



**TURUN
YLIOPISTO**
UNIVERSITY
OF TURKU

QUALITY OF LIFE AMONG PUBLIC SECTOR EMPLOYEES OF THE CITY OF PORI

With Reference to Self-Reported Work Ability

Elina Bergman



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To my dearests, family and friends

UNIVERSITY OF TURKU

Faculty of Medicine

Department of Clinical Medicine

General Practice

ELINA BERGMAN: Quality of Life among Public Sector Employees of the City of Pori, with Reference to Self-Reported Work Ability

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ABSTRACT

Quality of life is a broad concept defining a person's health, well-being and satisfaction in life. The aim of the present thesis was to examine how factors known to be important in cardiovascular disease prevention are related to quality of life and work ability among employees of the city of Pori. The factors studied included health habits, psychological symptoms and sleep quality.

The present study is part of the PORTAAT (PORi to Aid Against Threats) study, which aims to examine cardiovascular risk and protective factors among the employees of the city of Pori. Altogether 836 employees participated in the study in 2014, and 710 of them attended the follow-up visit in 2015. The majority of the participants were female. Information about the participants was gathered using self-administered questionnaires. Physical examinations were performed and laboratory measurements were taken. Quality of life was assessed using the EUROHIS-QOL 8-item index, and self-reported work ability with the Work Ability Index.

Quality of life of the study participants was on the same level as in the Finnish general population, and work ability among them was good on average. Good sleep quality, ideal cardiovascular health, frequent use of healthy foods as well as absence of occupational stress, depressive symptoms, anxiety, and chronic illnesses were associated with good quality of life. Good sleep quality, and absence of occupational stress and chronic illnesses were associated with good work ability. An improvement in sleep quality was associated with a positive change in quality of life and work ability, and increased use of sleep medications was associated with a decline in work ability.

This thesis provided information about several important factors associated with quality of life and work ability of the employees. However, the associations of good sleep quality with good quality of life and work ability were especially emphasised in this study. Accordingly, it would be important to pay attention to sleep problems among working-age people in primary and occupational healthcare.

KEYWORDS: EUROHIS-QOL 8-item index, healthy diet, ideal cardiovascular health, occupational stress, quality of life, quality of sleep, work ability

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TIIVISTELMÄ

Ihmisen terveyttä, hyvinvointia ja tyytyväisyyttä elämäänsä voidaan kuvata laajasti elämänlaadun käsitteellä. Tämän väitöstutkimuksen tavoitteena oli selvittää, miten tekijät, joiden tiedetään olevan tärkeitä sydän- ja verisuonitautien ehkäisyssä, ovat yhteydessä elämänlaatuun ja työkykyyn Porin kaupungin työntekijöillä. Tutkittuja tekijöitä olivat esimerkiksi elämäntavat, psyykkiset oireet ja unen laatu.

Väitöstutkimus oli osa PORTAAT (PORi to Aid Against Threats) -tutkimusta, jonka tavoitteena on selvittää valtimotautien riski- ja suojatekijöitä Porin kaupungin työntekijöillä. Tutkimukseen osallistui 836 työntekijää vuonna 2014, ja seurantakäynnille vuonna 2015 heistä saapui 710. Enemmistö tutkittavista oli naisia. Tiedot tutkittavista kerättiin kyselykaavakkeilla, ja lisäksi heille suoritettiin mittauksia ja laboratoriotutkimuksia. Elämänlaatua selvitettiin EUROHIS-QOL-8 mittarilla ja työkykyä Work Ability Score -mittarilla.

Tutkittavien elämänlaatu oli samalla tasolla kuin suomalaisessa väestössä keskimäärin, ja he arvioivat työkykynsä olevan kesimäärin hyvä. Hyvä unen laatu, ihanteellinen sydänterveys ja hyvien ruoka-aineiden runsas käyttö olivat yhteydessä hyvään elämänlaatuun. Työstressi, masennus- ja ahdistuneisuusoireet sekä krooniset sairaudet taas olivat yhteydessä huonompaan elämänlaatuun. Hyvä unen laatu oli yhteydessä hyvään työkykyyn, ja työstressi sekä krooniset sairaudet yhteydessä huonompaan työkykyyn. Unen laadun paraneminen vuoden seurannassa oli yhteydessä elämänlaadun ja työkyvyn paranemiseen, ja unilääkkeiden käytön lisääntyminen oli yhteydessä työkyvyn huononemiseen.

Tutkimuksessa saatiin tietoa useista tärkeistä tekijöistä, jotka ovat yhteydessä työntekijöiden elämänlaatuun ja työkykyyn, mutta erityisesti siinä korostui unen laadun yhteys sekä elämänlaatuun että työkykyyn. Perusterveydenhuollon ja työterveyshuollon vastaanotoilla olisikin tärkeää kiinnittää erityistä huomiota työikäisten uniongelmiin.

AVAINSANAT: elämänlaatu, EUROHIS-QOL-8, ihanteellinen sydänterveys, terveellinen ruokavalio, työkyky, työstressi, unen laatu

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Abbreviations

ANCOVA	Analysis of co-variance
ANOVA	Analysis of variance
AUDIT-C	Alcohol Use Disorders Identification Test
BBI-15	The 15-item Bergen Burnout Indicator
BBI-25	The 25-item Bergen Burnout Indicator
BMI	Body mass index
CBT-I	Cognitive behavioural therapy for insomnia
CI	Confidence interval
CV	Cardiovascular
DF	Degrees of freedom
EQ-5D	EuroQoL 5-dimensions tool
EQ-VAS	EuroQoL visual analogue scale measure
EUROHIS	The European Health Interview Survey
EUROHIS-QOL	EUROHIS quality of life 8-item index
FFQ	Food Frequency Questionnaire
FIOH	Finnish Institute of Occupational Health
GAD-7	General Anxiety Disorder 7-item Scale
GHQ-12	The 12-item General Health Questionnaire
HbA1c	Glycated haemoglobin
HDL-C	High-density lipoprotein cholesterol
HRQoL	Health-related quality of life
HRQoL4	The Centers for Disease Control and Prevention Healthy Days Measure
ICD-10	The International Classification of Diseases, 10th Revision
ICD-11	The International Classification of Diseases, 11th Revision
LDL-C	Low-density lipoprotein cholesterol
MBI-GS	The Maslach Burnout Inventory – General Survey
MCS	Mental Component Summary score
MDI	Major Depression Inventory
MOS	Medical Outcomes Survey
NHANES	National Health and Nutrition Examination Surveys

PCS	Physical Component Summary score
PORTAAT	PORi to Aid Against Threats
PORTAAT FFQ	Food frequency questionnaire for PORTAAT Study
PSQI	The Pittsburgh Sleep Quality Index
RAND 36	The RAND 36-Item Health Survey 1.0
QALY	Quality adjusted life years
QoL	Quality of life
SD	Standard deviation
SE	Standard error
SF-12	The 12-item Short Form Health Survey
SF-36	The 36-item Short Form Health Survey
THL	Finnish/National Institute for Health and Welfare, Terveyden ja hyvinvoinnin laitos
UK	The United Kingdom
US	The United States
VAS	Visual analogue scale
WAI	The Work Ability Index
WAS	The Work Ability Score
WHO	World Health Organization
WHOQOL	World Health Organization Quality of Life
WHOQOL-100	World Health Organization Quality of Life 100-item questionnaire
WHOQOL-BREF	World Health Organization Quality of Life 26-item questionnaire

List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

- I Bergman, E., Löyttyniemi, E., Veromaa, V., Rautava, P. & Korhonen, P.E. Ideal cardiovascular health and quality of life among Finnish municipal employees. *Preventive Medicine Reports* 2019; 15: 100922
- II Bergman, E., Löyttyniemi, E., Myllyntausta, S. Rautava, P. & Korhonen P.E. Factors associated with quality of life and work ability among Finnish municipal employees: a cross-sectional study. *BMJ Open*, 2020; 10: e035544
- III Bergman, E., Löyttyniemi, E., Myllyntausta, S., Rautava, P. & Korhonen, P.E. Temporal changes in self-reported sleep quality, sleep duration and sleep medication use in relation to temporal changes in quality of life and work ability over a 1-year period among Finnish municipal employees. *Journal of Sleep Research*, 2022; 15: e13605
- IV Bergman, E., Vepsäläinen, H., Erkkola, M., Laaksonen, M., Kautiainen, H., Penttinen, M.A., Rautava, P. & Korhonen, P.E. Healthy and unhealthy food consumption in relation to quality of life among Finnish female municipal employees: a cross-sectional study. *Nutrients*, 2022;14:3630

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1 Introduction

General quality of life (QoL) is maybe the most comprehensive outcome to measure health and well-being of an individual, and therefore encompasses numerous aspects. Physical and mental health, social relationships and environmental aspects are known to affect a person's perception of QoL and are thus evaluated with measurement tools for general QoL (Power, 2003; WHOQOL Group, 1998a, 1998b). Along with QoL, work ability is a factor with great significance for working-age people, and according to previous literature, a wide range of factors are negatively related to both QoL and work ability. Many of these are also known to be risk factors for non-communicable diseases, especially cardiovascular (CV) disease. For example depression, poor sleep quality, obesity, occupational stress and unhealthy diet have been shown to be associated with poorer QoL (Khatatbeh et al., 2022; Matsui et al., 2021; Saarni et al., 2007; Vajdi & Farhangi, 2020; Vesikansa et al., 2022) and work ability (Andersen et al., 2017; Mokarami et al., 2020; Oellingrath et al., 2019; Shiri et al., 2013; Yong et al., 2013), and all of these are also known risk factors for CV disease (Kivimäki et al., 2018; Kwok et al., 2018; Visseren et al., 2021; Wium-Andersen et al., 2020). This information might be used in designing health promotion, especially for the working-age population. It is sometimes difficult to motivate people in midlife to improve their health habits in order to prevent CV disease when they are older. Instead, improvements in well-being and capability in the near future might be better motivators. The bidirectional relationship between health behaviour and subjective well-being has also been detected in prospective studies, which confirms the usefulness of this approach (Stenlund et al., 2021a, 2021b, 2022). In addition, good QoL and work ability as such are essential goals for any treatment and health promotion.

In previous literature, health-related QoL (HRQoL) among public sector employees (Holstila et al., 2017; Lahelma et al., 2016) has been on an average level compared to the reference values of the 36-item Short Form Health Survey (SF-36) instrument (Ware et al., 1994). In addition, work ability among public sector employees in Finland (Saltychev et al., 2013) has been found to be approximately on the same level as in the Finnish general population (Gould et al., 2008; Kinnunen & Nätti, 2018; Koponen et al., 2018). However, information has been scarce about

the level of general QoL, and the factors associated with QoL or work ability among the public sector employees. More information about the essential factors associated with QoL and work ability of Finnish working-age people could help in designing effective health promotion for this population.

This thesis study was conducted to examine general QoL and work ability levels among public sector employees of the City of Pori and to assess the essential factors associated with these outcomes. The aims of the substudies were chosen from the aspect of combining information on QoL and work ability with factors important in health promotion and especially CV disease prevention. The study population consists of an active workforce with a mean age of 48 years, which makes them ideal subjects for health promotion in order to prevent a decline in health and work ability. The concept of ideal CV health, studied in the first substudy, was originally designed to offer cut-off values for health metrics leading to the best possible CV health, but information was scarce about the association between levels of ideal CV health and QoL. In the second substudy, the possible explanatory factors associated with QoL and work ability in the study population were studied as widely as possible. Several sociodemographic and work-related factors, as well as psychological symptoms and health habits were considered because they were known to be associated with QoL and work ability according to previous literature. It was thought that finding the most important factors associated with good and, accordingly, poor QoL and work ability, would help in target health-promoting actions to relevant factors. As sleep quality appeared to be a very significant factor associated with both QoL and work ability in the multivariable models of the first two cross-sectional substudies, changes in three relevant sleep parameters in relation to changes in QoL and work ability were studied in the third study with a prospective follow-up design. In the fourth work, the association of healthy and unhealthy food consumption with QoL was studied. Because diet is maybe the most important modifiable risk factor of metabolic diseases such as obesity and type 2 diabetes, it is also one of the essential targets for health promotion.

2 Review of the Literature

In this review of the literature, I will first introduce the definition and assessment of QoL, the main outcome measure of this thesis. I will present some previous information about factors known to be associated with QoL, as well as levels of QoL in different populations. After that, I will go through some previous literature about CV health and dietary habits in association with QoL. Thereafter, I will introduce the secondary outcome measure, work ability, and present previous information about sleep and work-related factors, which are studied in this thesis in association with both QoL and work ability.

2.1 Quality of Life

2.1.1 History of Defining and Measuring Well-Being

People have always sought happiness and a way to live a good life, but the most desirable goals have changed considerably through history (Veenhoven, 2017). Over time, philosophers, economists and medical researchers have also tried to define and measure our well-being or QoL. The simplest way of assessing well-being among the people of a nation is probably by measuring the gross domestic product. However, it is a very coarse indicator and tells nothing about how the wealth is distributed among the people. Combining the financial state with mortality or morbidity rates gives some more information, but again, with these tools, very little is known about how satisfied people are with their lives.

The interest of assessing QoL in medicine became more important when medical treatments began to lengthen the lifespan of patients. However, the additional time was sometimes of very bad quality. On the other hand, some treatments were able to improve QoL without extending the length of life (Kaplan & Bush, 1982). Simple measures of morbidity rates alone were thus no longer seen as valid for assessing population health (Bergner, 1985). The need to do so, and a desire to measure well-being beyond physical health status, led in the 1980s to the development of some measurement tools for the patients' functional status (WHOQOL Group, 1998b). In addition, tools to assess the impact of disease and impairment on daily activities and

behaviour, like the Sickness Impact Profile (Bergner et al., 1981), as well as instruments to measure perceived or self-rated health, like the Nottingham Health Profile (Hunt et al., 1981), were developed. However, these tools did not measure QoL *per se*, which was still referred to as ‘the missing measurement in health’ (Fallowfield, 1990; WHOQOL Group, 1998c).

One of the first attempts to develop an assessment tool for a wide, self-rated health status or general HRQoL, was the introduction of the SF-36 at the beginning of the 1990s (Ware & Sherbourne, 1992). However, a tool for measuring comprehensive, general QoL was still missing. Therefore, the World Health Organization (WHO) initiated the World Health Organization Quality of Life (WHOQOL) project in the early 1990s, to develop an internationally validated assessment tool for general QoL. Another goal of the project was to promote the holistic and humanistic aspects of health by calling for QoL measurements in healthcare. This perspective was based on the WHO definition of health as ‘a state of physical, mental and social well-being, not merely the absence of disease and infirmity’ (WHO, 1948).

To begin, the WHOQOL project needed to find agreement on a comprehensive definition of QoL. The new WHO definition of QoL was established in 1995 as ‘individuals’ perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. It is a broad ranging concept affected in a complex way by the persons’ physical health, psychological state, level of independence, social relationships and their relationship to salient features of their environment’ (WHOQOL Group, 1995). This definition presents QoL as a multidimensional concept that may reveal some deeper understanding of a person’s well-being. Therefore, it makes QoL a very interesting outcome to assess, yet quite difficult to measure. During the WHOQOL project, tools for measuring general QoL were developed. First, the 100-item WHOQOL-100 (WHOQOL Group, 1998b) and then a 26-item shortened version, WHOQOL-BREF scale (WHOQOL Group, 1998a), which is easier to use in health surveys.

2.1.2 Assessment of Quality of Life

To date, there are dozens of different scales for assessing QoL. The scales used in medical research are divided into tools measuring general or generic QoL and HRQoL. Again, the term ‘general QoL’ is used for both general HRQoL and QoL in its most multidimensional form, which makes the issue somewhat more complicated. However, the assessment tools for general QoL and general HRQoL are composed so that major chronic illnesses and psychiatric conditions (especially depression), as well as low socio-economic status, are usually associated with lower estimates of QoL.

Perception of general QoL in its most comprehensive form is usually based on the WHO definition of QoL, and one of its most popular measurement tools is

probably the 26-item WHOQOL-BREF scale (WHOQOL Group, 1998a), with over 2700 search matches in PubMed. This measurement tool includes domains for physical and mental health, level of independence and social relationships, as well as domains assessing environmental factors (e.g. financial resources and opportunities in one's living place), and personal values and beliefs.

The measurement tools for HRQoL can be used to assess a person's perception of QoL as affected by their health status. The measures are also used to calculate the likely impact of a treatment on the life of a patient. Measuring tools for general HRQoL typically include domains for physical and mental health and often also domains for level of independence and social relationships. It is thought that these domains can be directly affected by the use of medicines and other medical treatments (EUPATI, n.d.). One of the most popular tools for measuring general HRQoL is the SF-36 (Ware & Sherbourne, 1992), with over 16,000 search results in PubMed. To get a more precise assessment of how a certain health issue affects a person's HRQoL, specific tools have been developed to assess disease- or organ-specific HRQoL, such as breast cancer, kidney transplant or oral HRQoL.

In my thesis, I used the EUROHIS-QOL 8-item index (EUROHIS-QOL) to assess quality of life. It is a short tool for the assessment of general QoL and is derived from the WHOQOL-BREF scale. In this review of the literature, I will introduce the EUROHIS-QOL tool and its parent questionnaires WHOQOL-100 and WHOQOL-BREF. I will also introduce the most important assessment tools for general HRQoL.

WHOQOL-100

As already mentioned, the measurement tools for general QoL are mostly based on the work of the WHOQOL project in the early 1990s. The aim of the project was to develop a QoL assessment tool that would be applicable cross-culturally. Rather than simply developing a tool in one language and translating it into other target languages, the aim was to simultaneously develop the assessment tool in several languages for use in multiple cultures. After agreement on the WHO definition of QoL, the definition was broken down into domains and smaller facets that were considered necessary for the assessment. Field-testing for the pilot study was conducted in 15 centres on six continents, and 25 facets (each containing four questions) from six domains were chosen to the final WHOQOL-100. All questions are answered on a five-point Likert-type scale from 1 (very poor) to 5 (very good), concerning the respondent's preceding two weeks. Each facet score can range from 4 to 20, and the domain scores for the WHOQOL-100 are calculated by taking the mean of all facet scores included in each domain. (WHOQOL Group, 1995, 1998c)

The domains and facets are presented in Table 1. The WHOQOL-100 is validated in several countries and among groups with different health states. It has good internal consistency and discriminant validity, as well as a good test–retest reliability (Den Oudsten et al., 2009; Masthoff et al., 2005; Paredes et al., 2010; Skevington et al., 2001). It gives a detailed assessment of individual facets relating to QoL. However, it may be too lengthy, for example, for large epidemiological studies or for clinical use to assess treatment efficacy (WHOQOL Group, 1998a).

Table 1. The World Health Organization Quality of Life (WHOQOL-100) domains and facets.

Overall Quality of Life and General Health	
Domain I Physical	
	1 Pain and discomfort
	2 Energy and fatigue
	3 Sleep and rest
Domain II Psychological	
	4 Positive feelings
	5 Thinking, learning, memory and concentration
	6 Self-esteem
	7 Bodily image and appearance
	8 Negative feelings
Domain III Level of Independence	
	9 Mobility
	10 Activities of daily living
	11 Dependence on medication or treatments
	12 Working capacity
Domain IV Social Relationships	
	13 Personal relationships
	14 Social support
	15 Sexual activity
Domain V Environment	
	16 Physical safety and security
	17 Home environment
	18 Financial resources
	19 Health and social care: availability and quality
	20 Opportunities for acquiring new information and skills
	21 Participation in and new opportunities for recreation/leisure
	22 Physical environment: (pollution/noise/traffic/climate)
	23 Transport
Domain VI Spirituality/Religion/Personal Beliefs	
	24 Spirituality/religion/personal beliefs

Modified from WHOQOL Group, 1998b.

WHOQOL-BREF

To obtain a shorter version of the WHOQOL-100, the WHOQOL-BREF scale was developed by the WHOQOL Group soon after the initial measurement tool was introduced. The shortened tool was designed particularly for the use in large epidemiological studies where the WHOQOL-100 would have been too long. The comprehensiveness of the tool was maintained by selecting one question from each of the 24 facets of WHOQOL-100. In addition, two items from the Overall QoL and General Health facet were selected. The WHOQOL-BREF thus consists of 26 questions. The domains and facets of WHOQOL-BREF are presented in Table 2. The number of the domains is now four instead of six in WHOQOL-100. In this questionnaire all items are also answered on a five-point Likert-type scale from 1 (very poor) to 5 (very good) concerning the two preceding weeks. Domain scores for the WHOQOL-BREF can range from 4 to 20 (WHOQOL Group, 1998a).

Domain scores produced by the WHOQOL-BREF have been shown to correlate well with the WHOQOL-100 domain scores. WHOQOL-BREF internal consistency was found to be good, and discriminant validity between ill and healthy respondents was also shown to be comparable with WHOQOL-100 (WHOQOL Group, 1998a). Since its introduction, the WHOQOL-BREF has become much more popular among researchers than its parent questionnaire, probably because its length is one-fourth of that of the WHOQOL-100, but it is still able to give a comprehensive assessment of the participants' general QoL (WHOQOL Group, 1998a).

Table 2. The WHOQOL-BREF domains and facets (items). One item from each facet of the WHOQOL-100 was selected for the questionnaire, except from Overall Quality of Life and General Health, from which two items were selected.

Overall Quality of Life and General Health (2 Items)	
Domain I Physical Health	
	1 Pain and discomfort
	2 Sleep and rest
	3 Energy and fatigue
	4 Mobility
	5 Activities of daily living
	6 Dependence on medicinal substances and medical aids
	7 Work capacity
Domain II Psychological	
	8 Positive feelings
	9 Thinking, learning, memory and concentration
	10 Self-esteem
	11 Bodily image and appearance
	12 Negative feelings
	13 Spirituality/religion/personal beliefs
Domain III Social Relationships	
	14 Personal relationships
	15 Social support
	16 Sexual activity
Domain IV Environment	
	17 Freedom, physical safety and security
	18 Home environment
	19 Financial resources
	20 Health and social care: accessibility and quality
	21 Opportunities for acquiring new information and skills
	22 Participation in and opportunities for recreation/leisure activity
	23 Physical environment (pollution/noise/traffic/climate)
	24 Transport

Modified from WHOQOL Group, 1998a.

EUROHIS-QOL 8-item Index

An even shorter assessment tool for general QoL is the EUROHIS-QOL 8-item index (EUROHIS-QOL), which was developed as part of the European Health Interview Survey (EUROHIS) project and introduced in 2003. The EUROHIS project, run by the WHO Regional Office for Europe, aimed to develop common survey instruments for European countries to enhance the comparability of national health data from health interview surveys. The EUROHIS-QOL instrument was developed on the basis of the WHOQOL-100 and the WHOQOL-BREF, and the

large, multinational samples of the parent instruments could be utilised in the development work (Power, 2003).

The domains of the EUROHIS-QOL are similar to the longer instruments. In EUROHIS-QOL there are two items about overall QoL and general health, and two items from the domains of physical health and environmental aspects. In addition, there is one item about psychological aspects as well as social relationships (Table 3). The respondent is asked to answer the eight items of the EUROHIS-QOL concerning the prior two weeks, and the items are answered using a five-point Likert-type scale. Every question is scored from 1 (very poor) to 5 (very good). All scores can be added together and divided by 8 (the sum of the questions) to obtain the EUROHIS-QOL mean score (Schmidt et al., 2006).

The items for the tool were selected through careful analyses of the ones used in the parent instruments, to find the item or items that best represent the whole domain (Power, 2003). The derived version showed good internal consistency (Cronbach's alpha 0.80) and acceptable convergent validity with physical and mental health measures in the field testing in Germany, France and the United Kingdom (UK) (Power, 2003). A few years later, further validation studies were conducted in nine European countries and Israel. In these studies, the EUROHIS-QOL was shown to distinguish well between the physically or mentally ill population and healthy individuals across all countries. Again, the internal consistency of the tool was found good. All the participants in these studies were >35 years of age and almost 90% of the participants were <65 years of age. Half of the participants were employed or self-employed, and 24% were retired (Schmidt et al., 2006). There is also a study about EUROHIS-QOL, conducted in six countries (Australia, Brazil, Israel, Russia, Spain and the United States (US)) among primary care patients with a new confirmed diagnosis of major depression. In this setting, properties of the EUROHIS-QOL were assessed and also compared to the WHOQOL-BREF. Internal consistency was also found to be good (Cronbach's alpha 0.78) in this population, and the EUROHIS-QOL showed acceptable discriminant validity between depressed and nondepressed patients. The tool was also shown to be sensitive to change. The results of this study affirmed that the EUROHIS-QOL had retained the good psychometric properties of its parent WHOQOL-BREF (Da Rocha et al., 2012).

Despite its well-validated properties, the EUROHIS-QOL has not been used very often in medical research. It has, however, been used in national health surveys to assess QoL in Finland (Koponen et al., 2018; Koskinen et al., 2012), and there are Finnish national reference values for the EURHIS-QOL. The short and simple form of this tool makes it a useful instrument for assessing general QoL in studies where questionnaires should be as short as possible. I think that it could also be used to measure QoL, for example, at general practitioners' appointments, because a holistic approach to patients' lives is emphasised in primary healthcare.

Table 3. The EUROHIS-QOL 8-item index domains and items.

Overall Quality of Life and General Health	
	1 How would you rate your quality of life?
	2 How satisfied are you with your health?
Domain I Physical Health	
	3 Do you have enough energy for everyday life?
	4 How satisfied are you with your ability to perform your daily activities?
Domain II Psychological	
	5 How satisfied are you with yourself?
Domain III Social Relationships	
	6 How satisfied are you with your personal relationships?
Domain IV Environment	
	7 Have you enough money to meet your needs?
	8 How satisfied are you with the conditions of your living place?

From Power, 2003.

The SF-36 and SF-12 Instruments

The most-used assessment tool for general HRQoL is the SF-36, which was developed in the US and introduced at the beginning of the 1990s. It was first developed by the RAND corporation to measure health status in the Medical Outcomes Study (MOS), and the instrument was named the MOS SF-36 (Ware & Sherbourne, 1992). The licence of the instrument was then shifted to the MOS Trust Inc., but soon after that the RAND corporation introduced largely the same tool again, as the RAND 36-Item Health Survey 1.0 (RAND 36). The RAND 36 includes the same items as the ones in the SF-36, but the recommended scoring algorithm is somewhat different (Hays et al., 1993). A major difference between the tools is that the RAND 36 can be used in research free of charge, whereas SF-36 can only be used with a commercial licence (Lahelma et al., 2022). However, ‘SF-36 survey’ returns over 16,000 matches in PubMed, making it far more popular than any other measurement tool for QoL.

The SF-36 includes one multi-item scale that assesses eight health concepts: 1) limitations in physical activities because of health problems; 2) limitations in social activities because of physical or emotional problems; 3) limitations in usual role activities because of physical health problems; 4) bodily pain; 5) general mental health (psychological distress and well-being); 6) limitations in usual role activities because of emotional problems; 7) vitality (energy and fatigue); and 8) general health perceptions (Ware et al., 1993; Ware & Sherbourne, 1992). There are altogether 35 questions concerning the most recent four-week period and one question about changes in health over 12 months (Ware & Sherbourne, 1992). The questions are answered on Likert scales or dichotomised (Yes/No), and the answers are coded

according to a scoring manual. The sum score of every scale (health concept) can vary between 0 and 100, with higher scores indicating better results. There are also instructions on how to calculate component summary scores for physical and mental HRQoL from the sum scores of the eight scales (Ware et al., 1993, 1994). As a major difference compared to the WHO assessment tools for general QoL, most of the items in the SF-36 handle the limitations in well-being caused by health problems, not the dimensions of QoL themselves. This is, of course, one of the main ideas in assessing HRQoL.

There is also a shortened version of the SF-36, the 12-Item Short-Form Health Survey (SF-12), which was introduced in 1996. In the SF-12, the eight concepts of SF-36 are not handled separately, but the results from the 12 items are presented with Physical Component Summary (PCS) and Mental Component Summary (MCS) scores. The items were selected from the SF-36 questionnaire to best reproduce the variance in SF-36 PCS and MCS measures in the general US population and to reproduce the average scores for both SF-36 summary scores. The SF-12 was validated using the SF-36 as reference, and both PCS and MCS scores showed good relative validity in discriminating between groups of different health conditions. The test–retest reliability of the SF-12 was also on an acceptable level (Ware et al., 1996).

The EQ-5D Instrument

The EQ-5D is a short instrument to measure generic health status or HRQoL. It was developed by the EuroQoL Group, an international group of scientists originally from five European countries. The group was established in 1987, and the new assessment tool was introduced in 1990 (EuroQoL Group, 1990).

The instrument consists of a descriptive part and a quantitative visual analogue scale (VAS) of self-rated health. The descriptive part covers five dimensions of health: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each dimension is divided in the original version (later referred to as the EQ-5D-3L) into three levels: 1=no problem, 2=some or moderate problems, and 3=extreme problems. The results from the descriptive part can be presented as percentages of participants having problems with specific dimensions, or as a summative index figure, calculated according to specific instructions (EuroQoL Research Foundation, 2021a). The quantitative measure of the instrument, EQ-VAS, is a 20-cm vertical VAS, anchored at 100 (best imaginable health state) at the top and 0 (worst imaginable health state) at the bottom (EuroQoL Group, 1990; EuroQoL Research Foundation, 2021a; Rabin & De Charro, 2001). The validation of the instrument was first made in studies conducted in the UK, the Netherlands and Sweden (EuroQoL Group, 1990). Since then, the properties of the instrument have been tested in several populations.

In 2005, an EuroQoL task force was established to find ways to improve the EQ-5D instrument's sensitivity and reduce the ceiling effects by increasing the number of severity levels. A new version, referred to as the EQ-5D-5L, with five response levels was developed (EuroQol Research Foundation, 2021b; Herdman et al., 2011). The same dimensions as in EQ-5D-3L were used, but the new answering options were 1=no problem (no pain or anxiety), 2=slight problems, 3=moderate problems, 4=severe problems, and 5=unable to do (extreme pain or anxiety). The EQ-5D-5L has shown similar or better measurement properties compared with the EQ-5D-3L (Buchholz et al., 2018). Several studies have indicated that the 5L classification system can improve the discriminative power of health difference and decrease the ceiling effects compared to the 3L version (Janssen et al., 2018; P. Wang et al., 2016).

2.1.3 General Quality of Life in Finland

General QoL among the Finnish working-age population has in the latest two decades remained basically unchanged, and most people from the ages of 30 to 69 rate their QoL as good. However, a significant improvement has occurred in QoL of older inhabitants in Finland during the last twenty years. No significant differences between genders are detected in QoL in Finland (Koponen et al., 2018; Koskinen et al., 2012). QoL at population level has been assessed most recently in the FinHealth 2017 survey, in which the assessment tools used were the EUROHIS-QOL and a three-level assessment of self-rated quality of life (good/moderate/poor) (Koponen et al., 2018). In that survey, the estimates of QoL tended to decline in older age, but only in the population over 70 in the self-rated QoL and over 80 in the EUROHIS-QOL (Table 4). FinHealth 2017 was a comprehensive nationally representative health examination survey, coordinated by the Finnish Institute for Health and Welfare (THL). There are data from about 6,500 Finnish inhabitants, representing the whole country. Over 4,000 of the respondents were of working age. The results from the earlier comparable Health 2011 survey are considered national reference values for the EUROHIS-QOL instrument (Koskinen et al., 2012).

The measures in EUROHIS-QOL in Finland are approximately on the same level as in other Western European countries (the EUROHIS-QOL mean scores of Finnish people aged 30–80+ years are presented in Table 4). The mean scores in general population samples were 3.8 in France, 4.1 in Germany and 4.0 in the UK, and the differences between genders were minor. These samples consisted of randomly selected individuals aged 35–75 years. The proportion of participants aged 66–75 years was 12.5% in every sample (Schmidt et al., 2006). It would be especially interesting to compare the Finnish figures with results from other Nordic countries (Sweden, Denmark, Norway, or Iceland), since they have welfare state systems very

similar to those in Finland. To my knowledge, unfortunately, no information is available about EUROHIS-QOL levels among the general population in the Nordic countries other than Finland.

Some comparisons of general QoL between the Nordic countries can, however, be made using data from WHOQOL-BREF measurements among the general population, but use of this tool has been quite scarce in Finland and Sweden. In a study for the validation of WHOQOL-BREF in Denmark from 2004 (Noerholm et al., 2004), the mean scores of the four domains of the tool were presented on a 0–100 scale as follows: Physical, 77; Psychological, 69; Social relationships, 69 and Environmental, 74. In this study the participants were 1,600 males and females aged approximately 20–80 years (Noerholm et al., 2004). In a study for the validation of WHOQOL-BREF in Norway (Kalfoss et al., 2021), the figures were presented at a 4–20 scale but can be transformed to a 0 – 100 scale (WHOQOL Group, 1998a). On that scale the figures were as follows: Physical, 79; Psychological, 75; Social relationships, 71 and Environmental, 77. These data were from the year 2009, and the participants were 650 randomly selected Norwegians aged 18–75 years (Kalfoss et al., 2021). In a study for the validation of WHOQOL-BREF in Finland from the year 2014 (Vaarama et al., 2014), the data were collected from 4,300 randomly selected persons aged 18–98. The mean domain scores among them were as follows: Physical, 77; Psychological, 74; Social relationships, 79 and Environmental, 77 (Vaarama et al., 2014).

As a conclusion, the results from Finland, Denmark and Norway were approximately on a same level, although the social domain mean score was somewhat better in Finland. Compared to the data from other Western European countries collected for the international field-testing of the psychometric properties of the WHOQOL-BREF (Skevington et al., 2004), these results from the Nordic countries are on a similar or better level. The mean scores of the environmental domain especially were higher in Norway, Denmark and Finland (74–77) compared to the results from the UK, Italy, Spain and Germany (53–64) (Kalfoss et al., 2021; Noerholm et al., 2004; Skevington et al., 2004; Vaarama et al., 2014).

Table 4. Quality of life in Finland according to self-rated quality of life and the EUROHIS-QOL 8-item index. Results from the FinHealth 2017 survey.

Self-rated Quality of Life (%)							
Age	30–39	40–49	50–59	60–69	70–79	80+	P-value*
Men							
Good	80.9	79.8	72.7	74.6	69.6	53.0	
Moderate	15.9	17.3	22.5	21.1	27.7	36.6	
Poor	3.2	2.8	4.8	4.3	2.7	10.4	
Women							
Good	84.8	79.8	75.4	76.4	62.5	49.4	
Moderate	10.7	16.2	17.8	20.3	33.0	43.6	
Poor	4.5	4.0	3.3	4.4	4.4	7.0	
							0.282
EUROHIS-QOL (Mean)							
Men	4.0	4.0	3.9	4.0	4.0	3.8	
Women	4.0	4.0	4.0	4.0	3.9	3.8	
							0.560

*P-value indicates the difference between genders. Modified from Koponen et al., 2018.

2.1.4 Quality of Life among Public Sector Employees in Finland

The public sector is a large employment sector in Finland, with around 30% of Finnish employees working in it (Statistics Finland, 2017). The biggest employment sectors within the public sector are healthcare, education, and social services (Ministry of Finance and Commission for Local Authority Employers, 2006), and about 72% of the employees are women (Statistics Finland, 2017). There are some extensive studies on public sector employees in Finland. The largest is the Finnish Public Sector Study with over 100,000 participants from ten Finnish cities, but there is no information about QoL of the employees in that study. Another large study is the Helsinki Health Study with information about 9,000 employees of the City of Helsinki, the capital of Finland. To my knowledge, there are no studies among Finnish public sector employees with information about general QoL, but in the Helsinki Health Study, there are repeated measurements of HRQoL, made with the SF-36 (Holstila et al., 2017; Lahelma et al., 2005, 2013, 2016; Lindhom et al., 2013). The SF-36 component summary scores (PCS and MCS) among the employees examined in the Helsinki Health Study have been approximately on an average level (Holstila et al., 2017; Lahelma et al., 2016) compared with the reference values of the SF-36, which are gathered among the US general population (Ware et al., 1994).

There are also some studies where physical functioning of Finnish public sector employees has been compared with other countries' data. In one study, the SF-36

PCS of the employees aged 45–60 from the Helsinki Health Study and the Whitehall II Study were compared (Laaksonen et al., 2009). The Whitehall II Study is a longitudinal cohort study among civil servants working in London, UK. In that study, the lowest quartile cut-off was 47.3 (men) and 44.2 (women) in Helsinki, and 50.1 (men) and 46.4 (women) in London indicating a slightly better physical functioning among the UK group (Laaksonen et al., 2009). In another work, results from the Helsinki Health Study and the Whitehall II Study were compared with data from Japanese public sector employees (Martikainen et al., 2004). In that study, the lowest quartile of SF-36 PCS was used to define poor physical functioning. The cut-off point was obtained from pooled data of the study cohorts and was not reported. However, the prevalence of poor physical functioning was around 25% among Japanese and Finnish male employees, and 13% among British male employees. Among females, poor physical functioning was detected in Japan among 37%–40%, in Finland among 33% and in the UK among 27% of the employees. In the British cohort, a significantly greater proportion of the employees were working in higher administrative positions than in the Finnish or Japanese cohorts, which may at least partly explain the difference in PCS (Martikainen et al., 2004).

2.1.5 Factors Associated with Quality of Life

As QoL is a very broad concept, aiming to give a comprehensive assessment of a person's health, well-being and satisfaction with life, it is affected by numerous factors. The assessment tools for general QoL and HRQoL have therefore been constructed to measure several aspects that are found to be crucial for overall well-being. First, the assessment tools are designed so that the subjects whose well-being is declined due to physical or mental illness, get lower estimates of QoL than the healthy subjects (EuroQoL Group, 1990; Power, 2003; Ware & Sherbourne, 1992; WHOQOL Group, 1998a, 1998b). Educational level and socioeconomic status have also been found to be associated with QoL. In WHOQOL-100, WHOQOL-BREF and EUROHIS-QOL, there are specific items about environmental aspects (Power, 2003; WHOQOL Group, 1998a, 1998b), but higher educational level and socioeconomic status have also been found to be associated with better HRQoL (Mielck et al., 2012). Cohabiting has been found to be associated with better HRQoL in a Swedish population-based study (Michelson et al., 2000), and the WHOQOL and EUROHIS tools also have items concerning satisfaction about social relationships. From sociodemographic factors that are not directly assessed in the QoL questionnaires, age has been found to be associated with QoL. However, especially in developed countries like Finland, the decline in QoL occurs relatively late – in the Finnish general population only after 70 or 80 years of age (Koponen et al., 2018). Differences in QoL between genders among the general population in Finland (Table

4) are very small (Koponen et al., 2018), and in other European countries, the gender differences in QoL assessed with the EUROHIS-QOL tool are also found to be minor (Schmidt et al., 2006).

