies, body mass index (BMI) has been a predictor of SA in females but not in males.[20 22] It has been estimated that obesity is associated with an

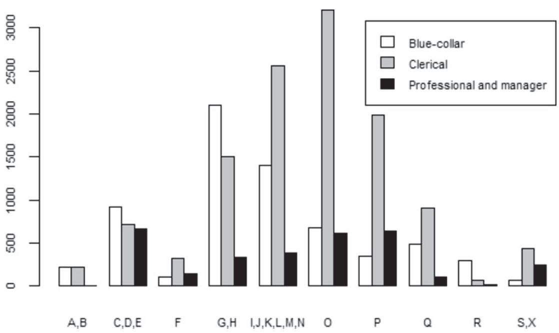

Figure 1 The distribution of the responses by occupational group and standard industrial classification by statistics Finland. A=agriculture, forestry and fishing; B=mining and quarrying; C=manufacturing; D=electricity, gas, steam and air conditioning supply; E=water supply; sewerage, waste management and remediation activities; F=construction; G=wholesale and retail trade; repair of motor vehicles; H=transportation and storage; I=accommodation and food service activities; J=information and communication; K=financial and insurance activities; L=real estate activities; M=professional, scientific and technical activities; N=administrative and support service activities; O=public administration and defence; compulsory social security; P=education; Q=health and social work activities; R=arts, entertainment and recreation; S=other service activities; X=industry unknown.

Table 3 The prevalence of work disability (WD) risk factors, problems with occupational well-being (OWB) and obesity and characteristics of the distribution of the number of sickness absence (SA) days by gender, occupational group (OG) and age

				WD risks (%)				Days on sickness absence				
OG	Gender	Age	Subjects, N	One	Two or more	Problems with OWB (%)	Obesity (BMI >30) (%)	% with zero SA	Median	Upper quartile	Mean of all values	Mean of non-zero values
BC	Female	≤30	701	19	13	25	13	29	5	13.0	12.7	17.9
		30–40	829	20	14	25	17	24	5	15.0	13.8	18.1
		40–50	1020	22	10	20	21	31	4	13.0	13.7	19.9
		50–60	1067	21	17	22	19	28	5	16.0	15.1	21.1
		>60	289	34	22	21	16	40	2	12.0	12.1	20.5
		All	3906	22	14	23	18	29	4	15	13.8	19.5
	Male	≤30	475	12	4	16	12	34	3	9	8.5	12.8
		30–40	702	16	6	19	20	29	3.5	10	9.7	13.6
		40–50	684	16	7	16	20	35	3	11	11.6	17.9
		50–60	659	20	12	17	24	38	2	11	11.5	18.7
		>60	177	25	13	11	24	53	0	8	9.9	21.1
		All	2697	17	8	17	20	35	3	10	10.4	16.1
	All		6603	28	12	20	19	32	4	12	12.4	18.2
C	Female	≤30	577	15	6	16	5	45	2	6	6.5	11.7
		30–40	1543	19	8	17	13	40	2	8	7.5	12.6
		40–50	2036	19	9	19	18	44	2	7	7.9	14.0
		50–60	2482	19	13	19	19	48	1	7	8.0	15.5
		>60	696	23	17	15	20	54	0	5	7.7	16.9
		All	7334	19	11	18	16	46	1	7	7.7	14.2
	Male	≤30	391	8	2	6	8	67	0	2.5	3.8	11.5
		30–40	1143	11	4	14	14	60	0	3	3.7	9.2
		40–50	1179	13	6	13	18	65	0	3	4.4	12.3
		50–60	1347	14	9	12	19	67	0	3	5.3	15.9
		>60	495	17	8	10	16	72	0	2	5.3	19.2
		All	4555	13	6	12	16	65	0	3	4.5	13.0
	All		11 889	17	9	16	16	53	0	5	6.5	13.8
P/M	Female	≤30	60	20	0	10	10	58	0	3	3.8	9.1
		30–40	349	13	7	13	9	54	0	4	5.0	10.8
		40–50	485	18	6	13	12	56	0	4	4.5	10.1
		50–60	414	19	8	14	18	53	0	5	6.0	12.8
		>60	139	23	12	15	17	61	0	4	6.5	16.8
		All	1447	18	7	13	13	55	0	4	5.2	11.6
	Male	≤30	79	6	3	10	5	66	0	2.5	2.5	7.4
		30–40	457	11	3	11	10	64	0	2	2.4	6.8
		40–50	543	10	2	8	14	71	0	2	3.4	11.7
		50–60	464	11	4	9	18	70	0	2	3.8	12.8
		>60	126	13	6	9	17	70	0	2	3.8	12.7
		All	1669	11	3	9	14	68	0	2	3.2	10.3
	All		3116	14	5	11	14	62	0	3	4.1	11.0
All	Female		12 687	20	11	19	17	42	2	9	9.3	15.9
	Male		8921	14	6	13	17	57	0	5	6.1	14.0
All			21 608	17	9	16	17	48	1	7	8.0	15.3

BC, blue collar; BMI, body mass index; C, clerical; P/M, professional/manager.

Table 4 Sickness absence (SA) by the HRA categories in different occupational groups by gender: means and the ratio of means

Interpretation of the HRA	Male SA days (N; mean; SD)			Male Ratio of means (95% CI)	Female SA days (N; mean; SD)			Female Ratio of means (95% CI)
Blue-collar workers								
No findings	274	5.18	10.50	Ref	198	6.95	17.83	Ref
Some symptoms	1060	7.18	15.73	**1.39 (1.07 to 1.87)**	1471	9.31	20.24	1.34 (0.96 to 2.11)
Health risk	691	8.33	16.56	**1.61 (1.23 to 2.19)**	843	12.04	22.42	**1.73 (1.24 to 2.74)**
WD risk	672	19.88	41.05	**3.84 (2.91 to 5.23)**	1394	20.64	38.19	**2.97 (2.15 to 4.67)**
Clerical employees								
No findings	532	2.43	12.20	Ref	425	4.48	16.6	Ref
Some symptoms	2198	3.10	10.61	1.28 (0.87 to 2.26)	3390	5.18	13.49	1.15 (0.84 to 1.80)
Health risk	953	4.08	11.57	**1.68 (1.11 to 3.00)**	1344	7.87	18.11	**1.75 (1.26 to 2.75)**
WD risk	872	9.80	25.2	**4.04 (2.69 to 7.19)**	2175	12.27	26.43	**2.74 (1.99 to 4.26)**
Professionals/managers								
No findings	232	1.77	4.71	Ref	95	2.00	3.76	Ref
Some symptoms	913	2.86	11.39	**1.61 (1.06 to 2.60)**	774	4.15	12.73	**2.08 (1.38 to 3.48)**
Health risk	292	3.89	12.15	**2.20 (1.29 to 3.69)**	220	5.98	14.81	**2.99 (1.79 to 5.20)**
WD risk	232	5.40	17.07	**3.05 (1.68 to 5.23)**	358	7.82	18.14	**3.91 (2.55 to 6.59)**

Bold values denote statistical significance at the $p < 0.05$ level.
HRA, health risk appraisal; WD, work disability.

increase in SA from 1.1 to 1.7 extra days missed annually compared with normal-weight employees in the USA.[21] It remains to be seen whether obesity acts as an additive risk factor for SA besides health problems.

In the present study, we evaluated how the HRA results predict SA in respondents from various industries and occupations and assessed the potential additive roles of self-reported health problems, occupational well-being and obesity. Our hypothesis was that self-reported health problems predict future SA, irrespective of gender and occupational group and that obesity has an additive effect.

METHODS

Study design, ethics and setting

The study design is a retrospective analysis of prospectively collected register data. The questionnaire data and SA register data were collected from one nationwide occupational health (OH) service provider's registers. Data privacy was strictly followed.

The study setting is OHS. Most Finnish employees use OHS for all their primary healthcare needs. In 2015, approximately 2.10 million Finnish employees (95% of the total workforce[24]) were covered by OHS. Besides 1.2 million preventive health examinations, OHS also performed 4.8 million illness-related visits.[25] The Finnish public social insurance system includes all lawful residents of Finland and provides health services and social service benefits for all members of the scheme, administered by The Social Insurance Institution of Finland (KELA). The SA benefit programme provides coverage for lost income due to medically certified sickness or disease from day 1 until the person can work again up to 52 weeks. After that, long-term benefits from the disability benefits system provide coverage for lost income.

Participants

The study participants were working-age Finnish residents, aged 18–68 years, who had completed the HRA (n=22 515). An invitation to the HRA had been sent to 33 990 employees, of which 11 475 had not responded (response rate 66%). We used HRA results collected as a part of preventive OHS in 2012–2015 and archival data of SA covering 2011–2016. The inclusion criteria was a completed HRA. Exclusion criteria were >150 SA days in the 12 months preceding the HRA (n=119), granted disability benefit (n=689), missing data concerning occupational group (n=79) and loss to follow-up (n=77). Some respondents were in several exclusion categories. Finally, we analysed the data from 21 608 employees.

Patient and public involvement

Patients were not involved in the design, recruitment or conduct of the study.

Measurements

Explanatory variables

The classified results of the HRA were used as the primary exposure variable. Other exposure variables included problems with occupational well-being and obesity. Gender, age, occupational group and SA days before the HRA were treated as confounding factors.

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Table 5 Predicting the odds for any sickness absence (SA) (logistic model) and the duration of SA, if any (zero-truncated negative binomial (NB) part) in the negative binomial Hurdle model: crude analysis

				Logistic model (0 vs >0)		Zero-truncated NB (>0)	
OG	Gender	HRA result category	N	OR	95% CI	RR	95% CI
BC	Female	(Intercept)		1.08	(0.82 to 1.43)	10.28	(7.81 to 13.53)
		No findings	198	1.00	Ref	1.00	Ref
		Some symptoms	1471	**1.78**	**(1.32 to 2.40)**	1.07	(0.80 to 1.42)
		Health risk	843	**2.05**	**(1.49 to 2.80)**	**1.36**	**(1.01 to 1.82)**
		WD risk, 1 risk factor	840	**3.13**	**(2.27 to 4.33)**	**1.58**	**(1.18 to 2.12)**
		WD risk, 2 risk factors	335	**4.91**	**(3.27 to 7.36)**	**2.36**	**(1.72 to 3.25)**
		WD risk, 3–5 risk factors	219	**5.59**	**(3.49 to 8.96)**	**3.43**	**(2.45 to 4.82)**
	Male	(Intercept)		1.23	(0.97 to 1.56)	6.64	(5.25 to 8.41)
		No findings	274	1.00	Ref	1.00	Ref
		Some symptoms	1060	**1.37**	**(1.04 to 1.79)**	1.27	(0.98 to 1.63)
		Health risk	691	**1.44**	**(1.08 to 1.91)**	**1.47**	**(1.13 to 1.92)**
		WD risk, 1 risk factor	456	**2.04**	**(1.49 to 2.79)**	**2.89**	**(2.19 to 3.82)**
		WD risk, 2 risk factors	147	**2.34**	**(1.51 to 3.63)**	**3.86**	**(2.70 to 5.51)**
		WD risk, 3–5 risk factors	69	**3.51**	**(1.83 to 6.71)**	**5.32**	**(3.41 to 8.30)**
C	Female	(Intercept)		0.62	(0.51 to 0.76)	8.05	(6.35 to 10.20)
		No findings	425	1.00	Ref	1.00	Ref
		Some symptoms	3390	**1.58**	**(1.28 to 1.94)**	0.87	(0.68 to 1.11)
		Health risk	1344	**1.94**	**(1.55 to 2.42)**	1.28	(0.99 to 1.65)
		WD risk, 1 risk factor	1403	**2.81**	**(2.24 to 3.51)**	**1.48**	**(1.15 to 1.91)**
		WD risk, 2 risk factors	500	**3.32**	**(2.54 to 4.36)**	**1.73**	**(1.30 to 2.30)**
		WD risk, 3–5 risk factors	272	**3.54**	**(2.56 to 4.88)**	**3.05**	**(2.21 to 4.21)**
	Male	(Intercept)		0.34	(0.28 to 0.42)	5.96	(4.51 to 7.86)
		No findings	532	1.00	Ref	1.00	Ref
		Some symptoms	2198	**1.36**	**(1.10 to 1.69)**	1.03	(0.77 to 1.37)
		Health risk	953	**1.46**	**(1.15 to 1.85)**	1.36	(0.99 to 1.86)
		WD risk, 1 risk factor	590	**2.59**	**(2.01 to 3.34)**	**1.84**	**(1.34 to 2.54)**
		WD risk, 2 risk factors	197	**3.19**	**(2.27 to 4.49)**	**3.22**	**(2.15 to 4.82)**
		WD risk, 3–5 risk factors	85	**4.16**	**(2.59 to 6.68)**	**3.83**	**(2.29 to 6.41)**
P/M	Female	(Intercept)		0.58	(0.38 to 0.88)	2.77	(1.59 to 4.83)
		No findings	95	1.00	Ref	1.00	Ref
		Some symptoms	774	1.23	(0.79 to 1.92)	**2.18**	**(1.26 to 3.78)**
		Health risk	220	1.45	(0.89 to 2.38)	**3.03**	**(1.65 to 5.58)**
		WD risk, 1 risk factor	254	**1.71**	**(1.06 to 2.78)**	**3.09**	**(1.71 to 5.60)**
		WD risk, 2 risk factors	69	**2.36**	**(1.25 to 4.46)**	**4.31**	**(2.09 to 8.90)**
		WD risk, 3–5 risk factors	35	**2.57**	**(1.16 to 5.69)**	**5.00**	**(2.10 to 11.9)**
	Male	(Intercept)		0.39	(0.29 to 0.52)	2.95	(1.80 to 4.81)
		No findings	232	1.00	Ref	1.00	Ref
		Some symptoms	913	1.06	(0.77 to 1.46)	**1.76**	**(1.12 to 2.78)**
		Health risk	292	1.38	(0.95 to 2.01)	**2.08**	**(1.23 to 3.51)**
		WD risk, 1 risk factor	176	1.43	(0.94 to 2.18)	**3.18**	**(1.76 to 5.73)**
		WD risk, 2 risk factors	36	**2.06**	**(1.00 to 4.21)**	1.35	(0.54 to 3.28)
		WD risk, 3–5 risk factors	20	**2.57**	**(1.02 to 6.46)**	2.51	(0.80 to 7.82)

