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Lifestyle, work ability and sick leave in a general Norwegian working population

- a cohort study from Telemark

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A PhD dissertation in
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Lifestyle, work ability and sick leave in a general Norwegian working population – a cohort study from Telemark County

Per Anna e Matteo

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Sammendrag

Bakgrunn: I dag utfordres den norske velferdsstatens bærekraft av demografiske endringer. En økning i forventet levealder betyr bl.a. at den sysselsatte delen av befolkningen må stå lenge i arbeid. God psykisk og somatisk helse ansees som en viktig forutsetning for et lengre arbeidsliv. Tidligere studier har funnet flere sammenhenger mellom livsstilsrelaterte risikofaktorer, arbeidsevne og sykefravær. Det er imidlertid få studier som har undersøkt disse sammenhengene ved hjelp av en summativ risikoindeks for livsstilsfaktorer.

Mål: Målet med denne avhandlingen var å undersøke om det kunne være sammenhenger mellom flere livsstilsrelaterte risikofaktorer, arbeidsevne og sykefravær i en allmenn yrkesaktiv befolkning i Telemark fylke. Videre var det et mål å utforske slike sammenhenger innenfor ulike grupper av ikke-smittsomme sykdommer.

Materiale og metode: Ved utgangspunktet (baseline) til den longitudinelle Telemark-studien (2013) ble egenadministrerte spørreskjemaer sendt ut per post til 50 000 personer i alderen 16-50 år i både landlige og urbane deler av fylket. 48 142 av dem som mottok spørreskjemaene var aktuelle som informanter, og totalt 16 099 informanter besvarte spørreundersøkelsen. Spørsmålene som inngikk i skjemaet dekket følgende områder: personopplysninger, arbeidsforhold, luftveisplager, luftveisplager og arbeid, røyke- og snusvaner, boligforhold, barndom og familie, fysisk aktivitet og kosthold, andre sykdommer og plager.

En oppfølgingsundersøkelse ble gjennomført fem år senere (2018) og spørreskjemaer ble sendt ut til de 16 099 som besvarte undersøkelsen i 2013. Totalt besvarte 7 952 informanter på begge undersøkelsene (2013 og 2018).

Av statistiske analyser ble logistisk regresjonsanalyse benyttet for å utforske sammenhengen mellom flere livsstilsrelaterte risikofaktorer, arbeidsevne og sykefravær. Andre analyser ble også gjennomført, herunder interaksjonsanalyse, testing av korrelasjon, og sammenheng og beregning av tilskrivbar risiko i befolkningen.

Hovedresultater: Alle deltakerne i artikkel I og artikkel II besvarte at de hadde vært i arbeid de foregående 12 månedene og svarte på spørsmålene om arbeidsevne og livsstilsrisikofaktorer (n = 10 355). I artikkel I var individuelle livsstilsrisikofaktorer og en livsstilsrisikoindeks assosiert med redusert arbeidsevne. Denne sammenhengen forble konsistent etter justering for alder, kjønn, nåværende yrke og utdanning. I artikkel II fant vi at legediagnostisert astma var en effektmodifiserende faktor i sammenhengen mellom livsstilsrisikofaktorer (fedme, røyking og livsstilsrisikoindeks) og sykefravær.

Artikkel III inkluderte personer som hadde vært i arbeid de foregående 12 månedene både ved oppstart og oppfølgingstidspunktet (n = 6 267). Artikkelen fant at usunt kosthold, lite fysisk aktivitet og røyking var forbundet med lav arbeidsevne. Denne sammenhengen var konsistent selv etter justering for potensielle konfunderende faktorer. Videre fant artikkelen at høy kroppsmasseindeks, tidligere og nåværende røyking, høy og svært høy livsstilsrisikoindeks var forbundet med høyere sykefravær. Tidligere røyking var forbundet med lav arbeidsevne blant personer som rapporterte psykisk sykdom, mens nåværende røyking var forbundet med sykefravær blant personer som rapporterte hjerte- og karsykdommer, diabetes eller psykiske lidelser.

Konklusjon: Basert på disse tre artiklene antyder funnene at individuelle livsstilsrisikofaktorer kan være knyttet til lavere arbeidsevne og høyere sykefravær. Spesielt var lav arbeidsevne forbundet med en høyere livsstilsrisikoindeks, noe som også ble vist å være tilfelle for sykefravær på oppfølgingstidspunktet. I alle tre studiene var røyking konsekvent forbundet med lav arbeidsevne og økt sykefravær (artikkel I-III). Videre var lege-diagnostisert astma en effektmodifikator i sammenhengen mellom fedme, røyking og livsstilsrisikoindeks og sykefravær i den andre artikkelen. Disse funnene bidrar til eksisterende kunnskap og støtter hypotesen om at retningslinjer for å redusere livsstilsrisikofaktorer kan bidra til bedre folkehelse og forlenget arbeidsliv. Siden røyking er spesielt knyttet til en sosial gradient i helse, vurderes det som viktig å vie oppmerksomhet på denne problemstillingen i fremtiden. Artiklene inkludert i avhandlingen viser at fremtidige studier av livsstilsrisikofaktorer kan inkludere livsstilsrisikofaktorer som forekommer samtidig og vurdere arbeidsrelaterte utfall (som arbeidevne og sykefravær) som tar hensyn til sosioøkonomiske forskjeller.

Abstract

Background: The sustainability of the Norwegian welfare state is being challenged by demographic changes. One consequence of increased life expectancy is that the working population is expected to work longer. Good mental and physical health is considered a key prerequisite for an extended working life. Previous studies have identified several associations between independent lifestyle risk factors, work ability and sick leave. However, few studies have investigated these associations using a summative lifestyle risk index.

Aim: The aim of this thesis was to investigate potential associations between multiple lifestyle risk factors, work ability and sick leave in a general working population in Telemark County in south-eastern Norway. A further aim was to explore such associations within different non-communicable disease groups.

Materials and method: At baseline of the longitudinal Telemark Study (2013), a self-administered questionnaire was posted to 50 000 persons aged 16–50 in both rural and urban parts of Telemark County. Of these persons, 48 142 were eligible and a total of 16 099 completed and returned the questionnaire. The questionnaire covered the following areas: personal information, working conditions, respiratory symptoms, respiratory symptoms and work, smoking and snuff habits, living conditions, childhood and family, physical activity and diet, and other diseases and illnesses.

In 2018, a five-year follow-up questionnaire was sent to the 16 099 persons who had responded in 2013. In total, 7 952 persons completed both questionnaires (2013 and 2018).

Logistic regression analysis was used to explore the associations between multiple lifestyle risk factors, work ability and sick leave. Other statistical analyses were also performed, including interaction analysis, correlation and association testing, and calculation of the population attributable fraction.

Main results: All subjects included in Paper I and Paper II had worked in the preceding 12 months and answered the questions on work ability and lifestyle risk factors (n=10 355). In Paper I, individual lifestyle risk factors and a lifestyle risk index were associated with reduced work ability. This finding remained consistent after adjustment for age, sex, current occupation and education. In Paper II, physician-diagnosed asthma was found to be an effect modifier in the association between lifestyle risk factors (obesity, smoking and lifestyle risk index) and sick leave.

Paper III included individuals who had been engaged in work in the preceding 12 months at both baseline and follow-up (n=6 267). The study found that unhealthy diet, low physical activity and smoking were associated with low work ability. This finding remained consistent after adjustment for potential confounders (Paper III). Further, the study showed that high body mass index, former and current smoking, and high and very high lifestyle risk indices were associated with higher rates of sick leave. Former smoking was associated with low work ability among persons who reported mental illness, while current smoking was associated with sick leave among persons who reported cardiovascular disease, diabetes or mental illness (Paper III).

Conclusion: Based on these three papers, this thesis suggests that individual lifestyle risk factors may be linked to lower work ability and higher rates of sick leave. In particular, poor work ability was associated with a higher lifestyle risk index score. This was also shown for sick leave at follow-up. In all three studies, smoking was consistently associated with low work ability and increased sick leave (Papers I–III). Lastly, physician-diagnosed asthma was an effect modifier in the association between obesity, smoking and lifestyle risk index and sick leave (Paper II). These findings add to current knowledge and support the hypothesis that policies aimed at reducing lifestyle risk factors may benefit population health and extend working life. Also, as smoking is particularly linked to a social gradient in health, this finding warrants future attention. Future studies examining lifestyle risk factors may benefit from the inclusion of co-occurring lifestyle risk factors and the assessment of work measures (i.e. work ability and sick leave) as outcomes considering socioeconomic differences.