2.2 Cardiovascular Health, Dietary Habits and Quality of Life

2.2.1 Defining and Promoting Cardiovascular Health

Both in Europe and in the US, comprehensive guidelines are being published to promote CV health and prevent cardiovascular disease (Arnett et al., 2019; Visseren et al., 2021). Several modifiable risk factors are being recognised, and goals and treatment suggestions are given to reach optimal CV health. The recommendations are very similar on both sides of the Atlantic Ocean. The American Heart Association has also developed a concept of ideal cardiovascular health, with recommended values of seven CV health metrics (Lloyd-Jones et al., 2010).

The importance of traditional risk factors for the development of CV disease has been indisputably demonstrated in many large studies. Smoking, low physical activity, unhealthy diet, obesity, hypertension, unfavourable levels of blood lipids, and diabetes are known to have a large impact on the development of atherosclerotic CV disease, whereas non-smoking, adequate physical activity, healthy diet, normal body mass index (BMI), and recommended levels in blood pressure, blood lipids and blood sugar are protective from CV disease (Arnett et al., 2019; Virani et al., 2021; Visseren et al., 2021). In addition to these traditional risk factors, psychosocial stress is also associated with the development and progression of CV disease. Psychosocial stress includes symptoms of mental disorders, like depression or anxiety, but also work and family stress, loneliness, and critical life events. Psychosocial stress is found to have direct biological effects but is also highly correlated with socio-economic and behavioural risk factors of CV disease, which may at least partly explain the association (Piepoli et al., 2016; Visseren et al., 2021; Whooley et al., 2008). Indicators of good mental health, like optimism and a strong sense of life purpose, have been associated with better CV health (Rozanski, 2014). In the latest updates, poor sleep has also been added to the risk factors of CV disease. Poor sleep quality, insomnia symptoms, as well as short and long sleep duration are associated with CV disease, while good sleep quality and a mid-range sleep duration are associated with better CV health (Kwok et al., 2018). In addition, obstructive sleep apnoea is associated with an elevated risk for CV disease (Virani et al., 2021).

2.2.2 Ideal Cardiovascular Health

To promote CV health and prevent CV disease, the American Heart Association introduced in 2010 the concept of ‘ideal cardiovascular health’ (also called ‘Life’s Simple 7’), with cut-off values for optimal levels of CV health metrics. The concept is defined by the absence of clinically manifest CV disease together with the presence of favourable health behaviours and health factors. With this concept the American Heart Association aimed at the goal: ‘By 2020, to improve the CV health of all Americans by 20% while reducing deaths from CV diseases and stroke by 20%’ (Lloyd-Jones et al., 2010). According to the concept, to achieve optimal levels of all the health metrics, the person should be non-smoking, have a normal BMI, a healthy diet and fulfil the recommendations for physical activity. Untreated blood pressure, total cholesterol, and fasting plasma glucose should be at recommended levels (Table 5). To lower the risk for CV disease, people should aim at reaching optimal levels in as many of these metrics as possible (Lloyd-Jones et al., 2010).

The presence of ideal cardiovascular health has been found to be related to both age and sex. The number of ideal metrics declines with older age, and at any age, females tend to have more ideal metrics than males (Benjamin et al., 2018). Several social risk factors (low family income, low education level, minority race, and single-living status) have been related to lower achievement of the ideal metrics (Caleyachetty et al., 2015). As a whole, the ideals have been proven hard to achieve. The prevalence of achieving 6 or 7 ideal metrics has been ranging from 0.5% to 14% worldwide (Younus et al., 2016). In Finland 9% of women and 3% of men aged 25–74 years reached at least 5 ideal metrics in 2007 (Peltonen et al., 2014). In the US, less than 1% of the general population reached all 7 ideals in the National Health and Nutrition Examination Surveys (NHANES) conducted between the years 2003 and 2008 (Shay et al., 2012), and the proportion has not risen since then (Virani et al., 2021). The prevalence of meeting ideal criteria for smoking and total cholesterol has increased in the US from 1999 to 2018, but at the same time the prevalence of ideal levels for blood glucose and BMI has declined. The prevalence of ideal diet has remained <1% in the US during the whole period (Virani et al., 2021). The prevalence of ideal diet varies greatly between different countries. The best results are achieved in Italy and Korea, and the worst in the US (Younus et al., 2016). This may indicate that Eastern and Mediterranean type dietary patterns fulfil the recommendations more easily than the Western dietary pattern. However, cuisines around the world are also difficult to compare with each other.

The relevance of achieving the recommended levels in these ideal health metrics has been confirmed in multiple independent studies. Strong inverse, stepwise associations of the number of CV health components at ideal levels have been detected with all-cause and CV disease mortality as well as with the prevalence of CV disease and stroke (Fang et al., 2016; Gao et al., 2020; Nguyen et al., 2021;

Virani et al., 2021). An analogous trend was also detected at the population level: the ambitious goal of the American Heart Association was not achieved in the US by 2020, since the prevalence of ideal CV health did not rise during the decade. Concurrently, the rate of deaths for CV disease, which had decreased for thirty years, started to rise again after the year 2010 (Virani et al., 2021). These results indicate that striving for the ideals appears to be highly beneficial, yet difficult.

Table 5. Definition of adult ideal cardiovascular health by the American Heart Association.

Goal/Metric	Ideal Cardiovascular Health Definition
Current Smoking	Never or quit >12 months ago
Body Mass Index	<25 kg/m ²
Physical Activity	≥150 min/week moderate intensity or ≥75 min/week vigorous intensity or combination
Healthy Diet Score	4–5 components Fruit and vegetables: ≥450 g per day Fish: ≥two 100 g servings per week (preferably oily fish) Fibre-rich whole grains: ≥three 30 g servings per day Sodium: <1500 mg per day Sugar-sweetened beverages: ≤450 kcal per week
Total Cholesterol	<5.18mmol/l (<200mg/dl; untreated values)
Blood Pressure	<120/<80 mmHg (untreated values)
Fasting Plasma Glucose	<5.6 mmol/l (<100 mg/dl; untreated values)

Modified from Lloyd-Jones et al., 2010.

2.2.3 Ideal Cardiovascular Health and Quality of Life

Ideal CV health has been found to be associated with better HRQoL. Cross-sectional studies from the US and China have reported a positive association between achievement of the ideal metrics and HRQoL, assessed with the EQ-5D-5L together with the EQ-VAS (Wu et al., 2021), and with the HRQoL4-instrument, which defines QoL by assessing the loss of healthy days caused by physical or mental illness (Allen et al., 2015; Odom et al., 2016). There is also a longitudinal study, in which ideal CV health in early adulthood was associated with higher HRQoL (measured with SF-12) in middle age (Pool et al., 2019). However, to my knowledge, there are no previous studies about the association of ideal CV health with general QoL.

The metrics of ideal cardiovascular health have been found to be individually associated with QoL. A negative relationship has been detected with smoking and QoL. The association is related to the number of cigarettes smoked, and smoking

cessation significantly improves QoL (Goldenberg et al., 2014). Lower BMI has been linked to better QoL in several studies (Kroes et al., 2016; Vesikansa et al., 2022), and according to cross-sectional data, there is a consistently positive association between physical activity level and HRQoL (Bize et al., 2007). QoL of individuals with hypertension has been found to be slightly worse than that of normotensive individuals (Trevisol et al., 2011), but the awareness of hypertension especially appears to lower the scores of HRQoL, not the hypertension *per se* (Korhonen et al., 2011). A low total cholesterol level in midlife predicts better physical functioning (SF-36 physical functioning scale) in old age (Hytinen et al., 2011). However, most of this effect of low cholesterol to QoL is probably due to the prevention of atherosclerotic diseases (Libby et al., 2019). The information about the effect of slightly elevated blood glucose on QoL is scarce, but several studies have shown that patients with type 2 diabetes have lower QoL than healthy people (Jing et al., 2018).

2.2.4 Diet and Quality of Life

Diet is maybe the most important individual modifiable factor behind obesity, metabolic syndrome, impaired glycaemic control, elevated blood pressure and blood lipid levels, and the benefits of a healthy diet have been indisputably demonstrated in several studies (Cosentino et al., 2020; Sofi et al., 2008; Visseren et al., 2021). The Western-type diet, which contains red meat, saturated fatty acids, sugar and salt abundantly, and vegetables, fruit and fibre scarcely, has been found especially unhealthy (Danaei et al., 2013). The Mediterranean diet instead, with a lot of vegetables, fruit, legumes and olive oil, has been found particularly good for CV health (Grosso et al., 2017; Visseren et al., 2021). Although information on a healthy diet is easily available, complying with the advice is difficult (Kwan et al., 2013), and in the US, for example, the prevalence of a recommended, ideal diet is extremely low (<1%) (Virani et al., 2021). Therefore, it would be important to find ways to motivate people for healthier eating.

In addition to the benefit for CV health, there are also several studies in which adherence to a recommended healthy diet has been associated with better QoL (Godos et al., 2019; Lee et al., 2019; Sanchez-Aguadero et al., 2016; Stenlund et al., 2021a; Vajdi & Farhangi, 2020). The Mediterranean diet has been studied in these works most frequently as an example of a healthy diet (Godos et al., 2019; Vajdi & Farhangi, 2020), but other healthy dietary patterns have also been linked with good QoL (Lee et al., 2019; Sanchez-Aguadero et al., 2016; Stenlund et al., 2021a; Vajdi & Farhangi, 2020). In the study by Lee et al. (2019) among Korean adults, high adherence to a modified Korean version (J. Y. Kim et al., 2011) of the Recommended Food Score (Kant et al., 2000) was associated with better QoL in every dimension of the WHOQOL-BREF (WHOQOL Group, 1998a) in women. Some studies have

also found a negative association between QoL and unhealthy or ‘Western’ dietary patterns (Vajdi & Farhangi, 2020). Positive changes in health behaviours, including changes in diet, have also been shown to improve subsequent well-being (Stenlund et al., 2022). Hence, it is possible that the positive impact on QoL might even work as a motivator for a lifestyle change (Stenlund et al., 2021a).

2.3 Work Ability

Workforce aging was the main reason to start the work ability research in Finland in the early 1980s, and the concept of work ability was originally developed by the Finnish Institute of Occupational Health (FIOH) (Ilmarinen, 2009). According to Ilmarinen (2008), work ability is understood as a balance between a person’s resources and work demands. The ground of work ability are health and functional capacity of the worker, but work ability is also affected by professional skills, values, attitudes, motivation and work itself. There are many well-known factors that are associated with work ability. For example higher age (Bridger & Bennett, 2011; Pohjonen, 2001), presence of chronic illnesses (Jędryka-Góral et al., 2006; Shiri et al., 2013), occupational stress (Yong et al., 2013) and depression (Elinson et al., 2004; Shiri et al., 2013) are associated with poorer work ability, whereas for example higher education (Martimo et al., 2007), lower BMI (Andersen et al., 2017; Bridger & Bennett, 2011), and good sleep quality (Ng & Chan, 2018) are linked with better work ability. In addition, many work-related factors like physically light work, support from supervisors and workmates, control over one’s work, and possibilities to develop at work have been associated with good work ability (Gould et al., 2008). Studies have shown that poor work ability is associated with increased risk of long-term sickness absence and early retirement (Burdorf et al., 2005; Salonen et al., 2003).

2.3.1 Assessment of Work Ability

Work ability has been defined and measured in different ways: good work ability has been defined as not being on a long-term sick-leave, and work ability has been assessed for example by summing together total days on sick-leave during the last year (Van Den Berg et al., 2009). The Work Ability Index (WAI) (Ilmarinen, 2007), developed by Ilmarinen et al., is probably the most popular instrument for the assessment of work ability nowadays (Van Den Berg et al., 2009).

The Work Ability Index

The development of the WAI was started by a multidisciplinary research group at FIOH in 1981 by conducting cross-sectional studies among municipal employees.

The new instrument was planned to be used in clinical occupational healthcare as well as in research, to assess work ability during health check-ups and surveys. Since then, the WAI has become a popular instrument for the assessment of work ability both in research and in practice, and it has been translated into at least 24 languages (Ilmarinen, 2007).

The employee answers the questions of the instrument at home and an occupational health professional rates the responses according to the instructions (Tuomi et al., 2006). The index can vary between 7 and 49 and is calculated as a summary measure of the seven items of the questionnaire (Table 6) (Ilmarinen, 2007). Assessed with this index, work ability is considered poor for scores of 7–27, moderate for scores of 28–36, good for scores of 37–43, and excellent for scores of 44–49 (Gould et al., 2008).

The WAI is a well validated instrument: The summary index and all its items are shown to predict work disability, retirement, and mortality. Also the test–retest reliability of the WAI is shown to be good (Ilmarinen, 2007).

Table 6. The items of the Work Ability Index.

Items	Range
1 Current work ability compared with the lifetime best	0–10
2 Work ability in relation to the demands of the job	2–10
3 Number of current diseases diagnosed by a physician	1–7
4 Estimated work impairment due to diseases	1–6
5 Sick leave during the past year (12 months)	1–5
6 Own prognosis of work ability 2 years from now	1–7
7 Mental resources	1–4

From Ilmarinen, 2007.

The Work Ability Score

The first item of the WAI is also used separately, as a simple measure of work ability. It is the question ‘What is your current work ability compared with your lifetime best?’ and referred to as the Work Ability Score (WAS). The WAS has a 0–10 response scale, where 0 stands for ‘completely unable to work’ and 10 stands for ‘work ability at its best’. Work ability is considered poor for scores of 0–5, moderate for scores of 6–7, good for scores of 8–9 and excellent for a score of 10 points, based on the same scoring that has been used in the WAI (Gould et al., 2008). The WAS has been shown to have a strong association with the WAI and is reliable in evaluating work ability (El Fassi et al., 2013). The WAS has also been shown to predict disability pension and long-term sickness absence, according to a Finnish register-based study (Kinnunen & Nätti, 2018).

2.3.2 Work Ability in Finland

The latest comprehensive report on work ability among the Finnish population was published in 2008 and based on the results of the Health 2000 Survey (Gould et al., 2008). The survey gathered information about Finnish residents aged 18 or older, and in the report on work ability there were data about 5,200 participants in the 30–64 age group. The work ability of these working-age participants was assessed with three indicators: the WAI, the WAS, and a three-level Work Ability Estimate, where the options were 1=completely fit for work, 2=partially disabled for work, and 3=completely disabled for work. Most people estimated their work ability as good in every indicator. Well-educated people and white-collar workers as well as those who lived in families estimated their work ability to be generally good, whereas farmers, part-time workers and unemployed people often assessed their work ability to be limited. Depression and back disorders were the health conditions that decreased work ability the most, but regardless of health status, work ability decreased in all population groups with older age. Physically light work, support from supervisors and workmates, control over one's work, and possibilities to develop at work were associated with good work ability (Gould et al., 2008).

The distribution of the WAI, WAS and the self-estimate of being completely fit for work according to age and gender in the employed Finnish population in the Health 2000 Study are presented in Table 7.

Table 7. Distribution (in percentage) of the Work Ability Index (WAI) and the Work Ability Score (WAS) according to gender and age in the employed Finnish population. Results from the Health 2000 Survey.

	Females, age groups				Males, age groups			
	18–29	30–44	45–54	55–64	18–29	30–44	45–54	55–64
WAI								
Excellent	48	32	16	8	59	39	23	18
Good	47	57	60	52	37	51	54	52
Moderate	5	10	21	31	4	8	19	22
Poor	0	1	3	9	0	1	4	8
WAS								
10 Points	46	39	19	11	53	41	21	13
8–9 Points	49	54	68	66	42	51	60	56
6–7 Points	4	6	9	19	4	7	16	24
0–5 Points	0	1	4	5	1	1	3	7
Being completely fit for work								
	97	94	83	53	97	92	80	55

Modified from Gould et al., 2008.

In the FinHealth Study in 2017, work ability was assessed with the WAS and the three-level Work Ability Estimate among the general population (age range 30–69). The WAS mean score adjusted for age was 7.8 in men and 8.0 in women on a scale of 0–10 (Koponen et al., 2018). The WAS mean scores among different age groups are presented in Table 8.

In addition, in a study by Kinnunen and Nätti (2018) the work ability of the Finnish population was reported with the WAS results from the Finnish Quality of Work Life Surveys of 1997, 2003 and 2008. The results from these three years were reported together. The largest share of the participants were 35–49 years of age (42%) and working in lower white-collar occupations (40%). The majority of the participants were women (54%). Most of the participants (87%) rated their work ability as good or excellent, and their WAS mean was 8.6.

Work ability has been approximately on the same level also in population-based surveys conducted in other Nordic welfare states. In a Swedish study, the WAS mean was 8.3 among employees currently in the labour market (Lundin et al., 2017), and in a Norwegian study among the general population aged 18–50, 87% of the participants assessed their current work ability as good or excellent (WAS 8–10) (Oellingrath et al., 2019). Data about work ability measured with WAI or WAS among the general working population or diverse occupations are also available from some other Western European countries. In a German nationwide panel study among 4,500 workers aged 31–60 years in different occupations, the WAS mean score was 8.0 (Freyer et al., 2019). In a study conducted in the Netherlands, the work ability data are available for a sample of workers invited for occupational health checks. The sample included 2,900 workers employed in construction (11%), industry (24%), public services (29%) and commercial services (36%), and the WAS mean among them was 8.0 (Schouten et al., 2016). The results from Luxemburg are also from health checks at a large multisectoral occupational health service, and the WAS mean among the 12,800 examined employees was 8.6 (El Fassi et al., 2013). These results indicate that the work ability also appears to be good on average in Western European countries other than Finland, Sweden and Norway.

Table 8. Self-reported work ability in different age groups among Finnish general population.

	30–39	40–49	50–59	60–69
Being completely fit for work*				
Males	89.1	88.1	75.2	60.8
Females	89.9	88.5	76.1	54.9
WAS mean				
Males	8.8	8.3	7.5	6.8
Females	8.8	8.5	7.8	6.9

* The proportion in percentages. WAS: Work ability score.
Modified from Koponen et al., 2018.

2.3.3 Work Ability among Public Sector Employees in Finland

As described in the section 2.1.4, about one-third of the Finnish labour force works in the public sector. The biggest employment sectors are healthcare, education, and social services (Ministry of Finance and Commission for Local Authority Employers, 2006), and 72% of the employees are women (Statistics Finland, 2017). The work ability of the public sector employees in Finland has been studied at least in the Finnish Public Sector Study, which is a large ongoing prospective cohort study of employees working in 10 towns and 21 hospitals in five hospital districts and one division of municipal health services in Finland. The study comprises 151,618 employees with a ≥ 6 -month job contract in any year between 1991–2005 (Saltychev et al., 2013). The original participants of the study have been examined repeatedly at 3 to 4 year intervals. In a paper by Saltychev et al, a cohort of approximately 3,300 participants in the Finnish Public Sector Study were studied, and the results from the years 1997–1998 and 2000–2002 were combined. In that data, 87% of the participants assessed their work ability as good (WAS 8–10), and the WAS mean was 8.2 among them. Most of the participants (63%) in that study were 41–50 years of age and 90% of the participants were women (Saltychev et al., 2013). These results are not fully comparable with the results of the whole Finnish population presented in the latter paragraph. However, work ability among public sector employees appears to be approximately on the same level as work ability among the entire working-age population in Finland.

Compared to Swedish and Danish public sector employees in 1999–2000 (Lund et al., 2009), the results from Finland rank between them. The WAS mean score among public sector employees in Sweden was 8.0 (SD 2.0) in a sample of over 7,000 employees (mean age 46 years), 83% of whom were female. Among the Danish sample of approximately 1,500 employees (mean age 42 years, 75% female), the WAS mean was 8.8 (SD 1.5). Of note, the mean age of the Danish sample is lower than in the Swedish sample, which may at least partly explain the higher WAS mean among the Danes (Lund et al., 2009).

2.3.4 Work Ability and Quality of Life

Although the view into a person's life is different when shaped by means of work ability or QoL, those two aspects are highly correlated. In a study among 1,534 clinical nurses in Taiwan, the WAI showed a correlation with all domains of WHOQOL-BREF, the environmental domain being the most highly correlated (Chiu et al., 2007). Satisfactory work ability, measured with the WAI, was also found to be a major determinant of QoL (all domains of WHOQOL-BREF) among Croatian clinical nurses (Milosevic et al., 2011). Both the WAI and the WAS were correlated

with all domains of WHOQOL-BREF in a study among Iranian construction workers (Mokarami et al., 2022), and the WAI was correlated with all domains of RAND 36 in a study among Finnish middle-aged men working in construction and industrial occupations (Sørensen et al., 2008). Accordingly, there are many similarities between the determinants of work ability and QoL. Deteriorated health in particular negatively affects both outcomes (Elinson et al., 2004; Jędryka-Góral et al., 2006; Schmidt et al., 2006; Shiri et al., 2013), whereas higher education is associated with better results in both outcomes (Martimo et al., 2007; Mielck et al., 2012). However, there are also differences: for example, higher age begins to negatively affect work ability considerably earlier than it affects QoL (Gould et al., 2008; Koponen et al., 2018).

2.4 Sleep, Quality of Life and Work Ability

Sleep is regulated by homeostatic processes and circadian rhythms that together define its timing and duration (Borbély et al., 2016). In addition to these basic regulators, sleep is also affected by numerous other factors. Work schedules, especially shift work (Kecklund & Axelsson, 2016), and social and family duties affect timing, duration and quality of sleep, and environmental factors such as noise, light or unpleasant temperature may cause sleep problems (Billings et al., 2020). Health habits, such as exercise (Chennaoui et al., 2015), nutrition (Pot, 2018), alcohol consumption (Ebrahim et al., 2013) and smoking (Htoo et al., 2004) have effects on sleep, as do many somatic and psychiatric illnesses – e.g. obesity, especially with obstructive sleep apnoea; chronic pain; depression or anxiety – and medications for several conditions (Meurling et al., 2019; Morphy et al., 2007; Tsuno et al., 2005; Wickwire & Collop, 2010). In addition, there is individual variation, not dependent on these factors, in how well we sleep and how much sleep we naturally need (Ferrara & De Gennaro, 2001).

However, sleep is essential to our health, and people with sleep problems are at risk of developing several adverse health conditions. In previous research, sleep assessments have mainly concentrated on two basic characteristics: sleep duration and sleep quality. Most of the studies demonstrating the effects of sleep on health have been based on the results in these two parameters. In my thesis, sleep has been evaluated with single, self-reported questions about sleep duration, sleep quality and sleep medication use, and I have studied how sleep is associated with QoL and work ability. Therefore, I will now introduce the assessment of these three sleep parameters, and their associations with health, QoL and work ability in previous literature.

2.4.1 Sleep Duration

Assessment of Sleep Duration

The gold standard of assessing sleep is the polysomnography measurement. Polysomnography can give accurate information about sleep duration, including nightly awakenings, as well as information about the structure of sleep. It is, however, difficult and expensive to conduct in large study populations, which makes it impossible to use in most epidemiological studies. Polysomnography also normally gives us information about only one night, and we do not know whether that night was typical for the subject or not (Kushida et al., 2005; Van De Water et al., 2011).

The most common way of assessing sleep duration in epidemiological studies has therefore been by simply asking the participants to estimate their typical sleep duration. In a meta-analysis of short sleep duration and health outcomes, most of the included studies had assessed sleep duration with self-reported tools. In that meta-analysis, the self-reported data were even preferred over objective measurements because of their better applicability in general community settings (Itani et al., 2017). However, self-reported sleep duration is known to differ from objective measurement (Silva et al., 2007). Patients with insomnia or obstructive sleep apnoea tend to underestimate their total sleeping time, while people with no sleep problems may overestimate it (McCall et al., 1995).

According to current understanding, simple self-reported sleep duration should not be considered a validated or reliable measure of biological sleep duration (Bianchi et al., 2017). The editors of *Sleep Medicine* question the reliability of self-reported sleep duration, especially as a single measure of sleep in cross-sectional studies. Rather they prefer that the epidemiologists focus on comprehensive phenotypic profiles combining subjective measures of sleep (including self-reported sleep quality) with objective measures over multiple nights. This is recommended to be obtained with small wearable devices, like accelerometers (actigraphs) (Bianchi et al., 2017). It has also been suggested that subjective feelings about sufficient or insufficient sleep duration may be as important as the actual sleep duration when studying health consequences of short sleep (Wennman et al., 2014). It has been found that greater satisfaction with sleep is associated with better quality of well-being regardless of subjectively or objectively measured sleep duration (Jean-Louis et al., 2000).

Sleep Duration and Health

Sufficient sleep duration varies between individuals, and also changes with age. Normal sleep duration is the longest in young children, starting from 14 to 17 hours in new-borns. The need for sleep then gradually decreases, being approximately 7–9 hours for adults. Sufficient sleep duration may be slightly shorter in the elderly than in the working-age population, but the most important alterations with age occur in the structure of sleep. Sleep becomes more fragmented and the proportion of deep sleep decreases. Part of the total sleep may also be from napping (Hirshkowitz et al., 2015; J. Li et al., 2018).

However, there is convincing evidence that sleep duration matters. Especially short, but also excessively long, sleep duration has been associated with several adverse health consequences, and the most favourable sleep duration for adult population appears to be 7–9 or 7–8 hours (Cappuccio et al., 2011; Hirshkowitz et al., 2015; Kwok et al., 2018). The National Sleep Foundation recommends 7–9 hours of sleep for adults at 26–64 years of age (Hirshkowitz et al., 2015), but in several studies, for example, risks for all-cause mortality and CV disease have shown to be elevated when sleep duration exceeds 8 hours (Cappuccio et al., 2011; Kwok et al., 2018). Excessively short or long sleep duration has been demonstrated to increase the risk for obesity (Itani et al., 2017; Jike et al., 2018; Patel & Hu, 2008), hypertension (Itani et al., 2017; Jike et al., 2018; Q. Wang et al., 2012), CV disease (Cappuccio et al., 2011; Itani et al., 2017; Jike et al., 2018; Kwok et al., 2018), type 2 diabetes (Anothaisintawee et al., 2016; Cappuccio et al., 2010a; Itani et al., 2017; Jike et al., 2018), depression (Zhai et al., 2015), decline in cognitive function (Kronholm et al., 2009) and all-cause, as well as CV, mortality (Cappuccio et al., 2010b; Itani et al., 2017; Jike et al., 2018; Kronholm et al., 2011). The associations are usually U-shaped, meaning that the risk for unfavourable effect rises when sleep duration is deviated more from the optimal, either to excessively short or long sleep duration. In addition to being detected with self-reported data, the U-shaped association between mortality and sleep duration has been detected with actigraphic recordings of sleep duration (Kripke et al., 2011).

The mechanisms underlying the associations between sleep duration and metabolic and CV diseases are not fully understood, but short sleep duration has been demonstrated to cause hormonal changes that contribute to the development of obesity and impaired glycaemic control (Kwok et al., 2018). Low-grade inflammation is also associated with reduced sleep (Kwok et al., 2018). These results indicate that short sleep could be an independent risk factor for metabolic and CV diseases. Conversely, there is no good evidence about the mechanisms that could explain the association between long sleep duration and CV disease. It has been suggested that this association is explained by the confounding factors and comorbidities associated with long sleep duration: depressive symptoms, low socio-

economic status, unemployment, low level of physical activity, and undiagnosed health conditions have all been shown to be associated with long sleep duration (Krueger & Friedman, 2009; Patel et al., 2006; Stranges et al., 2008). The association of CV and metabolic outcomes with long sleep duration may then reflect the role of long sleep as a marker, rather than a cause, of these conditions. There is thus evidence that the two peaks of the U-shaped association between sleep duration and health do not mean the same thing. Sleeping less than the average 7–8 hours has been found to be harmful, but there is no evidence that sleeping more than 8 hours would harm a healthy adult (Knutson & Turek, 2006).

2.4.2 Sleep Quality

Assessment of Sleep Quality

There is no standard definition for sleep quality, although it has been widely studied (Krystal & Edinger, 2008). There have, however, been attempts to define indicators for sleep quality. Sleep latency, number of over-5-minute awakenings during the night, wake time after sleep onset and sleep efficiency (the proportion of sleep of the time spent in bed) have been suggested as appropriate indicators of sleep quality (Ohayon et al., 2017). These indicators can be assessed only by objective measurement tools, like polysomnography or actigraphy. Such tools cannot be used in large population settings, and in addition, these assessment methods do not consider the individual's own perceptions of their sleep quality.

One's personal opinion about sleep quality does not always correspond to objective measures (Edinger et al., 2000), but that is the perspective that matters when a person comes to a physician's appointment and complains about sleep problems. It has also been suggested, that subjective feeling about insufficient sleep is as important a finding as the actual sleep duration or a diagnosed sleep disorder (Wennman et al., 2014), and there is evidence that better sleep satisfaction is related to greater well-being (Jean-Louis et al., 2000). In addition, it is notable that the diagnosis of insomnia is based only on subjective assessment of sleep rather than objective measurements (ICD-10, 2019). Therefore, in clinical work as well as in large population studies, the assessment of sleep quality is usually based on self-reporting tools. In research, the most-used self-reported questionnaire for the assessment of sleep quality is the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989). Sleep diaries can also be used to assess sleep quality, or the focus can be changed to assessing the presence of sleep difficulties, especially insomnia.

The PSQI was introduced in 1989 by Buysse et al. (1989) as a new instrument for the assessment of sleep in psychiatric practice and research. It assesses sleep

quality and disturbances over a one-month time period and consists of 19 individual questions from seven topics: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. It has good internal consistency (Cronbach's alpha 0.83) and test-retest reliability ($r=0.82$, over an average of 19 days) (Buysse et al., 1989; Carpenter & Andrykowski, 1998; Gentili et al., 1995). The individual item of subjective sleep quality 'During the past month, how would you rate your sleep quality overall?' (Very good, Fairly good, Fairly Bad, or Bad) was also found to correlate well with the global score of the questionnaire (Buysse et al., 1989). It should be noted that this questionnaire also contains items regarding the amount of sleep, especially the question of self-reported sleep duration, where reporting of shorter sleep leads to worse results. In studies evaluating both quality and duration of sleep, this should be considered a possible confounding factor. In some works, this problem has been solved by using only selected items of the questionnaire or excluding the sleep duration item (Matsui et al., 2020, 2021; Tang et al., 2017).

Poor sleep quality is often described in research as well as in clinical work as insomnia, whose diagnostic criteria do have many similarities with unfavourable results, for example, in the PSQI. According to International Classification of Diseases (ICD-10) insomnia is defined as a condition of unsatisfactory quantity and/or quality of sleep, which persists for a considerable period of time, including difficulty falling asleep, difficulty staying asleep, or early final waking (ICD-10, 2019). In the new version ICD-11 (ICD-11, 2021), the definition has been made somewhat more specific, and the requirement for daytime impairment has been added to the diagnostic criteria. However, by assessing sleep quality only by means of fulfilling the diagnostic criteria of insomnia or not, the information about the variation of sleep quality among moderate or good sleepers is lost. It also concentrates on a disorder or disturbance rather than evaluates the subjective perception of sleep quality, which could be considered a more positive approach.

Sleep Quality and Health

Not only adequate sleep duration but also good sleep quality has been found important for our health, and patients with poor sleep quality or insomnia are at risk of developing adverse health conditions. Insomnia is nowadays understood not only as a symptom of depression, but also as a risk factor (Baglioni et al., 2011). Poor subjective sleep quality is also found to be a risk factor for obesity (Madrid-Valero et al., 2017), type 2 diabetes (Anothaisintawee et al., 2016; Cappuccio et al., 2010a), and coronary heart disease (Kwok et al., 2018), and is also associated with hypertension (Lo et al., 2018). However, insomnia and poor sleep quality have not been linked to increased mortality (Kwok et al., 2018; Lovato & Lack, 2019). The

increased risk for metabolic and CV diseases with insomnia and poor sleep quality may be at least partially explained by the same mechanisms as with short sleep quality. The definition of insomnia and unfavourable results from the questionnaires assessing sleep quality include components like short sleep duration, long sleep latency and difficulty staying asleep, which means that short sleep duration is often a component of poor sleep quality. However, there is also a significant difference between those two parameters: poor sleep quality (and especially insomnia) is a person's perception of having problems sleeping, while sleep duration itself tells us nothing about the individual's satisfaction with their sleep.

2.4.3 Sleep Medication Use

Although cognitive behavioural therapy for insomnia (CBT-I) is the preferred treatment for insomnia (van Straten et al., 2018), sleep medications are also needed in the treatment of especially acute, but sometimes also chronic, insomnia (Sutton, 2021; Working group set up by the Finnish Medical Society Duodecim and the Finnish Sleep Research Society, 2020). The use of benzodiazepines has been advised to limit mainly in cases of acute insomnia, and the use should be restricted to short periods (Working group set up by the Finnish Medical Society Duodecim and the Finnish Sleep Research Society, 2020). There is evidence that sleep medication use is associated with significant adverse effects, such as daytime drowsiness and memory impairment (Holbrook et al., 2000), as well as falls in the elderly (Woolcott et al., 2009) and elevated mortality (Kripke, 2016). However, in recent years there has been debate as to whether some of these associations are due more to the underlying causes of the need for sleep medication than to the medications *per se*. This phenomenon is called confounding by indication (Neutel & Johansen, 2019). It has been shown that the excessive mortality risk with benzodiazepine use is created by treatment of the symptoms of approaching death (Kronholm et al., 2019). The risk of falling has also been shown to be elevated in elderly patients with sleep medication use and poor sleep quality, but not in those patients with good sleep quality and sleep medication use (Min et al., 2016).

The use of benzodiazepines as sleep medicines has, however, decreased in Finland during the 21st century (*Suomen Lääketilasto [Finnish Statistics on Medicines]*, 2019), and a considerable number of sleep medications, especially used by the working-age population, are not benzodiazepines. The use of melatonin (both prescribed and sold 'over the counter') has increased. In addition, the off-label use of low-dose mirtazapine and quetiapine as sleep medicines is becoming more common. The actual rate of this low-dose use is relatively difficult to investigate, as the official statistics report the daily use per 1,000 inhabitants as normal doses for primary psychiatric indications, and these doses are considerably higher than the

doses used for sleep problems. In addition, only the melatonin that is sold as medicine, not as a dietary supplement, is reported, so the actual use of melatonin is higher than shown in the statistics (*Suomen Lääketilasto [Finnish Statistics on Medicines]*, 2019). Both low-dose mirtazapine and quetiapine have been shown to be effective in the treatment of transient insomnia (Karsten et al., 2017). Mirtazapine is also recommended as an option for pharmacological treatment of primary insomnia in Finland, but the use of quetiapine is advised to be restricted mainly to patients with a psychotic illness (Working group set up by the Finnish Medical Society Duodecim and the Finnish Sleep Research Society, 2020). There may also be adverse side effects in long-term use of quetiapine when used in low doses (Carr et al., 2016). There is evidence that melatonin can be effective in the treatment of primary insomnia; it is easily available and its side effects are minor (Lemoine et al., 2011), which probably explains its growth in use in Finland.

2.4.4 Sleep and Quality of Life

According to previous literature, there is a close relationship between sleep and QoL. Short sleep duration (compared to mid-range sleep duration) has been associated with lower QoL in several cross-sectional studies (J.-H. Kim et al., 2015; Lallukka et al., 2018; Liu et al., 2018; Magee et al., 2011; Matsui et al., 2020, 2021; Stranges et al., 2008). Short sleep duration appears to be associated with poorer QoL regardless of sleep quality or sleep disturbances (Lallukka et al., 2018; Matsui et al., 2020), chronic diseases (Liu et al., 2018), perceived health status or depressive disorder (J.-H. Kim et al., 2015). Excessively long sleep duration has also been associated with lower QoL (Magee et al., 2011), also regardless of chronic diseases (Liu et al., 2018), perceived health status or depressive disorder (J.-H. Kim et al., 2015). In addition, there is evidence that long sleep duration is associated with poorer QoL regardless of sleep quality (Lallukka et al., 2018). However, in work by Matsui et al., no direct association between long sleep duration and poor QoL was found; instead, there was a significant association mediated by insomnia symptoms (Matsui et al., 2021). As with the association between sleep duration and health outcomes, it is suggested that the relationship between short sleep duration and poor QoL differs from the association between long sleep duration and poor QoL. Short sleep appears to be an actual risk factor for poor QoL, whereas long sleep duration can be understood more as a sign of underlying conditions that cause poor QoL (Matsui et al., 2021; Patel et al., 2006; Stranges et al., 2008).

Sleep quality has been found to be associated with QoL (Lallukka et al., 2018; LeBlanc et al., 2007; Mahirah et al., 2021; Marques et al., 2017; Matsui et al., 2021), and there is some evidence that sleep quality could be an even more powerful predictor of QoL than sleep duration. In a study by Lallukka et al. in an Australian

population-based sample, poor sleep quality in combination with short, mid-range or long sleep duration was associated with worse QoL regardless of the presence of chronic illnesses (Lallukka et al., 2018). In a Japanese study by Matsui et al., poor sleep quality was significantly associated with QoL both directly and through insomnia symptoms (Matsui et al., 2021). And in a study by Marques et al. among higher education students in Portugal, sleep quality was found to be associated with several facets of WHOQOL-BREF (Marques et al., 2017). That work is one of the few in which QoL was assessed with a tool for general QoL. Most of the above referred works have used measures for HRQoL, such as SF-36 or its abridgments, or EQ-5D. Like many others, Marques et al. used PSQI to evaluate sleep quality. However, they also compared the results in individual items of PSQI with QoL, and found that the item on self-reported sleep quality especially was a significant predictor of most aspects of QoL, regardless of the presence of psychopathological symptoms (Marques et al., 2017).