Continued

Table 5 Continued

OG	Gender	HRA result category	N	Logistic model (0 vs >0) OR	95% CI	Zero-truncated NB (>0) RR	95% CI

Logistic model refers to the model component for predicting membership to the subpopulation A with high propensity to zero absence, and zero-truncated NB to the component predicting the days on sick leave among the susceptible subpopulation B. To facilitate interpretation, for the zero-inflation part we have shown the ORs associated with the complementary propensity to having any sickness absence, that is, inclusion in subpopulation B.
Bold values denote statistical significance at the p < 0.05 level.
BC, blue collar; C, clerical; HRA, health risk appraisal; OG, occupational group; P/M, professional/manager; RR, risk ratio; WD, work disability.

The HRA result categories in declining priority order are 1) WD risk, 2) health risk, 3) some symptoms, 4) lifestyle issues and 5) no findings (table 1). Within the category 'WD risk', the results were further subdivided by the number of risk factors (1–5).

We constructed a dichotomous variable 'problems with occupational well-being', based on a series of questions modified from the JDCS model, the ERI model, the WLC theories and the presence of constant stress or dissatisfaction (table 2).[17–19] If any of the criteria were met, the respondent was classified as having a problem with occupational well-being.

BMI was categorised as underweight (<18.5), normal weight (18.5–25.0), overweight (25.0–30.0) and obese (>30.0). Normal weight was chosen as the reference class in the statistical models. Among males, underweight was combined with normal weight due to small numbers. Age was categorised into five classes: <30, 30–40, 40–50, 50–60 and >60 years. The age group 30–40 years was chosen the reference class in the statistical models. Occupational group was defined as blue-collar workers, clerical employees and professionals/managers. The number of SA days 12 months prior to the questionnaire was included as a continuous variable.

Sickness absence

We used SA days as the outcome variable. SA was operationalised as the accumulated number of days on sick leave during the 12-month follow-up after the survey. It includes the number of days and periods absent because of sickness. Overlapping and consecutive SA were combined. Maternity/paternity leave and absence from work to care for a sick child are not included in the SA.

The employer records the sick leave periods and dates when each SA starts and ends. If the SA is prescribed by the OH physician, the employer supplies the information to the OH care. In most cases, permanent employees are paid a full salary during their SA from the first day, up to 3 months. The employer receives sickness allowance from KELA after 10 working days, Sundays and other national holidays are excluded. The employee needs a medical certificate to qualify for sickness allowance. Mostly the blue-collar employees cannot complete their own certificates for any SA, while professional and manager employees must provide a written explanation for short SA and a medical certification for SA longer than 3 days. An employee may receive sickness allowance from KELA for <1 year of WD due to the same illness. If an employee is unfit for work because of an illness for longer than a year, it is possible to claim a disability benefit. The evaluation of eligibility for WD benefits is transferred to the pension insurance companies if the illness lasts longer than 1 year.

Statistical methods

We analysed how the number of future SA days vary based on the results of the HRA, taking into account other exposure variables and potential confounding factors. Missing values in the questionnaire-based variables were imputed with the multiple imputation method MICE software with predictive mean matching. We are not aware of any systematic reasons or motives that would cause the non-response to be different in the HRA response categories. Based on our best knowledge, missing questionnaire data are missing at random. The following items were used as determinants when conducting the missing data imputation: gender, age, problems with occupational well-being, stress and fatigue, job satisfaction, BMI, all-cause SA both 12 months prior to and after and the lifestyle questions in the HRA (alcohol consumption, exercise, smoking).

There were complex interactions between gender and other variables in our data and we performed all analyses stratified by gender and occupational group as has been suggested earlier.[26]

Baseline characteristics are presented using descriptive statistics. Patterns with SA means and SD and the ratio of means with 95% CIs were calculated by the HRA result classes separately by gender and occupational group.

When modelling SA data, a special challenge is that a large number of employees have no absenteeism due to sickness.[6] Ordinary count data methods like Poisson or negative binomial regression models are not directly suitable for the analysis in case of the excess count of zero days. Our approach was to try mixture regression, zero-inflated negative binomial regression and the Hurdle model. The first two approaches yielded problems when estimating the model's parameters. We chose the Hurdle model, which provides a combination of the two statistical models: a binary model determines whether the outcome is zero or positive (logistic regression) and a truncated at zero count model for the positive part of the count data. We used the truncated negative binomial regression model because it accounts for the overdispersion present in count data. The estimated ORs (with 95% CI) based on the binary part are reported in tabulated form. In the zero-truncated negative binomial part, the estimated risk ratios (RR) based on the regression coefficients of the HRA categories and covariates are reported with 95% CIs. The statistical analyses were performed using R V.3.4.4 software.

RESULTS

The average age of the participants was 45.3 years (SD 11; range 19–68) and 59% (n=12 687) were female, 6603 (32%) were blue-collar workers, 11 889 (56%) were clerical employees and 3116 (15%) belonged to the professional or manager category (figure 1). The non-respondents were slightly younger (average age 44.2 years, SD 12; t=−7.3; p<0.0001) than the respondents on the average. Also, males were less likely to respond than females with response rates 60% and 71%, respectively (χ^2=425.5; p<0.0001). The response rates were almost identical among blue-collar workers (65%), clerical employees (67%) and experts/managers (66%) (χ^2=14.3; p=0.0007).

A total of 172 331 days of SA were recorded in the study population during the 12-month follow-up. The distribution was heavily right-skewed in all age groups. Moreover, 48% had not been on SA at all, indicating a substantial zero component in the response distribution (table 3). The proportion of respondents with zero SA days was 35% in blue-collar males and 29% in females, 65% in clerical males and 46% in females, and 68% in professional/manager males and 55% in females.

The mean numbers of SA days among those with any SA were 18.2, 13.8, 11.0 days in blue collars, clericals and professionals/managers, respectively. An increasing trend of SA by age was observed among those with any SA. Females tend to have more SA days than males in all occupational groups. Twenty-six per cent of subjects reported 'WD risk factors', but their share of the total number of SA was 47% (table 3).

Belonging to the HRA category 'health risk' or 'WD risk factors' predicted higher mean values of SA during the follow-up, regardless of the occupational group or gender. The ratio of means of SA days varied between 2.7 and 4.0 among those with 'WD risk factors' and the reference category with no findings in the HRA, depending on gender and occupational group. The lower limit of the 95% CI was at the lowest 2.0. (table 4).

The results from fitting the Hurdle model are displayed in the table 5 (unadjusted model) and table 6 (adjusted model). The analyses were performed stratified by gender and occupational group due to complex interactions. We included the result of the HRA (six categories for blue collars and clericals and five categories for professionals/managers) as a covariate. The categories 'lifestyle issues and no findings" were combined as the reference class and the number of WD risk factors was analysed separately when possible. We excluded weight problems from the HRA 'health risk category' in the fully adjusted model. The average number of SA among the susceptible to any SA followed the pattern blue-collar workers>clerical employees>professionals/managers in both genders. There was some evidence of an overall decreasing trend in the susceptibility to SA by increasing age. In males in both clerical and professional and managerial positions, the number of SA days tended to increase by age, but not in females or blue-collar males. SA prior to the HRA predicted both susceptibility for SA and the number of SA days during the follow-up. The presence of 'WD risk factors' predicted susceptibility to and the mean number of days on SA in all occupational groups. In the unadjusted model, HRA category 'WD risk factors' predicted the probability of SA (OR at the lowest 1.7 with 95% CI at the lowest 1.1 by occupational groups) for both genders (table 5). HRA category 'some symptoms' (OR at the lowest 1.4 with 95% CI at the lowest 1.0) and 'health risk' (OR at the lowest 1.4 with 95% CI at the lowest 1.1) predicted the probability for SA in blue collars and clericals. When all covariates were included (table 6), the ORs and RRs decreased. The number of earlier SA days predicted the probability of SA (OR at the lowest 1.03 with 95% CI at the lowest 1.02 by occupational groups) in the adjusted model. The presence of multiple 'WD risk factors' increased both susceptibility and/or the number of SA days. Problems with well-being at work predicted SA in the professional and managerial group in both genders. Overweight and/or obesity predicted SA in all professional groups in both genders. All these effects are additive, that is, adjusted for each other within each stratum.

DISCUSSION

Self-reported health problems in the HRA—musculoskeletal problems, depressive symptoms, sleep problems, constant stress and feeling of exhaustion and doubts about work ability—predicted future SA in both genders, regardless of occupational group. Of note, the larger the number of these problems, labelled as 'WD risk factors', the higher were the odds for any SA and the larger the number of SA days, if any. In Finland, the two largest categories of the causes of SA and permanent WD are musculoskeletal disorders and mental and behavioural disorders.[27] Also, problems with sleep,[28] constant stress,[29] exhaustion[30] and attitudes towards work ability[6] have predicted SA in earlier studies. It seems that using a questionnaire for self-rating of symptoms of the common causes of SA is a valid way to identify individuals at risk of SA, as the HR:s were relatively high in our study. Obesity and earlier sick leave days also predicted future SA in an additive fashion.

The strengths of the study include the registry-based, prospectively collected extensive data from various industries. Recorded SA data have several advantages: the quality of the data in terms of coverage, accuracy and consistency over time is better to that achievable via self-reports.[31] We were also able to control key potential

Table 6 Predicting the odds for any sickness absence (SA) (logistic model) and the duration of SA, if any (zero-truncated negative binomial (NB) part) in the negative binomial Hurdle model: all covariates included