List of papers

Paper I

Oellingrath IM, De Bortoli MM, Svendsen MV, Fell AKM (2019)."Lifestyle and work ability in a general working population in Norway – a cross-sectional study". BMJ Open. 2019 Apr 3;9(4):e026215. doi: 10.1136/bmjopen-2018-026215

Paper II

De Bortoli MM, Fell AKM, Svendsen MV, Henneberger PK, Kongerud J, Oellingrath IM (2020) "Lifestyle, sick leave and work ability among Norwegian employees with asthma—A population-based cross-sectional survey conducted in Telemark County, Norway". PLOS One. 2020 Apr 17: doi: 10.1371/journal.pone.0231710

Paper III

De Bortoli MM, Oellingrath IM, Fell AKM, Burdorf A, Robroek S JW “Influence of lifestyle risk factors on work ability and sick leave in a general working population in Norway- a 5-year longitudinal study”. BMJ Open 2021;11:e045678. doi:10.1136/bmjopen-2020-045678

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Selected abbreviations

BMI	Body mass index
CI	Confidence interval
COPD	Chronic obstructive pulmonary disease
CVD	Cardiovascular diseases
HUNT	The Trøndelag Health Study
MVPA	Moderate to vigorous physical activity
NAAF	Norwegian Asthma and Allergy Association
NCD	Non-communicable disease
OECD	Organisation for Economic Co-operation and Development
OR	Odds ratio
PAF	Population attributable fraction
WAI	Work Ability Index
WAS	Work Ability score
WHO	World Health Organization

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1 Introduction

Many European countries are currently experiencing declining birth rates and increased life expectancy (1). In Norway, it is predicted that by 2030 for every person of working age there will be 0.4 person aged above 65 (2). This will have a profound impact on the Norwegian welfare state. In its 2013 report "Working better with age", the Organisation for Economic Co-operation and Development (OECD) stated that although the employment rate is high among persons aged 50–64 in Norway, efforts are needed to increase the scope for extended workforce participation in an ageing population (3). Therefore, it may be of interest to investigate whether lifestyle risk factors are associated with work outcomes from a public health perspective, since a significant proportion of the population engage in less healthy lifestyle behaviours (unhealthy diet, lack of physical activity, high body mass index and smoking), and certain lifestyle-related diseases are not decreasing in prevalence (4). Further, because there is a link between lifestyle risk factors and non-communicable diseases (NCD) (5), this thesis has sought to investigate whether the association between lifestyle risk factors and work outcomes is more pronounced or differs among persons with different chronic conditions and NCDs. The term NCD describes chronic diseases whose origins lie in genetic factors, environmental factors and personal lifestyle (6). Below, NCD will be used due to its more neutral connotations.

The three papers included in this thesis are based on data from the Telemark Study. The study was initiated by the Department of Occupational and Environmental Medicine at Telemark Hospital in cooperation with the University of Oslo/Department of Respiratory Medicine, Rikshospitalet, Oslo University Hospital. The Telemark Study comprises both a questionnaire-based cohort study and a case-control study. Its main objective is to identify health-promoting and preventive measures related to respiratory health. The cohort study element consists of a sample of the general adult population (age over 16 years at baseline), where the goal is to follow the participants for 20 years.

This PhD project began in 2017, and the first two papers are based on baseline data (2013) and the third paper combines baseline and follow-up data (2018). Since the primary focus of the Telemark Study is respiratory health and occupational exposure, the study design does not concentrate on lifestyle risk factor or work outcomes. Nevertheless, the Telemark Study is a rich source of data on subjects' personal details, working conditions, respiratory symptoms, respiratory symptoms and work, smoking and snuff habits, living conditions, childhood and family, physical activity and diet, and other diseases and illnesses. However, an important limitation of any self-completed questionnaire is a lack of objectively measured data. On the other hand, self-reporting facilitates the inclusion of numerous questions and participants due to its cost-effective design. Another important limitation is that although large data volumes can be collected, no information is generated on temporality of events. This makes it challenging to draw conclusions regarding the exposure-outcome relationship.

The first of the three papers included in this thesis focused on the association between lifestyle risk factors and work ability in the general working population. Since the Telemark Study mainly focuses on respiratory health, the second paper investigated whether persons with chronic respiratory diseases such as asthma have higher odds of reduced work ability and sick leave than persons without asthma. Finally, the third paper investigated whether the lifestyle risk factors identified at baseline are associated with five-year follow-up work ability or sick leave. As chronic diseases such as asthma had been covered in the second paper, the final paper aimed to expand the focus to include NCDs like other respiratory diseases, cardiovascular disease (CVD) and diabetes. Paper III therefore explored whether the association between lifestyle risk factors and work outcomes was different for persons reporting such NCDs. In addition, due to the high prevalence of mental illnesses among the subjects, Paper III also investigated whether the association between lifestyle risk factors and work outcomes was different for persons suffering from mental conditions.

Moreover, to incorporate a public health perspective the three papers included in this thesis explored possible factors other than morbidity and mortality associated with lifestyle risk factors. Both the design of the study and the study population have thus facilitated broader application of the Telemark Study data, beyond respiratory health and occupational health alone. Accordingly, the three papers are linked by the exposure variable – lifestyle risk index – and the outcome variables: work ability and sick leave. Since lifestyle risk factors often occur simultaneously and may therefore have synergetic effects (7), the lifestyle risk index was designed to explore whether the general adult population follows Norwegian governmental recommendations on a healthy lifestyle (diet, physical activity, body mass index and smoking). The index distinguishes between full adherence to the recommendations, some adherence and no adherence. Because few studies have focused on co-occurrence of unhealthy lifestyle behaviours, especially in relation to work outcomes, this approach supplements the existing literature on both health promotion and occupational epidemiology. Further, since a substantial proportion of the working population has an NCD and/or mental illness, Papers I–III contribute new knowledge on co-occurrence of lifestyle risk factors in relation to work outcomes among such conditions.

While the findings in the three papers are considered to contribute to the literature, it is also important to acknowledge limitations inherent in the study design. For example bias arising from self-reported questionnaire and lack of inclusion of additional lifestyle risk factors (e.g. alcohol, sleep). Accordingly, further development of the lifestyle risk index (e.g. components and cut-offs) and additional investigation of work outcomes (e.g. categorisation) may be important for future research.

In this initial chapter, the background and rationale for the three papers will be presented. The hypotheses and objectives are presented in the second chapter. The third chapter discusses materials and methods, starting with the study setting, study design and study variables. The rationale for decisions affecting dependent variables and the lifestyle risk index are also presented. The fourth chapter covers ethical and person-centred healthcare aspects. Chapter five presents the statistical analysis. The overall results from the three papers are shown in chapter six and then discussed in chapter seven. Chapter seven is divided into a discussion of the main findings and consideration of the employed methodology. In chapter eight, the main findings are reflected on from a person-centred healthcare perspective, while the ninth chapter contains concluding remarks on this thesis.

1.1 Background

The impact of lifestyle choices on health and society is difficult to quantify and are likely to vary over the course of one's life. Nevertheless, increased knowledge of different lifestyle factors and how they affect work ability and sick leave may help individuals, employers and society to facilitate healthy lifestyle behaviours. While several studies have assessed individual lifestyle risk factors such as diet, physical activity, body mass index (BMI) and smoking (8-10), few studies have assessed several such factors simultaneously. Further, studies have assessed lifestyle risk factors in relation to distinct occupational groups (11-13) , but few have investigated the relationship between co-occurring lifestyle risk factors and work outcomes in the general working population in Norway. Workforce participation is predicted to last longer as the general workforce ages. Prolonging working life is a political priority, and policies will be adopted that affect the future organisation and funding of the Norwegian welfare state. The results of this thesis can help inform such policy-making.

In Norway, life expectancy was 84.2 years for women and 80.5 years for men (2017), and most people enjoy good health well into old age (14). However, many people still find it challenging to follow government recommendations on healthy living. While many adults eat a varied diet, the intake of whole grains, fish, fruit and vegetables is too low for a large part of the population (15, 16). Unfortunately, only 30% of adults achieve recommended levels of physical activity (15), and the prevalence of overweight and obesity continues to rise (15). Today, there are more adults with overweight and obesity in Norway than adults with a normal weight (15, 16). More positively, the proportion of daily smokers has decreased from approximately 30% in 2000 to 10% in 2016 (15).

Lifestyle behaviours often occur simultaneously (17, 18). In this thesis, lifestyle is defined as the sum total of an individual's behavioural habits such as diet, physical activity and smoking. The definitions used in Papers I–III can be found from page 18. Interestingly, several of the lifestyle risk factors included in this thesis are targeted by the United Nations through Sustainable Development Goal 3: "Good health and well-being; ensure healthy lives and promote well-being for all at all ages" (19). Other factors with an impact on lifestyle but not considered further in this thesis are social participation, alcohol and illegal substance abuse, sexual practices and sleep (20).