Some associations have also been found between sleep medication use and HRQoL. In a Japanese study, insomnia was associated with low physical and mental component scores of Short Form 8, but sleep medication use was associated only with low PCS. Good sleepers with sleep medication had better MCS scores than poor sleepers with or without sleep medication. However, the scores were lower than in good sleepers without sleep medication (Sasai et al., 2010). There is also a placebo-controlled work from the US, which showed that long-term nightly pharmacologic treatment of primary insomnia with a hypnotic improved HRQoL and reduced work limitations (Walsh et al., 2007). These results suggest that insomnia itself is the primary cause for the decline in QoL, and a well-chosen treatment for insomnia improves well-being. However, the people who sleep well without any medication have the best results (Sasai et al., 2010).

Most of the studies examining the association between sleep parameters and QoL have been cross-sectional, but there is also evidence that changes in sleep duration, sleep quality and sleep medication use are temporally associated with subsequent health and well-being. In a general population-based study in the UK (Tang et al., 2017), poorer outcomes in the General Health Questionnaire (GHQ-12) and the SF-12 mental and physical component scores were predicted by a reduction in sleep duration, a decrease in sleep quality, and an increase in sleep medication use. Better outcomes, on the other hand, were predicted by an increase in sleep duration, an improvement in sleep quality, and a reduction in sleep medication use. Also in that study, changes in self-reported sleep quality (assessed with the self-reported sleep quality question from the PSQI) had the largest effects on outcomes (Tang et al., 2017).

2.4.5 Sleep and Work Ability

Sleep issues affect not only our health and well-being but also our ability to work. Particularly, poor sleep quality and insomnia symptoms, but also short sleep duration, especially along with poor sleep quality, have been associated with poorer work ability (Lallukka & Kronholm, 2016; Lian et al., 2015; Mokarami et al., 2020). Insomnia symptoms and sleep disturbances have also been found to predict sickness absence (Lallukka et al., 2013, 2014) and disability pension (Overland et al., 2008). The effect of insomnia symptoms on sickness absence has been detected regardless of sleep duration (Lallukka et al., 2013), but there is also a U-shaped association between sleep duration and sickness absence rate: the optimal sleep duration with the lowest rate of sickness absence appears to be 7–8 hours, and the rate of sickness absence is higher with shorter and longer sleep duration (Lallukka et al., 2014). Short sleep duration, poor sleep quality and use of sleep medication have also been found to be associated with poorer work productivity due to presenteeism, that is, being ill at work (Ishibashi & Shimura, 2020). In addition, poor sleep and functioning as well as unfavourable changes in these parameters have been found to be associated with premature exit from work (Kronholm et al., 2021).

2.5 Work-Related Factors, Work Ability and Quality of life

2.5.1 Occupational Stress and Burnout

Job burnout is most commonly defined as a severe state of exhaustion, cynicism and reduced professional efficacy. It is a consequence of long-lasting occupational stress, where the demands of the job exceed the capabilities, needs or resources of the worker (Maslach et al., 2001). Occupational burnout is not a medical diagnosis but is defined as a problem related to life-management difficulty (ICD-10, 2019). However, burnout is a risk factor for several mental and physical illnesses, as well as a predictor of increased mortality (Ahola, 2007; Kivimäki et al., 2018; Melamed et al., 2006; Toppinen-Tanner et al., 2009).

Assessment Tools for Occupational Stress and Burnout

The most commonly used assessment tools for job stress in Finland are the Maslach Burnout Inventory – General Survey (MBI-GS) and the Bergen Burnout Indicator 15 (BBI-15) (Ahola et al., 2018; Finnish Institute for Health and Welfare (THL), n.d.). Both questionnaires are based on the three-dimensional theory of job burnout and include items concerning exhaustion, cynicism and reduced professional efficacy.

The Maslach Burnout Inventory was originally developed in the US in 1981 to examine job burnout among human service occupations (Maslach & Jackson, 1981). In 1996, the MBI-GS, a new version suitable for all occupations was introduced (Maslach et al., 1996), and has since then become the most popular and the most studied instrument for the assessment of job burnout (Mäkikangas et al., 2012). The MBI-GS consists of 16 questions about exhaustion, cynicism and professional efficacy. The sum score of the MBI-GS is a weighted sum of the mean scores of the three dimensions, and can vary between 0 and 6, higher scores indicating more severe burnout symptoms. Structural and discriminant validity, internal consistency and test–retest reliability of MBI-GS have been found to be good (Finnish Institute for Health and Welfare (THL), n.d.; Maslach et al., 1996).

The Bergen Burnout Indicator with 25 questions (BBI-25) was originally developed in Norway in 1988 (Matthiesen & Dyregrov, 1991). It measures burnout as one entity, ‘job burnout syndrome’ and the result of the instrument is reported as a sum score of all 25 questions. The instrument is especially suitable for research in Nordic countries because the development and validation have been conducted in Norway. The BBI-25 was already well-validated, but the Finnish psychologists Näätänen et al., together with the original developer Stig Berge Matthiesen from Norway, wanted to further develop the questionnaire (Näätänen et al., 2003). Their idea was to divide the questions into three dimensions, measuring the different aspects of burnout introduced by the developers of the MBI-GS instrument. A sum score of all the dimensions would also be preserved. Suitable questions to measure the three dimensions were already included in the BBI-25. Another goal of the developers was to shorten the questionnaire somewhat, yet not lose its comprehensiveness. As a result of this work, the BBI-15 questionnaire was introduced in 2003. The validity of the new instrument was based on previous data from Norway and new data collected in Finland among over 10,000 employees.

Altogether, the BBI-15 consists of 15 items to assess job burnout in three dimensions (5 items each): exhaustion, cynicism and reduced professional efficacy. Responses are rated on a 6-point Likert-type scale (1=totally disagree, 6=totally agree). The scores of the items for each dimension are summed together to get the sum result of each dimension. The scores from all the 15 items can also be summed together to get the sum score for job burnout. Normative percentiles for different age groups and genders are available in the BBI-15 manual (Näätänen et al., 2003). The percentiles are scored as follows: Percentile 0–74: No burnout; Percentile 75–84: Mild burnout; Percentile 85–94: Moderate burnout; Percentile 95–100: Severe burnout. The sum score of the BBI-15 has been found to be associated with depression and low work ability, and the validity and the test–retest reliability of the BBI-15 is good (Näätänen et al., 2003; Salmela-Aro et al., 2011). When compared to the MBI-GS, the dimensions of exhaustion and cynicism are closely related

(correlations 0.87 and 0.88), but the dimension of reduced professional efficacy has a weaker correlation (0.30) (Näätänen et al., 2003).

Occupational Stress and Work Ability

It is not surprising that occupational stress and burnout have a negative association with work ability, since the symptoms of burnout are so tightly related to fundamental components of work life. It has been shown that occupational stress is associated with poorer results in the WAI among different occupational groups (Hatch et al., 2018; Yong et al., 2013). Occupational burnout, defined with the MBI-GS, has also been studied in a Finnish multidisciplinary epidemiological health survey, the Health 2000 Study, among a general population. Burnout was found to be an independent risk factor for medically certified sickness absence during the 2-year period after the basic measurements in a sample of 3,151 working-age participants (Ahola et al., 2008). In another work from the same study population, the presence of burnout was found to predict disability pension during a 4-year follow-up period. Each one-point increase in the overall sum score of MBI-GS was related to a 49% increase in the odds for a future disability pension (Ahola et al., 2009).

Occupational Stress and Quality of Life

Not only does occupational stress have severe negative associations with health and work ability of the employees, but it also affects their QoL. Occupational stress was negatively associated with both physical and mental component scores of the SF-36 among Chinese teachers (Yang et al., 2009), and similar associations were also seen among Greek nurses (Sarafis et al., 2016). In a population-based study in the US, job strain was negatively associated with five of the eight aspects of HRQoL in the SF-36: physical functioning, role functioning related to physical health, vitality, social functioning, and mental health (Lerner et al., 1994). In a recent review article, a negative correlation between burnout and QoL in studies among nurses was widely reported (Khatatbeh et al., 2022). However, in a Malaysian study among hospital employees, poor mental health was shown to have a significant mediating effect in the relationship between burnout and poor QoL (Woon & Tiong, 2020). This finding is probably more logical than surprising: the symptoms of burnout and depression are somewhat overlapping, and burnout is a known risk factor for depression (Ahola, 2007). QoL has also been found significantly lower among patients with depression (Saarni et al., 2007; Schmidt et al., 2006), and job burnout has been associated with poor sleep quality (B. Wang et al., 2021), a common symptom of depression (ICD-10, 2019).

2.5.2 Shift Work

The Effects of Shift Work on Health

Shift work is a term used to describe work schedules other than those during conventional daytime hours. It can mean fixed early morning, evening, and night work, as well as roster work and rotating three-shift work, which means that the employees rotate regularly between day, evening, and night shifts. Shift work disrupts the normal sleep-wake cycle, and often leads to sleep loss (Kecklund & Axelsson, 2016).

Kecklund and Axelsson (2016) have comprehensively reviewed the literature on health consequences of shift work and insufficient sleep. Several studies have found that shift work containing night shifts is a risk factor for adverse health consequences. Occupational accidents (Wagstaff & Lie, 2011), obesity (Proper et al., 2016), type 2 diabetes (Knutsson & Kempe, 2014), CV disease (Vyas et al., 2012) and breast (Jia et al., 2013), prostate (Rao et al., 2015), and colorectal cancers (X. Wang et al., 2015) are more common among employees whose work schedule includes night shifts. The unwanted health consequences are very similar to the ones that occur due to sleep loss and poor sleep quality, and it is suggested, that the effects are mediated by insufficient sleep and circadian disruption (Garde et al., 2020; Kecklund & Axelsson, 2016).

Circadian rhythms are physiological cyclic phenomena of the human body that are synchronized through light exposure. The circadian master clock is in the suprachiasmatic nucleus in the hypothalamus, and regulates bodily functions through nervous, humoral and endocrine pathways. The master clock also directly regulates the pineal gland, which produces melatonin, a hormone that signalises the dark–light cycle to most organs and tissues and is thus essential in maintaining the circadian synchronisation and the sleep–wake cycle (Buijs et al., 2003). Exposure to light at night-time in shift workers then suppresses their melatonin secretion. Different systems and cells also react to alterations in circadian rhythms at different speeds, which leads to a desynchronisation of rhythms with night shift work. The suppressed melatonin secretion and internal desynchronisation are thought to increase the risk for breast cancer at least (Haus & Smolensky, 2013).

Sleep duration has been found to be shorter among shift workers compared to daytime workers (Kecklund & Axelsson, 2016), and short sleep duration is linked with several adverse health consequences, such as type 2 diabetes, hypertension, obesity, CV disease and even mortality (Itani et al., 2017). Short sleep duration has been demonstrated to cause hormonal changes that contribute to the development of obesity and impaired glycaemic control, and low-grade inflammation is also associated with reduced sleep (Kwok et al., 2018). In addition of these changes in

physiology, it has been shown that shift work is also associated with poorer dietary habits with lower consumption of fruit and vegetables and more energy intake from saturated fats, which can further increase the risk for metabolic diseases such as type 2 diabetes (Hemiö et al., 2015).

The sleep duration of the shift workers is particularly short before early morning shifts and after night shifts. Average sleep duration has been found to be especially short with work schedules in which the rotation of the shifts is rapid (one to three similar shifts on a row) or the recovery time between shifts is short (<11 hours). Shift workers also report problems with sleeping more often than employees working conventional daytime hours, and 10–23 % of shift workers in rotating and night shift work develop a certain ‘shift work sleep disorder’ (Kecklund & Axelsson, 2016).

There are large personal differences on how employees tolerate shift work. One of the key features appears to be the chronotype, a genetically linked trait that refers to periods during the day when individuals are most awake and active. ‘Morning larks’ are most functional in the early morning hours, whereas ‘night owls’ are more awake and functional in the late afternoon and night hours. The morning types are found to have reduced tolerance for shift work. Other personal features, such as gender, age, previous sleep problems, mental and physical illnesses and social and family duties as well as some personality features can also affect the tolerance for shift work (Saksvik et al., 2011; Wickwire et al., 2017). As a conclusion, shift work containing night shifts can have adverse effects on health, mediated mostly by the effects of sleep loss and circadian disruption. However, the tolerance for shift work can vary markedly between individuals, and the unwanted consequences may affect especially those employees who are the most sensitive to shift work.

Shift Work, Quality of Life and Work Ability

There are several studies on the association of shift work and QoL. Many of them have been conducted on healthcare workers, but other occupational groups have also been studied. Most of the papers have the parallel result that shift workers often have poorer QoL than a normal population or employees working during conventional daytime hours (Kawabe et al., 2015; Lim et al., 2020; Nena et al., 2018; Turchi et al., 2019; Wickwire et al., 2017). The mediating factor between shift work and impaired QoL is at least partially thought to be disturbed sleep (Lim et al., 2020).

The association of shift work with work ability has not been very widely researched. In a study among women working in Iranian food supplier factories, work ability was detected to be the poorest among shift workers. In that study, good work ability was also found to be positively associated with good HRQoL (Tavakoli-Fard et al., 2016). In another study among Iranian industry workers, work ability was found to be the poorest among workers with three-shift schedules and with poor sleep

quality (Mokarami et al., 2020). However, there are also studies, in which work ability of the shift workers is not found to be worse than work ability of the daytime workers. In addition, there is evidence that forcing the employees to work on a schedule they find unsuitable for themselves is associated with significantly poorer work ability (Galatsch et al., 2013). This could be taken as an indicator that employees with lower work ability with shift work are willing to change their work pattern. In addition, the results of that study showed that fulfilling the employees' wishes for work scheduling improved their work ability (Galatsch et al., 2013). These findings support the model that shift work and other unconventional work schedules are especially unsuitable for some workers, whilst others can tolerate them quite well.

2.6 Summary of the Literature Review and Key Gaps in Earlier Research

The interest of this thesis is to study general QoL and work ability among public sector employees of the city of Pori and the factors associated with these outcomes. QoL is a very broad concept defining a person's health and well-being. There are many tools for the assessment of general QoL and HRQoL, but QoL in its most comprehensive meaning can be best assessed with tools based on the work of the WHOQOL project (WHOQOL Group, 1995). QoL among working-age Finns is good on average and has not changed significantly during the most recent two decades (Koponen et al., 2018; Koskinen et al., 2012). Along with QoL, work ability is very important for working-age people, and the WAI and the WAS have been found to be reliable tools to measure it by self-reporting (El Fassi et al., 2013; Ilmarinen, 2007). The majority of Finnish working-age people rate their work ability as good on average (Gould et al., 2008; Koponen et al., 2018). QoL and work ability have been found to be highly correlated in previous literature (Chiu et al., 2007; Milosevic et al., 2011; Mokarami et al., 2022), and despite some differences, many determinants of these two outcomes are similar. The factors that were chosen to be studied in association with QoL and work ability in this thesis are aspects that are relevant in health promotion and prevention of CV diseases. Some important previous findings about these factors, and gaps in earlier research, were as follows:

There is previous information about the associations of many individual CV risk factors with QoL (Bize et al., 2007; Goldenberg et al., 2014; Kroes et al., 2016), but only a few studies have investigated the concept of ideal CV health (with a combination of seven important CV health metrics) in association with QoL (Allen et al., 2015; Odom et al., 2016; Wu et al., 2021). To my knowledge, there are no previous works on the association of ideal CV health with general QoL. There is knowledge that adherence to a healthy diet, like the Mediterranean diet, is associated

with better QoL (Vajdi & Farhangi, 2020), but less has been known about the role of the consumption of healthy or unhealthy foods in association with QoL. Overall, although there is abundant information about factors associated with QoL in different populations, previous literature about associations with general QoL among the active public sector workforce was relatively scarce. More information was needed about the most important factors associated with QoL and work ability of these employees. This information could help in designing effective health promotion in order to prevent CV diseases and the decline in work ability. One important factor known to be associated with QoL and work ability is sleep. There is convincing evidence that sleep quality and duration are associated with health, QoL and work ability (Cappuccio et al., 2011; Kwok et al., 2018; Lallukka & Kronholm, 2016; Matsui et al., 2021) However, there were only a few previous studies about how changes in sleep are associated with QoL and work ability (Kronholm et al., 2021; Tang et al., 2017).

3 Aims

The aim of this thesis was to investigate general QoL and work ability, and the factors associated with these outcomes, among the employees of the City of Pori. The specific aims were:

1. To evaluate the association between the American Heart Association's concept of ideal CV health and QoL.
2. To widely assess factors that could be associated with QoL and self-reported work ability among the study participants.
3. To examine whether temporal changes in sleep parameters are associated with temporal changes in QoL and work ability over a one-year period.
4. To examine the association of the daily consumption frequencies of healthy and unhealthy food items with QoL in female employees.

4 Materials and Methods

4.1 Study Population

The study population of this thesis consisted of individuals participating the longitudinal PORTAAT (PORi To Aid Against Threats) survey in the years 2014 and 2015. The PORTAAT study was conducted among employees of the city of Pori (83,497 inhabitants in 2014) in southwest of Finland. The participating work units (10 out of 30) were selected by the chief of the welfare unit of Pori. The main selection criterion was that the work unit had not been involved in any health-promoting program other than routine occupational healthcare in the past few years. Invitations to participate and information on the study were sent to employees via email by the managers of the selected ten work units. The total number of employees in the chosen units was 2,570 (369 males, 2,201 females). Information events about the study were also organized for the employees. The employees willing to participate contacted the study contact person at their work unit, who then sent their contact information to the study nurse. There were no exclusion criteria. A total of 836 (104 males, 732 females) of the 2,570 invited employees participated in the study in 2014. The response rate in 2014 was 32.5%. All the initial respondents were invited to the second part of the study in 2015, and 710 (85%) of them (79 males, 631 females) attended. The participants' occupations included librarians, museum employees, janitors, information technology workers, social workers, nurses, physicians, administrative officials, and general office staff.

The formation of all the study populations is presented in Figure 1. The study population in the cross-sectional Study I is the 836 initial respondents at baseline in 2014. In the cross-sectional Study II, the study population is the 710 participants who attended the follow-up visit in 2015. The data from the year 2015 were chosen for Study II since complete information about psychosocial risk factors was available only from that year.

In the prospective follow-up Study III, 637 participants (76 males, 561 females) were included in the study population. The inclusion criteria were complete information about age, gender, educational level, and BMI at the first measurement point in 2014 and EUROHIS-QOL, WAS, and sleep duration at both measurement points (2014 and 2015). Participants who were pregnant at either time point ($n=7$),

were excluded. There were 126 participants who were excluded because they did not attend the follow-up visit and an additional 73 participants who were excluded due to missing information or pregnancy.

The study population in the cross-sectional Study IV consists of the 631 female participants who attended the follow-up visit in 2015. Information from the follow-up was chosen since data from the 45-item food frequency questionnaire (PORTAAT FFQ) were available only from that year. It is known that nutritional behaviours vary between genders (Grzymisławska et al., 2020), and since there were so few male participants, they were excluded from this study.

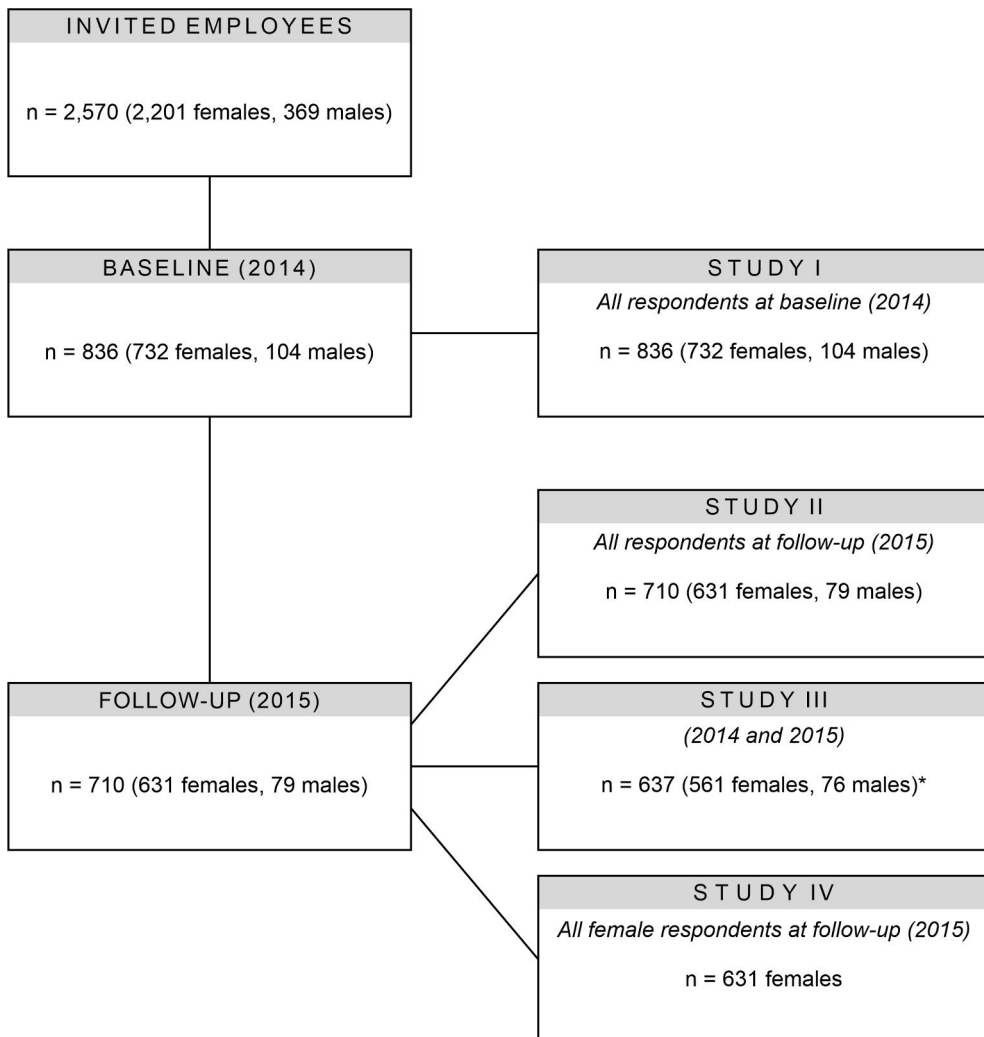


Figure 1. The formation of the study populations (Studies I–IV). *Subjects with missing information (n=66) or pregnancy (n=7) were excluded from the analyses.

4.2 Methods

4.2.1 Physical Examination and Questionnaires

At the enrolment visit with the study nurse, written informed consent to participate in the study was gathered from all the participants. Laboratory tests were taken after an overnight fast of at least eight hours, and the participants were given the study questionnaires to be completed at home before the next study visit. The questionnaires concerned the participants' health, QoL, work-related factors, lifestyle, sleep, psychosocial factors, and sociodemographic factors.

At the second appointment, height and weight were measured by the study nurse with subjects in a standing position without shoes and outer garments. Weight was measured to the nearest 0.1 kg with calibrated scales and height to the nearest 0.5 cm with a wall-mounted stadiometer. BMI was calculated as weight (kg) divided by the square of height (m²). Blood pressure was measured with an automatic validated blood pressure monitor with subjects in a sitting posture, after resting at least 5 minutes. Two readings taken at intervals of at least 2 minutes were measured, and the mean of these readings was used in the analysis. The subjects were instructed to perform blood pressure measurements at home (duplicate measurement twice a day) for a week if the mean reading of the twice measured blood pressure was at least 140 mmHg for systolic or 90 mmHg for diastolic blood pressure. Hypertension was defined as the use of medication for hypertension or if the mean reading of home blood pressure measures was at least 135 mmHg for systolic blood pressure or 85 mmHg for diastolic blood pressure. This threshold is recommended for diagnosing hypertension by home blood pressure measurements (Parati et al., 2008). The results of the questionnaires and laboratory tests were checked and reviewed with the participant. The study nurse gave personal recommendations for a healthy lifestyle, and if any medical problem needed further examination, the participant was guided to occupational healthcare.

Quality of Life (Studies I–IV)

QoL was assessed with the EUROHIS-QOL 8-item index (Power, 2003). The participants answered the questions at home before the study visits. Every question was scored from 1 to 5 (1 for very poor and 5 for very good). All scores were then added together and divided by 8 (the sum of the questions) to obtain the EUROHIS-QOL mean score (Schmidt et al., 2006).

Sociodemographic Factors (Studies I–IV)

Through self-administered questionnaires, information was gathered about age, gender, marital status (cohabiting or not; Study II, IV), having children <18 years of age (yes or no; Study II, IV), vocational education (vocational school, college-level education, or university-level education; Study I, II, III) and years of education (Study IV).

Work-Related Factors (Studies II, III)

Work ability was assessed with WAS, which is the first item of the WAI (Ilmarinen, 2007): ‘What is your current work ability compared with your lifetime best?’. On its 0–10 response scale, 0 stands for ‘completely unable to work’ and 10 stands for ‘work ability at its best’. Work ability was considered poor for scores of 0–5, moderate for scores of 6–7, good for scores of 8–9 and excellent for a score of 10 points, based on the scoring used in the WAI (Gould et al., 2008). Work-related stress (Study II) was evaluated with the BBI-15 (Näätänen et al., 2003). Responses for the 15 items of the BBI-15 are rated on a 6-point Likert-type scale (1=totally disagree, 6=totally agree). The total score of the indicator, which can vary from 15 to 90, was used in the analysis. The higher scores indicate more severe burnout symptoms; symptoms can be classified into severe, moderate, mild and no burnout, with specific threshold values according to gender and age (Näätänen et al., 2003). Burnout was assessed as a binary variable such that all scores from mild to severe burnout were set to indicate the presence of burnout symptoms. Working times (3-shift of not) were asked in the questionnaires (Study II).

Sleep (Studies I–IV)

Self-reported sleep quality was assessed with the question ‘During the past month, how would you rate your sleep quality overall?’ (Very good, Good, Poor, or Very poor). Sleep quality was categorised into these four classes in Studies I and III. In Study II, the two lowest classes of sleep quality were combined and set to indicate poor sleep quality. In Study IV, the variable was dichotomised into good/poor sleep quality. Sleep duration (Studies II, III) was measured with the question ‘During the past month, how many hours of sleep did you normally get at night?’. The participants were asked to answer the question in an open text field, and during the data entry, the answers were rounded to the nearest half an hour. Similar rounding of self-reported sleep duration has also been used in previous literature (Myllyntausta et al., 2017). Use of sleep medication (Studies II, III) was assessed with the question ‘During the past month, how often have you taken medicine (prescribed or ‘over the counter’) to help you sleep?’ (Not during the past month, Less than once a week,

Once or twice a week, or Three or more times a week). All these questions are items from the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989).

In Study III, three response categories were derived for all three sleep parameters to describe change in these variables between the two measurement points. For both sleep duration and use of sleep medication, the three categories were ‘increased’, ‘no change’ and ‘decreased’; for sleep quality, the categories were ‘improved’, ‘no change’ and ‘worse’. Any difference in sleep quality and sleep medication use and a difference of half an hour in sleep duration between baseline and follow-up were considered changes in the analyses.

Psychological Factors (Studies II, IV)

Depressive symptoms were assessed with the Major Depression Inventory (MDI) questionnaire (Bech et al., 2001). This inventory can be used as a diagnostic tool for major depression according to Diagnostic Manual of Mental Disorders (DSM-V) diagnostic criteria, as well as an assessment tool for the severity of depressive symptoms (Bech et al., 2001, 2015). To assess severity of depressive symptoms, a total score of 0–20 is considered no symptoms, 21–25 mild symptoms, 26–30 moderate symptoms and 31–50 severe depressive symptoms. In Studies II and IV, the total score of MDI was used as a continuous variable, and in Study II, the diagnostic tool was also used to determine whether a person was depressive or not.

Anxiety was assessed with the General Anxiety Disorder 7-item scale (GAD-7) (Spitzer et al., 2006). In the GAD-7, a total score of 0–4 is considered no anxiety, 5–9 mild anxiety, 10–14 moderate anxiety and 15–21 severe anxiety. This categorisation into four classes was used in Study II. In multivariable analyses of the same study, a binary variable for anxiety with a cut-off point of 10 of the total score was used. This cut-off is recommended by the developers of the GAD-7 questionnaire (Spitzer et al., 2006). In Study IV, the total score of GAD-7 was used as a continuous variable.

Food Consumption (Studies I, IV)

The food consumption frequencies in 2014 were reported using a non-quantitative 16-item Food Frequency Questionnaire (FFQ). The questionnaire was constructed for the PORTAAT Study based on diet questionnaires used in former Finnish population surveys. The FFQ had lines for white bread and dark (rye) bread; sweet bakery products; crisps; sweets; fresh fruit; fresh vegetables; berries; cheese; fat-free or low-fat ($\leq 1\%$) dairy products; other dairy products; sausages; red meat; white meat (poultry); fish; and eggs. The FFQ had five answer columns: Every day, On 3-

6 days a week, Few times a month, More rarely and Not at all. The instruction was to tick a suitable column.

In 2015, the food consumption frequencies during the prior week were reported using a non-quantitative 45-item FFQ (PORTAAT FFQ). This questionnaire was based on the version developed for and validated to study children's diets with parents filling in the questionnaires (Korkalo et al., 2019). The PORTAAT FFQ included eight food groups: vegetables, fruit, and berries; dairy products; fats and oils; fish; meat and eggs; cereal products; drinks; and others (i.e., sweets and snacks). Additional lines for the frequencies of meals and the use of dietary supplements were included. The PORTAAT FFQ had three answer columns: Not at all, Times per week and Times per day. The instruction was to either tick the 'Not at all' column or to write a number in one of the other columns.

For Study I, the consumption of fruit, vegetables, white meat, fish, and whole grain products was obtained directly from the 16-item FFQ. The use of unsaturated dietary fats was estimated based on the consumption of fat-free milk products, cheeses, red meat, sausages and crisps.

For Study IV, the items in the eight main categories of the PORTAAT FFQ were categorised into healthy and unhealthy foods, and 11 groups of healthy foods and six groups of unhealthy foods were derived (Table 9). Nutritionally neutral items were excluded. From the data collected with the FFQ, the mean daily consumption frequency of foods in the same group was summed and used as an indicator of dietary consumption. For example, the daily consumption frequency of whole grain breads, pasta, rice, porridge, muesli, etc. was summed and used as an indicator of whole grain product consumption. If the consumption frequency of a food was reported as times per week, the weekly consumption frequency was divided by seven to get the mean daily consumption frequency. Two sums of variables were derived: the consumption frequency of healthy foods was the sum of the consumption frequencies in the 11 healthy food groups, while the consumption frequency of unhealthy foods was the sum of the consumption frequencies in the six unhealthy food groups. Regular breakfast was defined as having breakfast every day.

Table 9. The healthy and unhealthy food groups.

Healthy Food Groups	Unhealthy Food Groups
Fat free milk and sour milk, low-fat cheese (fat <20%)	Red meat, sausages, red cold meat
Unflavoured nuts, seeds, and almonds	Juices and beverages sweetened with sugar
Legumes (peas, lentils, beans)	Savoury bakery products such as pies and pastries, potato crisps and nachos, popcorn, salted nuts
Fresh vegetables	Sweet bakery products (buns, pies, cookies, cakes), chocolate, sweets
Fresh fruit and berries	Alcohol
Whole grain pasta and rice, rye bread, rye crisp bread, breakfast cereal, muesli, porridge	High-fat dairy products: full fat milk and sour milk, full-fat cheese (fat >20%), butter, butter-oil spreads (fat >80%)
Fish and fish dishes	
Margarines and oils (cooking, bread spread, salad dressing)	
Cooked vegetables	
Eggs	
White meat	

From Study IV (Bergman et al. 2022) © 2022 The Authors. Published by MDBI. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>).

Other Health Habits (Studies I, II and IV)

Smoking status was assessed by a questionnaire and dichotomised into current smoking/non-smoking. Non-smoking was defined as having never smoked or having quit smoking >12 months ago (Studies I, II, IV). Alcohol consumption was assessed using the 3-item Alcohol Use Disorders Identification Test (AUDIT-C) (Bush et al., 1998). In Study II, alcohol consumption was dichotomised into harmful alcohol use or not, with a cut-off of 5 points in women and 6 points in men (Aalto et al., 2006; Tuunanen et al., 2007). In Study IV, the total score of AUDIT-C was used as a continuous variable.

Physical activity was assessed with a self-administered questionnaire about the frequency and duration of leisure-time physical activity and commuting activities in a typical week. The questionnaire was constructed for the PORTAAT Study based on physical activity questionnaires used in former population surveys. The participants were asked to assess their physical activity with the following six items; 1=No regular physical activity, 2=Light aerobic type (e.g. slow walking), 3=Moderate aerobic type (e.g. brisk walking), 4=Vigorous aerobic type (e.g. running), 5=Resistance type of training (e.g. gym training), 6=Activity related to balance (e.g. dance or games). Participants were instructed to report all weekly physical activity lasting longer than 10 minutes. Each item included a question about the frequency

and duration of activity. Both moderate aerobic type (3, e.g. walking) and vigorous aerobic type activity (4, e.g. running) were considered, and physical activity was reported as minutes (Study I) or hours (Study IV) per week.

Previously Diagnosed Diseases and Current Medication (Studies I–IV)

Information concerning previous medical history (diseases diagnosed by a physician) and medication used regularly (Study I), was gathered using self-administered questionnaires and from the medical records. Disease burden (Studies I, II, III) was defined as having at least one chronic disease diagnosed by a physician. In Study IV, the number of chronic, diagnosed diseases was used.

4.2.2 Laboratory Measurements

Laboratory tests were determined on blood samples which were obtained after at least eight hours of fasting. Plasma glucose, total cholesterol, high-density lipoprotein cholesterol (HDL-C) and triglycerides were measured enzymatically (Architect c4000/c8000). Low-density lipoprotein cholesterol (LDL-C) was calculated by the Friedewald's formula (Friedewald et al., 1972). Glycated haemoglobin (HbA1c) was analysed using the high performance liquid chromatography method, (Tosoh HLC-723G7 (G7)).

4.2.3 The Ideal Cardiovascular Health Metrics

The American Heart Association's ideal CV health metrics were used to assess the CV health of the participants (See Table 5). The ideal metrics were defined as binary variables, the participants either achieving the ideal or not. The cut-off values used for defining the ideal levels of the metrics were the ones recommended by the American Heart Association (Lloyd-Jones et al., 2010). A modified version of the classification was used, in which blood pressure, total cholesterol and glucose tolerance treated to goal were also regarded as ideal. This was based on the European guidelines on CV disease prevention (Piepoli et al., 2016), in which these medications are handled, in non-complicated cases, as primary prevention for CV disease. The diet score used was also modified from the original. In the American Heart Association's original metrics, the ideal diet metric is achieved by reaching four or five of the following recommendations: 1) fruit and vegetables: ≥ 450 g per day, 2) fish: \geq two 100 g servings per week (preferably oily fish), 3) fibre-rich whole grains: \geq three 30 g servings per day, 4) sodium: < 1500 mg per day and 5) sugar-sweetened beverages: ≤ 450 kcal per week. In my study, the dietary metric was defined as ideal if the consumption rate of at least three times a week was achieved

in four or five of the following food groups: fruit, vegetables, whole grains, unsaturated dietary fats, and white meat (poultry, fish). Furthermore, I used HbA1c instead of fasting plasma glucose to determine normoglycemia, because HbA1c can give an indication of glycemia over several preceding weeks rather than at a single time point (Selvin et al., 2007).

The CV health of the participants was categorised into three categories by the achievement of 0–2, 3–4 or 5–7 ideal metrics. This categorisation was based on previous research on the American Heart Association’s ideals to describe poor/unfavourable (0–2 ideal CV health metrics), intermediate (3–4) and ideal/favourable (5–7) levels of cardiovascular health (Willis et al., 2015).

Ideal Health Factors

Blood pressure was considered ideal if the systolic blood pressure was <120 mmHg and the diastolic blood pressure was <80 mmHg untreated or treated to goal with primary preventive medication. The ideal level of total cholesterol was <5.18 mmol/l (<200 mg/dl), and normoglycemia was defined as HbA1c <42 mmol/mol (International Expert Committee, 2009). Both total cholesterol and glucose tolerance were categorised as ideal if the goal levels were achieved either untreated or with primary preventive medication.

Ideal Health Behaviours

Ideal smoking status was defined as having never smoked or having quit smoking >12 months ago. The dietary metric was defined as ideal if the consumption rate of at least three times a week was achieved in four or five of the following food groups: fruit, vegetables, whole grains, unsaturated dietary fats, and white meat (poultry, fish). The ideal level of physical activity was defined as engaging in ≥ 75 minutes per week of vigorous intensity activities, or ≥ 150 minutes per week of moderate intensity activities, or a combination of ≥ 150 minutes per week of moderate and vigorous intensity activities. The ideal BMI was classified as <25.0 kg/m².

4.2.4 Statistical Analyses

The data are presented as means and with standard deviations (SD) or 95% confidence intervals (CI) for continuous variables, if the variable is normally distributed. Categorical variables are presented with counts and percentages (%). All statistical tests were performed as two-sided, with a significance level set at 0.05. Normality assumptions were checked visually together first with a Shapiro-Wilk test first before analysis and then with studentised residuals after analysis.

As a summary for Studies I–III, a chi-square test was used to study associations between two categorical variables in basic background comparisons and in univariate approaches. A one-way analysis of variance (ANOVA)/Student t-test was used when the response was continuous. Multivariable modelling was performed with a linear model, including both categorical and continuous explanatory variables in the models. These models were reported with F-values, degrees of freedom (DF), p-values and with model-based 95% CI for means. Details for modelling are presented below.