				Logistic model (0 vs >0)		Zero-truncated NB (>0)	
OG	Gender	Explanatory variable	N	OR	95% CI	RR	95% CI
BC	Female	(Intercept)		1.13	(0.82 to 1.56)	8.48	(6.48 to 11.10)
		No findings	198	1.00	Ref.	1.00	Ref.
		Some symptoms	1471	**1.70**	**(1.25 to 2.31**)	0.97	(0.74 to 1.27)
		Health risk	843	**1.70**	**(1.23 to 2.37**)	1.05	(0.79 to 1.40)
		WD risk, 1 risk factor	840	**2.68**	**(1.91 to 3.75**)	1.21	(0.91 to 1.61)
		WD risk, 2 risk factors	335	**3.65**	**(2.37 to 5.61**)	**1.51**	**(1.11 to 2.06**)
		WD risk, 3–5 risk factors	219	**3.46**	**(2.08 to 5.75**)	**1.95**	**(1.39 to 2.74**)
		BMI>18.5 and ≤25	1866	1.00	Ref.	1.00	Ref.
		BMI≤18.5	53	1.13	(0.58 to 2.21)	1.42	(0.94 to 2.17)
		BMI>25 and ≤30	1210	1.09	(0.92 to 1.29)	**1.23**	**(1.10 to 1.39**)
		BMI>30	684	**1.27**	**(1.02 to 1.58**)	**1.29**	**(1.12 to 1.49**)
		Age>30 and ≤40	829	1.00	Ref.	1.00	Ref.
		Age≤30	701	0.84	(0.66 to 1.07)	1.06	(0.91 to 1.24)
		Age>40 and ≤50	1020	**0.66**	**(0.53 to 0.82**)	1.02	(0.88 to 1.17)
		Age>50 and ≤60	1067	**0.71**	**(0.57 to 0.88**)	1.08	(0.94 to 1.24)
		Age>60	289	**0.40**	**(0.30 to 0.54**)	1.02	(0.82 to 1.28)
		Problems in well-being	881	0.99	(0.82 to 1.20)	1.04	(0.92 to 1.17)
		Sick leaves before the questionnaire		**1.048**	**(1.039 to 1.057**)	**1.019**	**(1.016 to 1.022**)
	Male	(Intercept)		1.12	(0.83 to 1.51)	5.23	(4.05 to 6.75)
		No findings	274	1.00	Ref.	1.00	Ref.
		Some symptoms	1060	1.28	(0.97 to 1.69)	1.05	(0.82 to 1.34)
		Health risk	691	1.33	(0.98 to 1.79)	1.25	(0.97 to 1.61)
		WD risk, 1 risk factor	456	**1.63**	**(1.17 to 2.28**)	**2.06**	**(1.57 to 2.72**)
		WD risk, 2 risk factors	147	**1.70**	**(1.06 to 2.75**)	**2.16**	**(1.53 to 3.07**)
		WD risk, 3–5 risk factors	69	1.81	(0.89 to 3.68)	**3.29**	**(2.13 to 5.08**)
		BMI≤25	933	1.00	ref.	1.00	ref.
		BMI>25 and ≤30	1205	**1.22**	**(1.01 to 1.47**)	1.16	(1.00 to 1.35)
		BMI>30	527	**1.57**	**(1.22 to 2.02**)	1.15	(0.96 to 1.38)
		Age>30 and ≤40	702	1.00	Ref.	1.00	Ref.
		Age<30	475	0.88	(0.68 to 1.14)	1.04	(0.86 to 1.26)
		Age>40 and ≤50	684	**0.74**	**(0.59 to 0.94**)	**1.38**	**(1.16 to 1.64**)
		Age>50 and ≤60	659	**0.56**	**(0.44 to 0.71**)	1.16	(0.97 to 1.39)
		Age>60	177	**0.31**	**(0.22 to 0.44**)	1.32	(0.96 to 1.82)
		Problems in well-being	447	**1.28**	**(1.00 to 1.64**)	1.04	(0.87 to 1.23)
		Sick leaves before the questionnaire		**1.053**	**(1.042 to 1.065**)	**1.020**	**(1.015 to 1.024**)

Continued

Table 6 Continued

OG	Gender	Explanatory variable	N	Logistic model (0 vs >0) OR	95% CI	Zero-truncated NB (>0) RR	95% CI
C	Female	(Intercept)		0.67	(0.54 to 0.83)	6.27	(4.94 to 7.96)
		No findings	425	1.00	Ref.	1.00	Ref.
		Some symptoms	3390	**1.47**	(**1.19 to 1.82**)	0.90	(0.72 to 1.14)
		Health risk	1344	**1.72**	(**1.36 to 2.18**)	1.17	(0.91 to 1.51)
		WD risk, 1 risk factor	1403	**2.30**	(**1.82 to 2.91**)	**1.34**	(**1.05 to 1.71**)
		WD risk, 2 risk factors	500	**2.47**	(**1.85 to 3.29**)	1.27	(0.96 to 1.68)
		WD risk, 3–5 risk factors	272	**2.45**	(**1.73 to 3.47**)	**2.20**	(**1.60 to 3.03**)
		BMI>18.5 and ≤25	3775	1.00	Ref.	1.00	Ref.
		BMI≤18.5	81	0.82	(0.52 to 1.30)	0.68	(0.43 to 1.07)
		BMI>25 and ≤30	2213	1.08	(0.96 to 1.20)	1.10	(0.99 to 1.22)
		BMI>30	1192	**1.37**	(**1.18 to 1.59**)	**1.23**	(**1.08 to 1.4**)
		Age>30 and ≤40	1543	1.00	Ref.	1.00	Ref.
		Age<30	577	0.94	(0.77 to 1.14)	1.01	(0.84 to 1.21)
		Age>40 and ≤50	2036	**0.80**	(**0.70 to 0.93**)	1.07	(0.94 to 1.21)
		Age>50 and ≤60	2482	**0.63**	(**0.55 to 0.72**)	1.12	(0.99 to 1.27)
		Age>60	696	**0.45**	(**0.37 to 0.55**)	1.13	(0.93 to 1.36)
		Problems in well-being	1308	1.10	(0.96 to 1.25)	1.05	(0.94 to 1.19)
		Sick leaves before the questionnaire		**1.053**	(**1.046 to 1.060**)	**1.019**	(**1.016 to 1.022**)
	Male	(Intercept)		0.36	(0.29 to 0.45)	4.30	(3.16 to 5.85)
		No findings	532	1.00	Ref.	1.00	Ref.
		Some symptoms	2198	**1.41**	(**1.13 to 1.76**)	1.01	(0.76 to 1.33)
		Health risk	953	**1.50**	(**1.16 to 1.93**)	1.07	(0.78 to 1.46)
		WD risk, 1 risk factor	590	**2.50**	(**1.91 to 3.27**)	**1.46**	(**1.06 to 2.02**)
		WD risk, 2 risk factors	197	**2.70**	(**1.87 to 3.91**)	**2.42**	(**1.61 to 3.65**)
		WD risk, 3–5 risk factors	85	**3.51**	(**2.11 to 5.86**)	**2.85**	(**1.68 to 4.85**)
		BMI≤25	1687	1.00	Ref.	1.00	Ref.
		BMI>25 and ≤30	211	1.12	(0.97 to 1.29)	1.18	(0.99 to 1.39)
		BMI>30	734	**1.23**	(**1.01 to 1.49**)	**1.35**	(**1.08 to 1.69**)
		Age>30 and ≤40	1143	1.00	Ref.	1.00	Ref.
		Age<30	391	0.82	(0.64 to 1.05)	1.25	(0.93 to 1.69)
		Age>40 and ≤50	1179	**0.75**	(**0.63 to 0.90**)	**1.33**	(**1.08 to 1.62**)
		Age>50 and ≤60	1347	**0.64**	(**0.54 to 0.76**)	**1.40**	(**1.13 to 1.73**)
		Age>60	495	**0.47**	(**0.37 to 0.60**)	**1.80**	(**1.34 to 2.43**)
		Problems in well-being	551	1.18	(0.97 to 1.44)	0.95	(0.76 to 1.18)
		Sick leaves before the questionnaire		**1.040**	(**1.032 to 1.048**)	**1.016**	(**1.010 to 1.022**)

Continued

Table 6 Continued

OG	Gender	Explanatory variable	N	Logistic model (0 vs >0)		Zero-truncated NB (>0)	
				OR	95% CI	RR	95% CI
P/M	Female	(Intercept)		0.57	(0.36 to 0.91)	2.66	(1.52 to 4.65)
		No findings	95	1.00	Ref.	1.00	Ref.
		Some symptoms	774	1.12	(0.71 to 1.76)	**1.88**	**(1.10 to 3.20)**
		Health risk	220	1.17	(0.69 to 1.99)	**2.00**	**(1.09 to 3.67)**
		WD risk, 1 risk factor	254	1.43	(0.86 to 2.36)	**2.06**	**(1.15 to 3.68)**
		WD risk, 2 risk factors	69	1.69	(0.86 to 3.33)	**2.32**	**(1.12 to 4.82)**
		WD risk, 3–5 risk factors	35	2.02	(0.87 to 4.73)	**2.99**	**(1.25 to 7.13)**
		BMI>18.5 and ≤25	817	1.00	Ref.	1.00	Ref.
		BMI≤18.5	11	0.31	(0.06 to 1.45)	0.70	(0.08 to 5.83)
		BMI>25 and ≤30	416	**1.46**	**(1.14 to 1.87)**	1.18	(0.89 to 1.57)
		BMI>30	193	1.27	(0.90 to 1.79)	1.16	(0.80 to 1.67)
		Age>30 and ≤40	349	1.00	Ref.	1.00	Ref.
		Age<30	6	0.85	(0.48 to 1.50)	0.64	(0.33 to 1.22)
		Age>40 and ≤50	485	0.88	(0.66 to 1.17)	0.95	(0.70 to 1.31)
		Age>50 and ≤60	414	0.92	(0.68 to 1.24)	1.13	(0.81 to 1.56)
		Age>60	139	**0.63**	**(0.42 to 0.96)**	1.48	(0.91 to 2.39)
		Problems in well-being	194	0.95	(0.68 to 1.32)	**1.64**	**(1.13 to 2.38)**
		Sick leaves before the questionnaire		**1.040**	**(1.025 to 1.056)**	**1.027**	**(1.015 to 1.039)**
	Male	(Intercept)		0.41	(0.29 to 0.57)	2.47	(1.54 to 3.97)
		No findings	232	1.00	Ref.	1.00	Ref.
		Some symptoms	913	1.07	(0.77 to 1.49)	1.17	(0.76 to 1.82)
		Health risk	292	1.37	(0.91 to 2.05)	1.08	(0.63 to 1.86)
		WD risk, 1 risk factor	176	1.38	(0.89 to 2.14)	1.46	(0.82 to 2.62)
		WD risk, 2 risk factors	36	1.96	(0.92 to 4.17)	0.67	(0.27 to 1.66)
		WD risk, 3–5 risk factors	20	2.39	(0.92 to 6.18)	1.23	(0.41 to 3.75)
		BMI≤25	631	1.00	Ref.	1.00	Ref.
		BMI>25 and ≤30	805	1.11	(0.88 to 1.40)	1.04	(0.76 to 1.42)
		BMI>30	228	**1.53**	**(1.09 to 2.15)**	**1.61**	**(1.03 to 2.53)**
		Age>30 and ≤40	457	1.00	Ref.	1.00	Ref.
		Age<30	79	1.02	(0.62 to 1.70)	1.14	(0.60 to 2.16)
		Age>40 and ≤50	543	**0.71**	**(0.54 to 0.93)**	**1.74**	**(1.23 to 2.47)**
		Age>50 and ≤60	464	**0.68**	**(0.51 to 0.91)**	**2.11**	**(1.45 to 3.08)**
		Age>60	126	**0.64**	**(0.41 to 1.00)**	**2.64**	**(1.46 to 4.76)**
		Problems in well-being	154	1.05	(0.73 to 1.53)	**1.86**	**(1.15 to 3.01)**
		Sick leaves before the questionnaire		**1.032**	**(1.017 to 1.046)**	**1.023**	**(1.009 to 1.037)**

Logistic model refers to the model component for predicting membership to the subpopulation A with high propensity to zero absence, and zero-truncated NB to the component predicting the days on sick leave among the susceptible subpopulation B. To facilitate interpretation, for the zero-inflation part we have shown the ORs associated with the complementary propensity to having any sickness absence, that is, inclusion in subpopulation B.
Bold values denote statistical significance at the $p < 0.05$ level.
Health risk category does not include weight problems.
BC, blue collar; BMI, body mass index; C, clerical; OG, occupational group; P/M, professional/manager; RR, risk ratio; WD, work disability.

confounders, like age, gender, prior SA and occupational group. Another strength is that we used an HRA that has earlier shown to be able to identify employees with a high number of SA days. The results of the present study in a prospective setting in various industries were well in line with the earlier findings in the construction industry.[6 32–34] Earlier studies have provided evidence for the effectiveness of targeted health surveillance measures carried out based on HRA results.[4 33 34] The HRA used in the present study was able to identify a subgroup with WD risk in an earlier study.[6] A randomised trial was carried out within the above-mentioned high-risk group, half of which received an invitation to OH services for targeted health surveillance and half of them received usual care. The difference between the targeted intervention group and the control group was 10.6 days in favour of the intervention during the 12-month follow-up.[32] The total cost of healthcare was on average €180 per person less in the intervention group than in the usual care group.[33] Thus, the HRA used in the present study seems to focus on the essential health problems.[32]

We consider 'healthy worker effect' as a potential limitation of our study. It might be present if employees with worse health level had not responded or they are less likely to hire.[35] This potential bias would underestimate the associations as the respondents would be healthier, and possibly have less SA than non-respondents. Similar bias would potentially result from a 'healthy worker survival effect', which means that only healthiest and strongest will remain in the working life.[36] Moreover, we did not include those who were on long-term sick leave or those who had already been granted a disability benefit before the HRA. All this might underestimate the associations. It may also be possible that the healthiest employees might not respond to the HRA, which would have an opposite effect on our estimates. In our study, the participants were slightly older than non-participants and participation rate was higher among females than males. This would potentially overestimate the associations if the respondents had more illnesses than non-respondents.