In 2018, 87% of deaths in Norway were due to NCDs (21) – 28% were linked to cardiovascular diseases (CVD), 28% to cancers, 8% to chronic respiratory diseases, 2% to diabetes and 22% to other NCDs (21). The aforementioned lifestyle risk factors are linked to higher risk of NCDs (22). As life expectancy increases, the prevalence of NCDs is also likely to increase. The total cost associated with disease – in terms of direct and indirect costs for individuals and society – is substantial for the majority of NCDs (23). Moreover, there are indications that persons with chronic diseases experience greater challenges in working life than their counterparts (24-26). According to a cross-national study covering 26 European countries, the health-related educational differences in employment were more pronounced in northern Europe than southern and continental Europe (24). The same study also found that the proportion of employed persons with a chronic disease and low education was 40% among women and 50% among men (2014) (24). Moreover, previous literature suggests that lifestyle risk behaviours, as well as morbidity and mortality, are linked to socioeconomic position (27). Education and occupation may be proxies for socioeconomic position and are also important factors that have been shown to be predictors of health outcomes (27). Existing literature also suggests that lower socioeconomic position, especially in terms of education, is associated with higher rates of sick leave (28, 29). Although not the main focus of this thesis, these aspects are important to consider when investigating a potential association between lifestyle risk factors and work outcomes.

Asthma is a chronic respiratory disease that affects a large age range in the general population. Globally, the prevalence of asthma was 3.6% in 2017 (30). In Europe, the highest prevalences were reported in the United Kingdom, France, Italy and Portugal (>10%) (31). One of the main purposes of the Telemark Study was to investigate the prevalence of asthma and possible risk factors for respiratory disease. At baseline (2013), 11.5% of participants reported having physician-diagnosed asthma, indicating a higher prevalence than found in previous studies conducted in Europe (32). Further, few studies had investigated the association between lifestyle risk factors and work outcomes for persons with NCDs and/or illness at the time of initiation of the Telemark Study. Because it was assumed that a substantial proportion of the study population would report suffering from a chronic disease and/or illness, the Telemark Study aimed to provide new, important knowledge on these associations.

The underlying causes of NCDs are complex and multifactorial. However, unhealthy lifestyle behaviours such as smoking, lack of physical activity and unhealthy diet are associated with increased prevalence of NCDs like cancer, CVD, diabetes and respiratory diseases (5, 22, 33). Moreover, for some NCDs such as asthma, inflammation is part of the aetiology (34). It is well-known that an increase in inflammatory responses can disrupt a person's normal cellular physiology (35). Modifiable risk factors like lack of physical activity, unhealthy diet and psychological stress have also been found to promote systemic inflammation and insulin resistance, thereby increasing the potential risk of obesity, diabetes, CVD, etc. (35). However, knowledge of the scope for reducing inflammation linked to chronic disease and modifiable risk factors is limited. Further, the workplace could serve as an important arena for health promotion, since a large proportion of the adult population spends a substantial amount of time at work (36). Examples of workplace health-promotion activities include an increased focus on ergonomics, educational measures, and lifestyle interventions such as facilities for physical activity (36).

The potential consequences of poor lifestyle behaviours include reduced work ability and increased levels of sick leave (10, 37). A Norwegian twin cohort study found that low education and unhealthy behaviours were associated with a higher proportion of sick leave at the individual level among men in the older age cohort (subjects born between 1948 and 1960) (38). In 2016, musculoskeletal disorders and mental illness accounted for the highest numbers of years lived with disability in Norway (4). This is consistent with the main causes of sick leave reported for Norway, namely musculoskeletal disorders, mental illness, respiratory diseases and "other conditions" (39). However, few studies have assessed these associations simultaneously over time. Based on current knowledge, several lifestyle risk factors appear to be associated with low work ability and sick leave (37, 40), and addressing them may thus improve work ability and reduce sick leave.

However, due to the complexity of lifestyle risk patterns, it is difficult to draw firm conclusions regarding causal associations (40).

1.1.1 Work ability and sick leave in Norway

Few Norwegian studies have researched work ability, a concept originally developed by the Finnish Institute of Occupational Health. The studies conducted in Norway have primarily concentrated on work ability among cancer survivors (41-43), persons undergoing occupational rehabilitation (44) and employees in different occupational sectors (45). Several longitudinal studies have been or are currently being conducted in Finland (Northern Finland birth cohort of 1966 and the Health 2000 Survey) (46, 47), Sweden (Swedish Working Life Cohort) (48) and Denmark (2010 Danish Work Environment Cohort Study) (49). However, comparing work ability across different cohort studies may be challenging due to differing occupational groups and work tasks, age composition and duration of follow-up. As many of the prior studies have focused on distinct occupational groups, specific sex, or specific age groups, the research group[1] wanted to explore associations between lifestyle and work outcomes in a broad setting, using the general working population. To the best of my knowledge, no such investigation has not been performed in a Norwegian setting before.

In the third quarter of 2019, the overall rate of sickness absence in Norway was 5.9% (1.0% self-certified) (50). The highest prevalence of physician diagnosed sick leave were registered in Nordland, Finmark, and Telemark counties (50). Norway has higher rates of sick leave than other northern European countries (51-53). There is no obvious

[1] 'The research group' or 'we' in this thesis refers to the Telemark research group. Members of the research group varied throughout the research process. Reflections and decisions made were according to the overall aim of this thesis. For Paper II included partners from the University of Oslo/Department of Respiratory Medicine, Rikshospitalet, Oslo University Hospital, Oslo, Norway, and the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Morgantown, W Va, USA. While for Paper III, the partners from the Department of Public Health, Erasmus University Medical Center, Rotterdam, The Netherlands, and the Oslo Centre for Biostatistics and Epidemiology, Oslo University Hospital, Oslo, Norway were active collaborators. References in this thesis to 'my' refer to the author.

explanation for this, but various factors including high sick leave benefits have been proposed as drivers of the high rates observed in Norway (51). Chapter 8 of the Norwegian National Insurance Act provides that employers must cover pay during the first 16 days of sick leave. Thereafter, the Norwegian national insurance system covers pay during sick leave, for up to 52 weeks (54).

Generally, however, cross-border comparison of sick leave is complicated by differences between national insurance systems and in workforce composition (i.e. age and sex) (51).

1.1.2 Determinants of work ability and sick leave

Both work ability and sick leave can be regarded as complex expressions of an individual's ability to perform work in a given timeframe. Work ability is likely to fluctuate throughout working life. The complexity of individual work ability is linked to personal characteristics, the work environment, socioeconomic position and the wider society. The concept of work ability also has implications for sick leave from a legislative perspective in Norway, where it is defined by the Norwegian Labour and Welfare Administration as the ability of a person to find and keep a job. If a person experiences reduced work ability, she/he can have her/his work ability evaluated (55). However, this thesis uses the definition of work ability represented by the Work Ability Index (WAI), which has been widely used in epidemiology for the past 30 years, since being proposed by the Finnish Institute of Occupational Health in the 1980s (56). The work ability concept, applied in the three papers included in this thesis (Paper I- III) is defined by Ilmarinen et al. as (57): "How good are workers at present and in the near future and how able are they to do their job with respect to work demands, health, and mental resources?".

An association between high BMI and low work ability has been identified previously (37, 58). Moreover, evidence from a recent scoping review and cross-sectional studies suggests an association between physical inactivity and low work ability (12, 59-61). The association between unhealthy diet and low work ability and sick leave is less investigated. Although a cross-sectional Egyptian study has suggested a positive association between healthy diet and good work ability (60), these findings could to some extent be confirmed in a Polish study with similar design (62). Moreover, the evidence concerning an association between smoking and low work ability is inconclusive (8, 12, 63) . Finally, other proposed factors associated with low work ability include: older age, decreased musculoskeletal function, high mental work demands, lack of autonomy, poor physical work environment and high physical workload (37). However, detailed investigation of these factors falls outside the scope of the present thesis. There is also convincing evidence that physical inactivity (64, 65), overweight and obesity (66, 67) and smoking (68) are associated with sick leave. Other potential factors with an influence on sick leave rates include sex, age, socioeconomic position, working conditions (i.e. physical and psychosocial factors), labour market conditions and the insurance system (40, 51, 69, 70).

Some studies have assessed multiple lifestyle risk factors in association to work ability and sick leave simultaneously (9, 10, 13). To the best of my knowledge, only one Polish cross-sectional study has used a lifestyle risk index in conjunction with WAI (71). That study investigated the association between a lifestyle risk index score (smoking, BMI, daily fibre intake and regular physical activity) and a WAI score among 187 men and women who were working full-time. The study concluded that a high lifestyle risk index score was associated with low work ability (71). Accordingly, the current thesis is probably the first general population study to investigate the relationship between a lifestyle risk index and both work ability and sick leave over time.

2 Hypotheses

This thesis seeks to investigate a number of hypotheses. Firstly, that unhealthy lifestyle behaviours such as unhealthy diet, lack of physical activity, high BMI and smoking are associated with low work ability and sick leave in the general working population. Secondly, that physician-diagnosed asthma is a possible effect modifier when studying the association between lifestyle risk factors and low work ability and sick leave. Thirdly, that the associations between lifestyle risk factors and work outcomes are different among persons with NCDs and illnesses (i.e. respiratory diseases, CVD or diabetes and mental illness) than among persons not reporting these diseases or illness.