In Study I, the association between categorical baseline characteristics and gender was evaluated with a chi-square test or with a two-sample t-test for numerical variables with an assumption of equal variances. To test the association between classified CV health (poor, intermediate or ideal) and explanatory characteristics (age, gender, disease burden, cohabiting, children < 18 years, sleep quality, education and items of the EUROHIS-QOL) separately, a one-way ANOVA or a chi-square test was used. The same tests were used to test the association of EUROHIS-QOL total score with CV health profiles, individual health metrics and other characteristics separately. A multi-way analysis of covariance (ANCOVA) was created for EUROHIS-QOL total score; age, gender, cohabiting, education, sleep quality, CV health as classified, and disease burden were all entered into the model. Model-based means of EUROHIS-QOL with 95% CI, F-values, and DF are presented. For multiple group comparisons, Tukey's adjusted method was used.

In Study II, the association between sleep quality and background variables was evaluated using a chi-square test or a one-way ANOVA. Association between EUROHIS-QOL/work ability (WAS) and background variables including sleep quality were examined first one by one (univariate approach), with one-way ANOVA or with linear regression. Two multivariable (ANCOVA) models (one for EUROHIS-QOL and one for WAS) were then built up; age, gender, and all factors with a significant association with QoL and/or work ability in the univariate approach were entered into the models. The method used was a linear model and assumptions were checked using studentised residuals. The results are reported as model-based means of EUROHIS-QOL or WAS with 95% CI, F-values and DF.

In Study III, models for multiway ANCOVA were built to study factors that could be associated with EUROHIS-QOL and WAS change. The outcome measures in the models were the mean changes of EUROHIS-QOL and WAS between the years 2014 and 2015, which were calculated by subtracting the baseline measurement from the 2015 measurement. Change in sleep quality, sleep duration, and sleep medication use were all entered in different models (due to collinearity issues) separately for EUROHIS-QOL change and WAS change. The results are reported as mean changes with 95% CI, F-values and DF. All the models were adjusted for age, gender, BMI, educational level, disease burden, and the studied

outcome measure (EUROHIS-QOL or WAS) level at baseline (2014). Multiple group comparisons between different classes of changes in sleep parameters in the adjusted models were also performed. Mean differences between the groups with 95% CI are reported to indicate effect sizes. For multiple group comparisons, Tukey's adjusted method was used.

In Study IV, the linearity across the four level groups of healthy foods consumed per day was evaluated using the Cochran-Armitage test (chi-square test for trend), ordered logistic regression and ANOVA with an appropriate contrast (orthogonal). Van der Waerden rank-based normalization (Solomon & Sawilowsky, 2009) was used to yield standardised scores for consumption frequencies of healthy and unhealthy foods.

A possible nonlinear relationship between EUROHIS-QOL and consumption frequencies was assessed by using four-knot restricted cubic spline regression models with knots located at the 5th, 35th, 65th, and 95th percentiles. For restricted cubic splines, also known as natural splines, knot locations are based on Harrell's recommended percentiles (Harrell, 2001). Multivariate linear regression analysis was used to identify the relationship between QoL and the normalised standard scores for consumption of (healthy and unhealthy) foods with standardised regression coefficient beta (β). The beta value is a measure of how strongly the predictor variable influences the criterion variable. The beta is measured in units of SD. Cohen's standard for beta values above 0.10, 0.30 and 0.50 represent small, moderate, and large relationships, respectively. The Finnish general population values for the EUROHIS-QOL (Koskinen et al., 2012) were weighted to match the age distribution of the study population. In the case of violation of the assumptions (e.g. non-normality) for continuous variables, a bootstrap-type method was used.

The differences in the levels of smoking and harmful alcohol use between baseline (Study I) and follow-up (Study II) were checked with McNemar's test to determine whether it is a true improvement, or a sign of selective dropout. These analyses were made for the thesis summary and were not used in any of the studies.

The analyses for Studies I, II and III, as well as the additional analysis for the summary, were performed using SAS, version 9.4 for Windows (SAS Institute Inc., Cary, NC, US). The analyses for Study IV were performed using the Stata 16.1, Stata Corp LP (College Station, TX, US) statistical package.

4.2.5 Ethical Issues

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study protocol and consent forms were reviewed

and approved by the Ethics Committee of the Hospital District of Southwest Finland (ETMK 43/180/2013). Written informed consent was obtained from all individual participants included in the study. All information gathered in the study is saved in a structured and secured database administered by the University of Turku. The information was coded to ensure that the study subjects cannot be identified from the data without using a specific code. The code is kept secured at the Department of General Practice of the University of Turku.

5 Results

5.1 Characteristics of the Participants

At baseline (Study I), there were 836 participants with a mean age of 48 years (SD 10, Range 19–67), 87.6% of whom were female. Harmful alcohol use was more common in men ($p=0.001$) and the men used statins more often than women ($p < 0.001$), but no other significant differences were detected between genders at baseline in the variables presented in Table 10. Basic characteristics, quality of sleep and EUROHIS-QOL mean scores from Studies I–IV are presented in Table 10. The differences between basic characteristics among the different study populations (Studies I–IV) were mostly small. Significant differences in the levels of smoking and harmful alcohol use were, however, detected between baseline (Study I) and follow-up (Study II). These differences were not analysed in any of the thesis studies, but additional analyses were performed for this summary. A significant decrease in both harmful drinking and smoking was detected (both $p < 0.0001$), but smoking and harmful drinking were also more frequent among the dropouts than among all the study participants at baseline. Of the dropouts 19%, and of all the participants 14%, were smoking at baseline. For harmful drinking, the corresponding figures were 37% vs. 24% at baseline. In the prospective follow-up Study III, the 199 participants who were excluded from the analyses did not vary significantly from the study cohort in terms of gender, BMI, disease burden, sleep duration, sleep quality, or QoL, but they were slightly older and less educated. They also used more sleep medications at the follow-up visit, and their work ability had developed more unfavourably during the follow-up period compared to the study cohort.

The initial response rate in the study was only 32.5%, and limited information about the non-respondents was available. Therefore, several analyses were made to examine how well the study participants resembled the whole personnel of the city of Pori, municipal employees in Finland, and the general population in Finland in the same age distribution. The gender distribution in the study (88% females) resembles the gender distribution among the employees working at the work units that were invited to participate in the study (86% females in 2014) and is close to the distribution among the employees of the city of Pori (78% females in 2014) (*Porin Kaupungin Henkilöstöraportti 2014*, 2014). The proportion of female employees is,

however, somewhat higher in the study population than among Finnish public sector employees in general (72% females) (Statistics Finland, 2017). The mean age of 48 years among the study participants resembled the mean age among all personnel of the city of Pori (46 years among all personnel and 48 years among the permanent personnel) (*Porin Kaupungin Henkilöstöraportti 2014*, 2014). The mean annual rate of sickness absence days did not vary significantly between the study participants and the non-participants in the included employment sectors. The mean incidence of sickness absence days was 11 days per year among the study participants during the 2-year period (2014–2015) (Vuorio et al., 2019), and the mean sickness absence rate among all employees of the selected work units was 12 days in 2015 (*Porin Kaupunki Henkilöstöraportti 2015*, 2015).

The prevalence of smoking in my study population at baseline was comparable to that among working-age people in Finland (13% in women and 16% in men vs. 14% and 17%, respectively (Helldán & Helakorpi, 2015). The proportion of obese (BMI ≥ 30 kg/m²) females was 20% in my study in 2014, while in the general working-age population it was 22% in 2011 and 26% in 2017 (Koponen et al., 2018). Male participants in my study population appeared to be more often obese than in the Finnish working-age population on average. The proportion of obese males was 31% in my study in 2014, and 24% in 2011 and 27% in 2017 in the general working-age population (Koponen et al., 2018). Depressive symptoms were rare in my study population. Only 2.5% of the participants reported a previous diagnosis of depression at baseline, and nine (1.3%) of the participants met the diagnostic criteria for major depression at follow-up. The prevalence of depression (a depressive disorder diagnosed or treated by a physician during the past 12 months) in 2016 was 8% among females and 6% among males in the Finnish general population (Koponen et al., 2018).

Table 10. Characteristics of the participants in Studies I–IV. The years refer either to baseline (2014) or follow-up (2015), where the data are derived from.

		Study I (2014) n=836		Study II (2015) n=710	Study III (2014) n=637	Study IV (2015) n=631
	All	Females	Males			
Gender n, (%)						
Female	732 (87.6)	-	-	631 (88.9)	561 (88.1)	631 (100)
Male	104 (12.4)	-	-	79 (11.1)	76 (11.9)	-
Age, years, mean (SD)	48.2 (10)	48.0(10)	49.7 (9)	49.0 (10)	48.0 (10)	49.0 (10)
Vocational education n, (%)						
Vocational school	26 (3.2)	23 (3.2)	3 (2.9)	21 (3.0)	16 (2.5)	
College level	429 (52.1)	379 (52.6)	50 (48.5)	361 (51.6)	322 (50.6)	
University level	368 (44.7)	318 (44.2)	50 (48.5)	318 (45.4)	299 (46.9)	
Cohabiting n, (%)	657 (78.6)	570 (77.9)	87 (83.7)	575 (81.2)		505 (80.0)
Current smoking n, (%)	114 (13.6)	97 (13.3)	17 (16.3)	64 (9.0)		52 (8.2)
Harmful alcohol use n, (%)	202 (24.3)	163 (22.4)	39 (37.9)	101 (14.2)		
Disease burden* n, (%)	503 (60.2)	441 (60.3)	62 (59.6)	468 (65.9)	383 (60.1)	
Cardiovascular medication n, (%)						
Statins	53 (6.3)	37 (5.1)	16 (15.4)			
Antihypertensive medication	181 (21.7)	155 (21.2)	26 (25.0)			
Diabetes medication	35 (4.2)	31 (4.2)	4 (3.8)			
Quality of sleep, n (%)						
Very good	99 (12.0)	81 (11.2)	18 (17.5)	103 (14.5)	71 (11.2)	479 (75.9)
Good	495 (60.1)	430 (59.6)	65 (63.1)	441 (62.1)	385 (60.9)	
Poor	208 (25.2)	189 (26.2)	19 (18.4)	151(21.2)	161 (25.5)	152 (24.1)
Very poor	20 (2.4)	19 (2.6)	1 (1.0)	15 (2.1)	15 (2.4)	
EUROHIS-QOL mean score (SD)	3.92 (0.54)	3.93 (0.53)	3.87 (0.56)	4.07 (0.51)	3.94 (0.52)	4.07 (0.52)

*At least one chronic disease diagnosed by a physician.

EUROHIS-QOL; EUROHIS-QOL 8-item index, SD; standard deviation

5.2 Ideal Cardiovascular Health and Quality of Life (Study I)

5.2.1 Prevalence of Ideal Cardiovascular Health

The prevalence of ideal CV health (5–7 ideal health metrics) was 25.1% (n=210), intermediate CV health (3–4 metrics) 53.6% (n=448), and poor CV health (0–2 metrics) 21.3% (n=178). The best achieved individual metric among the study population was the normal level of HbA1c, achieved by 94.4% of women and 88.5% of men. The most seldom achieved metric was the blood pressure level <120/80 mmHg, which was achieved by 20.8% of women and 7.7% of men (Table 11). Diabetes medication was used by 4.2% of female and 3.8% of male participants, and 21.2% of females and 25.0% of males used antihypertensives. Statins were used by 5.1% of females and 15.4% of males (Table 10). Females achieved the metrics of ideal BMI, healthy diet, ideal blood pressure and blood glucose level significantly better than males, but there was no significant difference in the achievement of ideal, intermediate or poor CV health between the genders ($p=0.069$) (Table 11). The mean age of the female participants was 1.7 years lower than the mean age of the males (48.0 vs. 49.7 years), but the difference between genders was not significant ($p=0.085$).

The individuals with more favourable CV health tended to be younger, cohabiting, and more educated. They typically had children <18 years of age and had better sleep quality. There was no significant difference in the presence of a disease burden (having at least one chronic disease diagnosed by a physician) or harmful alcohol use between the categories of CV health (data shown only in the original publication I; Bergman et al. 2019).

Table 11. The prevalence of achieving different levels of cardiovascular health and individual health metrics according to gender.

	All n=836	Females n=732	Males n=104	P-value*
Cardiovascular health profiles, n (%)				0.069
Poor (0–2 metrics)	178 (21.3)	149 (20.4)	29 (27.9)	
Intermediate (3–4 metrics)	448 (53.6)	391 (53.4)	57 (54.8)	
Ideal (5–7 metrics)	210 (25.1)	192 (26.2)	18 (17.3)	
Individual ideal health metrics, n (%)				
Non-smoking	722 (86.4)	635 (86.7)	87 (83.7)	0.39
Body mass index <25.0 kg/m ²	322 (38.5)	297 (40.6)	25 (24.0)	0.001
Adequate physical activity †	334 (40.0)	290 (39.6)	44 (42.3)	0.60
Healthy diet ‡	282 (33.7)	258 (35.2)	24 (23.1)	0.014
Total cholesterol <5.18 mmol/l	390 (46.7)	341 (46.6)	49 (47.0)	0.92
Blood pressure <120/80 mmHg	160 (19.1)	152 (20.8)	8 (7.7)	0.002
B-HbA1c <42mmol/mol (<6.0%)	783 (93.7)	691 (94.4)	92 (88.5)	0.020

* Difference between males/females. † Engaging in ≥ 150 minutes per week of moderately intense activities or ≥ 75 minutes per week of vigorously intense activities. ‡ Daily consumption of vegetables, fruit, whole grains, unsaturated dietary fats, and white meat (poultry, fish) at least three times a week was considered as a healthy diet. Intake of the ideal level of each dietary component was scored with one point for a range of 0–5. The dietary metric was considered as ideal if a score of 4–5 was achieved. B-HbA1c; glycated haemoglobin. Modified from Study I (Bergman et al. 2019) © 2019 The Authors. Published by Elsevier Inc. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

5.2.2 The Association of Ideal Cardiovascular Health with Quality of Life

The EUROHIS-QOL mean score increased according to the total number of ideal CV health metrics. The scores were 3.72, 3.91 and 4.10 among subjects with poor, intermediate and ideal CV health, respectively ($p < 0.0001$). Additionally, all subcategories of CV health differed significantly from each other (all p -values ≤ 0.0003). The mean scores of the individual items of the EUROHIS-QOL increased with more favourable CV health profiles. With poor CV health, the mean values of the individual items varied between 3.4 and 4.2 while with ideal CV health the mean values varied between 3.9 and 4.4. A significant positive association was present in all eight items. The mean scores of the EUROHIS-QOL according to CV health profiles are presented in Table 12.

Table 12. Mean scores of the EUROHIS-QOL 8-item index (total score and individual items) according to cardiovascular health profiles.

	Cardiovascular health profiles			P-value
	Poor 0–2 metrics (n=178)	Intermediate 3–4 metrics (n=448)	Ideal 5–7 metrics (n=210)	
EUROHIS-QOL, mean score (95% CI)*	3.72 (3.64–3.91)	3.91 (3.86–3.96)	4.10 (4.04–4.16)	<0.0001
Items of the EUROHIS-QOL, mean score (95% CI)				
How would you rate your quality of life?	3.70 (3.60–3.81)	3.89 (3.83–3.95)	4.02 (3.94–4.10)	<0.0001
How satisfied are you with your health?	3.37 (3.22–3.53)	3.68 (3.56–3.76)	3.99 (3.88–4.10)	<0.0001
How satisfied are you with your ability to perform your daily living activities?	3.81 (3.69–3.93)	4.05 (3.98–4.13)	4.30 (4.21–4.39)	<0.0001
How satisfied are you with yourself?	3.51 (3.39–3.64)	3.77 (3.70–3.84)	3.96 (3.88–4.04)	<0.0001
How satisfied are you with your personal relationships?	3.91 (3.80–4.03)	4.04 (3.97–4.11)	4.12 (4.01–4.22)	0.0098
How satisfied are you with the conditions of your living place?	4.23 (4.13–4.33)	4.30 (4.23–4.36)	4.40 (4.31–4.50)	0.011
Do you have enough energy for everyday life?	3.68 (3.56–3.81)	3.84 (3.76–3.93)	4.09 (3.97–4.39)	<0.0001
Have you enough money to meet your needs?	3.53 (3.38–3.68)	3.74 (3.65–3.83)	3.93 (3.79–4.06)	0.0004

*All pairwise comparisons $p \leq 0.0003$. CI; confidence interval, EUROHIS-QOL; EUROHIS-QOL 8-item index. Modified from Study I (Bergman et al. 2019) © 2019 The Authors. Published by Elsevier Inc. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

The association of EUROHIS-QOL mean score was examined first separately with individual health metrics and other characteristics of the participants. The EUROHIS-QOL mean score was significantly higher in participants having a healthy diet, a recommended level of physical activity, normal BMI, and a normal blood glucose level and in those who were non-smoking, compared to those who did not achieve these ideals. The EUROHIS-QOL mean score was also higher among those who were cohabiting, had good sleep quality, university-level education and no chronic illnesses. Levels of blood pressure and total cholesterol, harmful alcohol use and having children <18 years of age were not associated with EUROHIS-QOL mean score.

The CV health profiles and the background variables that were significantly associated with QoL in the univariate approach, were entered in the multiway analysis of covariance (ANCOVA) and adjusted with gender and age. Good QoL was positively associated in this model with good sleep quality, favourable CV health profile, absence of a disease burden, higher age, university-level education and cohabiting. Sleep quality had the most powerful impact on QoL in that model. The difference of EUROHIS-QOL mean score estimates between very good and very poor sleep quality was 0.70 units, and between the poor and the ideal CV health 0.32 units (Table 13).

Table 13. Predictors of quality of life in a multiway analysis of co-variance.

Predictors of quality of life	Model-based EUROHIS-QOL mean scores (95% CI)	F-value (DF)	P-value	P-values for group comparisons	
Quality of sleep		29.63 (3)	<0.0001		
Very good	4.09 (3.97–4.21)			Very good vs. Good	0.0041
Good	3.91 (3.82–4.00)			Very good vs. Poor	<0.0001
Poor	3.63 (3.53–3.73)			Very good vs. Very poor	<0.0001
Very poor	3.39 (3.16–3.62)			Good vs. Poor	<0.0001
				Poor vs. Very poor	0.14
Cardiovascular health profiles		18.26 (2)	<0.0001		
Ideal (5–7 metrics)	3.92 (3.80–4.03)			Ideal vs. Poor	<0.0001
Intermediate (3–4 metrics)	3.75 (3.65–3.86)			Ideal vs. Intermediate	0.0003
Poor (0–2 metrics)	3.60 (3.48–3.71)			Poor vs. Intermediate	0.0016
Disease burden*		18.92 (1)	<0.0001		
Yes	3.68 (3.58–3.78)				
No	3.83 (3.73–3.94)				
Education		4.48 (2)	0.012		
Vocational school	3.70 (3.49–3.91)			Vocational vs. College	0.94
College-level	3.73 (3.65–3.82)			Vocational vs. University	0.36
University-level	3.84 (3.75–3.92)			College vs. University	0.0089
Cohabiting		4.31 (1)	0.038		
Yes	3.80 (3.70–3.90)				
No	3.71 (3.60–3.83)				
Gender		3.71 (1)	0.054		
Female	3.81 (3.72–3.90)				
Male	3.71 (3.58–3.84)				
Age, slope estimate (SE) †	0.0058 (0.0019)	8.87 (1)	0.0030		

The impact of each variable on the outcome is displayed after adjusting for all other variables. * At least one chronic disease diagnosed by a physician † Slope value indicates the mean increase in EUROHIS-QOL mean score for one-year older person. CI; confidence interval, DF; degrees of freedom, SE; standard error. Modified from Study I (Bergman et al. 2019) © 2019 The Authors. Published by Elsevier Inc. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

5.3 Factors Associated with Quality of Life and Work Ability (Study II)

The basic characteristics of the participants at the follow-up visit (2015) are presented in Table 10. In addition to the characteristics examined at baseline, data about psychological symptoms and work-related factors were available from that

year. Only 9 (1.3%) of the participants were diagnosed as depressive according to the MDI diagnostic tool. All of them were also classified as anxious (GAD-7 score >10). The measures from these two psychological symptoms were combined for multivariable analyses. Additional characteristics among the participants of Study II are presented in Table 14.

Table 14. Additional characteristics of the participants of Study II (2015).

Characteristic	N (%)
3-shift work, n (%)	76 (10.9)
Body mass index, kg/m ² , mean (95% CI)	26.8 (26.42–27.13)
Depression, n (%)	9 (1.3)
MDI mean score (95% CI)	5.0 (4.57–5.43)
Level of anxiety, n (%)	
No anxiety (GAD-7 score 0–4)	534 (75.2)
Mild anxiety (5–9)	143 (20.1)
Moderate anxiety (10–14)	26 (3.7)
Severe anxiety (15–21)	7 (1.0)
BBI-15 mean score (95% CI)	31.6 (30.82–32.41)
At least mild occupational stress, n (%)	70 (10.6)
Sleep duration, hours, mean (95% CI)	7.00 (6.93–7.07)

BBI15; Bergen Burnout Indicator 15, CI; Confidence Interval, GAD-7; General Anxiety Disorder 7-item Scale, MDI; Major Depression Inventory. Modified from Study II (Bergman et al. 2020) © 2020 The Authors. Published by the BMJ Publishing Group Ltd. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by-nc/4.0/>).

5.3.1 Factors Associated with Sleep Quality

Because sleep quality turned out to be a very important factor associated with QoL in Study I, the characteristics of the study population of Study II were also examined according to sleep quality. Sleep quality was reported to be very good by 14.5%, good by 62.1%, poor by 21.2% and very poor by 2.1% of the participants. Poor and very poor sleep quality were combined and set to indicate poor sleep quality in the analyses. Good self-reported sleep quality was negatively associated with disease burden, the prevalence of depression and severity of depressive symptoms, anxiety and work stress, and positively associated with QoL and work ability. Better sleep quality was also associated with longer sleep duration (Table 15). There were only five participants with a previously diagnosed obstructive sleep apnoea and three with restless legs syndrome. During the previous month, 14.8% of the participants had used sleep medication at least occasionally. The use of sleep medication was more common in women (15.1% vs 12.6% in men, $p=0.038$).

Table 15. Characteristics of the participants of Study II (2015), according to sleep quality.

Characteristic	Sleep quality			P-value
	Very good (n=103)	Good (n=441)	Poor (n=166)	
Age mean, years (SD)	47.5 (10.6)	49.1 (9.7)	49.8 (9.2)	0.072
Gender, n (%)				0.10
Female	85 (13.5)	397 (62.9)	149 (23.6)	
Male	18 (22.8)	44 (55.7)	17 (21.5)	
Education, n (%)				0.36
Vocational school	4 (19.1)	14 (66.7)	3 (14.3)	
College-level	53 (14.7)	232 (64.3)	76 (21.1)	
University-level	45 (14.2)	188 (59.1)	85 (26.7)	
Cohabiting, n (%)	83 (14.4)	353 (61.4)	139 (24.2)	0.64
3-shift work, n (%)	15 (19.7)	44 (57.9)	17 (23.4)	0.41
Smoking, n (%)	9 (14.1)	44 (68.8)	11 (17.2)	0.45
Harmful alcohol consumption, n (%)	18 (17.8)	59 (58.4)	24 (23.8)	0.55
Body mass index, kg/m², mean (95% CI)	26.4 (25.50–27.25)	27.0 (26.54–27.46)	26.5 (25.72–27.24)	0.92
Disease burden*, n (%)	55 (11.8)	289 (61.8)	124 (26.5)	0.0016
Depression, n (%)	0 (0.0)	3 (33.3)	6 (66.7)	0.016
MDI mean score (95% CI)	2.4 (1.75–2.97)	4.1 (3.59–4.51)	9.2 (8.09–10.27)	<0.0001
Level of anxiety (GAD-7), n (%)				<0.0001
No anxiety	92 (17.2)	343 (64.2)	99 (18.5)	
Mild anxiety	10 (7.0)	85 (59.4)	48 (33.6)	
Moderate anxiety	1 (3.9)	10 (38.5)	15 (57.7)	
Severe anxiety	0 (0.0)	3 (42.9)	4 (57.1)	
BBI-15 mean score (95% CI)	28.3 (26.43–30.23)	31.0 (30.05–31.99)	35.4 (33.60–37.20)	<0.0001
At least mild occupational stress, n (%)	3 (4.3)	38 (54.3)	29 (41.4)	<0.0001
Sleep duration, hours, mean (95% CI)	7.50 (7.35–7.66)	7.17 (7.09–7.24)	6.23 (6.09–6.38)	<0.0001
EUROHIS-QOL mean score (95% CI)	4.38 (4.30–4.45)	4.09 (4.05–4.14)	3.83 (3.75–3.91)	<0.0001
WAS mean score (95% CI)	8.99 (8.78–9.20)	8.34 (8.22–8.46)	7.80 (7.55–8.04)	<0.0001
Level of work ability (WAS), n (%)				<0.0001
Poor	1 (3.7)	12 (44.4)	14 (51.9)	
Moderate	3 (2.6)	69 (60.5)	42 (36.8)	
Good	61 (13.3)	298 (64.9)	100 (21.8)	
Excellent	37 (34.6)	60 (56.1)	10 (9.4)	

*At least one chronic disease diagnosed by a physician, BBI-15; Bergen Burnout Indicator 15, CI; Confidence Interval, EUROHIS; EUROHIS-QOL 8-item index, GAD-7; General Anxiety Disorder 7-item Scale, MDI; Major Depression Inventory, SD; Standard deviation, WAS; Work Ability Score. Modified from Study II (Bergman et al. 2020) © 2020 The Authors. Published by the BMJ Publishing Group Ltd. Distributed under the terms of the Creative Commons Attribution License. (<http://creativecommons.org/licenses/by-nc/4.0/>).

5.3.2 Factors Associated with Quality of Life

QoL was first assessed separately with possible explanatory and background variables (age, gender, vocational education, cohabiting, smoking, harmful alcohol

consumption, BMI, disease burden, depression, level of anxiety, occupational stress, 3-shift work and sleep quality). In this univariate approach, QoL was positively associated with good sleep quality, university-level education, cohabiting, lower BMI and younger age, and negatively associated with occupational stress, depression, anxiety and disease burden. In the multiway ANCOVA, QoL was positively associated with good sleep quality, cohabiting, university-level education and lower BMI, and negatively associated with occupational stress, depression and/or anxiety and disease burden (Table 16).

Table 16. Factors associated with quality of life in the multivariable model. EUROHIS-QOL mean scores/slope together with 95% CI are based on model estimates.

	EUORHIS-QOL mean score/ slope	95% Confidence interval	F-value (DF)	P-value
Age	-0.00028	-0.0042–0.0036	0.02 (1)	0.89
Gender			0.00 (1)	0.99
Female	3.54	3.38–3.69		
Male	3.54	3.36–3.72		
Education			4.17 (2)	0.016
Vocational school	3.37	3.11–3.62		
College-level	3.59	3.44–3.74		
University-level	3.66	3.51–3.81		
Cohabiting			5.72 (1)	0.017
Yes	3.59	3.43–3.75		
No	3.48	3.31–3.66		
Body mass index	-0.018	(-0.025, -0.011)	23.91 (1)	<0.0001
Disease burden*			13.35 (1)	0.0003
Yes	3.47	3.31–3.63		
No	3.61	3.44–3.77		
Depression and/or anxiety †‡			13.92 (2)	<0.0001
No depression/No anxiety	3.89	3.77–4.00		
Only anxiety	3.59	3.36–3.82		
Depression and anxiety	3.14	2.81–3.46		
Occupational stress #			39.30 (1)	<0.0001
Yes	3.35	3.18–3.53		
No	3.72	3.56–3.88		
3-shift work			0.55 (1)	0.46
Yes	3.56	3.37–3.74		
No	3.52	3.36–3.67		
Self-reported sleep quality			22.02 (2)	<0.0001
Very good	3.74	3.56–3.92		
Good	3.53	3.36–3.69		
Poor	3.34	3.18–3.51		

The impact of each variable on the outcome is displayed after adjusting for all other variables. * At least one chronic disease diagnosed by a physician, † Depression defined by Major Depression Inventory (MDI) diagnostic tool, ‡ Anxiety defined by General Anxiety Disorder 7-item Scale (GAD-7), moderate or severe anxiety, # Defined by Bergen Burnout Indicator 15 (BBI-15), at least mild occupational stress. CI; Confidence Interval, DF; Degrees of freedom, EUROHIS-QOL; EUROHIS-QOL 8-item index. Modified from Study II (Bergman et al. 2020) © 2020 The Authors. Published by the BMJ Publishing Group Ltd. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by-nc/4.0/>).

5.3.3 Factors Associated with Work Ability

Work ability was reported excellent by 15.2%, good by 64.9%, moderate by 16.1% and poor by 3.8% of the participants. The WAS mean score among all participants was 8.31 (SD 1.37), and the median was 9.0 (Q1:8.0, Q3:9.0). Work ability was first assessed separately with the same explanatory and background variables that were also used with QoL. In this univariate approach, work ability was positively associated with good sleep quality, younger age, lower BMI, university-level education, female gender and 3-shift work, and negatively associated with disease burden, depression, anxiety and occupational stress. In the multiway ANCOVA, work ability was positively associated with good sleep quality, younger age, lower BMI and university-level education, and negatively associated with occupational stress and disease burden (Table 17).

Table 17. Factors associated with work ability in the multivariable model. WAS mean scores/slope together with 95% CI are based on model estimates.

	WAS mean score/slope	95% Confidence interval	F-value (DF)	P-value
Age	-0.012	(-0.022, -0.0018)	5.34 (1)	0.021
Gender			3.36 (1)	0.067
Female	7.83	7.43–8.23		
Male	7.56	7.09–8.04		
Education			4.74 (2)	0.0091
Vocational school	7.42	6.76–8.07		
College-level	7.70	7.32–8.09		
University-level	7.80	7.58–8.37		
Cohabiting			0.04 (1)	0.85
Yes	7.69	7.27–8.10		
No	7.71	7.26–8.18		
Body mass index	-0.023	(-0.042, -0.0041)	5.71 (1)	0.017
Disease burden*			12.23 (1)	0.0005
Yes	7.52	7.11–7.95		
No	7.87	7.44–8.30		
Depression and/or anxiety †‡			1.73 (2)	0.17
No depression/ No anxiety	8.02	7.72–8.31		
Only anxiety	7.67	7.07–8.27		
Depression and anxiety	7.41	6.57–8.25		
Occupational stress #			29.80 (1)	<0.0001
Yes	7.28	6.82–7.74		
No	8.12	7.70–8.54		
3-shift work			3.75 (1)	0.053
Yes	7.84	7.36–8.33		
No	7.55	7.16–7.95		
Self-reported sleep quality			14.44 (2)	<0.0001
Very good	8.13	7.66–8.60		
Good	7.68	7.25–8.10		
Poor	7.29	6.86–7.72		

The impact of each variable on the outcome is displayed after adjusting for all other variables. * At least one chronic disease diagnosed by a physician, † Depression defined by Major Depression Inventory (MDI) diagnostic tool, ‡ Anxiety defined by General Anxiety Disorder 7-item Scale (GAD-7), moderate or severe anxiety, # Defined by Bergen Burnout Indicator 15 (BBI-15), at least mild occupational stress. CI; Confidence Interval, DF; Degrees of freedom, WAS; Work Ability Score. Modified from Study II (Bergman et al. 2020) © 2020 The Authors. Published by the BMJ Publishing Group Ltd. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by-nc/4.0/>).

5.4 Temporal Changes in Sleep in Relation to Temporal Changes in Quality of Life and Work Ability (Study III)

The basic characteristics of the study population are presented in Table 10. In addition, the prevalence of obesity (BMI $\geq 30\text{kg/m}^2$) was 21.8% among the study cohort at baseline.

Changes in self-reported sleep quality, sleep duration and sleep medication use, and changes in EUROHIS-QOL and WAS were studied over a one-year period. At baseline, 72% of the participants had good or very good sleep quality, sleep duration was 7–8 hours/night in 70% of the participants, and 85% did not use sleep medications. Sleep quality and sleep medication use had remained unchanged in most of the participants at the follow-up visit, but changes in sleep duration were more common. EUROHIS-QOL and WAS mean scores had improved during the follow-up (Table 18). The results in the groups of ‘no change’ in all the three sleep parameters were already on a favourable level at baseline: In the group with no change in sleep quality, the reported level of sleep quality was good or very good in 81% of the participants. In the group of no change in sleep duration, 72% of the participants slept 7–8 hours/night, and in the group of no change in sleep medication use, only 7% of the participants had used sleep medications during the past month (data not shown).

Table 18. Change in sleep quality, sleep duration and sleep medication, as well as EUROHIS-QOL and WAS mean scores between the years 2014 and 2015.

	Change between 2014 and 2015
Sleep quality change n, (%)	
Worse	87 (13.8)
No change	404 (64.1)
Improved	139 (22.1)
Sleep duration change n, (%)	
Decreased	196 (30.8)
No change	248 (38.9)
Increased	193 (30.3)
Sleep medication use change n, (%)	
Increased	40 (6.4)
No change	543 (86.2)
Decreased	47 (7.5)
EUROHIS-QOL mean score change (95% CI)	0.14 (0.11–0.17)
WAS mean score change (95% CI)	0.20 (0.11–0.29)

CI; Confidence Interval, EUROHIS-QOL; EUROHIS-QOL 8-item index, WAS; Work Ability Score. Modified from Study III (Bergman et al. 2022) © 2022 The Authors. Published by John Wiley & Sons Ltd. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>).

5.4.1 Sleep and EUROHIS-QOL Change

Changes in self-reported sleep quality, sleep duration and sleep medication use were associated with changes in EUROHIS-QOL scores in multivariable models adjusted for age, gender, BMI, educational level, disease burden and EUROHIS-QOL level at the first measurement point (Table 19). In pairwise comparisons, improved and unchanged sleep quality compared to worse sleep quality were associated with a preferable change in EUROHIS-QOL. Additional exploratory analyses (data not shown) showed that good results in the group of unchanged sleep quality are based on the results of the participants, whose sleep quality was continuously good or very good. No change in sleep duration compared to a decrease, and no change in sleep medication use compared to increased use were also associated with favourable changes in EUROHIS-QOL (Table 19).

Disease burden was a significant predictor of QoL change in every model, but no other background variable was significantly associated with the outcome in any of the models.

Table 19. Changes in EUROHIS-QOL 8-item index according to changes in sleep parameters.

		Quality of life (EUROHIS-QOL 8-item index)				
		Mean change adjusted estimate (95% CI)	F value (DF)	P-value	Group comparisons	
					Mean difference adjusted estimate (95%CI)	P-value
Sleep quality			9.9 (2)	<0.0001		
	Worse	-0.05 (-0.15 to 0.05)			Worse vs. No change	-0.15 (-0.25 to -0.06) 0.0005
	No change	0.10 (0.03 to 0.18)			Worse vs. Improved	-0.21 (-0.32 to -0.10) <0.0001
	Improved	0.16 (0.07 to 0.24)			No change vs. Improved	-0.06 (-0.14 to -0.03) 0.25
Sleep duration			3.5 (2)	0.031		
	Decreased	0.05 (-0.03 to 0.13)			Decrease vs. No change	-0.08 (-0.16 to -0.00) 0.042
	No change	0.13 (0.05 to 0.21)			Decrease vs. Increase	-0.08 (-0.16 to 0.01) 0.075
	Increased	0.13 (0.05 to 0.21)			No change vs. Increase	0.00 (-0.07 to 0.08) 0.99
Sleep medication use			4.9 (2)	0.0076		
	Increased	-0.06 (-0.19 to 0.07)			Increase vs. No change	-0.17 (-0.31 to -0.04) 0.0073
	No change	0.12 (0.04 to 0.19)			Increase vs. Decrease	-0.12 (-0.29 to 0.06) 0.27
	Decreased	0.06 (-0.07 to 0.18)			No change vs. Decrease	0.06 (-0.07 to 0.18) 0.52

Adjusted mean changes with 95% confidence intervals (CI) in EUROHIS-QOL years 2014–2015 according to changes in sleep parameters. Adjusted mean change values, F-values, degrees of freedom (DF) and p-values are from three different models for multiway analysis of covariance to explain factors affecting the change in quality of life. Change in sleep quality, sleep duration and sleep medication use were all entered in different models with EUROHIS-QOL change. All models were adjusted for age, gender, body mass index, educational level, disease burden, and EUROHIS-QOL level at baseline. Group comparisons between different classes of sleep parameters are also presented. Mean differences in EUROHIS-QOL between groups are presented with 95% CI. P-values and 95% CI for group comparisons are adjusted with Tukey's method. CI, Confidence interval; DF, Degrees of freedom; EUROHIS-QOL, EUROHIS-QOL 8-item index. Modified from Study III (Bergman et al. 2022) © 2022 The Authors. Published by John Wiley & Sons Ltd. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>).

Table 20. Changes in Work Ability Score (WAS) according to changes in sleep parameters.

		Work ability (work ability score, WAS)					
		Mean change adjusted estimate (95% CI)	F value (DF)	P-value	Group comparisons		
						Mean difference adjusted estimate (95%CI)	P-value
Sleep quality			3.8 (2)	0.022			
	Worse	-0.20 (-0.51 to 0.10)			Worse vs. No change	-0.25 (-0.54 to 0.04)	0.11
	No change	0.05 (-0.18 to 0.28)			Worse vs. Improved	-0.41 (-0.76 to -0.06)	0.016
	Improved	0.21 (-0.06 to 0.47)			No change vs. Improved	-0.16 (-0.41 to 0.09)	0.28
Sleep duration			1.7 (2)	0.19			
	Decreased	0.01 (-0.23 to 0.26)			Decrease vs. No change	-0.01 (-0.25 to 0.22)	0.99
	No change	0.03 (-0.21 to 0.27)			Decrease vs. Increase	-0.17 (-0.42 to 0.07)	0.24
	Increased	0.19 (-0.06 to 0.43)			No change vs. Increase	-0.16 (-0.40 to 0.08)	0.26
Sleep medication use			4.8 (2)	0.0082			
	Increased	-0.44 (-0.83 to -0.052)			Increase vs. No change	-0.54 (-0.94 to -0.13)	0.0055
	No change	0.10 (-0.12 to 0.31)			Increase vs. Decrease	-0.48 (-1.01 to 0.05)	0.084
	Decreased	0.04 (-0.34 to 0.42)			No change vs. Decrease	0.06 (-0.32 to 0.43)	0.94

Adjusted mean changes with 95% confidence intervals (CI) in WAS years 2014–2015 according to changes in sleep parameters. Adjusted mean change values, F-values, degrees of freedom (DF) and p-values are from three different models for multiway analysis of covariance to explain factors affecting the change in work ability. Change in sleep quality, sleep duration and sleep medication use were all entered in different models with WAS change. All models were adjusted for age, gender, body mass index, educational level, disease burden, and WAS level at baseline. Group comparisons between different classes of sleep parameters are also presented. Mean differences in WAS between groups are presented with 95% CI. P-values and 95% CI for group comparisons are adjusted with Tukey's method. CI, Confidence interval; DF, Degrees of freedom; WAS, Work Ability Score. Modified from Study III (Bergman et al. 2022) © 2022 The Authors. Published by John Wiley & Sons Ltd. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>).