Analysis of the predictors and determinants of SA is difficult with traditional statistical methods because a substantial fraction is clustered at zero SA days. Also, the residual variability in the non-zero part of the SA distribution exceeds that predicted by a Poisson model for counts. Although the Hurdle model[37] was perhaps not able to deal with all the complexity associated with this type of response variable, among computationally feasible approaches it is clearly more appropriate than the simpler alternative models in dealing with both the extra-zero component and the overdispersion. However, the residual collinearity between age, weight, WD risk factors and problems with occupational well-being can cause imprecise estimates of the coefficient values and therefore the resulting out-of-sample predictions may be imprecise.

Our results provide further support to the fact that obesity is an independent risk factor for SA, which is in line with other recent studies.[20 22 38] A strong connection between prior SA and the later SA has been found earlier,[39 40] also in line with our findings. Blue-collar workers had the highest and the professional-level/manager-level employees had the lowest level of SA days in our study, the same way as in earlier studies.[41–44] We found that females tend to have more SA, as has been reported before.[45] Females also report more often symptoms or other health problems,[15] than males.

We conclude that the use of an HRA with predictive validity can improve the quality of health surveillance: screening questionnaires seem appropriate for targeting efforts to employees in need. They seem useful in identifying symptoms and signs that predict SA. These findings have implications for both management and the healthcare system in the prevention of WD. Further research is needed to assess whether the HRA also predicts long-term WD. Also, the effectiveness and cost-effectiveness of the targeted health surveillance for the risk groups warrant further research.

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PUBLICATION
II

Self-reported Health Problems in a Health Risk Appraisal Predict Permanent Work Disability: A Prospective Cohort Study of 22023 Employees from Different Sectors in Finland with up to Six-year Follow-up

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ORIGINAL ARTICLE

Self-reported health problems in a health risk appraisal predict permanent work disability: a prospective cohort study of 22,023 employees from different sectors in Finland with up to 6-year follow-up

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Abstract

Purpose Work disability (WD) as a medico-legal concept refers to disability benefits (DB) that are granted due to diseases that permanently reduce work ability. We studied whether an occupational healthcare instrument for the prediction of sickness absence (SA) risk—a health risk appraisal (HRA)—also predicts permanent WD.

Methods HRA results were combined with registry data on DB of 22,023 employees from different industry sectors. We analysed how the HRA risk categories predict DB and considered occupational group, gender, age, and prior SA as confounding variables. Cumulative incidence function illustrates the difference between the HRA risk categories, and the Fine–Gray model estimates the predictors of WD during 6-year follow-up.

Results The most common primary reasons for permanent WD were musculoskeletal (39%) and mental disorders (21%). Self-reported health problems in the HRA, labelled as "WD risk factors", predicted DB when controlling for age and prior SA. Hazard ratios were 10.9 or over with the lower limit of the 95% confidence interval 3.3 or over among those with two simultaneous WD risk factors. 14% of the females and 17% of the males with three or more simultaneous WD risk factors had received a DB, whereas the respective figures among those without findings were 1.9% and 0.3%.

Conclusions Self-reported health problems in the HRA, especially multiple simultaneous WD risk factors, predict permanent WD among both genders across occupational groups. Screening WD risk with a self-administered questionnaire is a potential means for identifying high-risk employees for targeting occupational healthcare actions.

Keywords Health risk appraisal · Work disability · Disability retirement · Cumulative incidence function

Introduction

The cost of work disability benefits (DB) has become a significant burden to public finances globally (Aumayr-Pintar et al. 2016). Across the OECD countries, public spending on DB is around 2–6% of the gross domestic product (GDP) of the working-age population, depending on the country (OECD 2010). In 2014, about 7% of the Finnish working-age population was on a DB, and the average age of the onset of a permanent DB was 52 (Laaksonen et al. 2016b).

Permanent work disability (WD) is a medico-legal concept (De Boer et al. 2008), which in Finland is defined as having been granted a DB. The benefits programme of the Social Insurance Institution of Finland (Kela) provides coverage for lost income due to medically certified sickness up to 1 year. Thereafter, the DB scheme, operated by pension

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insurance companies, covers lost income for those eligible. Work ability is assessed on the basis of the employee's remaining ability to earn an income from work that can reasonably be expected on the basis of their education, previous work history, age, housing conditions, and other social factors. A DB is granted if, based on the attending physician's statement, the employee's ability to work is permanently reduced and the expert panel agrees that the decrease in functional capacity and work ability is due to illness or injury. Thus, a granted DB serves a proxy for permanent WD in the present study.

Most Finnish employees use occupational healthcare services (OHS) for all primary healthcare needs. Finnish OHS covers approximately 90% of the total workforce (Lappalainen et al. 2016; Kela-Social Insurance Institution 2019), and carry out preventive and curative health care (Kela-Social Insurance Institution of Finland 2018). One of the primary tasks of OHS in Finland includes protection of employees' work ability, for which purpose early identification of WD risk would be desirable and, therefore, instruments to tap risks are developed in OHS. Work ability and disability are complex and multifactorial phenomena, determined by personal, socio-demographical, lifestyle- and health-related factors as well as organisational determinants, healthcare management, and legislation. In most countries with disability pension schemes, permanent WD is usually due to a chronic disease (De Boer et al. 2008), which reduces functional capacity and work ability (OECD 2010). The key employee-related predictors of WD reported in observational studies can be divided into demographic factors (e.g., age, gender and educational status) (Laaksonen et al. 2016a; Polvinen et al. 2016; Samuelsson et al. 2012), health status (Karpansalo et al. 2004), and work (e.g., type of occupation) (Haukenes et al. 2011; Borg et al. 2001; Leinonen et al. 2011; Polvinen et al. 2014). Previous studies also suggest that both short-term (Alexanderson et al. 2012; Karlsson et al. 2008; Kivimäki et al. 2004; Virtanen et al. 2006), and long-term (Airaksinen et al. 2018; Gjesdal et al. 2004; Lund et al. 2008) sickness absences (SA) predict new sick leaves and permanent WD.

Some screening questionnaires, such as the World Health Organization's Health and Work Performance Questionnaire (WHO-HPQ) (Kessler et al. 2003), the Work Ability Index (WAI) (Ilmarinen et al. 1997; Jääskeläinen et al. 2016; Kinnunen and Nätti 2018), and the 12-item Short Form Health Survey (SF-12) (Laaksonen et al. 2011; Roelen et al. 2015), to name a few, are used by researchers, but have not been implemented in broader clinical use. They are laborious to fill out, and more importantly, they are detached from the OHS processes such as occupational health surveillance. Only the WAI has evidence for the capability of predicting permanent WD (Kinnunen and Nätti 2018). Moreover, most of the previous studies have been performed among public sector employees (Airaksinen et al. 2018; Kinnunen and Nätti 2018; Laaksonen et al. 2011), or in specific industries or occupational groups (Kant et al. 2009; Niessen et al. 2012; Roelen et al. 2015; Schouten et al. 2015; Stange et al. 2016). There are different pension act legislations in the public and private sector in Finland, for which reason generalization based on public sector studies to the entire working life should be done with caution. Also, working cultures vary by sector and industry, which is reflected in much higher SA rates in the public sector than in the private sector (Seppänen 2010).

In the present study, we used a health risk appraisal (HRA), which was able to identify blue-collar employees in the construction industry with a high number of SA days in a previous study (Taimela et al. 2007). Especially multimorbidity, i.e., the presence of more than one simultaneous risk factor predicted SA days (Taimela et al. 2007). The HRA presents the results as different risk categories primarily based on self-reported symptoms and health behaviours. The online HRA is widely used in Finland and the Netherlands as a part of preventive occupational health services (OHS) by different providers to recognize employees at risk for SA and to target interventions for those in need. Previous randomised trial also showed that the targeted interventions put in place for employees with high risk of SA, based on the HRA results, were effective in reducing SA days (Taimela et al. 2008a, 2010) and reduced the use of healthcare resources (Taimela et al. 2008b). The predictive ability of the HRA on permanent WD has not been studied before.

We assessed whether the HRA, which is used as an occupational health-care instrument for the prediction of SA, also predicts permanent WD and if so, whether the WD risk increases by the number of self-reported health problems. We hypothesized that the HRA has an independent predictive effect on granted DB as a proxy measure of WD and that the higher the number of risk factors, the higher the WD risk.

Methods

Study design, ethics, and setting

The study design was an analysis of prospectively collected register data. We obtained the questionnaire data and the SA data from one OHS provider's registers. The DB data were obtained from the Finnish Centre for Pensions (ETK), which combines DBs under different pension act legislations into one that is linked to an employee's career, not to a particular employer, and the coverage of the register is practically 100%. We then combined the data registers using a unique identified, the Finnish social security code. Data privacy was strictly followed.

The Tampere University Research Ethics Board approved the study (ETL code R16074), and it was conducted in accordance with the Declaration of Helsinki.

The study setting was preventive OHS within the framework of the DB legislation in Finland.

Participants

The cohort was formed of employees from different companies who acquired their OHS from one nationwide provider, which offers services to a variety of sectors and company sizes. The participants were 19–68 years old Finnish residents, who had completed the HRA ($N = 22{,}023$) during 2012–2015. We included only the first response. The data on DBs from the national register of ETK covered years 2012–2017. We had access to the complete information on all DB events including their primary and secondary diagnoses based on the International Classification of Diseases, 10th Revision. Figure 1 shows the participants' exclusion and inclusion criteria.

Inclusion criteria were a completed HRA. An invitation to the HRA had been sent to 33,990 employees during 2012–2015, of which 11,475 had not responded (response rate 66%). We excluded the participants if DB had been previously granted ($N = 415$) or data concerning occupational group were missing ($N = 79$).

Measurements

Explanatory variables

The primary exposure variable of interest in the statistical models was the classified result of the HRA. The result categories in declining priority order are (1) work disability risk, (2) health risk, (3) some symptoms, (4) lifestyle issues, and (5) no findings (Table 1). The first category, labelled as "WD risk", includes the following self-reported health problems: musculoskeletal problems, depressive symptoms, sleep problems, constant stress and feeling of exhaustion, and doubts about work ability. Within the category "WD risk", the results were further subdivided by the number of risk factors (one, two, three or more). We combined the "lifestyle issues" and "no findings" categories as the reference class and included the result of the HRA (six categories) as a covariate in the statistical models.

Gender, age, occupational group and the accumulated SA days during the 12 months preceding the HRA were treated as confounding variables. Age was categorized into five classes: ≤ 30, 30–40, 40–50, 50–60, and > 60 years. Occupational group was defined as blue-collar workers, clerical employees, and professionals/managers. The number of SA days 12 months prior to the questionnaire was included as a continuous variable.