2.1 Objectives

The overall objectives of the thesis were:

- To investigate the association between multiple lifestyle risk factors and work ability in a general working population in a cross-sectional setting.
- To investigate whether physician-diagnosed asthma is an effect modifier in the associations between multiple lifestyle risk factors and work ability and sick leave in a cross-sectional setting.
- To explore the associations between multiple lifestyle risk factors and work ability and sick leave at five-year follow-up.
- To explore the associations between multiple lifestyle risk factors and work ability and sick leave among persons with NCDs such as respiratory diseases, CVD or diabetes and mental illness at five-year follow-up.

3 Material and methods

3.1 Study setting

The Telemark Study is a prospective general population-based cohort study with baseline data from 2013, designed to assess risk factors for respiratory disease. Telemark is a county in south-eastern Norway with a population of 170 023 in 2012 (173 400 in 2019) (72, 73). The county encompasses 15 296 km² of both rural and urban areas. The region is home to onshore industry in urban areas (Grenland region) and farming in rural districts. In 2011, the Grenland region – alongside Bergen and Oslo – had Norway's highest annual mean levels of fine particulate matter concentration (PM2.5 µg / m3) (74). Hence, studies of respiratory disease risk factors are therefore of particular interest.

Telemark County differed from the rest of Norway in certain socioeconomic respects at the time of data collection. For example, the proportion of low-income households was higher than the average for Norway as a whole (2013) (73). Further, in 2013 the proportion of 18–44 year olds who were receiving a disability pension was higher than the Norwegian average (3.4% versus 2.3%) (73). Also, the percentages of daily smokers were above average in the period 2009–2013, at 21% for persons aged 45–74 (average: 20%) and 20% for persons aged 16–44 (average: 15%) (five-year average for 2009–2013) (75). In 2013, the number of persons being treated for cardiovascular conditions in a hospital setting was higher in Telemark than the Norwegian average (20 per 1 000 compared to 18 per 1 000). Moreover, while the number of persons either taking medication or receiving primary care for type 2 diabetes in Telemark was in line with the national average in 2013, the prevalence of mental illness (defined as those receiving primary-care support) exceeded the national average (153 cases per 1 000 versus 135 cases per 1 000) (73). Mortality due to chronic obstructive pulmonary disease (COPD) and lung cancer was higher in Telemark than the Norwegian average in 2013 (43 per 100 000 versus 38 per 100 000) (73). In the context of the Telemark Study, it is particularly interesting that use of prescribed medication for asthma and COPD was higher in Telemark (82 per 1 000) than the Norwegian average (77 per 1 000) in the period 2011–

2013, for both sexes and in all age groups (0-74 years old) (76). Altogether, these figures motivated the initiation of the Telemark Study in 2013.

3.2 Study design

The Telemark Study is a questionnaire-based prospective cohort study, and includes a case-control study. Administrative responsibility for the Telemark Study lies with the Department of Occupational and Environmental Medicine of Telemark Hospital in Skien – one of five departments of occupational health in Norway. According to patient examinations registered in the period 2010–2015, the most common symptomatic organ during occupational health examinations was the upper and lower airways, with asthma, COPD and lung cancer being the most prevalent diagnoses (77).

Data was collected for the case control in both 2013 and 2018/2019. The cases were persons with physician-diagnosed asthma and reference persons were those who did not report asthma. The case-control study comprised of a lung function test, measurement of fractional nitric oxide, anthropometric measurement, blood samples and extended self-administered questionnaires completed on-site (Short Form 36, Asthma Control Questionnaire, plus additional questions on exposure and symptoms). The data was collected from residents in both rural (Notodden, Rjukan, Seljord) and urban regions (Skien). The primary objective of the Telemark Study is to identify preventive and health-promoting measures related to respiratory disease. The secondary aims are to identify environmental risk factors, occupational risk factors, individual risk factors and complex interactions. The studies included in this thesis fall under the latter two aims of the Telemark Study (Papers I–III). At baseline, the Telemark Study was called 'Asthma in Telemark' (see appendix 11.1). In an attempt to increase participation at five-year follow-up, the study was given the more general name 'Telemark Study'.

At the Telemark Study baseline, a random sample of 50 000 inhabitants were sent a questionnaire by post. To ensure sufficient statistical power in connection with five-year follow-up and future data collection, the questionnaire was sent to an additional 30 000 persons by post. At follow-up in 2018, the participants were also given the option of answering online (Figure 1).

Inclusion criteria: aged 16–50 living in Telemark county.

Exclusion criteria: unable to find an address or difficulties answering questionnaire due to language barriers. An additional exclusion criterion was also used in Paper I and Paper II: aged under 18. This age criterion was adopted because the majority of 16–18 year old persons attend upper secondary school.

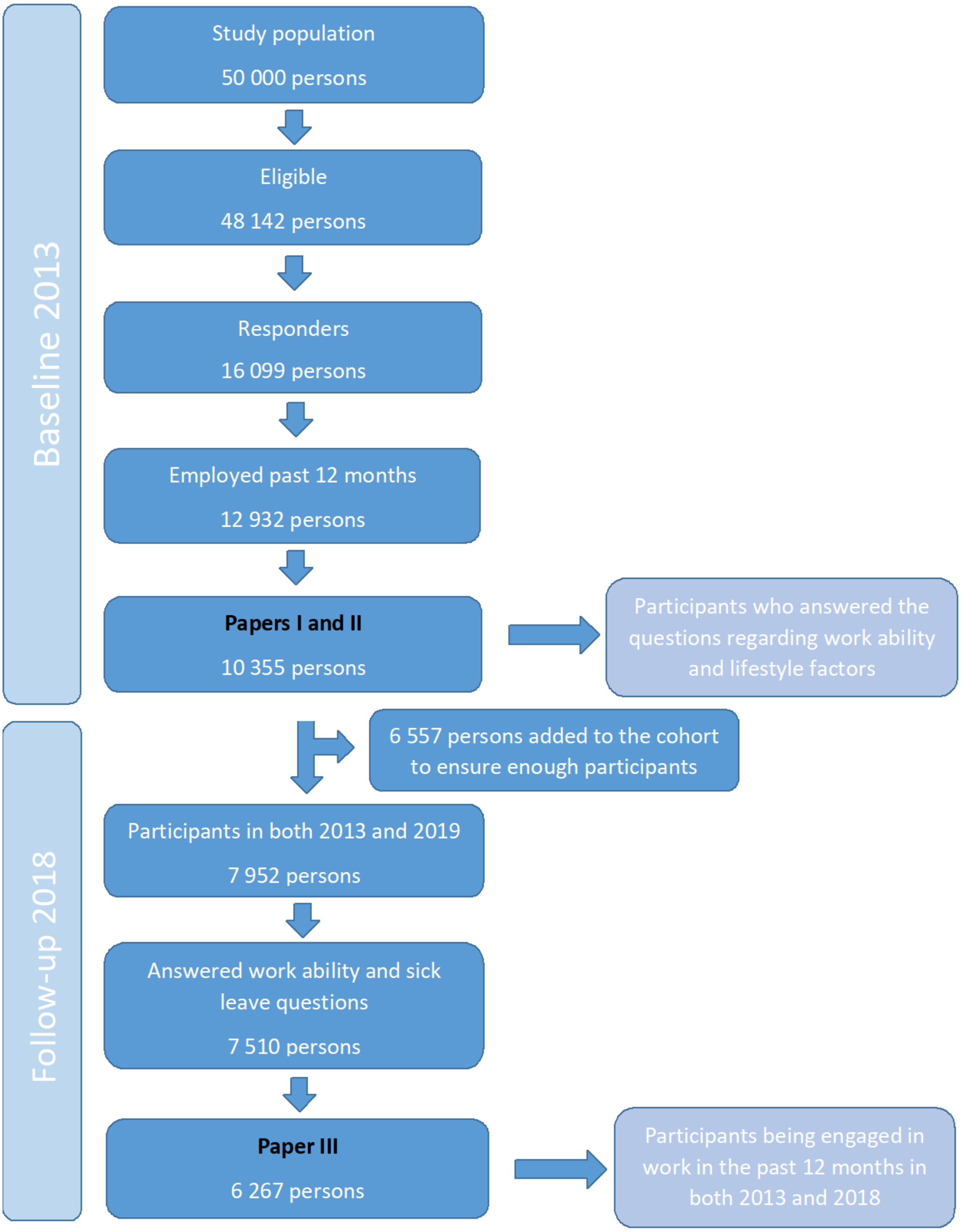
Inclusion and exclusion of subjects is shown in Figure 1.

The questionnaire was divided into nine sections, as follows:

1. Personal information
2. Working conditions
3. Respiratory symptoms
4. Respiratory symptoms and work
5. Smoking and snuff habits
6. Living conditions
7. Childhood and family
8. Physical activity and diet
9. Other diseases and illnesses

The questions from sections 1, 3, 4, 5, 8 and 9 (order of baseline questionnaire) have been incorporated into this thesis. In the 2018 follow-up questionnaires, 'medication' was included after the section on respiratory symptoms and work. See appendices for further information.