5.4.2 Sleep and WAS Change

Changes in sleep quality and sleep medication use were associated with changes in WAS in multivariable adjusted models. Increased use of sleep medication was associated with a decline in WAS. In pairwise comparisons, the difference in WAS change was significant when the group of increased use was compared to the group of no change in sleep medication use. The change in WAS also differed significantly between improved and worsened sleep quality. The change in WAS *per se* was not significant in any of the groups of sleep quality during the follow-up period (Table 20).

Disease burden was a significant predictor of the WAS change in every model, but no other background variable was significantly associated with the outcome in any of the models.

5.5 Healthy and Unhealthy Food Consumption and Quality of Life (Study IV)

Some basic characteristics of the study population are presented in Table 10. The characteristics of the participants were examined according to the quartiles of the consumption frequency of healthy food items. The participants with a higher consumption frequency of healthy food items tended to be younger and more often cohabiting. Their physical activity level was higher, they smoked more rarely, and ate regular breakfast more often than those with a lower consumption rate of healthy food items. They also had less symptoms of depression or anxiety. Blood fasting glucose level was significantly lower in those with a higher consumption rate of healthy foods, but no significant differences were detected in association with BMI, blood lipid levels, number of chronic diseases or harmful alcohol use (Table 21). The mean daily consumption frequency of food items from various healthy and unhealthy food groups among the participants is presented in Figure 2. The sum of the daily consumption frequencies in healthy foods varied between 2 and 30, and in unhealthy foods between 0.1 and 14.

Table 21. Characteristics of the participants of Study IV according to the quartiles of the consumption frequencies of healthy foods.

Characteristic	Healthy foods consumed per day				P-value (linearity)
	I (<7.5) n=126	II (7.5-10.4) n=189	III (10.5-14.7) n=189	IV (>14.7) n=126	
Age, years, mean (SD)	48 (10)	47 (9)	49 (10)	52 (9)	0.002
Education years, mean (SD)	13.7(2.7)	14.1(2.6)	14.0 (2.8)	14.1 (2.7)	0.52
Cohabiting, n (%)	94 (75)	149 (79)	156 (83)	106 (84)	0.036
PA, hours per week, mean (SD)	2.0 (3.5)	2.5 (2.2)	2.8 (3.2)	2.9 (2.2)	0.004
Good quality of sleep, n (%)	87 (69)	157 (83)	139 (74)	96 (76)	0.68
Regular breakfast, n (%)	98 (78)	173 (92)	176 (93)	115 (91)	<0.001
Audit-C, mean (SD)	3.0 (1.6)	2.7 (1.6)	2.7 (1.7)	2.7 (1.5)	0.11
Current smoking, n (%)	19 (15)	15 (8)	10 (5)	8 (7)	0.008
Blood pressure, mmHg, mean (SD)					
Systolic	129 (16)	130 (17)	132 (18)	133 (18)	0.029
Diastolic	85 (9)	84 (11)	85 (10)	84 (11)	0.95
Body mass index, kg/m ² , mean (SD)	26.9 (5.3)	27.2 (5.2)	26.6 (4.6)	26.2 (4.3)	0.11
Total cholesterol, mmol/l, mean (SD)	5.40 (0.99)	5.22 (0.85)	5.16 (0.94)	5.36 (0.88)	0.58
LDL cholesterol, mmol/l, mean (SD)	3.11 (0.78)	2.98 (0.71)	2.89 (0.77)	3.03 (0.69)	0.24
HDL cholesterol, mmol/l, mean (SD)	1.76 (0.42)	1.76 (0.43)	1.80 (0.45)	1.84 (0.48)	0.11
Triglycerides, mmol/l, mean (SD)	1.20 (0.57)	1.09 (0.57)	1.06 (0.56)	1.08 (0.59)	0.12
Fasting glucose, mmol/l, mean (SD)	5.60 (0.56)	5.45 (0.46)	5.51 (0.64)	5.43 (0.50)	0.041
Anxiety, GAD-7, mean (SD)	3.4 (3.3)	2.7 (3.2)	3.3 (3.7)	2.1 (2.7)	0.018
Major depression inventory (MDI), mean (SD)	6.5 (6.3)	4.2 (4.9)	6.1 (6.7)	3.7 (4.1)	0.013
Number of chronic diseases, mean (SD)	1.2 (1.3)	0.9 (1.0)	1.4 (1.4)	1.2 (1.2)	0.13
EUROHIS-QOL mean score, mean (SD)	3.95 (0.57)	4.13 (0.46)	4.01 (0.53)	4.19 (0.47)	0.010

AUDIT-C; The 3-item Alcohol Use Disorders Identification Test, GAD7; General Anxiety Disorder 7-item Scale, EUROHIS-QOL; EUROHIS QOL 8-item Index, HDL; High density lipoprotein, LDL; Low density lipoprotein, PA; Physical activity, SD; Standard deviation. From Study IV (Bergman et al. 2022) © 2022 The Authors. Published by MDBI. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>).

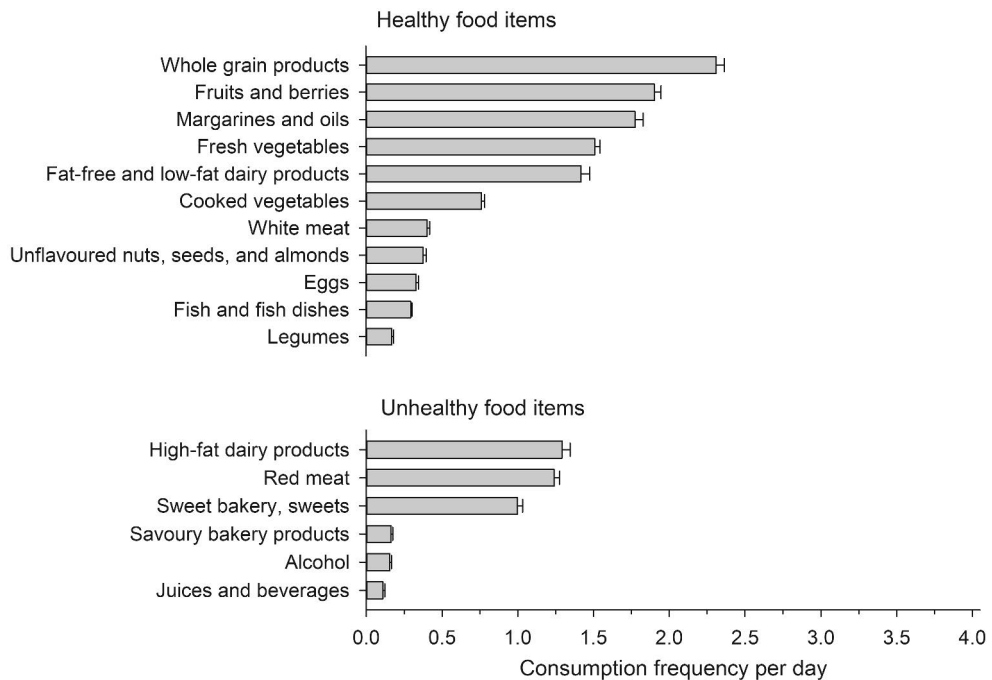


Figure 2. Mean daily consumption frequency for different groups of healthy and unhealthy food items. Whiskers show standard errors. From Study IV (Bergman et al. 2022) © 2022 The Authors. Published by MDBI. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>).

The EUROHIS-QOL mean score was positively associated with the consumption frequency of healthy food items (Table 21). The association remained significant when adjusted for age, BMI, education years and disease burden, smoking, and physical activity (p for linearity = 0.016). Figure 3 displays the EUROHIS-QOL mean score (continuous variable) as a function of rank-based normal scores of the consumption frequencies of healthy and unhealthy foods. A significant positive association was seen between the EUROHIS-QOL mean score and the consumption frequency of healthy foods ($p=0.002$), but the score was not associated with the consumption frequency of unhealthy foods.

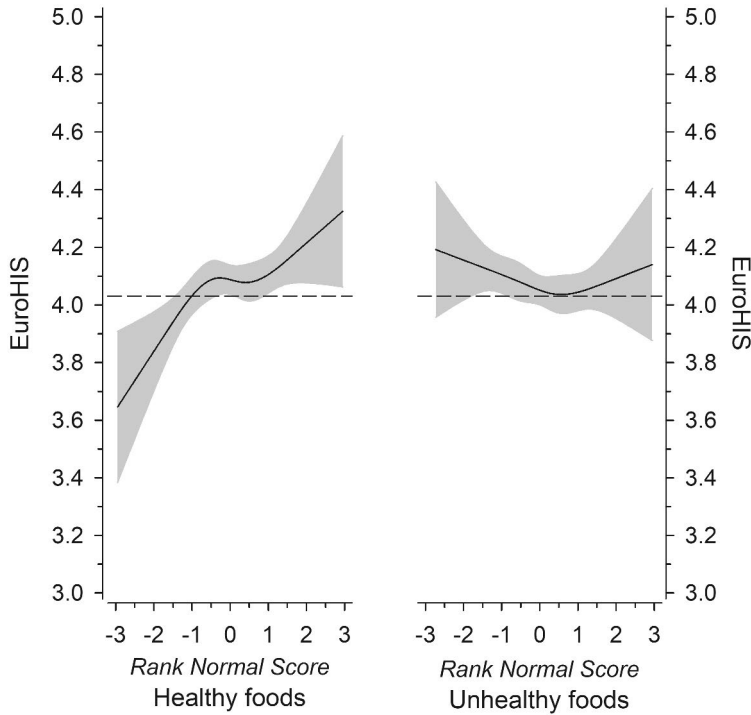


Figure 3. Relationships of EUROHIS-QOL 8-item Index mean score as the function of rank-based normal scores of the consumption frequencies of healthy and unhealthy food items. The curves were derived from 4-knot restricted cubic splines regression models. The models were adjusted for age, body mass index, education years, number of chronic diseases, smoking, and physical activity. Gray areas represent 95% confidence intervals. From Study IV (Bergman et al. 2022) © 2022 The Authors. Published by MDBI. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>).

The effect of the consumption of healthy and unhealthy foods on different dimensions of QoL is presented in Figure 4. The consumption of healthy foods had a small positive effect on physical health, psychological well-being, and environmental aspects of QoL. It had no effect on the domain of social relationships. The consumption of unhealthy foods had no significant effect on any dimension of QoL. The differences between the effects of healthy and unhealthy food consumption were significant between all other dimensions of QoL except psychological well-being.

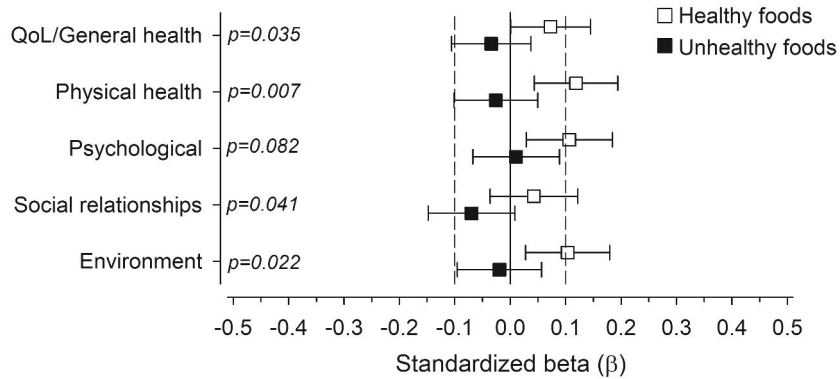


Figure 4. Relationships between consumption of (healthy and unhealthy) food items and different dimensions of quality of life (QoL). P-values are for the difference between the effect of healthy and unhealthy foods consumption. The models were adjusted for age, body mass index, education years, number of chronic diseases, smoking, and physical activity. Whiskers represent 95% confidence intervals. From Study IV (Bergman et al. 2022) © 2022 The Authors. Published by MDBI. Distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>).

6 Discussion

The main findings of this study were that good sleep quality, ideal CV health and frequent use of healthy food items were associated with better QoL among public sector employees. On the other hand, occupational stress, higher BMI, depression and/or anxiety, and presence of chronic illnesses were associated with poorer QoL. The most important factor associated with good work ability was good sleep quality, whereas occupational stress, presence of chronic illnesses and higher BMI were associated with worse work ability. In addition, changes in sleep quality, sleep duration and sleep medication use were associated with changes in QoL and work ability in a one-year follow-up. An improvement in sleep quality was especially associated with a positive change in QoL, and increased use of sleep medication was associated with a decline in work ability. Throughout the thesis, good sleep quality especially was found essential for good QoL and work ability of the employees.

6.1 Methodological Evaluation

6.1.1 Study Population and Generalisability

The study population for this thesis study was from the PORTAAT (PORi to Aid Against Threats) study. PORTAAT was a longitudinal study about risk factors and protective factors for CV health and mental health on working age employees. The study was conducted among the employees of the city of Pori in the years 2014 and 2015. The participants in the baseline visit in 2014 form the study population of Study I of this thesis, and the study population of Study II is the people who participated in the follow-up visit in 2015. In Study IV, the female respondents of the follow-up visit are studied, and in the prospective follow-up Study III, the study population is formed from the participants who entered the study visits in 2014 and 2015, and from whom I had all the necessary information to perform the analyses.

At baseline, there were no exclusion criteria, but the participating work units were selected by the chief of the welfare unit of Pori. The main selection criterion was that the work unit had not participated in any health-promoting program in the past few years. The aim was to get around 1,000 participants, who would represent different occupational and socio-economic groups. No power analysis was made in this

epidemiological study. There were altogether 836 employees (104 males, 732 females) who chose to participate in the study at baseline, and the response rate was 32.5%. The participants were from a wide range of occupations, including librarians, museum employees, janitors, information technology workers, social workers, nurses, physicians, administrative officials, and general office staff.

The response rate in the PORTAAT study was unfortunately fairly low, and it is therefore possible that the representativeness of the study sample is compromised. Some typical determinants for non-participation in health surveys, unemployment and living on social welfare (Karvanen et al., 2016), were excluded because of the nature of the study cohort. There are, however, also other typical differences between the participants and non-participants in health surveys. The non-participants typically have lower education, poorer physical and mental health, use more alcohol and smoke more often compared to the participants (Karvanen et al., 2016). It is possible that the healthiest part of the workforce is the most willing to attend voluntary health surveys, which may have resulted in the possibility that the findings in the present study reflect the situation in the mainly healthy section of the workforce, and subsequently, reduce the generalisability of the results.

To examine the possible selection bias, several basic characteristics were compared between the study participants and the personnel of the city of Pori as well as with Finnish public sector employees and the general population. Age, gender distribution, and sickness absence days of the participants were compared to the figures from the employees working at the work units that were invited to the study. The gender distribution was also compared to Finnish public sector employees, and prevalence of smoking, obesity and depression to the Finnish general population (see Chapter 5.1). Only the prevalence of depression was unexpectedly low among the study participants. The prevalence of depression in the active workforce is assumed to be lower than in the general population, since the individuals on a long-term sick-leave and disability pension, as well as the unemployed, are excluded. Nevertheless, it is still possible that depressive symptoms have prevented some of the employees from participating in the study. As a conclusion, despite the low response rate, I would say that the initial participants in the PORTAAT study represent the employees of the city of Pori quite well, and generalisability to the Finnish public sector employees is also relatively good.

All the initial respondents were invited to the follow-up visit, and 85% of them attended. All the 710 participants who attended the follow-up visit were included in the study population of Study II. The gender distribution had remained unchanged compared to baseline, and the proportions of different levels of vocational education were also similar at both visits (Table 10). Smoking and harmful drinking were more seldom at the follow-up visit. This was, however, mainly due to a significant improvement in both factors among the study participants during the follow-up, although smoking and harmful drinking were also somewhat more frequent among the dropouts than among all the study participants at baseline. The possible explanation for

the significant improvement in these two health habits is that the participants were given personal recommendations for a healthy lifestyle by the study nurse at the baseline visit. There is convincing evidence about the effectiveness of a minimal intervention in harmful alcohol use (O'Donnell et al., 2014). Heavy drinking was also very rare in the study population, and most of the participants fulfilling the definition of harmful alcohol use at baseline had the lowest possible scores still counted as harmful. It is likely that these participants have been able to decrease their alcohol use according to advice they were given. In addition, the phenomenon of regression toward the mean is known to happen in repeated measurements, meaning that extreme outcomes tend to be followed by more moderate ones in the subsequent measurements (Galton, 1886).

There is evidence that minimal intervention improves the success also in smoking cessation (Stead et al., 2013), and the proportion of smokers has decreased at population level in Finland during the 21st century (Helldán & Helakorpi, 2015). These two factors may have contributed to a smaller proportion of participants smoking at follow-up.

For the prospective follow-up Study III, 637 participants were included in the study population. There were 126 participants who were excluded from this study because they did not attend the follow-up visit and an additional 73 participants who were excluded due to missing information or pregnancy. The pregnant participants were excluded because pregnancy may have significant, but transient, effects on several factors studied here. Work ability (Pedersen et al., 2021) and sleep (Pien & Schwab, 2004; Sweet et al., 2020) in particular may be altered significantly, but transiently in pregnancy. The participants excluded from the analyses did not vary significantly from the study cohort in most of the studied factors, and this study population can be regarded as a representative sample of the employees.

In Study IV, all the 631 female participants who attended the follow-up visit were included in the study population. Nutritional behaviours are known to vary between genders (Grzymisławska et al., 2020), and since there were relatively few male participants, they were excluded from this study. In all the other studies men were included, since the results varied very little between genders. However, I am not able to make any conclusions about the results in male subjects particularly, since they were so few among the participants.

6.1.2 Evaluation of Measures

Evaluation of Measures for Quality of Life, Work Ability, Psychological Symptoms and Sleep

QoL of the participants was assessed using the EUROHIS-QOL 8-item index (Power, 2003), which is a well-validated instrument for the assessment of general QoL (Da

Rocha et al., 2012; Power, 2003; Schmidt et al., 2006). Although it is not very often used in medical research, it has some advantages and was chosen as the most suitable tool for this study. Since the study population consists of apparently healthy individuals from the active workforce, a tool measuring general QoL was preferred over a HRQoL tool. The questionnaire in the PORTAAT study was relatively long, and the tools chosen should be as short as possible, yet comprehensive enough. The other possible measurement tool for general QoL, the WHOQOL-BREF, is quite long and relatively scarcely used in Finland, especially among working-age individuals. EUROHIS-QOL has been used in national health surveys to assess QoL in Finland (Koponen et al., 2018; Koskinen et al., 2012), and there are Finnish national reference values for the tool. It is also one of the tools recommended by the THL for the assessment and follow-up of QoL in Finland (Finnish Institute for Health and Welfare (THL), n.d.).

Work ability was assessed with the WAS, which is the first item of the widely used and well-validated WAI (Ilmarinen, 2007). The WAS has been shown to have a strong association with the WAI and is reliable in evaluating work ability (El Fassi et al., 2013). Psychological symptoms were assessed with validated instruments. Depressive symptoms were assessed with the MDI (Bech et al., 2001), and the diagnostic tool and cut-off values for the severity of depressive symptoms were used according to the recommendations of the developers of the instrument (Study II) (Bech et al., 2001, 2015). Anxiety was assessed with the validated GAD-7, and the severity of anxiety was categorised according to the recommended cut-off values (Study II) (Spitzer et al., 2006). Occupational stress was assessed with the BBI-15 tool, which has been developed primarily in Finland (Näätänen et al., 2003) and is a validated tool for assessing occupational stress and burnout (Näätänen et al., 2003; Salmela-Aro et al., 2011).

Sleep quality, sleep duration and sleep medication use were assessed with three individual self-reported questions, which are all items on the well-validated PSQI (Buysse et al., 1989). These three items have also previously been used as a simple measurement of sleep (Tang et al., 2017). The individual item on subjective sleep quality, ‘During the past month, how would you rate your sleep quality overall?’ has been found to correlate well with the global score of the questionnaire (Buysse et al., 1989). Of note, the PSQI also contains items regarding sleep quantity, especially the question of self-reported sleep duration, where reporting of shorter sleep leads to worse results on the global score. From this point of view, assessing sleep quality with a single self-rated question may be less confounded by sleep duration than the PSQI global score (Matsui et al., 2021).

Sleep duration was assessed with the question ‘During the past month, how many hours of sleep did you normally get at night?’ According to current understanding, simple self-reported sleep duration should not be considered a validated or reliable measure of biological sleep duration (Bianchi et al., 2017). Self-reported sleep

duration is known to differ from objective measurement (Silva et al., 2007). However, objective measurement of sleep would need polysomnography measurements or accelerometers (actigraphs) for every participant, which is both difficult and expensive in large epidemiological studies. Therefore, the most common way of assessing sleep duration in epidemiological studies has been by self-report of typical sleep duration. In a meta-analysis of short sleep duration and health outcomes, most of the included studies had assessed sleep duration with self-reported tools. The self-reported data were even preferred over objective measurements in the meta-analysis, because of better applicability in general community settings (Itani et al., 2017).

The use of sleep medication was assessed with the question ‘During the past month, how often have you taken medicine (prescribed or ‘over the counter’) to help you sleep?’. Because this is the only item on the PSQI assessing the use of sleep medication, it can be regarded as a well-tested tool for the purpose. The items on the PSQI were derived from previous sleep quality questionnaires and clinical experience with sleep disorder patients, and field-tested during the development of the questionnaire. The PSQI also has a high internal consistency (Cronbach’s alpha 0.83) (Buysse et al., 1989). In addition, self-reporting is the only possible way in large studies to assess the use of both prescribed and over-the-counter medicines that are consumed occasionally when needed.

There are some similarities between the measurement tools for depression, anxiety, occupational stress, sleep and QoL. There is one question about sleep in the MDI, because sleep problems are part of the diagnostic criteria of depression. There is also one question about restlessness in the GAD-7 that resembles a question in the MDI. Depression and anxiety are medical conditions that are very close to each other, and some of the symptoms overlap. The BBI-15 has three questions that are close to questions of the MDI, and one of them is a sleep question. There is also one question in the BBI-15 that is quite close to a question in the GAD-7. The symptoms of occupational stress also partly overlap with depression and anxiety. Although work stress is not a medical diagnosis, it can lead to clinical depression if not handled properly. All these associations are due to well-known similarities in diagnostic criteria and/or definitions of the concepts of depression, anxiety and occupational stress. In the present study these factors were handled as explanatory variables in multivariable models. In Study II they were all added in the same models explaining possible associations with QoL and work ability and were thus adjusted for each other.

There are also some similarities between these tools and the EUROHIS-QOL. The MDI has a question about energy that closely resembles a question in the EUROHIS-QOL, and also a question about self-esteem, which is fairly close to the question about oneself in the EUROHIS-QOL. However, the EUROHIS-QOL is designed to distinguish between depressed and non-depressed populations (Power, 2003), which makes this similarity understandable. In the BBI-15 there are also two questions about social relationships that are quite close to one question in the EUROHIS-QOL.

Evaluation of Measures for Health Habits and Health Metrics

Information about smoking, alcohol consumption, physical activity and diet were collected by self-administered questionnaires. The results in questionnaires concerning health habits can be affected by reporting bias, since people are often willing to report what they think will be more acceptable answers to questions concerning these factors. However, the use of self-reported information is often the only possible way of assessing health habits, and validated questionnaires were used whenever possible. The well-validated AUDIT-C was used for the assessment of harmful alcohol consumption (Bush et al., 1998), and the cut-off values used in my study for men and women were found optimal for the Finnish population and drinking habits (Aalto et al., 2006; Tuunanen et al., 2007).

Smoking status was assessed by asking the participants to choose from three options: whether they were current smokers, had never smoked or had stopped smoking. With the third option, the time of smoking cessation was asked. The variable was used in the analyses dichotomised into non-smoking/current smoking, and the ex-smokers were categorised into non-smokers only if they had stopped smoking >12 months ago. This unambiguous categorization might not be as easily influenced by a reporting bias as would be for example the reporting of the number of cigarettes smoked per day. It has also been shown that the validity of self-reported smoking is high among the Finnish general population (Vartiainen et al., 2002).

The physical activity questionnaire was designed for self-reporting the type, intensity, frequency, and duration of all physical activity during a typical week, and the duration of moderate and vigorous aerobic type activity was used in the analyses as an indicator of health-promoting physical activity. These items were chosen because they were comparable with the recommendations for physical activity in the American Heart Association's ideal CV health concept (Lloyd-Jones et al., 2010).

The 16-item FFQ questionnaire used at baseline was constructed for the PORTAAT Study based on diet questionnaires used in former Finnish population surveys. The 45-item PORTAAT FFQ used at follow-up was based on the version developed for and validated to study children's diets (Korkalo et al., 2019), with specific attention paid to capture the consumption patterns of vegetables and fruit as well as sugary foods and beverages. A shortened, 25-item version of the FFQ has been tested for reproducibility with mostly moderate or good intraclass correlation coefficients (Määttä et al., 2018). The items in the main categories of the PORTAAT FFQ were categorised into healthy and unhealthy foods based on the Nordic Nutrition Recommendations (*Nordic Nutrition Recommendations 2012; Integrating Nutrition and Physical Activity*, 2014) for healthy and balanced diets and on previous scientific understanding about the association between diet and cognitive health (Nilsson et al., 2013; Wade et al., 2020). Since data on energy intake were not available, the statistical

analysis was adjusted for physical activity to include the effects of energy intake in the model.

Information concerning previous medical history (diseases diagnosed by a physician) and medication used regularly was gathered using self-administered questionnaires and from the medical records. Adding medical records improves the accuracy of the data compared to information collected solely by self-administered questionnaires. The clinical measurements (height, weight and blood pressure measurements) were performed by trained medical staff, which is clearly a more accurate method than self-report (Maukonen et al., 2018). The methods for blood pressure monitoring and BMI calculation are well standardised. The laboratory analyses were all performed in a single laboratory, and the methods for detecting plasma glucose, total cholesterol, HDL-C, LDL-C and HbA1c are standardised.

In Study I, the American Heart Association's ideal CV health metrics were used to determine the CV health of the participants. The cut-off values used for defining the ideal levels of the metrics were the ones recommended by the American Heart Association (Lloyd-Jones et al., 2010), but I used a modified version of the classification, in which blood pressure, total cholesterol and glucose tolerance treated to goal were also regarded as ideal. In the original definition, only untreated values are regarded as ideal, but according to the European Guidelines on CV disease prevention (Piepoli et al., 2016), the medications for hypertension, elevated cholesterol and blood glucose levels can be considered as primary prevention for CV disease in non-complicated cases. I also used HbA1c instead of fasting plasma glucose to determine normoglycemia, because HbA1c can give an indication of glycemia over several preceding weeks rather than at a single time point (Selvin et al., 2007). In addition, the diet score used in the present study was modified from the original American Heart Association definition. I did not have all the information to determine the diet exactly according to the original definition, and some modifications were also reasonable because the dietary habits in Finland differ from those in the US. It has also been common in other studies about the ideal CV health concept that the diet metric especially has been modified according to local cuisine or the information available (Odom et al., 2016; Wu et al., 2021).

6.2 Results in Relation to Earlier Research

I will now discuss the main results of my thesis in relation to relevant previous research. Many of the previous works about the association of QoL with factors I have also studied in my thesis have been made with measurement tools for HRQoL. Although the convergent validity between HRQoL and general QoL tools has not been shown to be very good (Castro et al., 2014; Huang et al., 2006), results about the associations of many factors with HRQoL and general QoL have been comparable. For example, the association of QoL with BMI (Kroes et al., 2016; Vesikansa et al.,

2022), diet (Lee et al., 2019; Vajdi & Farhangi, 2020), sleep quality (Marques et al., 2017; Matsui et al., 2021) and occupational burnout (Khatatbeh et al., 2022) have been shown to be quite similar, regardless of the outcome measure used. Additionally, both the HRQoL and the general QoL tools were originally designed so that the experienced decline in well-being caused by physical or mental illnesses leads to worse estimates of QoL (EuroQoL Group, 1990; Power, 2003; Ware & Sherbourne, 1992; WHOQOL Group, 1998a, 1998b).

The tools of general and health-related QoL are, however, designed to assess different aspects of well-being. Since my own study uses a general QoL measure, I have compared my results to previous works measuring general QoL whenever possible. In many cases the information has been, however, only available as measured with a HRQoL tool, and I have then needed to compare these results to my work.

6.2.1 Quality of Life of the Study Participants

QoL in my study population was on the same level as in the Finnish general population. The EURHOHIS-QOL mean score among the study participants at baseline was 3.9, while the reference values in Finland are 4.0 in men and 4.0–4.1 in women aged 30–65 years (Koskinen et al., 2012). To my knowledge, no other study among Finnish public sector employees has assessed QoL with a general QoL instrument. There is information about HRQoL of the municipal employees in the Helsinki Health Study, where QoL was assessed with the SF-36 mental and physical component scores (Lahelma et al., 2005, 2016). QoL of the employees was also in these studies on the average level according to the reference values provided by the SF-36 instrument (Ware et al., 1994). The study cohort of the Helsinki Health Study consists of almost 9,000 middle-aged (40–60 years at baseline) employees of the City of Helsinki, 80% of whom are women.

6.2.2 Ideal Cardiovascular Health in Relation to Quality of Life

The prevalence of having ideal CV health (5–7 ideal health metrics) was 25% among the study participants at baseline. This is a rather high proportion, since only 3% of men and 9% of women aged 30–74 reached the same level in a study among the Finnish general population (Peltonen et al., 2014). This difference can be caused partly because of the younger mean age of the PORTAAT study participants compared to the reference population. The main reason, however, may be in the methodological differences between these studies.

The biggest differences in achievement of the metrics were found in the metrics of physical activity, smoking, diet and blood glucose. The definition of ideal physical

activity of Peltonen et al. (2014) was markedly more vigorous than the original American Heart Association metric I used in my study. They also defined the smoking metric as ideal only if the person had never smoked, whereas I used the original metric, where smoking cessation >12 months ago is also categorised as ideal. The diet metric of neither of the studies was exactly the one recommended by the American Heart Association, but the one used in my study may have been slightly easier to achieve. I also used HbA1c <42 mmol/mol to define ideal blood glucose metric instead of the fasting plasma glucose <5.6 mmol/l used by Peltonen et al. and the original metrics. In addition, in my study, blood glucose, blood pressure and total cholesterol levels were categorised as ideal if the goal levels were achieved either untreated or with primary preventive medication. Diabetes medication was used by 4% of both female and male participants of my study, while 21% of females and 25% of males used antihypertensives. Cholesterol medications (statins) were used by 5% of females and 15% of males. Nevertheless, the proportion of participants achieving ideal levels of total cholesterol was very similar in my study compared to the study by Peltonen et al., and the proportion achieving ideal blood pressure was lower in my study. This may indicate that the metrics treated to goal with medication being categorised as ideal had less influence on the results than the other differences in the methodology. However, according to a systematic review, the prevalence of achieving 5–7 ideal metrics has also varied greatly in other previous studies (cf. 5%–35% in US studies, and 9%–43% in studies conducted in China, Korea, India, Spain, Iran, Bosnia/Herzegovina and Ecuador) (Younus et al., 2016).

The prevalence of ideal CV health has been found to decline with older age (Benjamin et al., 2018), and a similar trend was seen also in the present study. In previous literature, there is also a correlation between ideal CV health and gender, with women achieving more ideal health metrics than men (Benjamin et al., 2018). In my study, females achieved the metrics of ideal BMI, healthy diet, ideal blood pressure and blood glucose levels significantly better than males, but there was no significant difference in the achievement of the ideal, intermediate or poor CV health between the genders. This finding was most likely due to the low proportion of male participants in this study. There is also a previous finding that several social risk factors (low family income, low education level, minority race, and single-living status) have been related to lower achievement of the ideal metrics (Caleyachetty et al., 2015). In my study, all the participants were in the active workforce with a steady employment status, which already lines out many social risk factors. However, also in this study, the individuals with more favourable CV health tended to be cohabiting and better educated. They also had better sleep quality, which has also been associated with better CV health in previous literature (Kwok et al., 2018; Visseren et al., 2021).

The participants with a more favourable CV health profile assessed their QoL as being significantly better than those who achieved a lower number of ideal health metrics. The difference of 0.32 units in EUROHIS-QOL mean scores between the

groups with ideal and poor CV health can be considered clinically significant according to previous literature (Da Rocha et al., 2012; Schmidt et al., 2006). The EUROHIS-QoL mean scores among depressed populations have been found to be 0.39–0.61 units lower than in non-depressed populations (Da Rocha et al., 2012) and among chronically ill populations 0.26–0.40 units lower than in healthy populations (Schmidt et al., 2006). There are also a few previous studies, in which ideal CV health has been associated with better QoL. Cross-sectional studies from the US and China have reported a positive association between achievement of the ideal metrics and HRQoL, assessed with the EQ-5D-5L together with the EQ-VAS (Wu et al., 2021) and with the HRQoL4-instrument (Allen et al., 2015; Odom et al., 2016). Nevertheless, the current study is to my knowledge the first to report the association of ideal CV health with general QoL.

The other factors with a significant association with QoL in the multivariable model in Study I were good sleep quality, absence of chronic illnesses, older age, university-level education and cohabiting. A very interesting finding was that sleep quality, assessed with a single self-reported question, had the most powerful impact on QoL in that model. The difference between the model-based EUROHIS-QoL mean scores between the participants with very poor and very good sleep quality was 0.7 units. According to previous literature, there is a close relationship between sleep quality and QoL (Lallukka et al., 2018; LeBlanc et al., 2007; Mahirah et al., 2021; Marques et al., 2017; Matsui et al., 2021). However, it was slightly surprising that the association was also so strong among the present study population of active workforce with a very low prevalence of previously diagnosed depression (2.5%), a condition often found with sleep problems (Baglioni et al., 2011). This finding provoked my interest to study this subject further in forthcoming works.

6.2.3 Evaluation of Factors Associated with Quality of Life and Work Ability

Since the participants are all in the active workforce, self-reported work ability was chosen to be another outcome along with QoL in Study II. I wanted to examine as widely as possible the factors that could be associating with these two outcomes, and I was also interested to find out more about the factors associated with sleep quality.

In this study, self-reported sleep quality was negatively associated with the presence of chronic diseases, the prevalence of depression and severity of depressive symptoms, anxiety and work stress, and positively associated with QoL and work ability. These findings are similar compared to those in previous literature, in which depression (Baglioni et al., 2011; Tsuno et al., 2005), anxiety (Baglioni et al., 2010) and other chronic illnesses (Anothaisintawee et al., 2016; Kwok et al., 2018; Lo et al., 2018), as well as occupational stress (Knudsen et al., 2007; X. Li et al., 2019), have been associated with poor sleep quality. Good QoL (Lallukka et al., 2018; LeBlanc et

al., 2007; Mahirah et al., 2021; Marques et al., 2017; Matsui et al., 2021) and good work ability (Ng & Chan, 2018) have been associated with good sleep quality.

In a multivariable model, QoL was found to be positively associated with good sleep quality, university-level education and cohabiting, and negatively associated with occupational stress, higher BMI, depression and/or anxiety, and presence of chronic diseases. No significant association was found between age, gender or 3-shift work and QoL. The strongest associations with QoL were detected with occupational stress, BMI and sleep quality. The findings are consistent with previous literature. Occupational stress has been found to be associated with poorer QoL in several occupational groups (Khatatbeh et al., 2022; Lerner et al., 1994; Sarafis et al., 2016; Yang et al., 2009), and depression and anxiety are known to negatively affect QoL (Da Rocha et al., 2012; Palacin et al., 2004; Saarni et al., 2007). Higher BMI (Kroes et al., 2016; Vesikansa et al., 2022) and the presence of chronic illnesses (Schmidt et al., 2006) have been linked to poorer QoL, whereas higher education (Mielck et al., 2012) and cohabiting (Michelson et al., 2000) have been associated with good HRQoL. The close relationship between sleep quality and QoL was again confirmed in this model with several potential confounding factors, including depression and anxiety. In previous literature, sleep quality and HRQoL have been shown to be closely related among the general population (Lallukka et al., 2018; Matsui et al., 2021) as well as in the working population (Mahirah et al., 2021). It has been suggested that the association between QoL and sleep quality might be moderated by depression (Eryilmaz et al., 2005), but there is also evidence that the association is present regardless of psychopathological symptoms or chronic illnesses (Lallukka et al., 2018; Marques et al., 2017). In the present study, the association was confirmed in a model adjusted for depression and in a study cohort with a very low prevalence of depression.

In an analogous multivariable model for work ability, the results were largely similar to the ones from the model for QoL. The strongest associations with work ability were found with occupational stress and sleep quality. Work ability was also positively associated with university-level education and negatively associated with the presence of chronic illnesses, higher BMI and higher age. No significant associations with work ability were found with gender, cohabiting, depression/anxiety, or 3-shift work. Most of these findings are also consistent with previous literature. Occupational stress has been found to be associated with poorer work ability (Yong et al., 2013), as well as being a risk factor for sick leave (Ahola et al., 2008) and disability pension (Ahola et al., 2009). Chronic illnesses (Jędryka-Góral et al., 2006; Shiri et al., 2013), higher BMI (Andersen et al., 2017; Bridger & Bennett, 2011) and higher age (Bridger & Bennett, 2011; Pohjonen, 2001) are all known to negatively affect work ability, whereas higher education has been linked with better work ability (Martimo et al., 2007). Poor sleep quality has been associated with poorer work ability and elevated sickness absence rate (Lallukka et al., 2014; Lian et al.,

2015). The finding that depression and/or anxiety was not associated with work ability in this study was slightly surprising, since it was significantly associated with poorer QoL, and depression is known to negatively affect work ability (Elinson et al., 2004; Shiri et al., 2013). One possible explanation for this is that the employees whose work ability has clearly declined due to depression may be on long-term sick leave or outside the workforce and not able to take part in the PORTAAT Study.