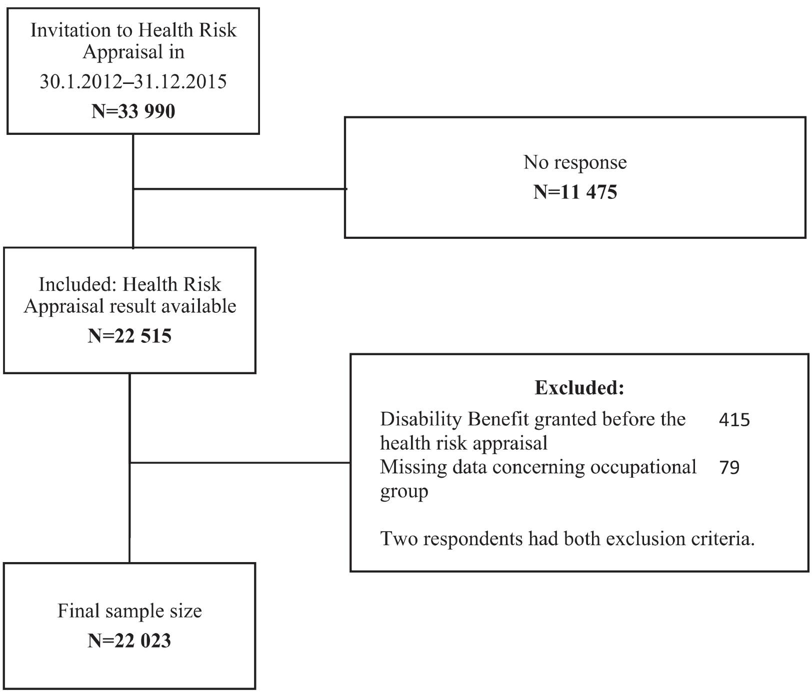

Fig. 1 Study flow

Table 1 Criteria for classifying employees into risk appraisal result categories

Topic	Criteria
Work disability risk: at least one of topics below	
Impairment due to musculoskeletal problems at work, OR pain hampers work	Numerical rating scale (0–10) score ≥ 5 At least moderate pain that affects work ability at least three times a week
Depressive symptoms	Depression score DEPS ≥ 11
Sleep problems	Problems falling asleep or night-time awakenings and daytime sleepiness daily or almost daily
Work-related constant fatigue OR work-related constant stress	Feeling of being squeezed empty Feeling tense, strained, nervous and/or anxious because work-related issues are constantly on one's mind
Doubt regarding work ability	Self-rated future work ability: uncertain of own ability or quite sure of not being able to continue in current job due to health reasons
Health risks: at least one of points below	
Weight problems	Body mass index (BMI) ≥ 30 or ≤ 18.5
Diabetes risk	Diabetes risk score ≥ 11
Excess use of alcohol	Males ≥ 350 ml/week, females ≥ 240 ml/week (expressed as absolute alcohol)
Some symptoms: at least one of points below	
Impairment due to musculoskeletal problems at work	Numerical rating scale (0–10) score = 4
Some depressive symptoms	DEPS score between 8 and 10
Some sleep problems	Problems falling asleep or night-time awakenings and daytime sleepiness 3–5 times a week
A chronic disease	Self-reported chronic diseases diagnosed by doctor
Symptoms	Self-reported symptoms
Lifestyle issues: at least one of points below	
Smoking	Smoking = yes
Physical inactivity	No physical activity during leisure time nor while commuting to work
Overweight	BMI between 25 and 30
No findings	
Previous criteria are not met	

Work disability

The outcome variable was a granted DB as a proxy measure of permanent WD, and it was operationalized dichotomously as a granted DB: yes/no. The mean follow-up time was 3.5 years (SD 1.1, range from 3 days to 5.9 years, median 3.3 years) from the date of the survey response.

DBs in our study consist of four categories as follows: (1) full and (2) partial disability pension, or (3) full and (4) partial rehabilitation subsidy. A DB is granted if the remaining maximum capacity to work is 40% (2/5), as in the case of a full-time benefit; or 60% (3/5), as in the case of a partial benefit. The duration of the DB can be until further notice or for a temporary period. The common requirement in all categories of DB is the permanent nature of reduction of work ability.

Statistical methods

It has been suggested that gender should not be treated as a covariate and that the analyses should be carried out separately by gender (Messing et al. 2003). Indeed, there were complex interactions in our study between gender and occupational groups (data not shown), and we performed all analyses stratified by gender.

We present descriptive statistics to describe the eligibility categories and the most common health issues that lead to DBs. We compared the demographic characteristics of the participants and non-participants using *t* test and Chi-squared test. We used the cumulative incidence function (CIF) to illustrate the difference between the HRA risk categories (Kim 2007), and the Fine–Gray proportional hazards model to estimate how HRA categories, age and occupational group affected the probability of events, i.e. a granted DB, prior to a follow-up (Fine and Gray 1999). The Fine–Gray model provides hazard ratio (HR) estimates to describe the relative effect of covariates, which are then also associated with the probability of a DB occurring over time. Model 1 included only the HRA categories; and Model 2, the fully adjusted model, also included age, occupational group and earlier SA.

The statistical analyses were performed using the cmprsk library and R 3.4.4 software.

Results

The mean age of the participants was 45.5 years (SD 11.1; range 19.1–68.0), 59% ($N = 12933$) were female, 31% ($N = 6807$) were blue-collar workers, 55% ($N = 12072$) were clerical employees, and 14% ($N = 3144$) belonged to the professional or manager category. The non-respondents were slightly younger (average age 44.2 years, SD 12.3; $t = -9.0$; $p < 0.0001$) than the respondents on the average. Also, males were less likely to respond than females with response rates 60% and 71%, respectively (Chi square 425.5; $p < 0.0001$). The response rates were almost identical among blue-collar workers (65%), clerical employees (67%) and experts/managers (66%), (Chi square 14.3; $p = 0.0007$).

A total of 379 participants in the cohort were granted a DB on the average 2 years (range from 3 days to 5.7 years) after the HRA. The overall annual incidence of a DB was 0.29%: 0.33% among the females and 0.23% among the males ($p = 0.23$). In the Fine–Gray model, which included gender as the explanatory variable and age, occupational group, and SA days before questionnaire as confounders, the HR for gender was 1.2 (0.9–1.5; males as the reference).

Of those who had received a DB, 149 (39%) participants had a primary diagnosis of a musculoskeletal disorder and 80 (21%) participants had a primary diagnosis of a mental or behavioural disorder (Table 2). Fifteen participants had both musculoskeletal and mental or behavioural diagnoses simultaneously (4% of all DBs).

Figure 2 presents the cumulative incidence of the DBs during the 6-year follow-up period in the HRA categories. The HRA "work disability risk" category predicted DB and there was a dose–response relationship between the number of WD risk factors and the probability of ending up on DB. Of the females with three or more WD risk factors, 14% received a DB at 6 years, while the respective figure among the males was 17%. The respective figures for those in the HRA "no symptoms" category was 1.9% for females and 0.3% for males.

In the fully adjusted Fine–Gray model, the HRA WD risk categories, age, occupational group, and SA before the HRA questionnaire predicted the probability of DB for both genders in an additive manner (Table 3). In the unadjusted model (Model 1), the HR for the probability of a DB was 36.2 (8.8–148.4) for the females and 47.7 (14.4–158.1) for the males in the HRA WD risk groups with three and more risk factors. When all covariates were included (Model 2), HR decreased among both genders, and was 17.3 (4.2–71.7) for the females, and 18.2 (5.4–60.8) for the males (Table 3). The same was also seen in the HRA WD risk categories with one and two risk factors. In the fully adjusted model, HR by age was the highest in the 50- to 60-year age group, among both genders [12.9 (4.8–35.2) for females, and 26.4 (3.6–192.8) for males]. By occupational group, blue-collar workers had the highest HRs [3.6 (1.7–7.9) for females and 2.4 (1.2–4.9) for males]. The higher the number of SA days prior to the survey, the higher the HR among both genders.

Discussion

Self-reported health problems in the HRA—musculoskeletal problems, depressive symptoms, sleep problems, constant stress and feeling of exhaustion, and doubts about work ability—predicted WD in both genders, in all occupational groups. Of note, the larger the number of these problems, labelled as "WD risk factors", the higher was the risk for WD. In Finland, the two largest categories of the causes of permanent WD are musculoskeletal disorders and mental and behavioural disorders (Social Insurance Institution of Finland 2019; Official Statistics 2018). Also, problems with sleep (Haaramo et al. 2012), constant stress (Juvani et al. 2018), exhaustion (Ahola et al. 2009), and attitudes towards work ability (Kinnunen and Nätti 2018) have predicted SA and/or WD in earlier studies. It seems that using a questionnaire for self-rating of relevant symptoms is a valid way to identify individuals at risk of WD, as the HRs were relatively high in our study. Age, occupational group and earlier SA also predicted future DB in an additive manner. By age, the risk of DB was the highest in the 50- to 60-year age group, among both genders.

Reporting health problems in the HRA had a strong, independent predictive value for future DB. Earlier studies have provided evidence that self-reports in a questionnaire predict DB (Bethge et al. 2017). The Work Ability Index (WAI) (Ilmarinen 2009) has been used in countries such as Finland and other Scandinavian countries, the Netherlands, and Germany (Bethge et al. 2017; Jääskeläinen et al. 2016). Two longitudinal studies have reported that the risk of a granted DB was higher among employees with poorer WAI scores [HR 7.8; 95% CI 2.6–23.4 (Bethge et al., 2017), and HR 5.0; 95% CI 4.4–5.6 (Jääskeläinen et al. 2016)]. Our results provide further support for earlier studies that perceived health and symptoms predict WD. Of note, the HRs in our study were exceptionally high among those reporting multiple "WD risk factors", i.e., health problems. Age has been a predictor of a future DB in previous studies (Gjesdal et al. 2004; Karlsson et al. 2008). By age, the risk of WD was the highest in the 50- to 60-year age group in our study population. This might be because of a "healthy worker survivor effect" (Osmotherly and Attia 2006), which means that only the healthiest and strongest remain in working life, and those who became unfit during their employment tend to leave working life

Table 2 Distribution of causes of disability benefits according to the ICD-10 classification (International Classification of Diseases, 10th revision)

Cause of disability benefit according to ICD-10 classification		The first diagnosis		The second diagnosis	
		N	%	*N*	%
M Diseases of musculoskeletal system and connective tissue		**149**	**39**	**120**	**32**
M40–M54	Spinal disorders	70	18	57	15
M17	Osteoarthritis of the knee	19	5	9	2
M75	Shoulder disorders	13	3	20	5
M19	Other osteoarthritis	10	3	8	2
	Other musculoskeletal disorders	37	10	26	7
F Mental and behavioural disorders		**80**	**21**	**40**	**11**
F32–F34	Mood (affective disorders)	56	15	8	2
F31	Bipolar affective disorder	9	2	1	< 1
F20–F29	Schizophrenia, schizotypal and delusional disorders	7	2	0	0
	Other mental and behavioural disorders	8	2	31	8
C Neoplasms		**40**	**11**	**11**	**3**
C50	Malignant neoplasm of the breast	13	3	2	< 1
C15–C26	Malignant neoplasm of digestive organs	9	2	0	0
C51–68	Malignant neoplasm of genital organs and urinary tract	5	1	2	< 1
	Other malignant neoplasms	13	3	7	2
G Diseases of the nervous system		**35**	**9**	**15**	**4**
G35	Multiple sclerosis	6	2	0	0
G20	Parkinson's disease	4	1	0	0
G24	Dystonia	3	< 1	0	0
	Other diseases of the nervous system	22	6	15	4
I Diseases of the circulatory system		**22**	**6**	**17**	**4**
I60–I69	Cerebrovascular diseases	12	3	1	< 1
I20–I25	Ischaemic heart disease	2	< 1	10	3
I42	Cardiomyopathy	3	< 1	0	0
I48	Atrial fibrillation and flutter	2	< 1	2	< 1
	Other diseases of the circulatory system	3	< 1	5	1
S Injuries		**15**	**4**	**9**	**2**
S40–S69	Injuries to upper limbs	8	2	3	< 1
S00–S19	Injuries to head and neck	3	< 1	1	< 1
S70–S99	Injuries to lower limbs	4	1	5	1
Others		**38**	**10**	**32**	**8**
H00–H59	Diseases of the eyes and adnexa	6	2	5	1
Q00–Q99	Congenital malformations	5	1	0	0
H81–H93	Diseases of the ears and mastoid process	4	1	3	< 1

Table 2 (continued)

Cause of disability benefit according to ICD-10 classification		The first diagnosis		The second diagnosis	
		N	%	*N*	%
T90–T93	Sequelae of injuries	4	1	0	0
Z59	Problems related to housing and economic	4	1	0	0
N08–N30	Diseases of the genitourinary system	3	< 1	0	0
E10–E11	Diabetes mellitus	2	< 1	3	< 1
E66	Obesity	1	< 1	5	1
Miscellaneous (*N* per category < 3)		9	2	16	4
No information or second reason not registered		**0**	**0**	**135**	**36**

Bold values denote the sum of conditions per category

A pension application may include multiple diagnoses, i.e., several ICD-10 classes

earlier (Osmotherly and Attia 2006). This effect was notable in our study, in which the over-60 age group had a lower rate of DBs than the 50- to 60-year age group. The HRs for DBs were highest among the blue-collar employees in the present study. This is in line with a previous study, in which the data were drawn from seven independent studies in Finland, France, the UK and the USA, and which reported an association with a low occupational grade and increased risks of health-related exit from work (Carr et al. 2018). A Finnish cohort study found that higher occupational classes are two times more likely to continue working beyond retirement age than lower occupational classes, while another cohort study found that hospitalization was slightly more associated with increased DB in the lower occupational classes. These studies indicate that lower occupational classes have poorer health. In our study, the gender difference was not statistically significant in terms of the annual incidence of granted DB. The findings of previous studies in this respect are contradictory. A previous prospective study found no overall gender difference in DB rates (Gjesdal et al. 2004), whereas other studies have found gender differences. A Finnish register-based retrospective study found a gender difference between different SA trajectories, which led to DB (Laaksonen et al. 2016a), although the associations with socio-demographic variables were weak. A Swedish twin cohort found that females are at a higher risk of DB (HR 1.31; 1.26–1.37) than males (HR 1.00; reference). In the present study, we found that earlier SA days predicted future DB, which is in line with previous studies (Kivimäki et al. 2004; Laaksonen et al. 2016a; Lund et al. 2008; Øyeflaten et al. 2014; Salonen et al. 2018).