Figure 1. Flow chart of study subjects included in Papers I–III



3.3 Study variables

3.3.1 Dependent variables

Work ability

Our studies adopted the concept of work ability developed by the Finnish Institute of Occupational Health (Papers I–III) (78). The Institute's WAI was initially developed in the 1980s based on a multidisciplinary approach incorporating the fields of medicine, epidemiology, occupational physiology, psychology and biostatistics (79). The index was designed primarily for large epidemiological studies and for the occupational health setting (56, 80). However, the WAI has been criticised for being too long and too complicated (56). It is important to note that the index was not designed to illustrate a theory. Rather, it was designed to predict employee outcomes (i.e. sick leave or disability pension) (47, 56). The WAI covers seven dimensions: exploring current work ability compared to lifetime best, work ability in relation to the demands of work, number of diseases, work impairment due to disease, sick leave in the past 12 months, predicted work ability in two years' time and, lastly, mental resources. The WAI score range from 7 to 49 (57). The WAI questionnaire is available in 26 languages (78) and has previously been shown to have cross-national stability in a sample of nurses (81).

As the Telemark Study's primary focus was on respiratory health and occupational exposure, and since space was limited in the postal questionnaire, the decision was made to include only the first single-item question in the WAI (79) – the Work Ability score (WAS) (47). The WAS scale ranges from 0 (poor work ability) to 10 (excellent work ability). Previous longitudinal studies have demonstrated that WAS can be a reasonable alternative to the complete WAI (82, 83). WAS has been recommended and used as a simple, reliable indicator of work ability in several population based studies (63, 82, 84, 85). Moreover, some studies have shown an association between WAS and future sick leave or disability (82, 83, 86).

In the three papers included in this thesis, work ability was assessed using the first WAI question: “We assume that your work ability, when it was at its best would rate 10 points. How many points would you give your current work ability?” (87). In Paper I and Paper II, the work ability score was divided into two categories: low work ability (WAS 0–7) and good work ability (WAS 8–10) (13, 88). The rationale for this dichotomisation was that prior studies have used the WAS with these cut-offs (13, 63, 82, 88). In Paper III, the score was categorised as “poor” (WAS 0–5), “moderate” (WAS 6–7) or “good” (WAS 8–10) (83). The reason for including an additional category in the final paper was to explore the observation that the variable was skewed to the left in the previous analyses, with most participants reporting WAS ≥5. The research group believe that categorising the WAS into three categories may generate additional information about work ability in the population.

Sick leave

In several countries, including Norway, sick leave has been the subject of both political focus (due to the cost to society) and academic study (as an outcome in medical studies) in recent decades. This has led to the adoption of different measures of sick leave in population-based studies. In the Telemark Study sick leave was included as an important outcome for workers with respiratory disease. As sick leave rates in Norway are relatively high, investigating outcomes for persons with respiratory conditions may be of particular importance. Moreover, the complete WAI includes sick leave, diagnosed disease and injuries (80), and is therefore considered a more “objective” measure of a person’s work ability (80).

In the Norwegian context, sickness benefits can be paid for up to one year. However, it is also possible to take self-certified sick leave for three consecutive work days up to four times a year without a medical certificate being required (54). Further, if the workplace is part of the IA Agreement (the Letter of Intent regarding a more inclusive working life), the self-certification allowance is increased to eight consecutive days, but no more than 24 days per year (89).

There is no consensus on the categorisation of self-reported sick leave. According to Hensing, Alexanderson, Allebeck and Bjurulf, there are five ways of assessing sick leave: incidence rate (frequency per person-time), duration (mean or median days spent absent during each episode of sick leave), cumulative incidence (proportion of persons on sick leave during a time period), frequency (sickness absence episodes), and length (number of days of sick leave) (90). In Papers II and III, sick leave was assessed using the question, "Have you been on sick leave during the past 12 months?" The follow-up question was, "If yes, for how many days?" Together with the response options (1–7 days, 8–14 days, 15 days–12 weeks, more than 12 weeks), this assessed the frequency and length of sick leave. Self-reported sick leave has been shown to be a reasonably accurate measure when verified through comparison with sick leave registers (91-93). In this context, it is important to note that the categorisation used in the papers is not equivalent to the one operationalised in the complete WAI. In the WAI, the categories are as follow: 0 days, 1–9 days, 10–24 days, 25–99 days, 100–365 days (87).

In Paper II, sick leave was specified dichotomously (Yes/No). In Paper III, it was divided into three categories: "no days", "short-term" (1–14 days) and "long-term" (≥15 days). The rationale for changing from a crude dichotomous measure in Paper II to a more nuanced measure in Paper III was to assess whether three categories could provide more information. Moreover, distinguishing between short-term and long-term sick leave may reveal patterns of sick leave that could be missed when a dichotomous measure is used (e.g. a common cold is likely to be a short-term condition, whereas acute, severe disease may entail long-term sick leave). Further, the chosen cut-offs are similar to the ones used in a different Norwegian study conducted in 2011 (69) and international studies (94, 95). This ensures better comparability of our results.

3.3.2 Independent variables

All of the independent variables are based on the Trøndelag Health Study (HUNT) (96). The rationale for this was to be able to compare our results with those reported from similar large cohort studies with similar settings.

Diet

Diet was determined using food frequency questions previously used in the Norwegian population-based HUNT3 study (2006–2008) (97). These questions had been selected from a larger validated food frequency questionnaire used in the Oslo Health Study of 2001 (98). The food frequency questions used in the present papers were: intake of fruits/berries, vegetables, boiled potatoes, pasta/rice, fatty fish, sausages/hamburgers and chocolate/candies, with the response options "0–3 times/month", "1–3 times/week", "4–6 times/week", "1 time/day", and "≥2 times/day". To reflect Norwegian recommendations on a varied and healthy diet (99), the following intake cut-off points were used: fruits/berries and vegetables (≥2 times/day), fatty fish (1–3 times/week) and sausages/hamburgers and chocolate/candies (≤1–3 times/week). The responses were coded 0 (not meeting general dietary recommendations), or 1 (meeting general dietary recommendations). A dietary sum score for each participant (scale 0–4) was calculated by adding up the individual indicator scores. The diet score reflects the number of recommendations met (100) and was trichotomised into the categories "unhealthy" (0–1), "average" (2) and "healthy" (3–4) diet to indicate different levels of health risk.

Physical activity

Moderate to vigorous leisure-time physical activity (MVPA) was assessed by applying questions covering frequency, intensity and duration of exercise as used in the HUNT1 (1984–1986) and HUNT3 (2006–2008) studies (101). The HUNT questionnaire has previously been validated by reference to objective measurement methods and the

International Physical Activity Questionnaire, and has been shown to have good internal consistency (101). To reflect the recommended sufficient MVPA for adults (≥150 minutes/week) (99), the responses to the three questions were combined to give a total MVPA score (101). For Paper I and Paper II this variable was labelled "physical activity" and dichotomised into "active" and "inactive/less active". In Paper III, the MVPA score was trichotomised to reflect more categories of physical activity. The following categories were used: "low MVPA" (less than 60 minutes of physical activity per week), "moderate MVPA" (between 60 minutes and up to 150 minutes per week) and "high MVPA" (150 minutes or more weekly).

Body mass index

Body mass index (BMI) was calculated based on self-reported weight and height (weight [kg]/(height squared [m^2])). The resulting figure was categorised in accordance with World Health Organization (WHO) reference values: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2) and obese (≥30 kg/m^2) (102). Body mass index is an imperfect measure of obesity, since it does not fully account for body composition and thus fails to consider e.g. high muscle mass and bone density (103). However, our research group concluded that BMI was a reasonable and efficient measure to use in the relatively large Telemark Study. An alternative measure of body composition is hip-waist circumference, but this data was only available for persons included in the case-control study and could therefore not be used. In Paper III, the underweight and normal weight categories were combined due to the low number of persons reporting underweight (1%).

Smoking

Smoking habits were divided into three categories: "current smoker", "former smoker" and "never smoked". The "current smoker" category included both daily and occasional smokers.

Lifestyle risk index

The three papers included in this thesis have sought to emphasise co-occurrence of multiple lifestyle risk factors (17, 18). The top ten lifestyle-related risk factors listed in the Global Burden of Diseases, Injuries, and Risk Factors Study (2017) include unhealthy diet, insufficient physical activity, high bodyweight and smoking (14). In our lifestyle risk index, we sought to reflect Norwegian governmental recommendations for preventing morbidity and mortality, covering diet, physical activity, bodyweight and smoking. However, it is important to bear in mind that there are multiple possible causes of a high BMI, including medication use and genetic predisposition (104). Still, it was deemed important to include BMI in the lifestyle risk index despite the fact that it may be a consequence of behaviour rather than a behaviour in itself. Notably, both underweight and overweight may be risk factors with regard to morbidity and mortality (103, 105). Accordingly, it would have been interesting to assess the underweight group separately if a sufficient sample size had been available

The research group chose to categorise the lifestyle risk factors, and weighted the categories based on current recommendations for good health and prevention of NCDs (99). Previous studies have usually divided risk factors into "no risk" and "at risk" (7, 71), based on current recommendations. In order to differentiate further, and to reflect the knowledge that risk often increases gradually, we also wanted to assess an intermediate risk-level group of participants assumed to be at moderate increased risk (such as persons with partly unhealthy diets, engaging in some physical activity, persons with underweight or overweight, and former smokers). These were assigned 0.5 points. This weighting was done to cover the possibility that some adherence to guidelines – e.g. moderate physical

activity – could be beneficial to health (106, 107). The participants who reported unhealthy diet, low physical activity, obesity or current smoking were assigned a score of 1 for each answer. As the relative significance of the risk factors with regard to good health, NCDs and occupational outcomes is not fully understood, we decided to weight them equally in the lifestyle risk index (scores 0–1).
Other lifestyle risk indices have incorporated factors such as prolonged sitting time, alcohol consumption and social participation (7, 108). These factors may be important when evaluating lifestyle risk, but were unfortunately not available for the present papers (as they were not included in the study questionnaires).