An interesting finding in the present study was that occupational stress was the factor most strongly associated with both QoL and work ability, even though the level of stress was very low among the study population. Only one-tenth of the participants had at least mild occupational stress symptoms, and severe symptoms were very rare. This finding indicates that it might be beneficial to effectively handle job stress problems promptly at a very mild stage. Another important finding was the strong association of self-reported sleep quality with both QoL and work ability. These significant associations were in this study reported among active workforce participants, with a very low prevalence of depression and with only 11% of the participants working in three shifts. This finding strengthens the idea of sleep quality being independently associated with good QoL and work ability in an employed population (Mahirah et al., 2021; Ng & Chan, 2018).

6.2.4 Sleep in Relation to Quality of Life and Work Ability

The strong association of sleep issues with QoL and work ability found in the present study and also in previous literature (Lallukka et al., 2018; Lian et al., 2015; Matsui et al., 2021) was conducive to the idea of further examining these associations in a longitudinal study. The changes in sleep quality, sleep duration and sleep medication use were studied in association with changes in QoL and work ability during the one-year follow up. Previous literature about the association of changes in sleep with QoL is scarce, but I found one previous work from the UK Household Longitudinal Survey (Tang et al., 2017). In that paper, Tang et al. showed that improvement in sleep quality, increase in sleep duration and decrease in sleep medication use were associated with better subsequent health and well-being, and the opposite changes in sleep parameters were associated with poorer results. The outcomes were measured with the SF-12 and the GHQ-12, but the possible effect of chronic illnesses was not controlled for in that study. Previous information about the association between changes in sleep and work ability is also scarce, but in a paper from the Helsinki Health Study, poor sleep and functioning as well as unfavourable changes in the above mentioned parameters were found to be associated with premature exit from work (Kronholm et al., 2021).

In my study, the changes in sleep parameters and in the outcomes (EUROHIS-QOL and WAS) were studied in six separate multivariable models. The models were adjusted for the same background variables used by Tang et al. (2017) and also for

chronic illnesses, which were found significantly associated with both QoL and work ability change in all six models. The change in EUROHIS-QOL was more favourable in the groups of improved and unchanged sleep quality compared to the group of worsened sleep quality, and the change in WAS also differed significantly between the groups of improved and worsened sleep quality. The findings with EUROHIS-QOL were consistent with Tang et al. for improved and worsened sleep quality. In the present study, the favourable change in EUROHIS-QOL in the group of unchanged sleep quality was based on the good results of the participants, whose sleep quality had remained continuously good or very good.

For sleep duration, the only significant difference was detected in the EUROHIS-QOL change between decreased and unchanged sleep duration. In previous literature, especially short (J.-H. Kim et al., 2015; Lallukka et al., 2018; Liu et al., 2018; Magee et al., 2011; Matsui et al., 2020, 2021; Stranges et al., 2008) but also excessively long (J.-H. Kim et al., 2015; Liu et al., 2018; Magee et al., 2011) sleep duration has been associated with lower QoL, with the mid-range sleep duration being the most favourable. The good results in the group of unchanged sleep duration might be because the proportion of participants sleeping the recommended 7–8 hours/night (Hirshkowitz et al., 2015) was highest in that group at follow-up.

For the use of sleep medications, the results were especially good in the group of unchanged use in both QoL and work ability change. In that group, the proportion of the participants using sleep medications was approximately 50% lower than in the whole study population, and their EUROHIS-QOL and WAS mean scores were higher at baseline as well as at follow-up, compared to the groups of increased or decreased use. The results in QoL and work ability change were especially poor in the group of increased use compared to unchanged use. In the group of increased use, a significant decline in work ability was also detected. No significant difference in either QoL or work ability change was detected between the groups of increased and decreased use. These results reflect that sleep problems that at some point have led to the use of sleep medications are associated with poorer development of QoL and work ability compared to the situation in which sleep medications have not been needed. According to previous literature about the associations between sleep medication use and HRQoL (Sasai et al., 2010; Walsh et al., 2007), it can be speculated that the association between increased use of sleep medications and unfavourable results in QoL and work ability are actually a sign of increased insomnia symptoms. In a Japanese study among a general population, patients who slept well with sleep medication had significantly better mental component scores of Short Form 8 than either insomniacs or insomniacs using sleep medication (Sasai et al., 2010). Treatment of primary insomnia with benzodiazepine for six months also improved the patients' HRQoL and reduced work limitations in a placebo-controlled clinical trial in the US (Walsh et al., 2007). I think that increased need for sleep medication should be taken as a sign of problems in sleeping, and in such case the physician should look for

underlying causes of insomnia (e.g. depression) and maybe also offer some other treatment options for sleep problems, like Cognitive Behavioural Therapy for Insomnia (CBT-I) (van Straten et al., 2018).

Changes in sleep quality were found to have the strongest association with changes in QoL, followed by changes in sleep medication use and sleep duration. Corresponding effects on health and well-being were also detected by Tang et al. (2017). However, I did not find significant differences between all the groups of declined and improved sleep parameters, as they did in their study. One of the explanations for this might be that their results were not controlled for chronic illnesses, which may have moderated some of the associations. In addition, a novel finding in my study was that changes in sleep medication use and sleep quality were associated with changes in work ability.

6.2.5 Healthy and Unhealthy Diet and Quality of Life

In Study IV, the consumption frequencies of healthy and unhealthy food items were examined in association with QoL in female employees. In previous literature, recommended dietary patterns have been associated with good health-related QoL and general QoL (Godos et al., 2019; Lee et al., 2019; Sanchez-Aguadero et al., 2016; Vajdi & Farhangi, 2020), and there is also evidence that an unhealthy ‘Western’ diet would be associated with poorer HRQoL (Vajdi & Farhangi, 2020). However, these associations have been detected with different diets, consisting of a mixture of healthy and unhealthy foods, and less has been known about the role of the consumption frequencies of healthy or unhealthy foods in association with QoL. A more frequent consumption of healthy food items was associated with better QoL in the present study. The association remained significant in the adjusted model and involved most dimensions of EUROHIS-QOL. However, the differences in the physical health metrics between the groups with different consumption frequencies of healthy foods were small, and the consumption frequency of unhealthy food items was not associated with QoL in this study.

There is indisputable evidence that abundant use of unhealthy foods is associated with unfavourable health consequences (Gupta & Wood, 2019; Visseren et al., 2021), and it is possible that more differences in physical health metrics would have been detected in comparison with the consumption frequencies of unhealthy foods. There is also previous data that an unhealthy diet would be associated with poorer HRQoL (Vajdi & Farhangi, 2020). However, the results of my study suggest that the negative effects of an unhealthy diet on QoL could predominantly be due to lack of healthy dietary components.

The healthiest way of eating would inevitably be following a recommended diet. The health benefits of eating according to the Mediterranean style diet or, for example, the Nordic Nutrition Recommendations (*Nordic Nutrition Recommendations 2012*;

Integrating Nutrition and Physical Activity, 2014) have been proven in several diet studies (Sofi et al., 2008; Tertsunen et al., 2020, 2021). The biggest problem in diet counselling is not the lack of knowledge or advice about healthy nutrition, but the patients' nonadherence to the recommended diet (Kwan et al., 2013). It is known that the risk for non-adherence even increases if the behavioural recommendations are complex (Martin et al., 2005). Subjective well-being is thought to be a goal that is shared with most people. Therefore, health-promoting actions enhancing well-being might be the most easily accepted and adhered to. There is evidence that favourable health behaviours, including a healthy diet, predict subjective well-being, and positive changes in health behaviours have a similar effect (Stenlund et al., 2021a, 2022). Thus, the positive association found in the present study between QoL and frequent consumption of healthy foods might be used to motivate people to change their diet. The advice to increase the consumption of healthy foods on a rather short list would be quite simple and reasonably achievable. And, if that change in diet increased the patient's experience of well-being, they might be more willing to proceed to other improvements as well.

6.3 Strengths and Limitations

This thesis has some clear strengths. A wide range of possible explanatory variables could be considered affecting QoL and work ability of the employees. A combination of clinical and self-reported data was used, and the clinical measurements were made by trained medical staff. The questionnaires were completed by the participants at home before the study visits, and validated questionnaires were used to evaluate QoL, depressive symptoms, anxiety, occupational stress, and food consumption. Information about chronic diseases was collected both with questionnaires and from medical records, which improves the accuracy of the data. QoL, sleep and work ability were assessed with subjective, self-reported tools, emphasising the person-centred approach to these factors. The changes in QoL, work ability and the sleep parameters were assessed by analysing repeated measurements rather than the participants' perceptions of occurred change. The results of this thesis are controlled in terms of employment status, since all the participants were working in the public sector during the study.

I also acknowledge some limitations. A major limitation of the study is that I am unable to determine any causality from the detected associations. The study designs are cross-sectional, and despite the longitudinal nature of one part, causality cannot be reported since changes in sleep parameters and outcomes have been measured concurrently. The stable employment status of an active workforce among all participants may have led to a possible healthy worker effect (C.-Y. Li & Sung, 1999), and the relatively low response rate of 32.5% in the study at baseline could have resulted in a biased study population. In addition, all the participants were employees

of one city in southwest of Finland. To test the possible bias, several comparisons were conducted between the study population and the personnel of the city of Pori as well as public sector employees and the general population in Finland. The comparisons and discussion about generalisability are presented in detail in chapters 5.1 and 6.1.1. The study participants resembled the personnel of the city of Pori very well in terms of age, gender distribution and the rate of sickness absence days. The gender distribution with female predominance is typical of the whole Finnish public sector, but understandably, it prevents me from making any conclusions about the male participants. The prevalence of smoking and obesity among the study participants was close to the levels among the Finnish general population, but the prevalence of depression was lower in the study population. As a conclusion, the results of this study can be generalised into the personnel of the city of Pori quite well, and to some extent also to the Finnish public sector employees. However, some caution must be exercised when the results are compared to the Finnish general population.

The assessment of sleep in this study was made with three individual self-reported items derived from the PSQI, and I did not have any objective measurement of sleep. This is a clear limitation in terms of sleep duration. Nevertheless, sleep quality can be assessed fairly reliably by self-report. Some of the assessment methods had been changed from baseline to follow-up, which prevented the longitudinal analysis of, for example, diet and psychological factors. Many of the studied factors also had to be dichotomised for the analyses, which may increase the probability of type I and type II errors.

6.4 Clinical Implications and Future Directions

The development of patient reported-outcome measures started in the early 1980s with the introduction of the first measurement tools for QoL, and self-rated health status is continuing (McKenna, 2011; OECD, 2017). Recently, the Finnish Institute for Health and Welfare reported that a general patient-reported outcome measure will be chosen for the national healthcare quality registers, to complement the data from clinical measurements (Finnish Institute for Health and Welfare (THL), 2021). I find it very important that patients' experiences of the efficacy of the treatments and their impact on general well-being are understood as outcomes as important as, for example, the laboratory measurements.

However, the importance of subjective well-being should be remembered not only when assessing patients with a particular illness or treatment but also in disease prevention. The results of this thesis offer new aspects for health promotion, especially for working-age patients in primary and occupational healthcare. I think that every person has an idea about how it feels to have good QoL and good work ability, and a decline in both of these factors is experienced negatively. Therefore, favourable health

behaviours might also be adopted more successfully if preserving health in older age is not the only incentive. Rather, well-being and good work ability here and now could also be used as motivational factors. The threat of heart disease might be somewhere far in the future, but the decline in QoL and work ability because of low physical activity, obesity, unfavourable diet or poor sleep may already be present. Therefore, knowledge about the positive association of favourable health habits with QoL and work ability could better encourage people to aim at the goals listed, for example, in the American Heart Association's ideals. For healthcare professionals, it is also important to know what factors are most frequently associated with QoL and work ability among the target population, because screening and actions could then be aimed especially at these issues.

The information about the positive connection between frequent use of healthy foods and QoL found in the present study could be used in motivating people to shift their diets towards healthier eating. The results suggest that the association of an unhealthy diet with poorer QoL, found in previous literature, might be predominantly caused by the lack of healthy food items in the diet. Therefore, starting to improve the diet by adding more healthy foods might be a useful approach. These findings could be used in giving simple and quick diet counselling, for example, at primary and occupational healthcare appointments.

Information about the strong connection of sleep and even mild occupational stress with QoL and work ability could direct the healthcare professionals to pay attention to these issues at normal consultations and health check-ups. Sleep and occupational stress should be assessed routinely, and patients with sleep problems and even mild symptoms of occupational stress should be offered appropriate help. According to the findings of the present study, these actions would be beneficial both from a health-oriented and an economic point of view. Special attention should be paid to employees whose sleep medication use has increased, because it was associated with a clear decline in work ability in the present study. The increased need for sleep medications should be regarded as a sign of increased insomnia symptoms. Underlying causes should be investigated, and effective treatment offered to these patients.

I suggest that processes for detecting and helping patients with poor sleep in primary healthcare should be developed. Poor sleep has previously been found to be a significant risk factor for obesity, type 2 diabetes, hypertension, CV disease and depression, which are all very common among patients in primary healthcare. Physicians and nurses are well-trained to screen for and handle many other important risk factors for these illnesses, and health habits such as diet, physical activity, smoking and alcohol consumption are asked about routinely at check-ups. Screening for sleep problems should be added to this list. There should also be an appropriate and cost-effective way to treat the problems found in the screening. The somatic and psychiatric illnesses found behind the sleep problems should, of course, be treated

according to current guidelines, but people with insomnia often need specialised help. One possible solution could be training sleep-oriented nurses for primary healthcare to support patients with sleep problems and to conduct basic CBT-I, the approach that has been found to be the most effective in treating insomnia.

To confirm the results of the present study, it would be necessary to investigate the connections found here in different study designs and populations. Most of the associations in my thesis were detected in cross-sectional studies, and the causality of the associations should be examined in longitudinal studies. This could further strengthen the credibility of the findings. The present study showed that temporal changes in sleep parameters were related to concurrent changes in QoL and work ability. To my knowledge, previous information about the association between changes in sleep and work ability is very scarce, and replication of these results in the future is important. It would also be interesting to address a sleep quality intervention with the subjects reporting poor sleep quality and examine its effects on QoL and work ability. Finally, because all the connections in my thesis were detected in reasonably healthy public employees of one city in Finland, comparable studies would be important to conduct among a wider range of occupational sectors and among the general population.

7 Conclusions

The main conclusions in this thesis study among Finnish public sector employees are the following:

1. Good sleep quality, ideal CV health, and frequent use of healthy foods as well as absence of occupational stress, depressive symptoms, anxiety, and chronic illnesses are associated with good QoL (Figure 5).
2. Good sleep quality and absence of occupational stress and chronic illnesses are associated with good work ability.
3. An improvement in sleep quality is associated with a positive change in QoL and work ability, and increased use of sleep medication is associated with a decline in work ability. Changes in sleep medication use and sleep duration are also associated with changes in QoL.

The importance of self-reported sleep quality in defining QoL and work ability was especially emphasised in this study. On that basis, sleep issues should be brought up in the consultations and health check-ups of primary and occupational healthcare, and help and advice should be offered to patients with poor sleep quality. According to my study, sleep quality can be assessed fairly well with a single question.

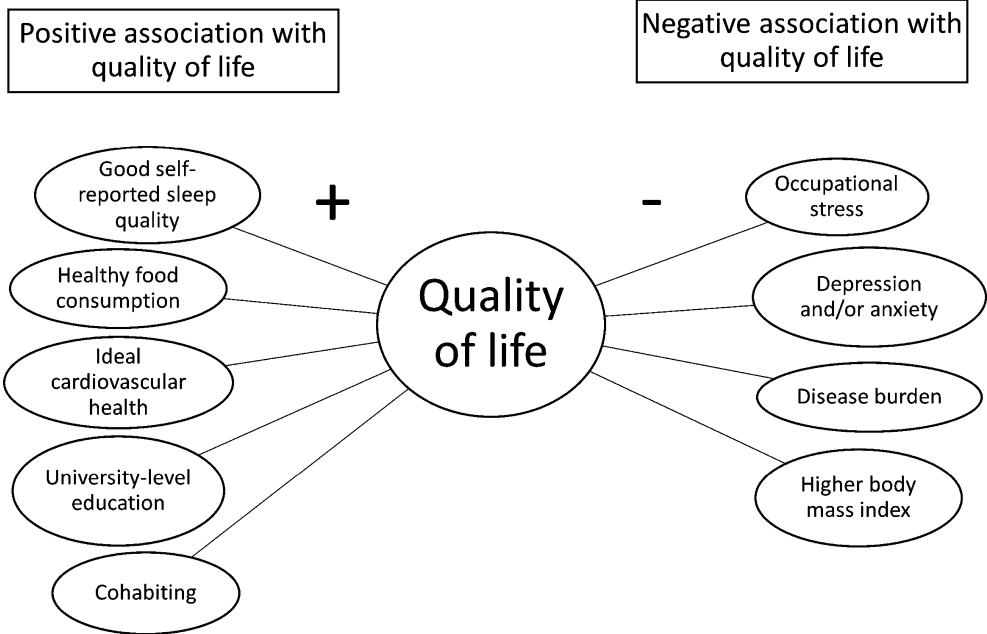


Figure 5. Factors found positively or negatively associated with quality of life among the study population of the present thesis.

Acknowledgements

Now I have eaten and thought, and I think everything is getting a little clearer.

Tove Jansson, Comet in Moominland

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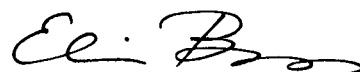
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A handwritten signature in black ink, appearing to read 'Elina Bergman', with a stylized flourish at the end.

Elina Bergman

References

- Aalto, M., Tuunanen, M., Sillanaukee, P., & Seppä, K. (2006). Effectiveness of structured questionnaires for screening heavy drinking in middle-aged women. *Alcoholism: Clinical and Experimental Research*, *30*(11), 1884–1888. <https://doi.org/10.1111/j.1530-0277.2006.00233.x>
- Ahola, K. (2007). Occupational Burnout and Health. In *People and Work; Research Reports*. Tampere, Finland.
- Ahola, K., Gould, R., Virtanen, M., Honkonen, T., Aromaa, A., & Lönnqvist, J. (2009). Occupational burnout as a predictor of disability pension: A population-based cohort study. *Occupational and Environmental Medicine*, *66*(5), 284–290. <https://doi.org/10.1136/oem.2008.038935>
- Ahola, K., Kivimäki, M., Honkonen, T., Virtanen, M., Koskinen, S., Vahtera, J., & Lönnqvist, J. (2008). Occupational burnout and medically certified sickness absence: A population-based study of Finnish employees. *Journal of Psychosomatic Research*, *64*(2), 185–193. <https://doi.org/10.1016/j.jpsychores.2007.06.022>
- Ahola, K., Tuisku, K., & Rossi, H. (2018). *Tietoa potilaalle: Työuupumus (burnout)*. Lääkärikirja Duodecim. Retrieved 14 February, 2022, from <<https://www.terveysportti.fi/apps/dtk/ltk/article/dlk00681/search/työuupumus>>
- Allen, N. B., Badon, S., Greenlund, K. J., Huffman, M., Hong, Y., & Lloyd-Jones, D. M. (2015). The association between cardiovascular health and health-related quality of life and health status measures among U.S. adults: a cross-sectional study of the National Health and Nutrition Examination Surveys, 2001-2010. *Health and Quality of Life Outcomes*, *13*(1), 152. <https://doi.org/10.1186/s12955-015-0352-z>
- Andersen, L. L., Izquierdo, M., & Sundstrup, E. (2017). Overweight and obesity are progressively associated with lower work ability in the general working population: cross-sectional study among 10,000 adults. *International Archives of Occupational and Environmental Health*, *90*(8), 779–787. <https://doi.org/10.1007/s00420-017-1240-0>
- Anothaisintawee, T., Reutrakul, S., Van Cauter, E., & Thakkinstian, A. (2016). Sleep disturbances compared to traditional risk factors for diabetes development: Systematic review and meta-analysis. *Sleep Medicine Reviews*, *30*, 11–24. <https://doi.org/10.1016/j.smrv.2015.10.002>
- Arnett, D. K., Blumenthal, R. S., Albert, M. A., Buroker, A. B., Goldberger, Z. D., Hahn, E. J., Himmelfarb, C. D., Khera, A., Lloyd-Jones, D., McEvoy, J. W., Michos, E. D., Miedema, M. D., Muñoz, D., Smith, S. C., Virani, S. S., Williams, K. A., Yeboah, J., & Ziaeian, B. (2019). 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Journal of the American College of Cardiology*, *74*(10), e177–e232. <https://doi.org/10.1016/j.jacc.2019.03.010>
- Baglioni, C., Battagliese, G., Feige, B., Spiegelhalter, K., Nissen, C., Voderholzer, U., Lombardo, C., & Riemann, D. (2011). Insomnia as a predictor of depression: A meta-analytic evaluation of longitudinal epidemiological studies. *Journal of Affective Disorders*, *135*(1–3), 10–19. <https://doi.org/10.1016/j.jad.2011.01.011>
- Baglioni, C., Spiegelhalter, K., Lombardo, C., & Riemann, D. (2010). Sleep and emotions: A focus on insomnia. *Sleep Medicine Reviews*, *14*(4), 227–238. <https://doi.org/10.1016/j.smrv.2009.10.007>

- Bech, P., Rasmussen, N. A., Olsen, L. R., Noerholm, V., & Abildgaard, W. (2001). The sensitivity and specificity of the Major Depression Inventory, using the Present State Examination as the index of diagnostic validity. *Journal of Affective Disorders*, *66*(2–3), 159–164. [https://doi.org/10.1016/S0165-0327\(00\)00309-8](https://doi.org/10.1016/S0165-0327(00)00309-8)
- Bech, P., Timmerby, N., Martiny, K., Lunde, M., & Soendergaard, S. (2015). Psychometric evaluation of the Major Depression Inventory (MDI) as depression severity scale using the LEAD (Longitudinal Expert Assessment of All Data) as index of validity. *BMC Psychiatry*, *15*, 190. <https://doi.org/10.1186/s12888-015-0529-3>
- Benjamin, E. J., Virani, S. S., Callaway, C. W., Chamberlain, A. M., Chang, A. R., Cheng, S., Chiuve, S. E., Cushman, M., Dellinger, F. N., Deo, R., De Ferranti, S. D., Ferguson, J. F., Fornage, M., Gillespie, C., Isasi, C. R., Jiménez, M. C., Jordan, L. C., Judd, S. E., Lackland, D., ... Muntner, P. (2018). Heart disease and stroke statistics - 2018 update: A report from the American Heart Association. *Circulation*, *137*(12), E67–E492. <https://doi.org/10.1161/CIR.0000000000000558>
- Bergner, M. (1985). Measurement of Health Status. *Medical Care*, *23*(5), 696–704. <https://doi.org/10.1097/00005650-198505000-00028>
- Bergner, M., Bobbitt, R. A., Carter, W. B., & Gilson, B. S. (1981). The sickness impact profile: Development and final revision of a health status measure. *Medical Care*, *19*(8), 787–805. <https://doi.org/10.1097/00005650-198108000-00001>
- Bianchi, M. T., Thomas, R. J., & Westover, M. B. (2017). An open request to epidemiologists: please stop querying self-reported sleep duration. *Sleep Medicine*, *35*, 92–93. <https://doi.org/10.1016/j.sleep.2017.02.001>
- Billings, M. E., Hale, L., & Johnson, D. A. (2020). Physical and social environment relationship with sleep health and disorders. *Chest*, *157*(5), 1304–1312. <https://doi.org/10.1016/j.chest.2019.12.002>
- Bize, R., Johnson, J. A., & Plotnikoff, R. C. (2007). Physical activity level and health-related quality of life in the general adult population: A systematic review. *Preventive Medicine*, *45*(6), 401–415. <https://doi.org/10.1016/j.ypmed.2007.07.017>
- Borbély, A. A., Daan, S., Wirz-Justice, A., & Deboer, T. (2016). The two-process model of sleep regulation: A reappraisal. *Journal of Sleep Research*, *25*(2), 131–143. <https://doi.org/10.1111/jsr.12371>
- Bridger, R. S., & Bennett, A. I. (2011). Age and BMI interact to determine work ability in seafarers. *Occupational Medicine*, *61*(3), 157–162. <https://doi.org/10.1093/occmed/kqr003>
- Buchholz, I., Janssen, M. F., Kohlmann, T., & Feng, Y. S. (2018). A systematic review of studies comparing the measurement properties of the three-level and five-level versions of the EQ-5D. *Pharmacoeconomics*, *36*(6), 645–661. <https://doi.org/10.1007/s40273-018-0642-5>
- Buijs, R. M., van Eden, C. G., Goncharuk, V. D., & Kalsbeek, A. (2003). The biological clock tunes the organs of the body: Timing by hormones and the autonomic nervous system. *Journal of Endocrinology*, *177*(1), 17–26. <https://doi.org/10.1677/joe.0.1770017>
- Burdorf, A., Frings-Dresen, M. H. W., van Duivenbooden, C., & Elders, L. A. M. (2005). Development of a decision model to identify workers at risk of long-term disability in the construction industry. *Scandinavian Journal of Work, Environment and Health*, *31*(Suppl 2), 31–36.
- Bush, K., Kivlahan, D. R., McDonell, M. B., Fihn, S. D., & Bradley, K. A. (1998). The AUDIT alcohol consumption questions (AUDIT-C): An effective brief screening test for problem drinking. *Archives of Internal Medicine*, *158*(16), 1789–1795. <https://doi.org/10.1001/archinte.158.16.1789>
- Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193–213. [https://doi.org/10.1016/0165-1781\(89\)90047-4](https://doi.org/10.1016/0165-1781(89)90047-4)
- Caleyachetty, R., Echouffo-Tcheugui, J. B., Muenning, P., Muntner, P., & Shimbo, D. (2015). Association between cumulative social risk and ideal cardiovascular health in US adults: NHANES 1999–2006. *International Journal of Cardiology*, *191*, 296–300. <https://doi.org/10.1016/j.ijcard.2015.05.007>

- Cappuccio, F. P., Cooper, D., D'Elia, L., Strazzullo, P., & Miller, M. A. (2011). Sleep duration predicts cardiovascular outcomes: A systematic review and meta-analysis of prospective studies. *European Heart Journal*, *32*(12), 1484–1492. <https://doi.org/10.1093/eurheartj/ehr007>
- Cappuccio, F. P., D'Elia, L., Strazzullo, P., & Miller, M. A. (2010a). Quantity and quality of sleep and incidence of type 2 diabetes: A systematic review and meta-analysis. *Diabetes Care*, *33*(2), 414–420. <https://doi.org/10.2337/dc09-1124>
- Cappuccio, F. P., D'Elia, L., Strazzullo, P., & Miller, M. A. (2010b). Sleep duration and all-cause mortality: A systematic review and meta-analysis of prospective studies. *Sleep*, *33*(5), 585–592. <https://doi.org/10.1093/sleep/33.5.585>
- Carpenter, J. S., & Andrykowski, M. A. (1998). Psychometric evaluation of the Pittsburgh Sleep Quality Index. *Journal of Psychosomatic Research*, *45*(1), 5–13. [https://doi.org/10.1016/S0022-3999\(97\)00298-5](https://doi.org/10.1016/S0022-3999(97)00298-5)
- Carr, C. N., Lopchuk, S., Beckman, M. E., & Baugh, T. B. (2016). Evaluation of the use of low-dose quetiapine and the risk of metabolic consequences: A retrospective review. *Mental Health Clinician*, *6*(6), 308–313. <https://doi.org/10.9740/mhc.2016.11.308>
- Castro, P. C., Driusso, P., & Oishi, J. (2014). Convergent validity between SF-36 and WHOQOL-BREF in older adults. *Revista de Saude Publica*, *48*(1), 63–67. <https://doi.org/10.1590/S0034-8910.2014048004783>
- Chennaoui, M., Arnal, P. J., Sauvet, F., & Léger, D. (2015). Sleep and exercise: A reciprocal issue? *Sleep Medicine Reviews*, *20*, 59–72. <https://doi.org/10.1016/j.smr.2014.06.008>
- Chiu, M. C., Wang, M. J. J., Lu, C. W., Pan, S. M., Kumashiro, M., & Ilmarinen, J. (2007). Evaluating work ability and quality of life for clinical nurses in Taiwan. *Nursing Outlook*, *55*(6), 318–326. <https://doi.org/10.1016/j.outlook.2007.07.002>
- Cosentino, F., Grant, P. J., Aboyans, V., Bailey, C. J., Ceriello, A., Delgado, V., Federici, M., Filippatos, G., Grobbee, D. E., Hansen, T. B., Huikuri, H. V., Johansson, I., Juni, P., Lettino, M., Marx, N., Mellbin, L. G., Ostgren, C. J., Rocca, B., Roffi, M., ... Chowdhury, T. A. (2020). 2019 ESC Guidelines on diabetes, pre-diabetes, and cardiovascular diseases developed in collaboration with the EASD. *European Heart Journal*, *41*(2), 255–323. <https://doi.org/10.1093/eurheartj/ehz486>
- Da Rocha, N. S., Power, M. J., Bushnell, D. M., & Fleck, M. P. (2012). The EUROHIS-QOL 8-item index: Comparative psychometric properties to its parent WHOQOL-BREF. *Value in Health*, *15*(3), 449–457. <https://doi.org/10.1016/j.jval.2011.11.035>
- Danaei, G., Singh, G. M., Paciorek, C. J., Lin, J. K., Cowan, M. J., Finucane, M. M., Farzadfar, F., Stevens, G. A., Riley, L. M., Lu, Y., Rao, M., & Ezzati, M. (2013). The global cardiovascular risk transition: Associations of four metabolic risk factors with national income, urbanization, and western diet in 1980 and 2008. *Circulation*, *127*(14), 1493–1502. <https://doi.org/10.1161/CIRCULATIONAHA.113.001470>
- Den Ouden, B. L., Van Heck, G. L., Van der Steeg, A. F. W., Roukema, J. A., & De Vries, J. (2009). The WHOQOL-100 has good psychometric properties in breast cancer patients. *Journal of Clinical Epidemiology*, *62*(2), 195–205. <https://doi.org/10.1016/j.jclinepi.2008.03.006>
- Ebrahim, I. O., Shapiro, C. M., Williams, A. J., & Fenwick, P. B. (2013). Alcohol and Sleep I: Effects on Normal Sleep. *Alcoholism: Clinical and Experimental Research*, *37*(4), 539–549. <https://doi.org/10.1111/acer.12006>
- Edinger, J. D., Fins, A. I., Glenn, D. M., Sullivan, R. J., Bastian, L. A., Marsh, G. R., Dailey, D., Hope, T. V., Young, M., Shaw, E., & Vasilas, D. (2000). Insomnia and the eye of the beholder: Are there clinical markers of objective sleep disturbances among adults with and without insomnia complaints? *Journal of Consulting and Clinical Psychology*, *68*(4), 586–593. <https://doi.org/10.1037/0022-006X.68.4.586>
- El Fassi, M., Bocquet, V., Majery, N., Lair, M. L., Couffignal, S., & Mairiaux, P. (2013). Work ability assessment in a worker population : comparison and determinants of Work Ability Index and Work Ability score. *BMC Public Health*, *13*, 305.

- Elinson, L., Houck, P., Marcus, S. C., & Pincus, H. A. (2004). Depression and the Ability to Work. *Psychiatric Services*, 55(1), 29–34. <https://doi.org/10.1176/appi.ps.55.1.29>
- Eryilmaz, M. M., Ozdemir, C., Yurtman, F., Cilli, A., & Karaman, T. (2005). Quality of sleep and quality of life in renal transplantation patients. *Transplantation Proceedings*, 37(5), 2072–2076. <https://doi.org/10.1016/j.transproceed.2005.03.084>
- EUPATI. (n.d.). *Measuring Health-related quality of life (HRQoL)*. Retrieved May 11, 2022, from <<https://toolbox.eupati.eu/resources/measuring-health-related-quality-of-life-hrqol/>>
- EuroQoL Group. (1990). EuroQol - a new facility for the measurement of health-related quality of life. *Health Policy*, 16(3), 199–208. [https://doi.org/10.1016/0168-8510\(90\)90421-9](https://doi.org/10.1016/0168-8510(90)90421-9)
- EuroQol Research Foundation. (2021a). *EQ-5D-3L User guide: Basic information on how to use the EQ-5D-3L instrument* (6.0). Rotterdam, the Netherlands.
- EuroQol Research Foundation. (2021b). *EQ-5D-5L User guide: Basic information on how to use the EQ-5D-5L instrument* (3.0). Rotterdam, the Netherlands.
- Fallowfield, L. (1990). *The Quality of Life: The Missing Measurement in Health Care*. Souvenir Press. London, UK.
- Fang, N., Jiang, M., & Fan, Y. (2016). Ideal cardiovascular health metrics and risk of cardiovascular disease or mortality: A meta-analysis. *International Journal of Cardiology*, 214, 279–283. <https://doi.org/10.1016/j.ijcard.2016.03.210>
- Ferrara, M., & De Gennaro, L. (2001). How much sleep do we need? *Sleep Medicine Reviews*, 5(2), 155–179. <https://doi.org/10.1053/smr.2000.0138>
- Finnish Institute for Health and Welfare (THL). (n.d.). *TOIMIA-tietokanta*. Retrieved March 20, 2022, from <<https://www.terveysportti.fi/apps/dtk/tmi?toc=802599>>
- Finnish Institute for Health and Welfare (THL). (2021). *National health care quality registers*. Retrieved May 14, 2022, from <<https://thl.fi/en/web/social-welfare-and-health-care-reform/health-and-social-services-system-performance-assessment/national-health-care-quality-registers>>
- Freyer, M., Formazin, M., & Rose, U. (2019). Factorial Validity of the Work Ability Index Among Employees in Germany. *Journal of Occupational Rehabilitation*, 29(2), 433–442. <https://doi.org/10.1007/s10926-018-9803-9>
- Friedewald, W. T., Levy, R. I., & Fredrickson, D. S. (1972). Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clinical Chemistry*, 18(6), 499–502.
- Galatsch, M., Li, J., Derycke, H., Müller, B. H., & Hasselhorn, H. M. (2013). Effects of requested, forced and denied shift schedule change on work ability and health of nurses in Europe -Results from the European NEXT-Study. *BMC Public Health*, 13(1137). <https://doi.org/10.1186/1471-2458-13-1137>
- Galton, F. (1886). Regression towards mediocrity in hereditary stature. *Journal of the Anthropological Institute*, 15, 246–263.
- Gao, B., Wang, F., Zhu, M., Wang, J., Zhou, M., Zhang, L., & Zhao, M. (2020). Cardiovascular health metrics and all-cause mortality and mortality from major non-communicable chronic diseases among Chinese adult population. *International Journal of Cardiology*, 313, 123–128. <https://doi.org/10.1016/j.ijcard.2020.04.048>
- Garde, A. H., Begtrup, L., Bjorvatn, B., Bonde, J. P., Hansen, J., Hansen, Å. M., Härmä, M., Jensen, M. A., Kecklund, G., Kolstad, H. A., Larsen, A. D., Lie, J. A., Moreno, C. R. C., Nabe-Nielsen, K., & Sallinen, M. (2020). How to schedule night shift work in order to reduce health and safety risks. *Scandinavian Journal of Work, Environment and Health*, 46(6), 557–569. <https://doi.org/10.5271/sjweh.3920>
- Gentili, A., Weiner, D. K., Kuchibhatla, M., & Edinger, J. D. (1995). The Test-retest reliability of the Pittsburgh Sleep Quality Index in nursing home residents. *Journal of American Geriatrics Society*, 43(11), 1317–1318.