The key strength of our study is its prospectively collected, extensive, registry-based data from various industries. We were also able to control potential confounders such as age, gender and occupational group. The archival data of DBs at the ETK were comprehensive and virtually no data were lost to follow-up (Finnish Centre for Pensions 2018). We combined all four DB categories as one as the proxy measure for WD: this way, no data were lost and virtually all the DB recipients had had at least 1 year of sickness allowance before the granted DB. Another strength is that we used the HRA, which can identify employees with a high number of SA days (Taimela et al. 2007). The follow-up continued at least 2 years after the completed HRA. Sickness allowance is paid for a maximum of 1 year after the onset of WD in Finland and the DB decision is typically made shortly after the sickness allowance period. Thus, the 2-year follow-up period was long enough to detect all new potential DB receivers.

We chose to use the Fine–Gray model to estimate the effect of the covariates on the rate at which WD occurs. Although the model was perhaps not able to deal with all the complexity associated with our data, among computationally

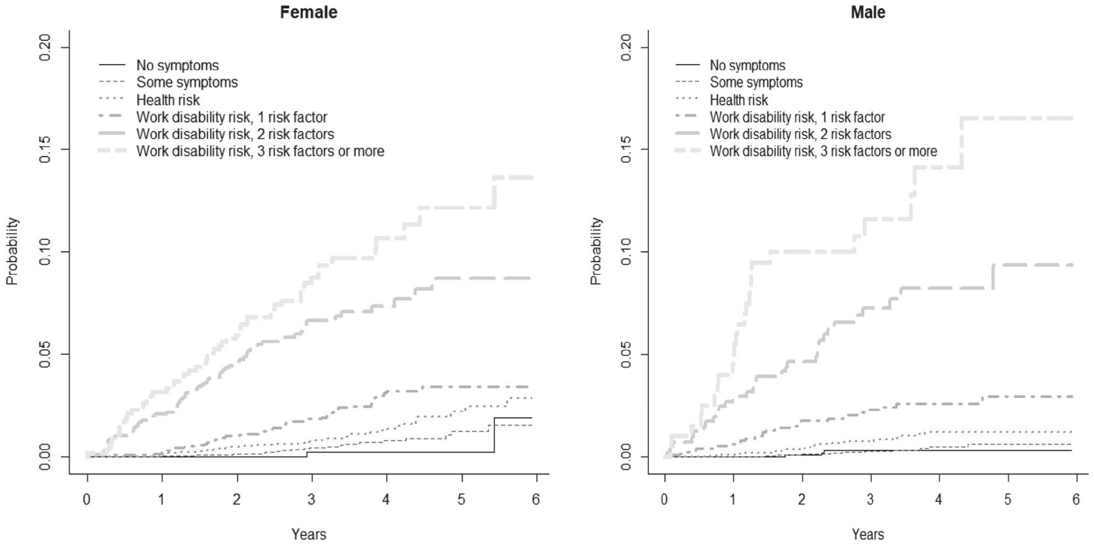

Fig. 2 Cumulative incidence of disability benefits over 6-year follow-up period by different health risk appraisal risk groups among females and males

feasible approaches, it is more appropriate than, e.g., the Kaplan–Meier survival analysis that tends to overestimate cumulative incidence of health-related events (Lacny et al. 2018). Besides, it was easier to add variables to Fine–Gray model than for example in Kaplan–Meier. Moreover, we prefer talking about cumulative hazards to "survival at work" conceptually. However, interpretation of the HR estimates from the Fine–Gray model is not straightforward. We recommend interpreting the covariates as having an effect on the incidence of WD (i.e., on the CIF). However, the magnitude of the relative effect of the covariate on the subdistribution hazard function is different from the magnitude of the effect of the covariate on the CIF. Yet one can conclude that if a variable increases the subdistribution hazard function, it will also increase the incidence of the event. However, one cannot infer that the exact magnitudes of these two effects are the same (Austin and Fine 2017).

We did not have access to the statutory accident insurance data, so WD resulting from accidents at work, occupational diseases, and traffic accidents are not included in our study. Moreover, our results can only cautiously be generalized to the entire working-age population, because people outside working life were not involved in our study. Another limitation of study is the potential selection bias due to differences between respondents and non-respondents. "Healthy worker effect" might be present if employees with worse health level had not responded or they are less likely to hire (Chowdhury et al. 2017). Similar bias would potentially result from a "healthy worker survival effect", which means that only healthiest and strongest will remain in the working life (Nordström et al. 2016). All this might underestimate the associations. It may also be possible that the healthiest employees might not respond to the HRA, which would have an opposite effect on our estimates.

Some DB criteria are comparable between countries, such as requirements for a health condition in relation to work and the permanence of the condition (De Boer et al. 2008). However, the implementation of the legislation varies between countries (OECD 2010) and, therefore, our results must be interpreted with caution in the international context. However, we assume that the phenomenon itself—severe self-rated health problems predict WD—manifests in different medico-legal contexts.

The outcome of interest was rare in the entire population in our study, which is visible in the wide confidence limits for the different risk categories for both genders. However, permanent WD is very costly for society (OECD 2010), and the underlying diseases and disorders are a burden to disabled individuals in addition to their lost income. Hence, it is important to identify predictors of SA and WD and to determine how to prevent WD. Practical tools are needed to identify the risk factors for WD and to target interventions for those in need. The HRA used in the present study seems to function in OHS as a practical tool to recognize employees at increased risk for SA and DB early for the purpose of targeting OHS actions to those who need special support in maintaining their work ability.

Table 3 Probability of disability benefit by covariates over time

Females	*N*	Model 1		Model 2	
Explanatory variable		HR	95% CI	HR	95% CI
No findings or lifestyle issues only	711	1.00	Ref.	1.00	Ref.
Some symptoms	5101	2.27	[0.55–9.43]	1.95	[0.47–8.09]
Health risk	3021	**4.33**	**[1.05–17.93]**	3.06	[0.74–12.64]
Work disability risk, 1 risk factor	2560	**8.48**	**[2.08–34.63]**	**5.95**	**[1.46–24.32]**
Work disability risk, 2 risk factors	969	**25.87**	**[6.35–105.44]**	**14.98**	**[3.68–61.00]**
Work disability risk, 3 and more risk factors	571	**36.23**	**[8.85–148.37]**	**17.34**	**[4.19–71.75]**
Age ≤ 30	1343			1.00	Ref.
Age > 30 and ≤ 40	2750			2.46	[0.83–7.25]
Age > 40 and ≤ 50	3578			**3.94**	**[1.39–11.09]**
Age > 50 and ≤ 60	4102			**12.92**	**[4.75–35.16]**
Age > 60	1160			**3.76**	**[1.24–11.41]**
Occupational group: professional and manager	1456			1.00	Ref.
Occupational group: clerical	7452			**2.53**	**[1.18–5.44]**
Occupational group: blue-collar	4025			**3.64**	**[1.68–7.89]**
Sick leave days before questionnaire				**1.009**	**[1.006–1.012]**
Males	*N*	Model 1		Model 2	
Explanatory variable		HR	95% CI	HR	95% CI
No findings or lifestyle issues only	1040	1.00	Ref.	1.00	Ref.
Some symptoms	3702	1.22	[0.35–4.27]	0.89	[0.25–3.18]
Health risk	2478	3.19	[0.96–10.64]	1.96	[0.59–6.50]
Work disability risk, 1 risk factor	1260	**8.22**	**[2.51–26.89]**	**3.84**	**[1.17–12.57]**
Work disability risk, 2 risk factors	410	**26.79**	**[8.20–87.52]**	**10.86**	**[3.34–35.29]**
Work disability risk, 3 and more risk factors	200	**47.75**	**[14.42–158.11]**	**18.17**	**[5.43–60.81]**
Age ≤ 30	947			1.00	Ref.
Age > 30 and ≤ 40	2310			2.19	[0.25–18.94]
Age > 40 and ≤ 50	2426			6.62	[0.87–50.14]
Age > 50 and ≤ 60	2554			**26.43**	**[3.62–192.75]**
Age > 60	853			**11.93**	**[1.53–93.17]**
Occupational group: professional and manager	1688			1.00	Ref.
Occupational group: clerical	4620			1.36	[0.68–2.72]
Occupational group: blue-collar	2782			**2.41**	**[1.19–4.90]**
Sick leave days before questionnaire				**1.011**	**[1.008–1.014]**

Bold values denote statistical significance at the $p < 0.05$ level

Subdistribution hazard ratios obtained from the Fine–Gray model describe the relative effect of covariates on the subdistribution hazard function. Covariates in this model can be interpreted as having an effect on the cumulative incidence function of disability benefits occurring over follow-up. Model 1 includes the health risk appraisal risk classes only. Fully adjusted Model 2 includes age, occupational group and prior sick leave days as covariates

The aggregated results may also be utilised in promoting sustainable working conditions.

Our results indicate high HRs for permanent WD among employees belonging to in the HRA work disability risk category and provide further support that in addition to prior absence from work, physically demanding work and age, self-reported health problems play an independent role in identifying employees who are at an increased risk of WD. Further research is needed to assess the effectiveness and cost-effectiveness of targeted health surveillance among the risk groups.

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Data sharing statement No additional data are available due to data privacy reasons.

Compliance with ethical standards

Conflict of interest Author Minna Pihlajamäki has received a Finnish Work Environment Fund scholarship. Author Heikki Arola is employed by Terveystalo. Author Simo Taimela is employed by Evalua International. Authors Jukka Uitti, Mikko Korhonen, and Tapio Nummi are employed by the Tampere University. There are no other competing interests to declare.

Patient consent This study used solely secondary data retrieved from registers.

Ethical approval The Tampere University Research Ethics Board approved the study (ETL code R16074).

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PUBLICATION
III

Subjective Cognitive Complaints and Sickness Absence: A Prospective Cohort Study in 7059 Employees in Primarily Knowledge-intensive Occupations

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Subjective cognitive complaints and sickness absence: A prospective cohort study of 7059 employees in primarily knowledge-intensive occupations

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ABSTRACT

Knowledge-intensive work requires capabilities like monitoring multiple sources of information, prioritizing between competing tasks, switching between tasks, and resisting distraction from the primary task(s). We assessed whether subjective cognitive complaints (SCC), presenting as self-rated problems with difficulties of concentration, memory, clear thinking and decision making predict sickness absence (SA) in knowledge-intensive occupations. We combined SCC questionnaire results with reliable registry data on SA of 7743 professional/managerial employees (47% female). We excluded employees who were not active in working life, on long-term SA, and those on a work disability benefit at baseline. The exposure variable was the presence of SCC. Age and SA before the questionnaire as a proxy measure of general health were treated as confounders and the analyses were conducted by gender. The outcome measure was the accumulated SA days during a 12-month follow-up. We used a hurdle model to analyse the SA data. SCC predicted the number of SA days during the 12-month follow-up. The ratio of the means of SA days was higher than 2.8 as compared to the reference group, irrespective of gender, with the lowest limit of 95% confidence interval 2.2. In the Hurdle model, SCC, SA days prior to the questionnaire, and age were additive predictors of the likelihood of SA and accumulated SA days, if any. Subjective cognitive complaints predict sickness absence in knowledge-intensive occupations, irrespective of gender, age, or general health. This finding has implications for supporting work ability (productivity) among employees with cognitively demanding tasks.

1. Introduction

Subjective cognitive complaints (SCC) are comprehended as difficulties of concentration, memory, clear thinking and decision making (Stenfors et al., 2013a,b). SCC involve problems with mental executive capacity to monitor multiple sources of data, prioritize competing tasks, switch between tasks, and resist distraction from the task. All these are also associated with impairment of work ability (WA) (Barbe et al., 2018). SCC often co-occur with other common psychological health problems, including chronic stress, exhaustion, sleeping problems, and depression (Stenfors et al., 2013a). The prevalence of SCC increases by age (Burmester et al., 2016). Among older employees, the contributors to cognitive decline include disease burden, e.g., depressive symptoms and poor sleep quality (LaMonica et al., 2019). It has also been suggested that SCC reduce WA in phases that are not yet characterized by clinical illness (Aasvik et al., 2015), but compelling evidence is scarce.

Sickness absence (SA) causes a considerable burden both on an individual level and in the societal context. The OECD countries spend approximately 2% of their gross domestic product (GDP) on sickness benefits (Organisation for Economic Co-operation and Development, (OECD), 2010). The average rates of SA of working time across Europe vary between 3% and 6%. In Finland, SA accounts for 4.3% (9.9 days) of work time (Edwards & Greasley, 2010). A Eurofound study estimated that the cost of absences was approximately 20 billion euros in Finland, a country with a labour force of 2.4 million, in 2010 (Edwards & Greasley, 2010).