A summative index featuring the four individual factors was then constructed. To investigate different levels of lifestyle risk, the lifestyle risk index was divided into four categories: “low risk score” (total score 0–0.5), “moderate risk score” (total score 1–1.5), “high risk score” (total score 2–2.5) and “very high risk score” (total score 3–4).

Adjustment variables

Sex/gender: female or male.

Age: The participants were all aged between 18 and 50 years, and were grouped into three categories: “18–30 years”, “31–40 years” and “41–50 years”. In Paper I and Paper II, age was analysed as a categorical variable, while in Paper III age was studied as a continuous variable. Further, due to the longitudinal design of Paper III, persons aged 16 and above were included in the analysis in that paper.

Educational level: The participants’ highest attained educational level was categorised as follows: “primary and lower secondary education” (10 years or less), “upper secondary education” (an additional three to four years), and “university or university college”.

Occupational group: The participants were classified by a trained research assistant based on self-reported current occupation (as at 2013), using the International Standard

Classification of Occupations (ISCO-88) (109). The 10 occupational groups were combined into five groups for use in the analyses.

Disease groups

The self-reported information on disease groups used in the three papers was based on validated questions from the HUNT 1–3 studies (96) and the European Community Respiratory Health Survey (110). The disease groups were chosen according to their prevalence in the population, with asthma being the main focus. However, an important note is that illness is dissimilar from disease in that the latter is based on "objective" diagnosis, while illness entails a "subjective" experience (111).

Physician-diagnosed asthma: participants were classified as having asthma if they answered "Yes" to the question, "Has a physician ever diagnosed you with asthma?"

Respiratory diseases: participants were defined as having a respiratory disease if they answered "Yes" to any of the following questions: "Has a physician ever diagnosed you with asthma?"; "Has a physician told you that you have chronic obstructive pulmonary disease (COPD)?"; and "Do you have, or have you ever had, any chronic lung disease other than asthma or COPD?". In Paper II, the latter two questions were grouped together and labelled 'Other chronic lung diseases'.

Cardiovascular diseases and diabetes: participants were defined as having cardiovascular disease if they answered "Yes" to any of the following questions: "Do you have, or have you ever had, any of the following: stroke/aneurism and/or atrial fibrillation?"; "Has a physician ever told you that you have heart failure (weak heart, water on the lungs or swollen legs)?"; and "Have you ever been hospitalised with a heart attack or heart cramp (angina)?". Further, participants were defined as having diabetes if they answered "Yes" to the question, "Has a physician told you that you have diabetes?". In Paper III, diabetes and cardiovascular disease were combined due to the close links between the two diseases (112).

Mental illness: the participants were asked whether they had ever sought help for mental problems. The question adopted the wording of a corresponding question used in the HUNT2 (1995-1997) study (113). The rationale for asking subjects whether they sought help for a mental illness rather than if they ever had a mental illness, is that the former wording gives an indication of severity of the illness itself.

4 Ethical considerations and principles guiding the research process

4.1 Ethical considerations

The study was approved by the Regional Ethical Committee (REK identification number 2012/1665). The follow-up study was also approved by the data protection officer at Telemark Hospital. It was concluded that the purpose of the study and the methods used do not violate generally accepted ethical principles.

Participation was voluntary. The consent of the participants was assumed if they returned the questionnaire. The first two pages were separated from the answers before further data processing. Moreover, the first page of the questionnaire stated that personal identifying information would not be stored together with the participants' answers.

Instructions for participants were provided on the second page of the questionnaire, as was contact information (mobile telephone number and email address). On the last two pages, participants were given information on the background to the study, advantages and disadvantages of participation, data storage, detailed information regarding voluntary participation, financial disclosures, privacy, the right to disclosure of held data and the right to have data erased.

A unique study identification code was generated for each respondent. This code and each participant's true identity were stored separately and subject to strict access controls at Telemark Hospital.

To reduce the potential for random and systematic errors, it was important that enough participants answered the questions. To increase the participation rate, participants were automatically entered in a lottery to increase their motivation. The prize offered was an iPad or a travel voucher. Further, two reminders were mailed to non-responders – one after 1.5 months and one after three months. The same number of reminders and intervals of reminders were used in connection with five-year follow-up.

In the follow-up study, it was possible to complete the questionnaire online. This was approved by the relevant Regional Ethical Committee and the data protection officer. All participants were issued with a unique ID code which they could use to log on to a secure website containing the online version of the questionnaire. This ID code was not the same as the unique study identification code mentioned above.

4.2 Person-centred health care approach

The objective for the present part of the Telemark Study was to conduct the research using a person-centred approach. Among the guiding principles of the Telemark Study research group were the inclusion of informants and user representation of research subjects of special relevance to the study. This was accomplished by including user representatives from the Norwegian Asthma and Allergy Association (NAAF) in the steering committee of the study. The user representatives made helpful contributions to the development of questionnaires and examination methods. Further, a user representative from NAAF participated in the piloting of the questionnaire and dissemination of the results. These contributions by NAAF were important and valuable in the research process. The guiding principles supplemented the applied person-centred healthcare research principles by ensuring the inclusion of participants in the study process (114).

Further, all three papers included in this thesis have been published on an open-access basis to increase stakeholder engagement with them. In addition, participants were informed of the results of the baseline study both between the data-collection points and at the follow-up stage. Lastly, with the overall focus on asthma in mind, a journal which aims to disseminate knowledge to general practitioners in Scandinavia (*Allergy in practice*) was used in addition to the peer-reviewed journals. The user representative from NAAF has also been included in the dissemination of results to the public and policymakers through regional, national and international media outlets. In addition, the website of the Telemark Study has been kept continuously updated with new study results.

5 Statistical analysis

All statistical analyses were conducted using SPSS versions 23–26 and Word Excel. In all three papers, statistical significance was concluded for a p-value of less than 0.05.

Table 1. Overview of variables and statistical analyses used in the three papers included in this thesis

	Variables	Statistics	Regression analysis
Paper I	Dependent: dichotomous WAS Independent: diet, MVPA (two categories), BMI, smoking, lifestyle risk index Adjusted for: age, sex, education, occupation	Correlation: Spearman's rho between independent variables	Multiple logistic regression
Paper II	Dependent: dichotomous WAS and sick leave Independent: diet, MVPA (two categories), BMI, smoking, lifestyle risk index Adjusted for: age, sex, education, other chronic lung diseases	Correlation: Spearman's rho between independent variables Phi coefficient between dependent variables	Multiple logistic regression. Stratified by physician-diagnosed asthma/no asthma Interaction term included (physician-diagnosed asthma*independent variables)
Paper III	Dependent: trichotomised and sick leave. Dichotomous WAS and sick leave Independent: diet, MVPA (three categories), BMI, smoking, lifestyle risk index Adjusted for: age, sex, education	Association: Chi-squared test between for both independent variables and between dependent variables	Multinomial logistic regression. Multiple logistic regression stratified by disease groups (respiratory diseases, CVD or diabetes, and mental illness)

Abbreviations: BMI=body mass index, CVD=cardiovascular diseases, MVPA=moderate to vigorous physical activity, WAS=work ability score

5.1 Descriptive statistics

Descriptive statistics were expressed as numbers, percentages, means and standard deviations in Papers I to III.

5.1.1 Test statistics

The rationale for preparing inferential test statistics before the logistic regression models was to investigate how the variables, both independent and dependent, related to each other. Papers I and II investigated correlations between independent variables, while Paper III analysed associations between them. The two analyses differ in that correlation is a measurement of strength between two variables (115) while association explores whether one variable is dependent on the other variable (116). These tests were performed before the logistic regression analyses for exploratory purposes and in preparation for further analysis.