- Godos, J., Castellana, S., & Marranzano, M. (2019). Adherence to a Mediterranean dietary pattern is associated with higher quality of life in a cohort of Italian adults. *Nutrients*, *11*(5), 981. <https://doi.org/10.3390/nu11050981>
- Goldenberg, M., Danovitch, I., & IsHak, W. W. (2014). Quality of life and smoking. *The American Journal on Addictions*, *23*(6), 540–562. <https://doi.org/10.1111/j.1521-0391.2014.12148.x>
- Gould, R., Ilmarinen, J., Järvisalo, J., & Koskinen, S. (2008). *Dimensions of Work Ability*. Finnish Centre for Pensions. <https://doi.org/10.1108/02656710210415668>
- Grosso, G., Marventano, S., Yang, J., Micek, A., Pajak, A., Scalfi, L., Galvano, F., & Kales, S. N. (2017). A comprehensive meta-analysis on evidence of Mediterranean diet and cardiovascular disease: Are individual components equal? *Critical Reviews in Food Science and Nutrition*, *57*(15), 3218–3232. <https://doi.org/10.1080/10408398.2015.1107021>
- Grzymisławska, M., Puch, E. A., Zawada, A., & Grzymisławski, M. (2020). Do nutritional behaviors depend on biological sex and cultural gender? *Advances in Clinical and Experimental Medicine*, *29*(1), 165–172. <https://doi.org/10.17219/acem/111817>
- Gupta, R., & Wood, D. A. (2019). Primary prevention of ischaemic heart disease: populations, individuals, and health professionals. *The Lancet*, *394*, 685–696. [https://doi.org/10.1016/S0140-6736\(19\)31893-8](https://doi.org/10.1016/S0140-6736(19)31893-8)
- Harrell, F. (2001). *Regression Modeling Strategies; With Applications to Linear Models, Logistic Regression, and Survival Analysis*. Springer. New York, NY.
- Hatch, D. J., Freude, G., Martus, P., Rose, U., Müller, G., & Potter, G. G. (2018). Age, burnout and physical and psychological work ability among nurses. *Occupational Medicine*, *68*(4), 246–254. <https://doi.org/10.1093/occmed/kqy033>
- Haus, E. L., & Smolensky, M. H. (2013). Shift work and cancer risk: Potential mechanistic roles of circadian disruption, light at night, and sleep deprivation. *Sleep Medicine Reviews*, *17*(4), 273–284. <https://doi.org/10.1016/j.smrv.2012.08.003>
- Hays, R. D., Sherbourne, C. D., & Mazel, R. M. (1993). The rand 36-item health survey 1.0. *Health Economics*, *2*(3), 217–227. <https://doi.org/10.1002/hec.4730020305>
- Helldán, A., & Helakorpi, S. (2015). *Health behaviour and health among the Finnish adult population, spring 2014*. National Institute for Health and Welfare (THL). Tampere, Finland.
- Hemiö, K., Puttonen, S., Viitasalo, K., Härmä, M., Peltonen, M., & Lindström, J. (2015). Food and nutrient intake among workers with different shift systems. *Occupational and Environmental Medicine*, *72*(7), 513–520. <https://doi.org/10.1136/oemed-2014-102624>
- Herdman, M., Gudex, C., Lloyd, A., Janssen, M., Kind, P., Parkin, D., Bonsel, G., & Badia, X. (2011). Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). *Quality of Life Research*, *20*(10), 1727–1736. <https://doi.org/10.1007/s11136-011-9903-x>
- Hirshkowitz, M., Whitton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., Hazen, N., Herman, J., Adams Hillard, P. J., Katz, E. S., Kheirandish-Gozal, L., Neubauer, D. N., O'Donnell, A. E., Ohayon, M., Peever, J., Rawding, R., Sachdeva, R. C., Setters, B., Vitiello, M. V., & Ware, J. C. (2015). National Sleep Foundation's updated sleep duration recommendations: final report. *Sleep Health*, *1*(4), 233–243. <https://doi.org/10.1016/j.sleh.2015.10.004>
- Holbrook, A. M., Crowther, R., Lotter, A., Cheng, C., & King, D. (2000). Meta-analysis of benzodiazepine use in the treatment of insomnia. *Canadian Medical Association Journal*, *162*(2), 225–233.
- Holstila, A., Mänty, M., Rahkonen, O., Lahelma, E., & Lahti, J. (2017). Changes in leisure-time physical activity and physical and mental health functioning: a follow-up study. *Scandinavian Journal of Medicine and Science in Sports*, *27*(12), 1785–1792. <https://doi.org/10.1111/sms.12758>
- Htoo, A., Talwar, A., Feinsilver, S. H., & Greenberg, H. (2004). Smoking and sleep disorders. *The Medical Clinics of North America*, *88*(6), 1575–1591. <https://doi.org/10.1016/j.mcna.2004.07.003>
- Huang, I. C., Wu, A. W., & Frangakis, C. (2006). Do the SF-36 and WHOQOL-BREF measure the same constructs? Evidence from the taiwan population. *Quality of Life Research*, *15*(1), 15–24. <https://doi.org/10.1007/s11136-005-8486-9>

- Hunt, S. M., McKenna, S. P., McEwen, J., Williams, J., & Papp, E. (1981). The Nottingham health profile: Subjective health status and medical consultations. *Social Science and Medicine. Part A Medical Sociology*, *15*(3 Pt 1), 221–229. [https://doi.org/10.1016/0271-7123\(81\)90005-5](https://doi.org/10.1016/0271-7123(81)90005-5)
- Hyttinen, L., Strandberg, T. E., Strandberg, A. Y., Salomaa, V. V., Pitkälä, K. H., Tilvis, R. S., & Miettinen, T. A. (2011). Effect of cholesterol on mortality and quality of life up to a 46-year follow-up. *The American Journal of Cardiology*, *108*(5), 677–681. <https://doi.org/10.1016/j.amjcard.2011.04.016>
- ICD-10. (2019). *International Statistical Classification of Diseases and Related Health Problems 10th Revision*. <<https://icd.who.int/browse10/2019/en#>>
- ICD-11. (2021). *International Statistical Classification of Diseases and Related Health Problems 11th Revision*. <<https://icd.who.int/browse11/l-m/en>>
- Ilmarinen, J. (2007). The Work Ability Index (WAI). *Occupational Medicine*, *57*(2), 160–160. <https://doi.org/10.1093/occmed/kqm008>
- Ilmarinen, J. (2008). *Towards a longer worklife! Ageing and the quality of worklife in the European Union*. Finnish Institute of Occupational Health (FIOH) and Ministry of Social Affairs and Health. Helsinki, Finland.
- Ilmarinen, J. (2009). Work ability - A comprehensive concept for occupational health research and prevention. *Scandinavian Journal of Work, Environment and Health*, *35*(1), 1–5. <https://doi.org/10.5271/sjweh.1304>
- International Expert Committee. (2009). International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. *Diabetes Care*, *32*(7), 1327–1334. <https://doi.org/10.2337/dc09-9033>
- Ishibashi, Y., & Shimura, A. (2020). Association between work productivity and sleep health: A cross-sectional study in Japan. *Sleep Health*, *6*(3), 270–276. <https://doi.org/10.1016/j.sleh.2020.02.016>
- Itani, O., Jike, M., Watanabe, N., & Kaneita, Y. (2017). Short sleep duration and health outcomes: a systematic review, meta-analysis, and meta-regression. *Sleep Medicine*, *32*, 246–256. <https://doi.org/10.1016/j.sleep.2016.08.006>
- Janssen, M. F., Bonsel, G. J., & Luo, N. (2018). Is EQ-5D-5L better than EQ-5D-3L? A head-to-head comparison of descriptive systems and value sets from seven countries. *PharmacoEconomics*, *36*(6), 675–697. <https://doi.org/10.1007/s40273-018-0623-8>
- Jean-Louis, G., Kripke, D. F., & Ancoli-Israel, S. (2000). Sleep and quality of well-being. *Sleep*, *23*(8), 1115–1121. <https://doi.org/10.1093/sleep/23.8.1k>
- Jędryka-Góral, A., Bugajska, J., Lastowiecka, E., Najmiec, A., Rell-Bakalarska, M., Bownik, I., Michalak, J. M., & Kochmański, M. (2006). Work ability in ageing workers suffering from chronic diseases. *International Journal of Occupational Safety and Ergonomics*, *12*(1), 17–30. <https://doi.org/10.1080/10803548.2006.11076665>
- Jia, Y., Lu, Y., Wu, K., Lin, Q., Shen, W., Zhu, M., Huang, S., & Chen, J. (2013). Does night work increase the risk of breast cancer? A systematic review and meta-analysis of epidemiological studies. *Cancer Epidemiology*, *37*(3), 197–206. <https://doi.org/10.1016/j.canep.2013.01.005>
- Jike, M., Itani, O., Watanabe, N., Buysse, D. J., & Kaneita, Y. (2018). Long sleep duration and health outcomes: A systematic review, meta-analysis and meta-regression. *Sleep Medicine Reviews*, *39*, 25–36. <https://doi.org/10.1161/JAHA.118.008552>
- Jing, X., Chen, J., Dong, Y., Han, D., Zhao, H., Wang, X., Gao, F., Li, C., Cui, Z., Liu, Y., & Ma, J. (2018). Related factors of quality of life of type 2 diabetes patients: a systematic review and meta-analysis. *Health and Quality of Life Outcomes*, *16*(1). <https://doi.org/10.1186/s12955-018-1021-9>
- Kalfoss, M. H., Reidunsdatter, R. J., Klöckner, C. A., & Nilsen, M. (2021). Validation of the WHOQOL-Bref: psychometric properties and normative data for the Norwegian general population. *Health and Quality of Life Outcomes*, *19*(1), 1–12. <https://doi.org/10.1186/s12955-020-01656-x>
- Kant, A. K., Schatzkin, A., Graubard, B. I., & Schairer, C. (2000). A Prospective Study of Diet Quality and Mortality in Women. *The Journal of the American Medical Association*, *283*(16), 2109–2115.

- Kaplan, R. M., & Bush, J. W. (1982). Health-related quality of life measurement for evaluation research and policy analysis. *Health Psychology, 1*(1), 61–80. <https://doi.org/10.1037/0278-6133.1.1.61>
- Karsten, J., Hagenauw, L. A., Kamphuis, J., & Lancel, M. (2017). Low doses of mirtazapine or quetiapine for transient insomnia: A randomised, double-blind, cross-over, placebo-controlled trial. *Journal of Psychopharmacology, 31*(3), 327–337. <https://doi.org/10.1177/0269881116681399>
- Karvanen, J., Tolonen, H., Härkönen, T., Jousilahti, P., & Kuulasmaa, K. (2016). Selection bias was reduced by recontacting nonparticipants. *Journal of Clinical Epidemiology, 76*, 209–217. <https://doi.org/10.1016/j.jclinepi.2016.02.026>
- Kawabe, Y., Nakamura, Y., Kikuchi, S., Suzukamo, Y., Murakami, Y., Tanaka, T., Takebayashi, T., Okayama, A., Miura, K., Okamura, T., Fukuhara, S., & Ueshima, H. (2015). Relationship of type of work with health-related quality of life. *Quality of Life Research, 24*(12), 2927–2932. <https://doi.org/10.1007/s11136-015-1024-5>
- Kecklund, G., & Axelsson, J. (2016). Health consequences of shift work and insufficient sleep. *BMJ (Online), 355*, i5210. <https://doi.org/10.1136/bmj.i5210>
- Khatatbeh, H., Pakai, A., Al-Dwaikat, T., Onchonga, D., Amer, F., Prémusz, V., & Oláh, A. (2022). Nurses' burnout and quality of life: A systematic review and critical analysis of measures used. *Nursing Open, 9*(3), 1564–1574. <https://doi.org/10.1002/nop2.936>
- Kim, J.-H., Park, E.-C., Yoo, K.-B., & Park, S. (2015). The association between short or long sleep times and quality of life (QOL): Results of the Korea National Health and Nutrition Examination Survey (KNHANES IV–V). *Journal of Clinical Sleep Medicine, 11*(6), 625–634.
- Kim, J. Y., Yang, Y. J., Yang, Y. K., Oh, S. Y., Hong, Y. C., Lee, E. K., & Kwon, O. (2011). Diet quality scores and oxidative stress in Korean adults. *European Journal of Clinical Nutrition, 65*(12), 1271–1278. <https://doi.org/10.1038/ejcn.2011.120>
- Kinnunen, U., & Nätti, J. (2018). Work ability score and future work ability as predictors of register-based disability pension and long-term sickness absence: A three-year follow-up study. *Scandinavian Journal of Public Health, 46*(3), 321–330. <https://doi.org/10.1177/1403494817745190>
- Kivimäki, M., Pentti, J., Ferrie, J. E., Batty, G. D., Nyberg, S. T., Jokela, M., Virtanen, M., Alfredsson, L., Dragano, N., Fransson, E. L., Goldberg, M., Knutsson, A., Koskenvuo, M., Koskinen, A., Kouvonen, A., Luukkonen, R., Oksanen, T., Rugulies, R., Siegrist, J., ... Deanfield, J. (2018). Work stress and risk of death in men and women with and without cardiometabolic disease: a multicohort study. *The Lancet Diabetes and Endocrinology, 6*(9), 705–713. [https://doi.org/10.1016/S2213-8587\(18\)30140-2](https://doi.org/10.1016/S2213-8587(18)30140-2)
- Knudsen, H. K., Ducharme, L. J., & Roman, P. M. (2007). Job stress and poor sleep quality: Data from an American sample of full-time workers. *Social Science and Medicine, 64*(10), 1997–2007. <https://doi.org/10.1016/j.socscimed.2007.02.020>
- Knutson, K. L., & Turek, F. W. (2006). The U-shaped association between sleep and health: The 2 peaks do not mean the same thing. *Sleep, 29*(7), 878–879. <https://doi.org/10.1093/sleep/29.7.878>
- Knutsson, A., & Kempe, A. (2014). Shift work and diabetes – a systematic review. *Chronobiology International, 31*(10), 1146–1151. <https://doi.org/10.3109/07420528.2014.957308>
- Koponen, P., Borodulin, K., Lundqvist, A., Sääksjärvi, K., & Koskinen, S. (Eds.). (2018). *Terveys, toimintakyky ja hyvinvointi Suomessa – FinTerveys 2017 -tutkimus. [Health, functional capacity and welfare in Finland – FinHealth 2017 study.] Report 4/2018*. National Institute for Health and Welfare (THL). Helsinki, Finland.
- Korhonen, P. E., Kivelä, S.-L., Kautiainen, H., Järvenpää, S., & Kantola, I. (2011). Health-related quality of life and awareness of hypertension. *Journal of Hypertension, 29*(11), 2070–2074. <https://doi.org/10.1097/HJH.0b013e32834bbca7>
- Korkalo, L., Vepsäläinen, H., Ray, C., Skaffari, E., Lehto, R., Hauta-Alus, H. H., Nissinen, K., Meinilä, J., Roos, E., & Erkkola, M. (2019). Parents' reports of preschoolers' diets: Relative validity of a

- food frequency questionnaire and dietary patterns. *Nutrients*, *11*, 159. <https://doi.org/10.3390/nu11010159>
- Koskinen, S., Lundqvist, A., & Ristiluoma, N. (Eds.). (2012). *Terveys, toimintakyky ja hyvinvointi Suomessa 2011 [Health, functional capacity and welfare in Finland in 2011.] Report 68/2012*. National Institute for Health and Welfare (THL). Helsinki, Finland.
- Kripke, D. F. (2016). Mortality risk of hypnotics: Strengths and limits of evidence. *Drug Safety*, *39*(2), 93–107. <https://doi.org/10.1007/s40264-015-0362-0>
- Kripke, D. F., Langer, R. D., Elliott, J. A., Klauber, M. R., & Rex, K. M. (2011). Mortality related to actigraphic long and short sleep. *Sleep Medicine*, *12*(1), 28–33. <https://doi.org/10.1016/j.sleep.2010.04.016>
- Kroes, M., Osei-Assibey, G., Baker-Searle, R., & Huang, J. (2016). Impact of weight change on quality of life in adults with overweight/obesity in the United States: a systematic review. *Current Medical Research and Opinion*, *32*(3), 485–508. <https://doi.org/10.1185/03007995.2015.1128403>
- Kronholm, E., Jousilahti, P., Laatikainen, T., Lallukka, T., Peltonen, M., Seppänen, J., & Virta, L. (2019). Trajectories in hypnotic use and approaching death: a register linked case–control study. *Sleep Medicine*, *57*, 153–161. <https://doi.org/10.1016/j.sleep.2018.02.005>
- Kronholm, E., Laatikainen, T., Peltonen, M., Sippola, R., & Partonen, T. (2011). Self-reported sleep duration, all-cause mortality, cardiovascular mortality and morbidity in Finland. *Sleep Medicine*, *12*(3), 215–221. <https://doi.org/10.1016/j.sleep.2010.07.021>
- Kronholm, E., Marshall, N. S., Mänty, M., Lahti, J., Lahelma, E., Pietiläinen, O., Rahkonen, O., & Lallukka, T. (2021). Associations of sleep and health functioning with premature exit from work: A cohort study with a methodological emphasis. *International Journal of Environmental Research and Public Health*, *18*(4), 1–21. <https://doi.org/10.3390/ijerph18041725>
- Kronholm, E., Sallinen, M., Suutama, T., Sulkava, R., Era, P., & Partonen, T. (2009). Self-reported sleep duration and cognitive functioning in the general population. *Journal of Sleep Research*, *18*(4), 436–446. <https://doi.org/10.1111/j.1365-2869.2009.00765.x>
- Krueger, P. M., & Friedman, E. M. (2009). Sleep duration in the united states: A cross-sectional population-based study. *American Journal of Epidemiology*, *169*(9), 1052–1063. <https://doi.org/10.1093/aje/kwp023>
- Krystal, A. D., & Edinger, J. D. (2008). Measuring sleep quality. *Sleep Medicine*, *9*(Suppl. 1), 10–17. [https://doi.org/10.1016/S1389-9457\(08\)70011-X](https://doi.org/10.1016/S1389-9457(08)70011-X)
- Kushida, C. A., Littner, M. R., Morgenthaler, T., Alessi, C. A., Bailey, D., Coleman, J., Friedman, L., Hirshkowitz, M., Kapen, S., Kramer, M., Lee-Chiong, T., Loube, D. L., Owens, J., Pancer, J. P., & Wise, M. (2005). Practice parameters for the indications for polysomnography and related procedures: An update for 2005. *Sleep*, *28*(4), 499–521. <https://doi.org/10.1093/sleep/28.4.499>
- Kwan, M. W. M., Wong, M. C. S., Wang, H. H. X., Liu, K. Q. L., Lee, C. L. S., Yan, B. P. Y., Yu, C. M., & Griffiths, S. M. (2013). Compliance with the dietary approaches to stop hypertension (DASH) diet: A systematic review. *PLoS ONE*, *8*(10), e78412. <https://doi.org/10.1371/journal.pone.0078412>
- Kwok, C. S., Kontopantelis, E., Kuligowski, G., Gray, M., Muhyaldeen, A., Gale, C. P., Peat, G. M., Cleator, J., Chew-Graham, C., Loke, Y. K., & Mamas, M. A. (2018). Self-reported sleep duration and quality and cardiovascular disease and mortality: A dose-response meta-analysis. *Journal of the American Heart Association*, *7*(15), e008552. <https://doi.org/10.1161/JAHA.118.008552>
- Laaksonen, E., Martikainen, P., Head, J., Rahkonen, O., Marmot, M. G., & Lahelma, E. (2009). Associations of multiple socio-economic circumstances with physical functioning among Finnish and British employees. *European Journal of Public Health*, *19*(1), 38–45. <https://doi.org/10.1093/eurpub/ckn123>
- Lahelma, E., Aittomäki, A., Laaksonen, M., Lallukka, T., Martikainen, P., Piha, K., Rahkonen, O., & Saastamoinen, P. (2013). Cohort profile: The helsinki health study. *International Journal of Epidemiology*, *42*(3), 722–730. <https://doi.org/10.1093/ije/dys039>

- Lahelma, E., Martikainen, P., Rahkonen, O., Roos, E., & Saastamoinen, P. (2005). Occupational class inequalities across key domains of health: Results from the Helsinki Health Study. *European Journal of Public Health, 15*(5), 504–510. <https://doi.org/10.1093/eurpub/cki022>
- Lahelma, E., Pietiläinen, O., Rahkonen, O., Lahti, J., & Lallukka, T. (2016). Mental symptoms and cause-specific mortality among midlife employees. *BMC Public Health, 16*(1), 1142. <https://doi.org/10.1186/s12889-016-3816-0>
- Lahelma, E., Rahkonen, O., & Lallukka, T. (2022). Commercialization challenges open science. *European Journal of Public Health, 32*(3), 337–338. <https://doi.org/10.1093/eurpub/ckac033>
- Lallukka, T., Haaramo, P., Rahkonen, O., & Sivertsen, B. (2013). Joint associations of sleep duration and insomnia symptoms with subsequent sickness absence: The Helsinki Health Study. *Scandinavian Journal of Public Health, 41*(5), 516–523. <https://doi.org/10.1177/1403494813481647>
- Lallukka, T., Kaikkonen, R., Härkänen, T., Kronholm, E., Partonen, T., Rahkonen, O., & Koskinen, S. (2014). Sleep and sickness absence: A nationally representative register-based follow-up study. *Sleep, 37*(9), 1413–1425. <https://doi.org/10.5665/sleep.3986>
- Lallukka, T., & Kronholm, E. (2016). The contribution of sleep quality and quantity to public health and work ability. *The European Journal of Public Health, 26*(4), 532. <https://doi.org/10.1093/eurpub/ckw049>
- Lallukka, T., Sivertsen, B., Kronholm, E., Bin, Y. S., Øverland, S., & Glozier, N. (2018). Association of sleep duration and sleep quality with the physical, social, and emotional functioning among Australian adults. *Sleep Health, 4*(2), 194–200. <https://doi.org/10.1016/j.sleh.2017.11.006>
- LeBlanc, M., Beaulieu-Bonneau, S., Mérette, C., Savard, J., Ivers, H., & Morin, C. M. (2007). Psychological and health-related quality of life factors associated with insomnia in a population-based sample. *Journal of Psychosomatic Research, 63*(2), 157–166. <https://doi.org/10.1016/j.jpsychores.2007.03.004>
- Lee, J. E., Kim, Y. J., Park, H. J., Park, S., Kim, H., & Kwon, O. (2019). Association of recommended food score with depression, anxiety, and quality of life in Korean adults: The 2014-2015 National Fitness Award Project. *BMC Public Health, 19*(1), 956. <https://doi.org/10.1186/s12889-019-7298-8>
- Lemoine, P., Garfinkel, D., Laudon, M., & Zisapel, N. (2011). Prolonged-release melatonin for insomnia – an open-label long-term study of efficacy, safety, and withdrawal. *Therapeutics and Clinical Risk Management, 7*, 301–311. <https://doi.org/10.2147/term.s23036>
- Lerner, D. J., Levine, S., Malspeis, S., & D'Agostino, R. B. (1994). Job strain and health-related quality of life in a national sample. *American Journal of Public Health, 84*(10), 1580–1585. <https://doi.org/10.2105/AJPH.84.10.1580>
- Li, C.-Y., & Sung, F.-C. (1999). A review of the healthy worker effect in occupational epidemiology. *Occupational Medicine (Lond), 49*(4), 225–229.
- Li, J., Vitiello, M. V., & Gooneratne, N. S. (2018). Sleep in Normal Aging. *Sleep Medicine Clinics, 13*(1), 1–11. <https://doi.org/10.1016/j.jsmc.2017.09.001>
- Li, X., Gao, X., & Liu, J. (2019). Cross-sectional survey on the relationship between occupational stress, hormone levels, and the sleep quality of oilfieldworkers in Xinjiang, China. *International Journal of Environmental Research and Public Health, 16*(18), 3316. <https://doi.org/10.3390/ijerph16183316>
- Lian, Y., Xiao, J., Liu, Y., Ning, L., Guan, S., Ge, H., Li, F., & Liu, J. (2015). Associations between insomnia, sleep duration and poor work ability. *Journal of Psychosomatic Research, 78*(1), 45–51. <https://doi.org/10.1016/j.jpsychores.2014.09.009>
- Libby, P., Buring, J. E., Badimon, L., Hansson, G. K., Deanfield, J., Bittencourt, M. S., Tokgözoğlu, L., & Lewis, E. F. (2019). Atherosclerosis. *Nature Reviews. Disease Primers, 5*(1), 56. <https://doi.org/10.1038/s41572-019-0106-z>
- Lim, Y. C., Hoe, V. C. W., Darus, A., & Bhoo-Pathy, N. (2020). Association between night-shift work, sleep quality and health-related quality of life: A cross-sectional study among manufacturing

- workers in a middle-income setting. *BMJ Open*, *10*(9), e034455. <https://doi.org/10.1136/bmjopen-2019-034455>
- Lindholm, V., Lahti, J., Rahkonen, O., Lahelma, E., & Lallukka, T. (2013). Joint association of physical activity and body weight with subsequent physical and mental functioning: a follow-up study. *BMC Public Health*, *13*, 197. <https://doi.org/10.1186/1471-2458-13-197>
- Liu, Y., Wheaton, A. G., Croft, J. B., Xu, F., Cunningham, T. J., & Greenlund, K. J. (2018). Relationship between sleep duration and self-reported health-related quality of life among US adults with or without major chronic diseases, 2014. *Sleep Health*, *4*(3), 265–272. <https://doi.org/10.1016/j.sleh.2018.02.002>
- Lloyd-Jones, D. M., Hong, Y., Labarthe, D., Mozaffarian, D., Appel, L. J., Van Horn, L., Greenlund, K., Daniels, S., Nichol, G., Tomaselli, G. F., Arnett, D. K., Fonarow, G. C., Ho, P. M., Lauer, M. S., Masoudi, F. A., Robertson, R. M., Roger, V., Schwamm, L. H., Sorlie, P., ... Rosamond, W. D. (2010). Defining and setting national goals for cardiovascular health promotion and disease reduction: The American heart association's strategic impact goal through 2020 and beyond. *Circulation*, *121*(4), 586–613. <https://doi.org/10.1161/CIRCULATIONAHA.109.192703>
- Lo, K., Woo, B., Wong, M., & Tam, W. (2018). Subjective sleep quality, blood pressure, and hypertension: a meta-analysis. *Journal of Clinical Hypertension*, *20*(3), 592–605. <https://doi.org/10.1111/jch.13220>
- Lovato, N., & Lack, L. (2019). Insomnia and mortality: A meta-analysis. *Sleep Medicine Reviews*, *43*, 71–83. <https://doi.org/10.1016/j.smr.2018.10.004>
- Lund, T., Christensen, K. B., Vaez, M., Labriola, M., Josephson, M., Villadsen, E., & Voss, M. (2009). Differences in sickness absence in Sweden and Denmark: The cross national HAKNAK study. *European Journal of Public Health*, *19*(3), 343–349. <https://doi.org/10.1093/eurpub/ckn128>
- Lundin, A., Leijon, O., Vaez, M., Hallgren, M., & Torgén, M. (2017). Predictive validity of the Work Ability Index and its individual items in the general population. *Scandinavian Journal of Public Health*, *45*(4), 350–356. <https://doi.org/10.1177/1403494817702759>
- Määttä, S., Vepsäläinen, H., Lehto, R., Erkkola, M., Roos, E., & Ray, C. (2018). Reproducibility of preschool personnel and guardian reports on energy balance-related behaviors and their correlates in Finnish preschool children. *Children*, *5*(11), 144. <https://doi.org/10.3390/children5110144>
- Madrid-Valero, J. J., Martínez-Selva, J. M., & Ordoñana, J. R. (2017). Sleep quality and body mass index: a co-twin study. *Journal of Sleep Research*, *26*(4), 461–467. <https://doi.org/10.1111/jsr.12493>
- Magee, C. A., Caputi, P., & Iverson, D. C. (2011). Relationships between self-rated health, quality of life and sleep duration in middle aged and elderly Australians. *Sleep Medicine*, *12*(4), 346–350. <https://doi.org/10.1016/j.sleep.2010.09.013>
- Mahirah, D., Sauter, C., Thach, T. Q., Dunleavy, G., Nazeha, N., Christopoulos, G. I., Soh, C. K., & Car, J. (2021). Factors associated with health-related quality of life in a working population in Singapore. *Epidemiology and Health*, *42*, e2020048. <https://doi.org/10.4178/epih.e2020048>
- Mäkikangas, A., Häätinen, M., Kinnunen, U., & Pekkonen, M. (2012). Maslachin yleisen työuupumuksen arviointimenetelmän (MBI-GS) rakenne ja pysyvyys: pitkittäistutkimus kuntoutusasiakkaiden keskuudessa. *Sosiaalilääketieteellinen Aikakauslehti*, *49*(1), 60–68.
- Marques, D. R., Meia-Via, A. M. S., da Silva, C. F., & Gomes, A. A. (2017). Associations between sleep quality and domains of quality of life in a non-clinical sample: results from higher education students. *Sleep Health*, *3*(5), 348–356. <https://doi.org/10.1016/j.sleh.2017.07.004>
- Martikainen, P., Lahelma, E., Marmot, M., Sekine, M., Nishi, N., & Kagamimori, S. (2004). A comparison of socioeconomic differences in physical functioning and perceived health among male and female employees in Britain, Finland and Japan. *Social Science and Medicine*, *59*(6), 1287–1295. <https://doi.org/10.1016/j.socscimed.2004.01.005>
- Martimo, K. P., Varonen, H., Husman, K., & Viikari-Juntura, E. (2007). Factors associated with self-assessed work ability. *Occupational Medicine*, *57*(5), 380–382. <https://doi.org/10.1093/occmed/kqm028>

- Martin, L. R., Williams, S. L., Haskard, K. B., & DiMatteo, M. R. (2005). The challenge of patient adherence. *Therapeutics and Clinical Risk Management*, *1*(3), 189–199.
- Maslach, C., & Jackson, S. E. (1981). The measurement of experienced burnout. *Journal of Occupational Behavior*, *2*, 99–113. <https://doi.org/10.1002/job.4030020205>
- Maslach, C., Jackson, S. E., & Leiter, M. P. (1996). *Maslach Burnout Inventory manual* (3rd ed.). Consulting Psychologists Press. Palo Alto, CA
- Maslach, C., Schaufeli, W. B., & Leiter, M. P. (2001). Job Burnout. *Annual Review of Psychology*, *52*, 397–422.
- Masthoff, E. D., Trompenaars, F. J., Van Heck, G. L., Hodiament, P. P., & De Vires, J. (2005). Validation of the WHO Quality of Life assessment instrument (WHOQOL-100) in a population of Dutch adult psychiatric outpatients. *European Psychiatry*, *20*(7), 465–473. <https://doi.org/10.1016/j.eurpsy.2004.09.012>
- Matsui, K., Kuriyama, K., Yoshiike, T., Nagao, K., Ayabe, N., Komada, Y., Okajima, I., Ito, W., Ishigooka, J., Nishimura, K., & Inoue, Y. (2020). The effect of short or long sleep duration on quality of life and depression: an internet-based survey in Japan. *Sleep Medicine*, *76*, 80–85. <https://doi.org/10.1016/j.sleep.2020.10.012>
- Matsui, K., Yoshiike, T., Nagao, K., Utsumi, T., Tsuru, A., Otsuki, R., Ayabe, N., Hazumi, M., Suzuki, M., Saitoh, K., Aritake-Okada, S., Inoue, Y., & Kuriyama, K. (2021). Association of subjective quality and quantity of sleep with quality of life among a general population. *International Journal of Environmental Research and Public Health*, *18*(23), 12835. <https://doi.org/10.3390/ijerph182312835>
- Mathiesen, S. B., & Dyregrov, A. (1991). *Manual for Bergen Burnout Indicator*. Universitetet i Bergen. Bergen, Norway.
- Maukonen, M., Männistö, S., & Tolonen, H. (2018). A comparison of measured versus self-reported anthropometrics for assessing obesity in adults: a literature review. *Scandinavian Journal of Public Health*, *46*(5), 565–579. <https://doi.org/10.1177/1403494818761971>
- McCall, W. V., Turpin, E., Reboussin, D., Edinger, J. D., & Haponik, E. F. (1995). Subjective estimates of sleep differ from polysomnographic measurements in obstructive sleep apnea patients. *Sleep*, *18*(8), 646–650. <https://doi.org/10.1093/sleep/18.8.646>
- McKenna, S. P. (2011). Measuring patient-reported outcomes: Moving beyond misplaced common sense to hard science. *BMC Medicine*, *9*, 86. <https://doi.org/10.1186/1741-7015-9-86>
- Melamed, S., Shirom, A., Toker, S., & Shapira, I. (2006). Burnout and risk of type 2 diabetes: A prospective study of apparently healthy employed persons. *Psychosomatic Medicine*, *68*(6), 863–869. <https://doi.org/10.1097/01.psy.0000242860.24009.f0>
- Meurling, I. J., Shea, D. O., & Garvey, J. F. (2019). Obesity and sleep: A growing concern. *Current Opinion in Pulmonary Medicine*, *25*(6), 602–608. <https://doi.org/10.1097/MCP.0000000000000627>
- Michelson, H., Bolund, C., Nilsson, B., & Brandberg, Y. (2000). Health-related Quality of Life Measured by the EORTC QLQ-C30: Reference Values From a Large Sample of the Swedish Population. *Acta Oncologica*, *39*(4), 477–484. <https://doi.org/10.1080/028418600750013384>
- Mielck, A., Reitmeir, P., Vogelmann, M., & Leidl, R. (2012). Impact of educational level on health-related quality of life (HRQL): results from Germany based on the EuroQol 5D (EQ-5D). *European Journal of Public Health*, *23*(1), 45–50. <https://doi.org/10.1093/eurpub/ckr206>
- Milosevic, M., Golubic, R., Knezevic, B., Golubic, K., Bubas, M., & Mustajbegovic, J. (2011). Work ability as a major determinant of clinical nurses' quality of life. *Journal of Clinical Nursing*, *20*(19–20), 2931–2938. <https://doi.org/10.1111/j.1365-2702.2011.03703.x>
- Min, Y., Kirkwood, C. K., Mays, D. P., & Slattum, P. W. (2016). The effect of sleep medication use and poor sleep quality on risk of falls in community-dwelling older adults in the US: A prospective cohort study. *Drugs and Aging*, *33*(2), 151–158. <https://doi.org/10.1007/s40266-015-0339-9>

- Ministry of Finance and Commission for Local Authority Employers. (2006). *The Finnish public sector as employer*. Helsinki, Finland. <http://old.adapt.it/adapt-indice-a-z/wp-content/uploads/2014/08/finish_govemnet211.pdf>
- Mokarami, H., Cousins, R., & Kalteh, H. O. (2022). Comparison of the work ability index and the work ability score for predicting health-related quality of life. *International Archives of Occupational and Environmental Health*, 95(1), 213–221. <https://doi.org/10.1007/s00420-021-01740-9>
- Mokarami, H., Kalteh, H. O., & Marioryad, H. (2020). The effect of work-related and socio-demographic factors on Work Ability Index (WAI) among Iranian workers. *Work*, 65(1), 137–143. <https://doi.org/10.3233/WOR-193066>
- Morphy, H., Dunn, K. M., Lewis, M., Boardman, H. F., & Croft, P. R. (2007). Epidemiology of insomnia: A longitudinal study in a UK population. *Sleep*, 30(3), 274–280. <https://doi.org/10.1093/sleep/30.3.274>
- Myllyntausta, S., Salo, P., Kronholm, E., Aalto, V., Kivimäi, M., Vahtera, J., & Stenholm, S. (2017). Changes in sleep duration during transition to statutory retirement: A longitudinal cohort study. *Sleep*, 40(7), zsx087. <https://doi.org/10.1093/sleep/zsx087>
- Näätänen, P., Aro, A., Mathiesen, S. B., & Salmela-Aro, K. (2003). *Bergen Burnout Indicator 15*. Edita. Helsinki, Finland.
- Nena, E., Katsaouni, M., Steiropoulos, P., Theodorou, E., & Constantinidis, T. C. (2018). Effect of shift work on sleep, health, and quality of life of health-care workers. *Indian J Occup Environ Med.*, 22(1), 29–34. <https://doi.org/10.4103/ijoem.IJOEM>
- Neutel, C. I., & Johansen, H. L. (2019). Benzodiazepines vs mortality - Causation or confounding? *Sleep Medicine*, 57, 151–152. <https://doi.org/10.1016/j.sleep.2018.12.016>
- Ng, J. Y. K., & Chan, A. H. S. (2018). The work ability of Hong Kong construction workers in relation to individual and work-related factors. *International Journal of Environmental Research and Public Health*, 15(5), 990. <https://doi.org/10.3390/ijerph15050990>
- Nguyen, A. T. H., Saeed, A., Bambs, C. E., Swanson, J., Emechebe, N., Mansuri, F., Talreja, K., Reis, S. E., & Kip, K. E. (2021). Usefulness of the American Heart Association’s ideal cardiovascular health measure to predict long-term major adverse cardiovascular events (from the heart SCORE study). *The American Journal of Cardiology*, 138, 20–25. <https://doi.org/10.1016/J.AMJCARD.2020.10.019>
- Nilsson, A., Tovar, J., Johansson, M., Radeborg, K., & Björck, I. (2013). A diet based on multiple functional concepts improves cognitive performance in healthy subjects. *Nutrition and Metabolism*, 10(1), 49. <https://doi.org/10.1186/1743-7075-10-49>
- Noerholm, V., Groenvold, T., Watt, J. B., Rasmussen, N.-A., & Bech, P. (2004). Quality of life in the Danish general population - normative data and validity of WHOQOL-BREF using rasch and item response theory models. *Quality of Life Research*, 13(2), 531–540.
- Nordic Nutrition Recommendations 2012; Integrating nutrition and physical activity* (5th ed.). (2014). Nordic Council of Ministers. Copenhagen, Denmark. <<https://doi.org/http://dx.doi.org/10.6027/Nord2014-002>>
- O’Donnell, A., Anderson, P., Newbury-Birch, D., Schulte, B., Schmidt, C., Reimer, J., & Kaner, E. (2014). The impact of brief alcohol interventions in primary healthcare: A systematic review of reviews. *Alcohol and Alcoholism*, 49(1), 66–78. <https://doi.org/10.1093/alcalc/agt170>
- Odom, E. C., Fang, J., Zack, M., Moore, L., & Loustalot, F. (2016). Associations between cardiovascular health and health-related quality of life, Behavioral Risk Factor Surveillance System, 2013. *Preventing Chronic Disease*, 13, E99. <https://doi.org/10.5888/pcd13.160073>
- OECD. (2017). *Recommendations to OECD ministers of health from the high level reflection group on the future of health statistics*. <https://www.oecd.org/els/health-systems/Recommendations-from-high-level-reflection-group-on-the-future-of-health-statistics.pdf>
- Oellingrath, I. M., De Bortoli, M. M., Svendsen, M. V., & Fell, A. K. M. (2019). Lifestyle and work ability in a general working population in Norway: A cross-sectional study. *BMJ Open*, 9(4), e026215. <https://doi.org/10.1136/bmjopen-2018-026215>