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SA is a complex, multifactorial phenomenon determined by personal, socio-demographical, lifestyle- and health-related factors. Other factors such as the role of the health care system, legislation, and organizations' physical and psychosocial risk factors also play a role in SA (Janssens et al., 2014; Loisel et al., 2001; Szubert et al., 2016). Psychosocial risks have been recognized as causing poor health and SA (Catalina-Romero et al., 2015; Clausen et al.,2014; Janssens et al., 2014; Strømholm et al., 2015; Sundstrup et al., 2018), also in the Finnish setting (Hinkka et al., 2013; Laaksonen et al., 2010; Väänänen et al., 2004). However, as employees need a medical certificate to qualify for SA in Finland (Social Insurance Institution of Finland, 2017), the immediate reason for SA is always labelled as a medical diagnosis.

The aim of the present study was to assess weather SCC predict SA. We evaluated how a SCC questionnaire used in clinical practice to recognize early phase cognitive impairment (Ahveninen et al., 2014) predicts SA among respondents from various knowledge-intensive, sedentary occupations. We considered the potential confounding effects of gender, age, and prior SA days as a proxy measure of general health. Our underlining hypothesis was that SCC, indicating hampered cognition in demanding tasks, predicts SA.

2. Materials and methods

2.1. Study design, ethics and setting

The study design was a retrospective analysis of prospectively collected register data. We had access to a large nationwide database of one occupational health service (OHS) provider, which included both responses to the questionnaire and registry data on SA.

The Tampere University Research Ethics Board approved the study (ETL-code R16074), and it was conducted in accordance with the Declaration of Helsinki. We strictly adhered to data privacy.

The study setting was OHS in Finland within the context of Finnish SA legislation. In most cases, permanent employees are paid a full salary from the first day of their SA, for up to three months. After ten working days, an employer receives sickness allowance from the Kela (The Social Insurance Institution of Finland), which is a state institution that manages the basic security of people living in Finland in different life situations. The sickness allowance is provided based on an application, in which the employer reports the data concerning SA periods and dates. After three months employee starts to receive sickness allowance from Kela and salary is no longer paid by the employers. An employee receives Kela sickness allowance for a maximum of one year of work disability from the same illness. If work disability lasts for longer than one year, the responsibility of providing benefits shifts to pension insurance companies. Therefore, in the present study, the primary outcome was defined as SA days during the 12-month follow-up after the questionnaire.

2.2. Participants

The study participants were professional and managerial employees aged 18–68 years, who had completed a questionnaire (N = 13 164) during 2009–2015 as a part of nationwide OHS services in one particular service provider. The archival data of SA covered years 2008–2016. Fig. 1 illustrates the study flow.

The questionnaire was completed as a part of an occupational health surveillance program. Usually, occupational health surveillance is conducted every three years, and some of the employees had participated in multiple surveillances during 2008–2016. Exclusion criteria were unknown identification code (N = 3343), other than first response (N = 2087), previously granted permanent disability benefit (N = 81), and another occupational group than a professional/manager (N = 462).

The final sample size was N = 7059. The exact response rate is not available, because the exact number of invitations was not available in the registry data. In a previous cohort study with the same instrument, the response rate was 64% (Ahveninen et al., 2019). In the present study the participants were mainly from the information and communication industries (47%); professional, scientific and technical activities (23%); public administration; defence and compulsory social security (9%); and education (7%) (Finland. Tilastokeskus, 1979). The corresponding figures in Finland, according to official statistics, are 4%, 11%, 7% and 11% (Findicator, 2018).

2.3. Questionnaire

The online questionnaire is used in Finland as a part of preventive OHS by one nationwide provider to recognize employees at risk of exhaustion and to target interventions for those in need. The questionnaire includes a set of nine screening questions, derived from various theoretical frameworks, assessing psychosocial workload and individual resources for coping. If any of the trigger questions indicates potential psychosocial problems at work, seven additional questions concerning cognitive function are asked. Table 1 shows the topics and cut-off limits of the trigger questions.

Table 2 shows the topics for the seven questions that are used to calculate the SCC score. The response options for the SCC categories were 1) I strongly disagree, 2) I somewhat disagree, 3) I somewhat agree, and 4) I strongly agree with the question. The SCC score is calculated as the average of the sum of the seven questions. Cut-off limit for the abnormal SCC score, ≥ 2.4, is based on a preliminary non-published study (N = 30), where participants responded to the SCC questions and conducted neuropsychological examinations. Cronbach's alpha for the SCC score in our data was 0.98.

2.4. Outcome measure

The outcome measure was SA from work. SA was operationalized as the accumulated number of SA days during the 12-month follow up after the questionnaire. This included the number of days and periods absent because of sickness. We combined overlapping and consecutive SA. We did not include maternity or paternity leave and absence from work to care for a sick child as SA.

2.5. Exposure variable

We classified the results concerning SCC as follows. First, the respondents who did not indicate any problems with the psychosocial screening questions, and therefore were not asked the SCC questions, were classified as belonging to the reference class. Second, we categorized the SCC score into normal/abnormal, based on the *a priori* cut-off limit. Thus, the exposure variable consists of three categories: 1) reference (no psychosocial load); 2) some psychosocial load, but normal SCC score; and 3) psychosocial load and abnormal SCC score.

2.6. Potential confounding factors

We identified potential confounders in the study as gender (Messing et al., 2003; Messing and Mager Stellman, 2006), age (Osmotherly & Attia, 2006), general health (Ferrie et al., 2009; Kivimäki et al., 2003), and socioeconomic status (Bouville et al., 2018). We stratified the analyses by gender and included age (five categories) as a potential confounder. Of the available options, we chose to include accumulated SA days before the questionnaire (continuous variable) as a generic measure of health and well-being. Socioeconomic status was operationalized as occupational group and this potential confounder was controlled by the selection of the respondents, who included employees with professional/managerial status only. Other occupational groups (blue-collar workers and clerical employees) were excluded from the study due to small numbers.

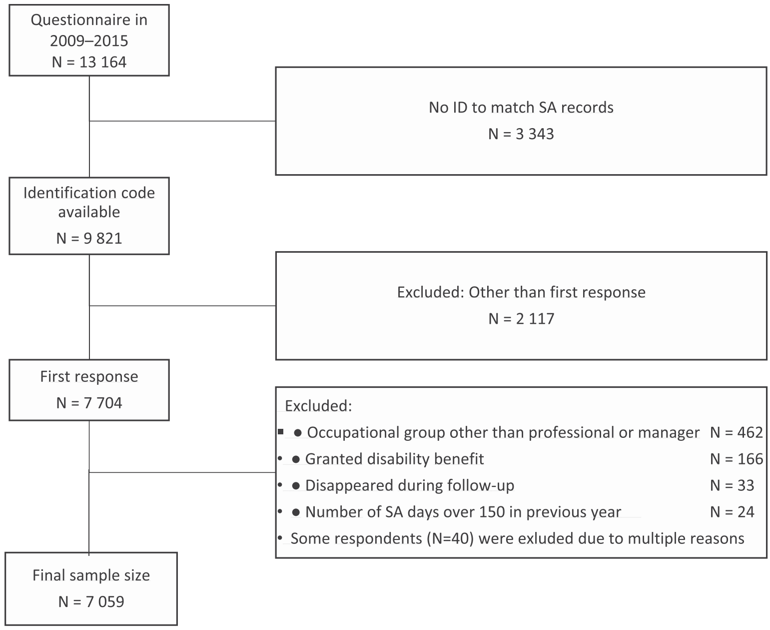

Fig. 1. Study flow.

Table 1
Topics and cut-off limits for the trigger questions.

Topic	Cut-off limits*
1. Duration of working hours per week.	≥45 h/week.
2. Time pressure from workload and feeling of strain within the last two months.	Continuous perception of pressure and job strain.
3. Ability to achieve meaningful outcomes at work, which gives satisfaction.	Completely disagree.
4. Self-perception of overall resources.	With the current working tempo, individual resources remain adequate at the maximum for another 6 months.
5. Well-being and energy.	The last time when felt well and energized was already over 3 months ago.
Physical condition.	Poor.
7. Psychological resources.	Feeling overloaded, but able to cope.
8. Level of energy after a working day.	Three or less on a scale from 1 to 10 (1 = extremely tired, 10 = extremely energetic).
9. Sleep difficulties within the last three months.	At least three nights per week.

* If any of the trigger questions met or exceeded the cut-off, the additional seven questions concerning subjective cognitive complaints (SCC) were asked.

Table 2
The topics for the questions that formed subjective cognitive complaints (SCC) score.

1	Memory difficulties
2	Difficulties in planning and organizing own work tasks
3	Forgetting agreed issues and work tasks
4	Difficulties in concentration
5	Delays in recollection
6	Disruptions to thinking
7	Difficulties in recollection

Variables

2.7. Statistical methods

Baseline characteristics are presented using descriptive statistics. We calculated the patterns with SA means (SD) and the ratio of means with 95% confidence intervals from the questionnaire SCC classes, separately by gender.

There were complex interactions between gender and other variables in our data and we performed all analyses stratified by gender and occupational group as has also been suggested earlier (Messing et al., 2003).

A particular challenge when modelling SA data is that a large number of employees have no absenteeism (Taimela et al., 2007). We tried mixture regression, zero-inflated negative binomial regression, and the Hurdle model. The first two approaches yielded problems when estimating the model's parameters. We chose the Hurdle model, which allows the study of the presence of SA and its duration separately. It provides a combination of two statistical models: logistic regression model determines whether the outcome is zero or positive, and truncated negative binomial regression models the part of the actual counts. We used truncated negative binomial regression because it also accounted for the overdispersion in the counts data (Niedhammer et al., 2013; Taimela et al., 2007). The actual estimation of the model parameters was conducted using R library pscl (Jackman, 2012) with R 3.4.4 software version. We used 95% confidence intervals to report the estimated odds ratios (with 95% CI), based on the binary part, and the estimated risk ratios, based on the regression coefficients of the part of the count with the covariates.

Table 3
Prevalence of abnormal subjective cognitive complaints (SCC) and number of days on sickness absence (SA) during 12-month follow-up by gender and age.

			SCC (%)			% with zero SA days	Days on sick leave			
Gender	Age	Subjects, N	N/A#	normal	abnormal		Median	Upper quartile	Mean of all values	Mean of non-zero values
Male	< 30	190	36	59	5	55	0	3.75	3.0	6.8
	≥30 and < 40	987	37	53	10	50	0	3	4.4	8.9
	≥40 and < 50	1135	30	55	15	54	0	4	5.6	12.3
	≥50 and < 60	1242	29	57	14	62	0	3	4.8	12.4
	≥60	300	26	59	15	61	0	3.25	4.9	12.4
	All	3854	32	56	13	56	0	3	4.9	11.1
Female	< 30	171	14	73	13	41	2	5.5	5.2	8.7
	≥30 and < 40	661	21	62	17	41	2	6	8.1	13.8
	≥40 and < 50	935	22	58	20	43	2	6.5	7.1	12.6
	≥50 and < 60	1201	20	61	19	47	1	7	7.7	14.4
	≥60	237	17	65	19	52	0	7	8.6	17.8
	All	3205	20	61	19	45	1	6	7.5	13.6
All		7059	26	58	15	51	0	5.5	6.1	12.4

N/A indicates the group of the participants who did not indicate any problems with the psychosocial screening questions, and therefore were not asked the SCC questions.

3. Results

The final study sample consisted of the 7059 professional and managerial employees who had responded to the questionnaire for the first time in 2009–2015 (Fig. 1). The average age of the participants was 46.7 years (SD 9.8; range 19.2–67.3). Of them, 45% (N = 3205) were female. The excluded respondents were slightly older on the average (51.8 years, SD 11.9; t 14.1, $p < 0.005$) and a larger proportion of them were men (55%; chi-squared 90.3, $p < 0.005$) than of the participants.

The SCC result was classified less likely within the abnormal category in the under-30 age group than the older age groups (Table 3). 13% of the males belonged to the abnormal SCC category, while the respective figure for females was 15% (chi-squared 130.69, $p < 0.005$). The proportion of respondents with zero SA days was higher in the at least50 age group than the younger age groups for both genders (OR = 1.24, $p < 0.003$ for the females, and OR = 1.43, $p < 0.005$ for males) (Table 3). The average number of SA days among the "susceptible to any SA" group was higher among the females.

Belonging to the abnormal SCC category predicted higher mean SA values during the follow-up, regardless of gender. The ratio of means for SA days varied between 2.8 and 3.1 among those in the abnormal SCC category and the reference category, depending on gender. The lowest limit of the 95% confidence interval (CI) was 2.1 (Table 4).