In Paper I, Spearman's rho was calculated to assess the correlation between the individual lifestyle risk factors (independent variables). Spearman's rho was chosen due to the rank ordered variables. The correlation indicates whether there is a monotonic relationship between two variables. The result was presented as a number from -1 to +1, with the two values representing negative and positive correlation, respectively. For example, a positive correlation between diet and BMI means that when diet increases in value (going from healthy to unhealthy diet), BMI also increases (higher BMI). In Paper II, the correlation was also assessed using Spearman's rho (independent variables). In addition, a phi coefficient was calculated for the dependent variables (dichotomous). The phi coefficient was calculated because although it was assumed that the two work outcomes were conceptually close, it was still necessary to assess this statistically. Since both WAS and sick leave were dichotomous, we used a phi coefficient (117). Further, since the first two papers had already assessed the correlation between the independent variables, the next step in the research process was to assess the association between the independent variables. This was of particular interest because some correlation between the independent variables was found in the first two papers. To explore this further, the research group decided to investigate how the variables were associated. In Paper III, a chi-square test (χ^2) was used to assess the association between the independent variables and the association between the dependent variables (trichotomised). By considering both the cross-tables and the chi-square test, we analysed whether the grouping of subjects among the categories of one variable is independent of the grouping of categories of another variable. For example the association between BMI and smoking yielded χ^2= 59.74 ($p<0.05$), meaning that there is some association between these variables.

5.2 Multiple logistic regression

For the first two papers, the dependent variables were dichotomous, and a multiple logistic regression method was therefore used. Before the full model was implemented, a univariate logistic regression model was applied to all the individual lifestyle risk factors, without adjustment (Crude Odds Ratio [OR]).

5.3 Multinomial logistic regression

In Paper III, the dependent variables were split into three categories, thus multinomial logistic regression analysis was carried out. Short-term and long-term sick leave were compared with no sick leave as the reference category (118). Multinomial regression was used to gain insight into the potential association of lifestyle risk factors with different levels of sick leave and work ability. Alternatively, multiordinal logistic regression could have been used. In an ordered model, the reference category is not kept the same (118). However, the aim was to contrast with the reference categories no sick leave/excellent work ability in order to explore the associations between lifestyle risk factors and different levels of sick leave/work ability. Further, since our analysis included both baseline and follow-up data we also analysed consistency (cross-tabulation) for the individual lifestyle risk factors.

5.4 Variables included in the models

The lifestyle risk factors were selected intentionally from the available Telemark Study data, based on prior knowledge of their potential association with work ability and sick leave. In Paper I and Paper II, the full model was applied, including all the independent variables (lifestyle risk factors) and adjustment variables. In all three papers, 'adjustment variables' denotes variables used in the model which are important to adjust for in the logistic regression model.

5.4.1 Confounding

In epidemiological studies, it is common practice to assess the association between an exposure (independent variable) and an outcome (dependent variable). However, prior knowledge suggested that some variables (confounding variables) in the dataset would distort this association. Specifically, a priori (or by test) observations indicated that such additional variables are associated with both exposure and outcome (119). One way to conceptualise such confounding bias is presented in Figure 2, which illustrates the known associations of age with both physical activity (exposure) and work ability (dependent variable). Accordingly, the adjustment variable 'age' was included in the multiple logistic regression models of work ability/sick leave. See also the discussion of 'confounding' in the methodological consideration (page 65). Without an adjustment for such background variables, the OR (effect measure) may be estimated incorrectly.

According to Hosmer and Lemeshow (118), the calculated change in beta coefficients indicates how much a model changes as model variables are adjusted. For example, Table 2 in Paper II shows a statistical significance of OR 1.8 for the association between a very high lifestyle risk score and sick leave among persons without asthma. The importance of adjusting for gender in this association can be calculated using the following formula:

$$\Delta\widehat{\beta}\,\% = 100 * \frac{(\widehat{\beta}crude - \widehat{\beta}adjusted)}{\widehat{\beta}adjusted}$$

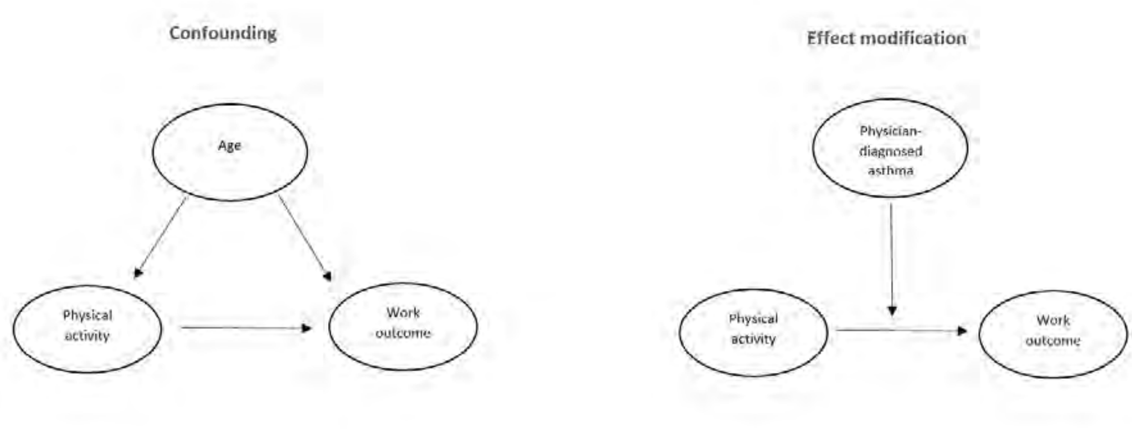
where the beta coefficient of a very high lifestyle risk score is .477 without adjustment for gender ($\widehat{\beta}crude$) and .576 with adjustment for gender ($\widehat{\beta}adjusted$).

The change in the beta coefficient in this example would be -17% (100x (.477−.576)/.576). In other words, gender is a confounding variable with respect to the association between a very high risk score and sick leave among persons with asthma, as the change was greater than 10%–20%, and is thus important to adjust for in the analysis (118).

5.4.2 Effect modification

In epidemiology, the term 'effect modifier' is defined as an independent variable (e.g. physician-diagnosed asthma) which modifies the effect of another independent variable (e.g. lifestyle risk index) on the dependent variable (e.g. sick leave), but which is not part of the causal pathway between the second independent variable and the dependent variable (120, 121). See also the discussion of 'effect modification' in the methodological consideration (page 66) and Figure 2 for the distinction between confounding and effect modification. In studies involving multiple exposures, it is important to remember that one factor may modify the effect of another.

Figure 2. Difference between confounding and effect modification



The hypothesis underpinning Paper II was that physician-diagnosed asthma could function as an effect modifier between lifestyle risk factors and work ability and sick leave (see Paper II, Figure 2). First, a stratified multiple logistic regression analysis was conducted to compare the subjects who reported physician-diagnosed asthma with those who did not. Thereafter, to explore the possibility that physician-diagnosed asthma was an effect modifier, we tested this statistically by including a multiplicative interaction term in the multiple logistic regression model (121). The interaction terms were; physician-diagnosed asthma*individual lifestyle risk factors and the lifestyle risk index, respectively. The reference group consisted of those who responded negative to the question whether they had physician-diagnosed asthma. It should be noted that the two groups, i.e. persons with and without physician-diagnosed asthma, are heterogeneous in terms of information on other diseases. A statistically significant interaction term could indicate that asthma is an effect modifier in the association between lifestyle risk factors and work ability/sick leave.

5.5 Multiple imputation

Missing values may frequently occur in cohort studies based on self-reported questionnaires (115). In Paper I and Paper II, a complete case analysis which excluded all participants with missing values for any of the independent and dependent variables was performed. However, Paper III employed a multiple imputation approach. The rationale for doing so was to minimise potential selection bias stemming from the exclusion of all cases with missing values (115). Further, because the number of subjects in the different disease groups was already small, an additional aim was to explore whether an increase in the number of subjects would alter the results.

In Paper III, the proportions of missing values were 0.5% for smoking habits, 3% for education, 3% for diet, 3% for physical activity and 17% for BMI. It was assumed that the missing values where missing at random (115).

Table 2. Multiple imputation model used in Paper III

Variable	Predictors only	Predictors and multiple imputation
Diet		x
MVPA		x
BMI		x
Smoking		x
Education		x
Age	x	
Sex	x	
WAS baseline	x	
Sick leave baseline	x	
Respiratory diseases	x	
CVD or diabetes	x	
Mental illness	x	

Abbreviations: BMI=body mass index, CVD=cardiovascular diseases, MVPA=moderate to vigorous physical activity, WAS=work ability score

5.6 Stratification

The stratification of the study population was motivated by the hypothesis that subjects in disease and/or illness groups would have a different association between unhealthy lifestyle and work outcomes, than person without disease and/or illness. One of the reasons for stratifying the sample is to reveal confounding and/or effect modification (122). If the stratified analysis reveals potential effect modification, the next step is to test this statistically (see 5.4.2 on effect modification).

In Paper II, stratification was based on physician-diagnosed asthma. In Paper III, a stratified analysis was conducted to explore the association between lifestyle risk factors and sick leave/work ability among persons with specific NCDs such as respiratory diseases, CVD or diabetes and mental illness.

5.7 Population attributable fraction

The population attributable fraction (PAF) is a theoretical epidemiological measure used to explore the impact of exposure in a population (123). In this case, the PAF provided an indication as to what percentages of low WAS or sick leave were attributable to unhealthy diet, lack of physical activity, overweight, obesity and smoking.