- Ohayon, M., Wickwire, E. M., Hirshkowitz, M., Albert, S. M., Avidan, A., Daly, F. J., Dauvilliers, Y., Ferri, R., Fung, C., Gozal, D., Hazen, N., Krystal, A., Lichstein, K., Mallampalli, M., Plazzi, G., Rawding, R., Scheer, F. A., Somers, V., & Vitiello, M. V. (2017). National Sleep Foundation's sleep quality recommendations: first report. *Sleep Health*, 3(1), 6–19. <https://doi.org/10.1016/j.sleh.2016.11.006>
- Overland, S., Glozier, N., Sivertsen, B., Stewart, R., Neckelmann, D., Krokstad, S., & Mykletun, A. (2008). A comparison of insomnia and depression as predictors of disability pension: The HUNT study. *Sleep*, 31(6), 875–880. <https://doi.org/10.1093/sleep/31.6.875>
- Palacin, C., Martinez-Alonso, M., Codony, M., Girolamo, G., Bernert, S., Brugha, T. S., Russo, L. J., Almansa, J., Haro, J. M., Angermeyer, M. C., Lepine, J. P., Gasquet, I., Kessler, R. C., Arbabzadeh-Bouchez, S., Alonso, J., Vollebergh, W. A. M., Ormel, J., Mazzi, F., Buist-Bouwman, M. A., ... Bryson, H. (2004). Use of mental health services in Europe: results from the European Study of the Epidemiology of Mental Disorders (ESEMeD) project. *Acta Psychiatrica Scandinavica*, 109(s420), 38–46. <https://doi.org/10.1111/j.1600-0047.2004.00330.x>
- Parati, G., Stergiou, G. S., Asmar, R., Bilo, G., De Leeuw, P., Imai, Y., Kario, K., Lurbe, E., Manolis, A., Mengden, T., O'Brien, E., Ohkubo, T., Padfield, P., Palatini, P., Pickering, T., Redon, J., Revera, M., Ruilope, L. M., Shennan, A., ... Mancia, G. (2008). European society of hypertension guidelines for blood pressure monitoring at home: A summary report of the second international consensus conference on home blood pressure monitoring. *Journal of Hypertension*, 26(8), 1505–1530. <https://doi.org/10.1097/HJH.0b013e328308da66>
- Paredes, T., Simões, M. R., & Canavaro, M. C. (2010). Psychometric properties of the World Health Organization Quality of Life Questionnaire (WHOQOL-100) in Portuguese patients with sarcoma. *Psychology, Health and Medicine*, 15(4), 420–433. <https://doi.org/10.1080/13548506.2010.482139>
- Patel, S. R., & Hu, F. B. (2008). Short sleep duration and weight gain: A systematic review. *Obesity*, 16(3), 643–653. <https://doi.org/10.1038/oby.2007.118>
- Patel, S. R., Malhotra, A., Gottlieb, D. J., White, D. P., & Hu, F. B. (2006). Correlates of long sleep duration. *Sleep*, 29(7), 881–889. <https://doi.org/10.1093/sleep/29.7.881>
- Pedersen, P., Momsen, A. M. H., Andersen, D. R., Nielsen, C. V., Nohr, E. A., & Maimburg, R. D. (2021). Associations between work environment, health status and sick leave among pregnant employees. *Scandinavian Journal of Public Health*, 49(2), 149–158. <https://doi.org/10.1177/1403494820919564>
- Peltonen, M., Laatikainen, T., Borodulin, K., & Wikström, K. (2014). Prevalence of ideal cardiovascular health in an adult Finnish population: the national FINRISK 2007 study. *Int Heart Vasc Dis J*, 2(3), 3–10.
- Pien, G. W., & Schwab, R. J. (2004). Sleep disorders during pregnancy. *Sleep*, 27(7), 1405–1417. <https://doi.org/10.1093/sleep/27.7.1405>
- Piepoli, M. F., Hoes, A. W., Agewall, S., Albus, C., Brotons, C., Catapano, A. L., Cooney, M.-T., Corrà, U., Cosyns, B., Deaton, C., Graham, I., Hall, M. S., Hobbs, F. D. R., Lochen, M.-L., Löllgen, H., Marques-Vidal, P., Perk, J., Prescott, E., Smulders, Y., ... Verschuren, W. M. M. (2016). 2016 European Guidelines on cardiovascular disease prevention in clinical practice. *European Heart Journal*, 37, 2315–2381. <https://doi.org/10.1093/eurheartj/ehw106>
- Pohjonen, T. (2001). Perceived work ability of home care workers in relation to individual and work-related factors in different age groups. *Occupational Medicine*, 51(3), 209–217. <https://doi.org/10.1093/occmed/51.3.209>
- Pool, L. R., Ning, H., Huffman, M. D., Reis, J. P., Lloyd-Jones, D. M., & Allen, N. B. (2019). Association of cardiovascular health through early adulthood and health-related quality of life in middle age: The Coronary Artery Risk Development in Young Adults (CARDIA) Study. *Preventive Medicine*, 126, 105772. <https://doi.org/10.1016/j.ypmed.2019.105772>
- Porin kaupungin henkilöstöräpöortti 2014. (2014). Pori, Finland. <<http://docplayer.fi/2645481-Porin-kaupungin-henkilostoraportti-2014.html>>

- Porin kaupunki Henkilöstöraportti 2015. (2015). Pori, Finland. <<https://docplayer.fi/28278945-Porin-kaupunki-henkilostoraportti-2015.html>>
- Pot, G. K. (2018). Sleep and dietary habits in the urban environment: The role of chrono-nutrition. *Proceedings of the Nutrition Society*, 77(3), 189–198. <https://doi.org/10.1017/S0029665117003974>
- Power, M. (2003). Development of a common instrument for quality of life. In A. Nosikov & C. Gudex (Eds.), *EUROHIS: Developing common instruments for health surveys* (pp. 145–159). IOS Press. Amsterdam, the Netherlands.
- Proper, K. I., Van De Langenberg, D., Rodenburg, W., Vermeulen, R. C. H., Van Der Beek, A. J., Van Steeg, H., & Van Kerkhof, L. W. M. (2016). The relationship between shift work and metabolic risk factors: A systematic review of longitudinal studies. *American Journal of Preventive Medicine*, 50(5), e147–e157. <https://doi.org/10.1016/j.amepre.2015.11.013>
- Rabin, R., & De Charro, F. (2001). EQ-5D: A measure of health status from the EuroQol Group. *Annals of Medicine*, 33(5), 337–343. <https://doi.org/10.3109/07853890109002087>
- Rao, D., Yu, H., Bai, Y., Zheng, X., & Xie, L. (2015). Does night-shift work increase the risk of prostate cancer? A systematic review and meta-analysis. *OncoTargets and Therapy*, 8, 2817–2826. <https://doi.org/10.2147/OTT.S89769>
- Rozanski, A. (2014). Behavioral cardiology: Current advances and future directions. *Journal of the American College of Cardiology*, 64(1), 100–110. <https://doi.org/10.1016/j.jacc.2014.03.047>
- Saarni, S. I., Suvisaari, J., Sintonen, H., Pirkola, S., Koskinen, S., Aromaa, A., & Lönnqvist, J. (2007). Impact of psychiatric disorders on health-related quality of life: General population survey. *British Journal of Psychiatry*, 190, 326–332. <https://doi.org/10.1192/bjp.bp.106.025106>
- Saksvik, I. B., Bjorvatn, B., Hetland, H., Sandal, G. M., & Pallesen, S. (2011). Individual differences in tolerance to shift work - A systematic review. *Sleep Medicine Reviews*, 15(4), 221–235. <https://doi.org/10.1016/j.smrv.2010.07.002>
- Salmela-Aro, K., Rantanen, J., Hyvönen, K., Tilleman, K., & Feldt, T. (2011). Bergen Burnout Inventory: Reliability and validity among Finnish and Estonian managers. *International Archives of Occupational and Environmental Health*, 84(6), 635–645. <https://doi.org/10.1007/s00420-010-0594-3>
- Salonen, P., Arola, H., Nygård, C. H., Huhtala, H., & Koivisto, A. M. (2003). Factors associated with premature departure from working life among ageing food industry employees. *Occupational Medicine*, 53(1), 65–68. <https://doi.org/10.1093/occmed/kqg012>
- Saltychev, M., Laimi, K., Oksanen, T., Pentti, J., Kivimäki, M., & Vahtera, J. (2013). Does perceived work ability improve after a multidisciplinary preventive program in a population with no severe medical problems? The Finnish Public Sector Study. *Scandinavian Journal of Work, Environment and Health*, 39(1), 57–65. <https://doi.org/10.5271/sjweh.3298>
- Sanchez-Aguadero, N., Alonso-Dominguez, R., Garcia-Ortiz, L., Agudo-Conde, C., Rodriguez-Martin, C., de Cabo-Laso, A., Sanchez-Salgado, B., Ramos, R., Maderuelo-Fernandez, J. A., Gomez-Marcos, M. A., & Recio-Rodriguez, J. I. (2016). Diet and physical activity in people with intermediate cardiovascular risk and their relationship with the health-related quality of life: Results from the MARK study. *Health and Quality of Life Outcomes*, 14, 169. <https://doi.org/10.1186/s12955-016-0572-x>
- Sarafis, P., Rousaki, E., Tsounis, A., Malliarou, M., Lahana, L., Bamidis, P., Niakas, D., & Papastavrou, E. (2016). The impact of occupational stress on nurses' caring behaviors and their health related quality of life. *BMC Nursing*, 15, 56. <https://doi.org/10.1186/s12912-016-0178-y>
- Sasai, T., Inoue, Y., Komada, Y., Nomura, T., Matsuura, M., & Matsushima, E. (2010). Effects of insomnia and sleep medication on health-related quality of life. *Sleep Medicine*, 11(5), 452–457. <https://doi.org/10.1016/j.sleep.2009.09.011>
- Schmidt, S., Mühlhan, H., & Power, M. (2006). The EUROHIS-QOL 8-item index: Psychometric results of a cross-cultural field study. *European Journal of Public Health*, 16(4), 420–428. <https://doi.org/10.1093/eurpub/cki155>

- Schouten, L. S., Bültmann, U., Heymans, M. W., Joling, C. I., Twisk, J. W. R., & Roelen, C. A. M. (2016). Shortened version of the work ability index to identify workers at risk of long-term sickness absence. *European Journal of Public Health, 26*(2), 301–305. <https://doi.org/10.1093/eurpub/ckv198>
- Selvin, E., Crainiceanu, C. M., Brancati, F. L., & Coresh, J. (2007). Short-term variability in measures of glycemia and implications for the classification of diabetes. *Archives of Internal Medicine, 167*(14), 1545–1551. <https://doi.org/10.1001/archinte.167.14.1545>
- Shay, C. M., Ning, H., Allen, N. B., Carnethon, M. R., Chiuve, S. E., Greenlund, K. J., Daviglius, M. L., & Lloyd-Jones, D. M. (2012). Status of cardiovascular health in US adults: Prevalence Estimates from the National Health and Nutrition Examination Surveys (NHANES) 2003–2008. *Circulation, 125*(1), 45–56. <https://doi.org/10.1161/CIRCULATIONAHA.111.035733>
- Shiri, R., Kaila-Kangas, L., Ahola, K., Kivekäs, T., Viikari-Juntura, E., Heliövaara, M., Miranda, H., & Leino-Arjas, P. (2013). The relation of co-occurring musculoskeletal pain and depressive symptoms with work ability. *Journal of Occupational and Environmental Medicine, 55*(11), 1281–1285. <https://doi.org/10.1097/jom.0b013e3182a4ffc4>
- Silva, G. E., Goodwin, J. L., Sherrill, D. L., Arnold, J. L., Bootzin, R. R., Smith, T., Walsleben, J. A., Baldwin, C. M., & Quan, S. F. (2007). Relationship Between Reported and Measured Sleep Times. *Journal of Clinical Sleep Medicine, 3*(6), 622–630. <https://doi.org/10.5664/jcsm.26974>
- Skevington, S. M., Carse, M. S., & de C Williams, A. C. (2001). Validation of the WHOQOL-100: Pain management improves quality of life for chronic pain patients. *The Clinical Journal of Pain, 17*(3), 264–275. <https://doi.org/10.1097/00002508-200109000-00013>
- Skevington, S. M., Lotfy, M., & O’Connell, K. A. (2004). The World Health Organization’s WHOQOL-BREF quality of life assessment: Psychometric properties and results of the international field trial a Report from the WHOQOL Group. *Quality of Life Research, 13*(2), 299–310. <https://doi.org/10.1023/B:QURE.0000018486.91360.00>
- Sofi, F., Cesari, F., Abbate, R., Gensini, G. F., & Casini, A. (2008). Adherence to Mediterranean diet and health status: Meta-analysis. *BMJ, 337*, a1344. <https://doi.org/10.1136/bmj.a1344>
- Solomon, S. R., & Sawilowsky, S. S. (2009). Impact of rank-based normalizing transformations on the accuracy of test scores. *Journal of Modern Applied Statistical Methods, 8*(2), 448–462. <https://doi.org/10.22237/jmasm/1257034080>
- Sörensen, L. E., Pekkonen, M. M., Männikkö, K. H., Louhevaara, V. A., Smolander, J., & Alén, M. J. (2008). Associations between work ability, health-related quality of life, physical activity and fitness among middle-aged men. *Applied Ergonomics, 39*(6), 786–791. <https://doi.org/10.1016/j.apergo.2007.11.001>
- Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of Internal Medicine, 166*, 1092–1097. <https://doi.org/10.1001/archinte.166.10.1092>
- Statistics Finland. (2017). *Official Statistics of Finland (OSF): Labour force survey [e-publication]. Employment And Unemployment 2017, Appendix table 39. Employees aged 15-74 in permanent and temporary (fixed-term) work by employer sector and sex in 2017*. Retrieved January 15, 2022, from <http://www.stat.fi/til/tyti/2017/13/tyti_2017_13_2018-04-12_tau_039_en.html>
- Stead, L. F., Buitrago, D., Preciado, N., Sanchez, G., Jamie, H.-B., & Lancaster, T. (2013). Physician advice for smoking cessation. *Cochrane Database of Systematic Reviews*. <https://doi.org/10.1002/14651858.CD000165.pub4>
- Stenlund, S., Koivumaa-Honkanen, H., Sillanmäki, L., Lagström, H., Rautava, P., & Suominen, S. (2021a). Health behavior of working-aged Finns predicts self-reported life satisfaction in a population-based 9-years follow-up. *BMC Public Health, 21*, 1815. <https://doi.org/10.1186/s12889-021-11796-4>
- Stenlund, S., Koivumaa-Honkanen, H., Sillanmäki, L., Lagström, H., Rautava, P., & Suominen, S. (2021b). Subjective well-being predicts health behavior in a population-based 9-years follow-up

- of working-aged Finns. *Preventive Medicine Reports*, 24, 101635. <https://doi.org/10.1016/j.pmedr.2021.101635>
- Stenlund, S., Koivumaa-Honkanen, H., Sillanmäki, L., Lagström, H., Rautava, P., & Suominen, S. (2022). Changed health behavior improves subjective well-being and vice versa in a follow-up of 9 years. *Health and Quality of Life Outcomes*, 20, 66. <https://doi.org/10.1186/s12955-022-01972-4>
- Stranges, S., Dorn, J. M., Shipley, M. J., Kandala, N. B., Trevisan, M., Miller, M. A., Donahue, R. P., Hovey, K. M., Ferrie, J. E., Marmot, M. G., & Cappuccio, F. P. (2008). Correlates of short and long sleep duration: A cross-cultural comparison between the United Kingdom and the United States: The Whitehall II Study and the Western New York Health Study. *American Journal of Epidemiology*, 168(12), 1353–1364. <https://doi.org/10.1093/aje/kwn337>
- Suomen Lääketilasto [Finnish Statistics on Medicines]. (2019). Finnish Medicines Agency and Social Insurance Institution. Helsinki, Finland. <<https://www.julkari.fi/handle/10024/140837>>
- Sutton, E. (2021). Insomnia. *Annals of Internal Medicine*, 174(3), ITC33–ITC48. <https://doi.org/10.7326/AITC202103160>
- Sweet, L., Arjyal, S., Kuller, J. A., & Dotters-Katz, S. (2020). A review of sleep architecture and sleep changes during pregnancy. *Obstetrical & Gynecological Survey*, 75(4), 253–262. <https://doi.org/10.1097/OGX.0000000000000770>
- Tang, N. K. Y., Fiecas, M., Afolalu, E. F., & Wolke, D. (2017). Changes in sleep duration, quality, and medication use are prospectively associated with health and well-being: Analysis of the UK household longitudinal study. *Sleep*, 40(3), zsw079. <https://doi.org/10.1093/sleep/zsw079>
- Tavakoli-Fard, N., Mortazavi, S. A., Kuhpayehzadeh, J., & Nojomi, M. (2016). Quality of life, Work ability and other important indicators of women's occupational health. *International Journal of Occupational Medicine and Environmental Health*, 29(1), 77–84. <https://doi.org/10.13075/ijom.1896.00329>
- Tertsunen, H. M., Hantunen, S., Tuomainen, T. P., & Virtanen, J. K. (2020). Healthy Nordic diet and risk of disease death among men: the Kuopio Ischaemic Heart Disease Risk Factor Study. *European Journal of Nutrition*, 59(8), 3545–3553. <https://doi.org/10.1007/s00394-020-02188-2>
- Tertsunen, H. M., Hantunen, S., Tuomainen, T. P., & Virtanen, J. K. (2021). Adherence to a healthy Nordic diet and risk of type 2 diabetes among men: the Kuopio Ischaemic Heart Disease Risk Factor Study. *European Journal of Nutrition*, 60(7), 3927–3934. <https://doi.org/10.1007/s00394-021-02569-1>
- Toppinen-Tanner, S., Ahola, K., Koskinen, A., & Väänänen, A. (2009). Burnout predicts hospitalization for mental and cardiovascular disorders: 10-Year prospective results from industrial sector. *Stress and Health*, 25(4), 287–296. <https://doi.org/10.1002/smi.1282>
- Trevisol, D. J., Moreira, L. B., Kerkhoff, A., Fuchs, S. C., & Fuchs, F. D. (2011). Health-related quality of life and hypertension: A systematic review and meta-analysis of observational studies. *Journal of Hypertension*, 29(2), 179–188. <https://doi.org/10.1097/HJH.0b013e328340d76f>
- Tsuno, N., Besset, A., & Ritchie, K. (2005). Sleep and depression. *The Journal of Clinical Psychiatry*, 66(10), 1254–1269. <https://doi.org/10.4088/jcp.v66n1008>
- Tuomi, K., Ilmarinen, J., Jahkola, A., Katajarinne, L., & Tulkki, A. (2006). *Work Ability Index* (2nd revise). Finnish Institute of Occupational Health.
- Turchi, V., Verzuri, A., Nante, N., Napolitani, M., Bugnoli, G., Severi, F. M., Cecilia, Q., & Messina, G. (2019). Night work and quality of life. A study on the health of nurses. *Ann Ist Super Sanità*, 55(2), 161–169. https://doi.org/10.4415/ANN_19_02_08
- Tuunanen, M., Aalto, M., & Seppä, K. (2007). Binge drinking and its detection among middle-aged men using AUDIT, AUDIT-C and AUDIT-3. *Drug and Alcohol Review*, 26(3), 295–299. <https://doi.org/10.1080/09595230701247756>
- Vaarama, M., Luoma, M.-L., Siljander, E., & Merillinen-Porras, S. (2014). Validity and reliability of Finnish version of WHOQOL-Bref on adult population in Finland. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2373890>

- Vajdi, M., & Farhangi, M. A. (2020). A systematic review of the association between dietary patterns and health - related quality of life. *Health and Quality of Life Outcomes*, *18*, 337. <https://doi.org/10.1186/s12955-020-01581-z>
- Van De Water, A. T. M., Holmes, A., & Hurley, D. A. (2011). Objective measurements of sleep for non-laboratory settings as alternatives to polysomnography - a systematic review. *Journal of Sleep Research*, *20*(1 Pt 2), 183–200. <https://doi.org/10.1111/j.1365-2869.2009.00814.x>
- Van Den Berg, T. I. J., Elders, L. A. M., De Zwart, B. C. H., & Burdorf, A. (2009). The effects of work-related and individual factors on the Work Ability Index: A systematic review. *Occupational and Environmental Medicine*, *66*(4), 211–220. <https://doi.org/10.1136/oem.2008.039883>
- van Straten, A., van der Zweerde, T., Kleiboer, A., Cuijpers, P., Morin, C. M., & Lancee, J. (2018). Cognitive and behavioral therapies in the treatment of insomnia: A meta-analysis. *Sleep Medicine Reviews*, *38*, 3–16. <https://doi.org/10.1016/j.smr.2017.02.001>
- Vartiainen, E., Seppälä, T., Lillsunde, P., & Puska, P. (2002). Validation of self reported smoking by serum cotinine measurement in a community-based study. *Journal of Epidemiology and Community Health*, *56*(3), 167–170. <https://doi.org/10.1136/jech.56.3.167>
- Veenhoven, R. (2017). Greater Happiness for a Greater Number: Did the Promise of Enlightenment Come True? *Social Indicators Research*, *130*(1), 9–25. <https://doi.org/10.1007/s11205-015-1128-x>
- Vesikansa, A., Mehtälä, J., Jokelainen, J., Mutanen, K., Lundqvist, A., Laatikainen, T., Ylisaukko-oja, T., Saukkonen, T., & Pietiläinen, K. H. (2022). The association of body mass index with quality of life and working ability: a Finnish population-based study. *Quality of Life Research*, *31*, 413–423. <https://doi.org/10.1007/s11136-021-02993-0>
- Virani, S. S., Alvaro, A., Aparicio, H. J., Benjamin, E. J., Callaway, C. W., Carson, A. P., Cheng, S., Elkind, M. S. V., Evenson, K. R., Ferguson, J. F., Knutson, K. L., Lee, C. D., Lewis, T. T., Loop, M. S., Lutsey, P. L., Mackey, J., & Matchar, D. B. (2021). Heart disease and stroke statistics – 2021 update: A report from the American Heart Association. *Circulation*, *143*, E254–E743. <https://doi.org/10.1161/CIR.0000000000000950>
- Visseren, F. L. J., Mach, F., Smulders, Y. M., Carballo, D., Koskinas, K. C., Bäck, M., Benetos, A., Biffi, A., Boavida, J. M., Capodanno, D., Cosyns, B., Crawford, C., Davos, C. H., Desormais, I., di Angelantonio, E., Franco, O. H., Halvorsen, S., Hobbs, F. D. R., Hollander, M., ... Williams, B. (2021). 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice. *European Heart Journal*, *42*(34), 3227–3337. <https://doi.org/10.1093/eurheartj/ehab484>
- Vuorio, T., Suominen, S., Kautiainen, H., & Korhonen, P. (2019). Determinants of sickness absence rate among Finnish municipal employees. *Scandinavian Journal of Primary Health Care*, *37*(1), 3–9. <https://doi.org/10.1080/02813432.2019.1568710>
- Vyas, M. V., Garg, A. X., Iansavichus, A. V., Costella, J., Donner, A., Laugsand, L. E., Janszky, I., Mrkobrada, M., Parraga, G., & Hackam, D. G. (2012). Shift work and vascular events: Systematic review and meta-analysis. *BMJ*, *345*, e4800. <https://doi.org/10.1136/bmj.e4800>
- Wade, A. T., Davis, C. R., Dyer, K. A., Hodgson, J. M., Woodman, R. J., Keage, H. A. D., & Murphy, K. J. (2020). A Mediterranean diet supplemented with dairy foods improves mood and processing speed in an Australian sample: results from the MedDairy randomized controlled trial. *Nutritional Neuroscience*, *23*(8), 646–658. <https://doi.org/10.1080/1028415X.2018.1543148>
- Wagstaff, A. S., & Lie, J. A. S. (2011). Shift and night work and long working hours – a systematic review of safety implications. *Scandinavian Journal of Work, Environment and Health*, *37*(3), 173–185. <https://doi.org/10.5271/sjweh.3146>
- Walsh, J. K., Krystal, A. D., Amato, D. A., Rubens, R., Caron, J., Wessel, T. C., Schaefer, K., Roach, J., Wallenstein, G., & Roth, T. (2007). Nightly treatment of primary insomnia with eszopiclone for six months: Effect on sleep, quality of life, and work limitations. *Sleep*, *30*(8), 959–968. <https://doi.org/10.1093/sleep/30.8.959>

- Wang, B., Lu, Q., Sun, F., & Zhang, R. (2021). The relationship between sleep quality and psychological distress and job burnout among chinese psychiatric nurses. *Industrial Health, 59*(6), 427–435. <https://doi.org/10.2486/indhealth.2020-0249>
- Wang, P., Luo, N. E. S., Tai, E. S., & Thumboo, J. (2016). The EQ-5D-5L is more discriminative than the EQ-5D-3L in patients with diabetes in Singapore. *Value in Health Regional Issues, 9c*, 57–62. <https://doi.org/10.1016/j.vhri.2015.11.003>
- Wang, Q., Xi, B., Liu, M., Zhang, Y., & Fu, M. (2012). Short sleep duration is associated with hypertension risk among adults: A systematic review and meta-analysis. *Hypertension Research, 35*(10), 1012–1018. <https://doi.org/10.1038/hr.2012.91>
- Wang, X., Ji, A., Zhu, Y., Liang, Z., Wu, J., Li, S., Meng, S., Zheng, X., & Xie, L. (2015). A meta-analysis including dose-response relationship between night shift work and the risk of colorectal cancer. *Oncotarget, 6*(28), 25046–25060. <https://doi.org/10.18632/oncotarget.4502>
- Ware, J. E., Kosinski, M. A., & Keller, S. D. (1994). *SF-36 Physical and Mental Health Summary Scales: A User's Manual*. Health Assessment Lab, New England Medical Center. Boston, MA
- Ware, J. E., Kosinski, M. A., & Keller, S. D. (1996). A 12-Item Short-Form Health Survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care, 34*(3), 220–233.
- Ware, J. E., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (Sf-36): I. conceptual framework and item selection. *Medical Care, 30*(6), 473–483. <https://doi.org/10.1097/00005650-199206000-00002>
- Ware, J. E., Snow, K. K., Kosinski, M. A., & Gandek, B. (1993). *SF-36 Health Survey Manual and Interpretation Guide*. The Health Institute, New England Medical Center. Boston, MA
- Wennman, H., Kronholm, E., Partonen, T., Tolvanen, A., Peltonen, M., Vasankari, T., & Borodulin, K. (2014). Physical activity and sleep profiles in Finnish men and women. *BMC Public Health, 14*(1), 1–10. <https://doi.org/10.1186/1471-2458-14-82>
- WHO. (1948). WHO definition of Health. In *Official records of the World Health Organization No 2*. (p. 100).
- Whooley, M. A., Vittinghoff, E., Carney, R. M., Ali, S., Feldman, M. D., Schiller, N. B., & Browner, W. S. (2008). Depressive symptoms, health behaviors, and risk of cardiovascular events in patients with coronary heart disease. *JAMA - Journal of the American Medical Association, 300*(20), 2379–2388. <https://doi.org/10.1001/jama.2008.711>
- WHOQOL Group. (1995). The World Health Organization Quality of Life Assessment (WHOQOL): position paper from the World Health Organization. *Social Science and Medicine, 41*(10), 1403–1409. [https://doi.org/10.1016/0277-9536\(95\)00112-K](https://doi.org/10.1016/0277-9536(95)00112-K)
- WHOQOL Group. (1998a). Development of the World Health Organization WHOQOL-BREF quality of life assessment. *Psychological Medicine, 28*, 551–558. <https://doi.org/10.5.12>
- WHOQOL Group. (1998b). The World Health Organization Quality of Life Assessment (WHOQOL): Development and general psychometric properties. *Social Science and Medicine, 46*(12), 1569–1585. [https://doi.org/10.1016/S0277-9536\(98\)00009-4](https://doi.org/10.1016/S0277-9536(98)00009-4)
- WHOQOL Group. (1998c). *WHOQOL User Manual*. World Health Organization. https://doi.org/10.4091/iken1991.9.1_123
- Wickwire, E. M., & Collop, N. A. (2010). Insomnia and sleep-related breathing disorders. *Chest, 137*(6), 1449–1463. <https://doi.org/10.1378/chest.09-1485>
- Wickwire, E. M., Geiger-Brown, J., Scharf, S. M., & Drake, C. L. (2017). Shift work and shift work sleep disorder: Clinical and organizational perspectives. *Chest, 151*(5), 1156–1172. <https://doi.org/10.1016/j.chest.2016.12.007>
- Willis, B. L., DeFina, L. F., Bachmann, J. M., Franzini, L., Shay, C. M., Gao, A., Leonard, D., & Berry, J. D. (2015). Association of ideal cardiovascular health and long-term healthcare costs. *American Journal of Preventive Medicine, 49*(5), 678–685. <https://doi.org/10.1016/j.amepre.2015.03.034>
- Wium-Andersen, M. K., Wium-Andersen, I. K., Prescott, E. I. B., Overvad, K., Jorgensen, M. B., & Osler, M. (2020). An attempt to explain the bidirectional association between ischaemic heart

- disease, stroke and depression: A cohort and meta-analytic approach. *British Journal of Psychiatry*, 217(2), 434–441. <https://doi.org/10.1192/bjp.2019.130>
- Woolcott, J. C., Richardson, K. J., Wiens, M. O., Patel, B., Marin, J., Khan, K. M., & Marra, C. A. (2009). Meta-analysis of the impact of 9 medication classes on falls in elderly persons. *Archives of Internal Medicine*, 169(21), 1952–1960. <https://doi.org/10.1001/archinternmed.2009.357>
- Woon, L. S.-C., & Tiong, C. P. (2020). Burnout, mental health, and quality of life among employees of a Malaysian hospital: A cross-sectional study. *Annals of Work Exposures and Health*, 64(9), 1007–1019. <https://doi.org/10.1093/annweh/wxaa075>
- Working group set up by the Finnish Medical Society Duodecim and the Finnish Sleep Research Society. (2020). *Insomnia: Current Care Guidelines*. <https://www.kaypahoito.fi/hoi50067#s27>
- Wu, X., Liu, X., Liao, W., Kang, N., Sang, S., Abdulai, T., Niu, M., He, Y., Zhai, Z., Pan, M., Wang, C., & Li, Y. (2021). The association between ideal cardiovascular health and health-related quality of life in adults: A population-based cross-sectional study. *International Journal of Public Health*, 66, 592043. <https://doi.org/10.3389/ijph.2021.592043>
- Yang, X., Ge, C., Hu, B., Chi, T., & Wang, L. (2009). Relationship between quality of life and occupational stress among teachers. *Public Health*, 123(11), 750–755. <https://doi.org/10.1016/j.puhe.2009.09.018>
- Yong, M., Nasterlack, M., Pluto, R.-P., Lang, S., & Oberlinner, C. (2013). Occupational stress perception and its potential impact on work ability. *Work*, 46(3), 347–354. <https://doi.org/10.3233/WOR-121556>
- Younus, A., Aneni, E. C., Spatz, E. S., Osondu, C. U., Roberson, L., Ogunmoroti, O., Malik, R., Ali, S. S., Aziz, M., Feldman, T., Virani, S. S., Maziak, W., Agatston, A. S., Veledar, E., & Nasir, K. (2016). A systematic review of the prevalence and outcomes of ideal cardiovascular health in US and non-US populations. *Mayo Clinic Proceedings*, 91(5), 649–670. <https://doi.org/10.1016/j.mayocp.2016.01.019>
- Zhai, L., Zhang, H., & Zhang, D. (2015). Sleep duration and depression among adults: A meta-analysis of prospective studies. *Depression and Anxiety*, 32(9), 664–670. <https://doi.org/10.1002/da.22386>

Appendices

PORTAAT Questionnaires

(The questionnaires of the PORTAAT Study were in Finnish. These questionnaires have been translated by the author for this thesis summary.

If a question was used only at baseline [2014] or at follow-up [2015], the year is mentioned with the question.)

These questionnaires are designed to gather information about your well-being and habits. All information will be handled confidentially, and all researchers involved in the study have confidentiality obligations.

Please, answer the following questions by ticking the box that best describes your situation or write your answer on the lines. Return the questionnaire to the study nurse at the study visit.

(2014) Do you have any diseases diagnosed by a physician?

No Yes. Please, list the diseases here:

(2015) Do you have any diseases diagnosed by a physician during the past year?

No Yes. Please, list the diseases here:

Do you have a permanent medication? No Yes. Please, list the names of the medications here:

Do you have children?

- No Yes, under 18 years of age, (number) _____
- Yes, over 18 years of age, (number) _____

What is your current life situation?

- I live alone I live with a partner I am a single parent
- I am divorced I am widowed Other

QUESTIONNAIRE ABOUT WORK AND OCCUPATION

What is your occupation? _____

Which one of the following best describes your current work time arrangements?

- Fixed daytime work Two-shift work Three-shift work
- Part-time work Fixed evening work Fixed night work

(2014) Which one of the following best describes your vocational education?

- Vocational course
- Vocational school or apprenticeship
- Vocational institute
- University of applied sciences or bachelor’s degree
- University or Institute of higher education
- None of the mentioned

(2015) How many years have you been studying? Add together school and education years starting from the first grade of elementary/primary school.

- No finished school/education Elementary school (6–7 years)
- Comprehensive school (9 years) Upper secondary school

Assume that your work ability at its best has score of 10 points. What is your current work ability compared with your lifetime best? (0–10) Please circle as appropriate. (WAS)

0 1 2 3 4 5 6 7 8 9 10

Completely unable to work

Work ability at its best

SLEEP

During the past month, how many hours of sleep did you normally get at night?

_____ hours _____ minutes

During the past month, how would you rate your sleep quality overall?

Very good Good Poor Very poor

During the past month, how often have you taken medicine (prescribed or ‘over the counter’) to help you sleep?

Not during the past month

Less than once a week

Once or twice a week

Three or more times a week

PHYSICAL ACTIVITY

How much physical activity do you get during a typical week? Add together all regular physical activity that lasts at least 10 minutes at a time. You can choose several options.

No regular physical activity during a typical week

Light aerobic type physical activity (e.g. slow walking)

on _____ days a week, altogether _____ hours _____ minutes a week

Moderate aerobic type physical activity (e.g. brisk walking)

on _____ days a week, altogether _____ hours _____ minutes a week

- Vigorous aerobic type physical activity (e.g. running)
on _____ days a week, altogether _____ hours _____ minutes a week
- Resistance type of training (e.g. gym training)
on _____ days a week, altogether _____ hours _____ minutes a week
- Physical activity related to balance (e.g. dance or games)
on _____ days a week, altogether _____ hours _____ minutes a week

SMOKING

- I have never smoked regularly
- I have stopped smoking in (year) _____
- I am currently smoking _____ cigarettes per day

(2014) DIET

How often do you eat the following foods or drink the following beverages?

Please, tick the appropriate box.

	Every day	3–6 days a week	A few times a month	More seldom	Never
Dark (rye) bread					
White bread					
Sweet bakery products, biscuits					
Crisps or comparable					
Sweets					
Fresh fruit					
Fresh vegetables					
Berries					
Cheese					
Fat-free or low-fat ($\leq 1\%$) dairy products					
Other dairy products					
Sausage					
Red meat (beef, pork, mutton)					
White meat (poultry)					
Fish					
Eggs					

(2015) FOOD FREQUENCY QUESTIONNAIRE (PORTAAT FFQ) HY ME/2015

Think about the previous week. How many times a day or times a week did you eat the following food products? Please, fill in the appropriate figure in the suitable box for every food group. Tick the box of 'Not at all' if you did not eat that food during the last week. **Please, fill in only one column per row!**

	Not at all	Times per week	Times per day
<i>For example: fat-free milk and sour milk</i>			2
MEALS			
Breakfast			
Hot meal (e.g. lunch, dinner)			
Snack			
VEGETABLES, FRUIT, AND BERRIES			
Fresh vegetables (e.g. lettuce, tomato, cucumber, grated carrots)			
Cooked vegetables and canned vegetables (as a side dish, e.g. mushrooms)			
Potatoes (in any form)			
Peas, beans, lentils and soya (e.g. tofu, falafel, chickpeas, seitan, hummus)			
Fresh fruit			
Canned and frozen fruit			
Berries (fresh and frozen)			
Berry and fruit soups and fools			
DAIRY PRODUCTS			
Fat-free milk and sour milk			
Low-fat ($\leq 1\%$) milk and sour milk			
Full fat milk and sour milk			
Low-fat cheese (fat $\leq 20\%$, e.g. Polar 15, cottage cheese)			
Full-fat cheese (fat $> 20\%$, e.g. Oltermanni, Emmental, feta)			
Yoghurt, quark, and curdled milk			
Ice cream (e.g. Pingviini, Tofuline)			

FATS			
Vegetable oil <i>in cooking</i>			
Oil-based salad dressings			
Butter, butter-oil spread 80% fat (e.g. Oivariini) <i>on bread</i>			
Margarine ≥60% fat (e.g. Keiju, Becel, Flora) <i>on bread</i>			
Margarines, bread spreads, <60% fat (e.g. Voilevi, kevyt Becel) <i>on bread</i>			
FISH			
Fish dishes and products (e.g. fish soup, fried fish, tuna)			
MEAT AND EGGS			
Red meat (beef, pork, mutton, lamb, game; e.g. meatballs)			
White meat (poultry, e.g. turkey stew, chicken wok)			
Cold cuts of meat (e.g. smoked ham, turkey cold cut)			
Sausages and frankfurters (e.g. mettwurst, lauantai-sausage)			
Eggs (as such , e.g. fried, cooked, omelette)			
GRAIN PRODUCTS			
Whole grain (dark) pasta and rice			
White pasta and rice			
Rye bread, rye crisp bread			
Light whole grain bread (e.g. multigrain bread, graham rolls, high-fibre oat bread)			
White bread (e.g. French bread, white toast)			
Breakfast cereals, muesli			
Porridge			
Sweet bakery products (e.g. buns, pies, cookies, cakes)			
Savoury bakery products (e.g. pies, pastries)			

BEVERAGES			
Juices sweetened with sugar			
Fruit juice (no added sugar)			
Soft drinks and energy drinks sweetened with sugar (e.g. Coca-Cola, Jaffa, Red Bull)			
Low-sugar soft drinks and juices (e.g. diet soft drinks, beverages sweetened with stevia)			
Light alcoholic drinks (e.g. beer, cider, wine)			
Spirits (e.g. spirits, liqueur, whisky, cognac)			
OTHER			
Chocolate (e.g. milk chocolate, chocolate raisins, pralines)			
Sweets (e.g. salty liquorice and fruit candy, lollies)			
Unflavoured nuts, seeds and almonds			
Crisps, popcorn, salted peanuts (e.g. potato crisps, nachos)			
DIETARY SUPPLEMENTS			
Multivitamin and mineral products, (e.g. Multi-tabs, Multivita)			
Vitamin D supplements (e.g. DeviSol, Minisun)			
Other dietary supplements			



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