The results of fitting the Hurdle model are displayed in Table 5. The Model 1 includes the crude estimates and the Model 2 is adjusted with age (five classes) and the number of SA days during the 12 months preceding the questionnaire. We conducted the analyses stratified by gender. In the Model 1, the odds ratio (OR) for being susceptible to any SA in the abnormal SCC category was 1.70 (1.35–2.13) for the females and 1.45 (1.17–1.78) for the males. The corresponding rate ratios (RR) for SA duration were 2.62 (2.06–3.33) for the females and 3.25 (2.49–4.25) for the males. In the Model 2, the ORs were 1.45 (1.15–1.84) and 1.35 (1.09–1.67), respectively, and the RRs were 2.39 (1.89–3.01) and 2.21 (1.72–2.82), respectively.

The likelihood to have zero SA was higher in the older age groups, but higher age predicted higher SA count if any. SA prior to the questionnaire predicted both susceptibility to SA and the number of SA days during the follow-up.

4. Discussion

4.1. Key results

Subjective cognitive complaints (SCC) predicted both the likelihood of SA and the number of SA days, if any, in both genders in primarily knowledge-intensive occupations. Of note, the independent role of SCC as a predictor of SA remained also in the adjusted model where age and prior sickness absence days as a proxy measure of general health were accounted for. This indicates that SCC is an early indicator of future SA risks in cognitively demanding occupations.

4.2. Strengths and weaknesses of the study

One of the strengths of our study is the extensive, registry based and prospectively collected data from various industries. The recorded SA data quality in terms of coverage, accuracy, and consistency over time was better than that which could be achieved through self-reports (Stapelfeldt et al., 2012). We were also able to control key potential confounders such as age, gender and general health.

Table 4
Sickness absence by different subjective cognitive complaints (SCC) category and gender: means and ratio of means.

		Male						Female					
			SA days						SA days				
Psychosocial load§	SCC	Participants (N)	Median	Mean	SD	Ratio of means	95% CI	Participants (N)	Median	Mean	SD	Ratio of means	95% CI
No	N/A#	1215	0	3.5	9.6	ref.		648	1	5.2	14.2	ref.	
Yes	NORMAL	2142	0	4.3	14.3	**1.2**	**1.0–1.5**	1962	1	6.2	15.5	1.2	0.9–1.5
Yes	Ab-normal	497	2	10.6	30.4	**3.1**	**2.2–4.1**	595	3	14.5	31.2	**2.8**	**2.1–3.7**

Bold values denote statistical significance at the $p < 0.05$ level.

§ Psychosocial load refers to the results of the screening questionnaire.

N/A indicates the group of the participants who did not indicate any problems with the psychosocial screening questions, and therefore were not asked the SCC questions.

Table 5
Predicting propensity to be susceptible versus immune to any sickness absence (Logistic model) and duration of sickness absence, if susceptible (Zero-truncated negative binomial (NB) part) in negative binomial Hurdle model. The Model 1 is unadjusted and includes subjective cognitive complaints (SCC) only. The Model 2 is adjusted for age and prior sick leaves as covariates.

		Logistic model (0 vs. > 0)		Zero-truncated NB (> 0)	
Explanatory variable	N	OR	95%CI	RR	95%CI
MALE					
Model 1 (unadjusted)					
(Intercept)		0.85	0.76–0.95	3.04	2.34–3.94
No psychosocial load	1215	1.00	ref.	1.00	ref.
Psychosocial load, but normal SCC	2142	0.79	0.69–0.91	**1.59**	**1.31–1.92**
Abnormal SCC	497	**1.45**	**1.17–1.78**	**3.25**	**2.49–4.25**
Model 2 (adjusted)					
(Intercept)		0.94	0.80–1.10	2.51	2.00–3.16
No psychosocial load	1215	1.00	ref.	1.00	ref.
Psychosocial load, but normal SCC	2142	**0.79**	**0.68–0.91**	**1.34**	**1.12–1.60**
Abnormal SCC	497	**1.35**	**1.09–1.67**	**2.21**	**1.72–2.82**
Age ≥30 and < 40	987	1.00	ref.	1.00	ref.
Age < 30	190	0.89	0.65–1.22	0.96	0.66–1.41
Age ≥40 and < 50	1135	0.84	0.70–1.00	**1.52**	**1.24–1.87**
Age ≥50 and < 60	1242	0.63	**0.53–0.74**	**1.59**	**1.29–1.96**
Age ≥60	300	0.66	**0.50–0.86**	**1.58**	**1.13–2.21**
SA before the questionnaire		**1.049**	**1.038–1.060**	**1.034**	**1.026–1.042**
FEMALE					
Model 1 (unadjusted)					
(Intercept)		1.10	0.94–1.28	5.83	4.76–7.14
No psychosocial load	648	1.00	ref.	1.00	ref.
Psychosocial load, but normal SCC	1962	1.04	0.87–1.25	1.20	0.98–1.47
Abnormal SCC	595	**1.70**	**1.35–2.13**	**2.62**	**2.06–3.33**
Model 2 (adjusted)					
(Intercept)		1.10	0.89–1.36	5.01	3.96–6.33
No psychosocial load	648	1.00	ref.	1.00	ref.
Psychosocial load, but normal SCC	1962	1.00	0.84–1.20	1.21	1.00–1.47
Abnormal SCC	595	**1.45**	**1.15–1.84**	**2.39**	**1.89–3.01**
Age ≥30 and < 40	661	1.00	ref.	1.00	ref.
Age < 30	171	1.08	0.77–1.54	**0.64**	**0.46–0.91**
Age ≥40 and < 50	935	0.87	0.71–1.07	0.91	0.74–1.12
Age ≥50 and < 60	1201	0.78	**0.64–0.94**	1.18	0.97–1.45
Age ≥60	237	0.63	**0.47–0.86**	**1.52**	**1.09–2.13**
SA before the questionnaire		1.051	**1.040–1.062**	**1.020**	**1.014–1.026**

Logistic model refers to model component for predicting membership to subpopulation A with high propensity to zero absence, and Zero-truncated NB to the component predicting days on sick leave among susceptible subpopulation B. To facilitate interpretation, for zero-inflation we show odds ratios associated with complementary propensity to having any sickness absence—that is, inclusion in subpopulation B. Bold values denote statistical significance at the $p < 0.05$ level.

Analysis of the predictors and determinants of SA is difficult with traditional statistical methods because a substantial fraction is clustered at zero SA days. Also, the residual variability in the non-zero part of the SA distribution exceeds that predicted by a Poisson model for counts. Although the Hurdle model (Smithson & Merkle, 2013) was perhaps not able to deal with all the complexity associated with this type of response variable, among computationally feasible approaches it is clearly more appropriate than the simpler alternative models in dealing with both the extra-zero component and the overdispersion.

We do not know the exact response rate in our study, nor have any information of the non-respondents, which must be considered as potential limitations. A "healthy worker effect" may be present since health of employed people is generally better than that of the unemployed population, or if employees with worse health level had not responded (Korkeila et al., 2001). This potential bias would underestimate the associations as the respondents would have less cognitive complaints, and possibly less SA than non-respondents. Similar bias would potentially result from a "healthy worker survival effect", which means that only healthiest and strongest will remain in the working life (Nordström et al., 2016). Moreover, we did not include those who are on long-term SA or those who had already been granted a disability benefit before the questionnaire. All this might underestimate the associations. It may also be possible that the healthiest employees might not respond to the questionnaire, which would have an opposite effect on our estimates. Moreover, the study population consisted solely of professionals and managers. Generalizations to other occupational groups must thus be made cautiously.

Another limitation of our study is the lack of proper psychometric validation of the SCC questionnaire. It has previously been studied in a preliminary study only, using a selected population from one information technology company (Ahveninen et al., 2014). However, Cronbach's alpha was in our study at an acceptable level for the SCC (0.98). In the present study, we focused on the predictive validity of abnormal SCC on SA.

4.3. Similarities with and differences to previous studies

In an earlier preliminary cohort study among professional/managerial employees (N = 180), 42% of those with abnormal SCC category had long-term SA (over 30 days) (Ahveninen et al., 2014). Another cohort study (N = 2898) found that the abnormal SCC category had an association with an increasing number of SA days (13.9 SA days/employee/year) compared to those with normal SCC category (5.3 SA days/employee/year) (Ahveninen et al., 2019). Our study is line with these earlier studies.

Most studies focusing on the association between SCC and SA have included employees with health-related conditions, such as depression (Salomonsson et al., 2018) or stress-related symptoms (burnout/exhaustion) (Salvagioni et al., 2017). Obviously these conditions are related to sickness absence (Ahola et al., 2008; Kansaneläkelaitos et al., 2018; Kausto et al., 2017), but we are not aware of other prospective cohort studies that would be focusing on how SCC affects SA behavior.

The length of the SA varies by age (Bouville et al., 2018), depending on the underlying diagnosed disease. The older seem to have longer spells of SA than the younger (Dekkers-Sánchez et al., 2008; Donders et al., 2012; Salonen et al., 2018), but the younger seem to have more frequently short spells of SA than the older (Sumanen et al., 2015; Taimela et al., 2007). This is in line with our results: The propensity to have zero SA days was higher in the over 50-year age groups for both genders. Our results also provide further support to a connection between prior and future SA, as has been reported earlier (Cohen & Golan, 2007; Laaksonen et al., 2011).

Further research is needed to understand the causal pathways between psychosocial loading, cognitive performance, SCC, illnesses and SA. We also suggest studying whether the questionnaire predicts permanent work disability. The effectiveness and cost-effectiveness of interventions targeted to the risk groups also warrant further research.

5. Conclusion

Our results indicate that subjective cognitive complaints predict sickness absence in knowledge-intensive occupations, irrespective of gender, age, or general health. Thus, SCC seems to act as an early indicator of future SA risks in cognitively demanding occupations. This finding has implications for supporting work productivity among employees with cognitively demanding tasks.

What is already known about this subject?

The prevalence of subjective cognitive complaints, like difficulties of concentration, memory, clear thinking and decision making, increases with age. They also often coincide with chronic stress, exhaustion, sleeping problems, and depression, but little is known about their associations with sickness absence.

What are the new findings?

Subjective cognitive complaints predicted both the likelihood of sickness absence and the count of sickness absence days, if any, during 12-month follow-up among both genders in knowledge-intensive occupations after adjustments with age and prior sickness absence.

How might this impact on policy or clinical practice in the foreseeable future?

In knowledge-intensive occupations, subjective cognitive complaints act as an early indicator in identifying employees who are at an increased risk of sickness absence.

6. Additional Information

Contributions: MP, JU, HAR, JO, and ST participated in planning the study. MK and TN conducted the statistical analyses. MP, HAR, HAH, and ST interpreted the results. MP and ST wrote the first draft of the manuscript, and all authors commented and approved the final manuscript as submitted.

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Patient consent: This study used solely secondary data retrieved from registers.

Ethical approval: The Tampere University Research Ethics Board approved the study. (ETL code R16074).

Data sharing statement: No additional data are available due to data privacy reasons.

Declaration of interest: MP reports personal fees from a Finnish Work Environment Fund scholarship received during the conduct of the study; HAR and HAH are employed by Terveystalo; ST is employed by Evalua International; JU, JO, MK, and TN are employed by the University of Tampere; JO reports receiving personal fees from Terveystalo during the conduct of the study. There are no other competing interests to declare.

Declaration of submission: The Corresponding Author has the right to grant on behalf of all authors and does grant on behalf of all authors, an exclusive license (or non-exclusive licence for UK Crown and US Federal Government employees) on a worldwide basis to Preventive Medicine Reports, and its Licensees to permit this article (if accepted) to be published and to exploit all subsidiary rights, as set out in our license. The article has not been previously published and is not under consideration for publication elsewhere.

CRediT authorship contribution statement

Minna Pihlajamäki: Conceptualization, Project administration, Writing - original draft. **Heikki Arola:** Methodology, Writing - review & editing. **Heini Ahveninen:** Methodology, Writing - review & editing. **Jyrki Ollikainen:** Methodology, Data curation, Writing - review & editing. **Mikko Korhonen:** Formal analysis, Writing - review & editing. **Tapio Nummi:** Formal analysis, Writing - review & editing. **Jukka Uitti:** Conceptualization, Supervision, Writing - review & editing. **Simo Taimela:** Conceptualization, Supervision, Writing - review & editing.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2020.101103.

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PUBLICATION
IV

Subjective Cognitive Complaints and and Permanent Work Disability: A Prospective Cohort Study. Pihlajamäki

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