The equation employed for unhealthy diet was:

$$PAF = (Pe*(OR-1)/(1+ Pe*(OR-1)))*100$$

where Pe is the prevalence of exposure to unhealthy diet and OR represents the association between unhealthy diet and low work ability or sick leave. In Paper III, the PAF for the effect of unhealthy diet on poor WAS was calculated as follows: (0.07*(1.57-1)/(1+0.07*(1.57-1)))*100 = 4%.

In Paper I, we calculated the PAF for each lifestyle risk factor and for the effect of the combined factors on work ability. In Paper III, the calculation examined low WAS and long-term sick leave. In that paper, the combined effect of lifestyle risk factors included the extremes of the independent variables (unhealthy diet, low physical activity, obesity and current smoking). In Paper I, on the other hand, the combined effect of lifestyle risk factors was calculated (i.e. incorporating all the individual factors: average and unhealthy diet, low physical activity, overweight and obesity, and former and current smoking).

The PAF is a fictive percentage in the sense that it assumes the possibility of complete eradication of the outcome if the exposure is eliminated. While this is not actually possible in a complex environment, the PAF does provide an indication of the impact of such exposure in a population.

5.8 Sensitivity analyses

Several sensitivity analyses were performed to assess the robustness of the results (120).

The sensitivity analysis for Paper II entailed application of a stricter definition of asthma through separate assessment of subjects who reported having active asthma. These participants were defined as persons who had used asthma medication or reported respiratory symptoms in the past 12 months. Similar results were obtained by this stratification.

Further, the sensitivity analysis in Paper III did not include multiple imputation (n=5 206; complete data), but still yielded similar results to the imputed dataset (see appendix to Paper III).

6 Results

6.1 Participation at baseline and follow-up

At baseline, a random sample of 50 000 inhabitants of Telemark County were sent a questionnaire by post. Of these, 48 142 persons eligible (had a postal address, were still alive at the time the questionnaire was mailed to them, and could fill-inn a Norwegian questionnaire) for inclusion in the Telemark Study. Ultimately, 16 099 individuals participated, equating to a response rate of 33%. In Paper I and Paper II, the study population comprised 10 355 persons who reported having been in paid work during the past 12 months and for whom complete data were obtained on lifestyle risk factors and work ability.

A total of 7 952 (49%) participants completed the questionnaire at the five-year follow-up stage (2018). Only participants who answered the questions on sick leave and work ability were included. Participants were also excluded if they reported not having been in paid work in the past 12 months at baseline or follow-up. This yielded a study sample of 6 267 subjects for Paper III.

6.1.1 Population characteristics at baseline and follow-up

The study population in Paper I and Paper II included slightly more females (54%) than males (46%). In addition, 45% of the sample population was in the oldest age group (41–50). In terms of education, most participants had completed either upper secondary or university/university college education (87% in total). The participants were also categorised into occupational groups: 26% were allocated to the occupational group comprising legislators, senior officials, managers, professionals and armed forces (groups 0–I–II), while 26% were classified as technicians and associated professionals (group III).

Regarding the independent variables, 57% of participants stated that they had a healthy diet, 52% reported being engaged in sufficient physical activity, 48% were of normal weight and 54% had never smoked. The majority (87%) reported having a good work ability (WAS 8–10) and 68% reported no sick leave days in the past 12 months (Figures 3 and 4).

Figure 3.Distribution of Work Ability score (WAS) in the study population at baseline (2013)

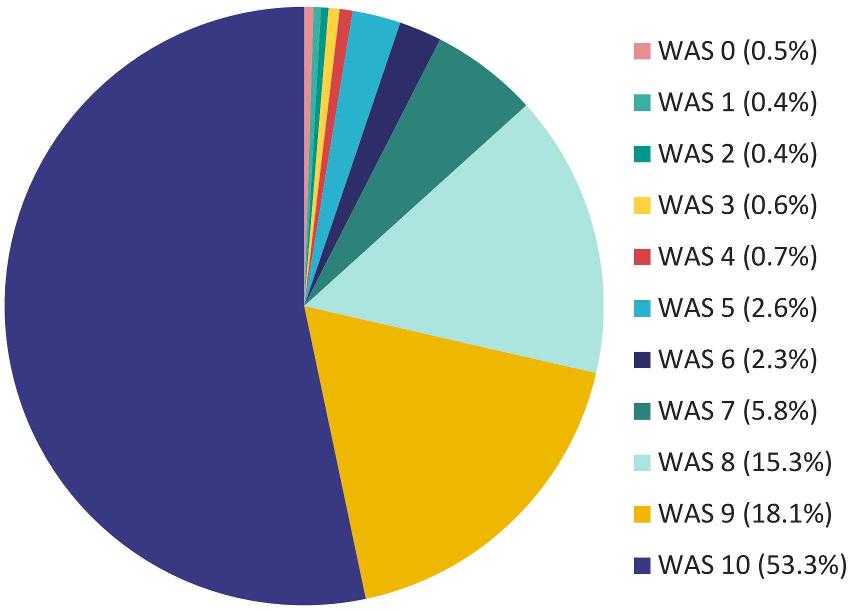
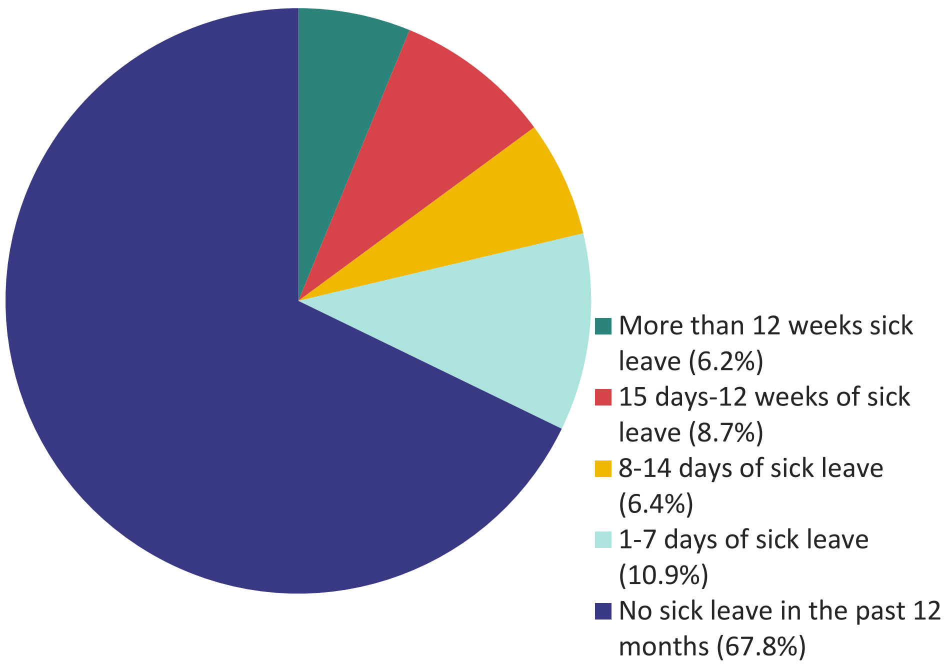


Figure 4. Distribution of sick leave in the study population at baseline (2013)



The study population at follow-up (Paper III) comprised of 6 267 persons who answered the questions on work ability and sick leave and were employed at both baseline and follow-up. Once again, more females (57%) than males (43%) completed the questionnaire. Moreover, 53% of the participants had a high level of education, and the mean age was 39 years (standard deviation 8.7). In this sample, 59% of the participants reported having a healthy diet, 54% reported a high MVPA and 49% reported having a normal weight (of these, 1% reported underweight), and 57% had never smoked. Importantly, cross-tabulation revealed sufficient consistency in the individual lifestyle risk factors from baseline to five-year follow up (Table 3).

Table 3. Agreement between baseline and follow-up individual lifestyle risk factors*

	Same health status	Decreased health status	Increased health status
Diet	63%	23% (more unhealthy)	14%
Physical activity	72%	10% (less MVPA)	18%
BMI category	77%	15% (higher BMI)	8%
Smoking status	85%	5% (started smoking)	10%

*Results are based on participants with complete information on all individual lifestyle variables both at baseline and five-year follow-up (n=3 424).

In this study population, 70% of the subjects had not taken any sick leave days in the past 12 months, and 85% reported having a good work ability. In Paper III, the sample was divided into disease groups: respiratory diseases (n=688), CVD or diabetes (n=348), and mental illness (n=948). The overall responses were similar to the total sample population, with a few exceptions: subjects who had CVD or diabetes reported more obesity (25% versus 14% in total sample population). The persons who either had CVD or diabetes or reported mental illness were more frequently current smokers than the total sample

(26% and 27% respectively, versus 20% in the total sample population). Lastly, subjects in all disease groups reported a higher prevalence of long-term sick leave, moderate and poor work ability compared to the total sample population. The distribution of the population characteristic is shown in Figures 5 and 6.

Figure 5. Distribution of sample characteristics independent and dependent variables in Papers I and II

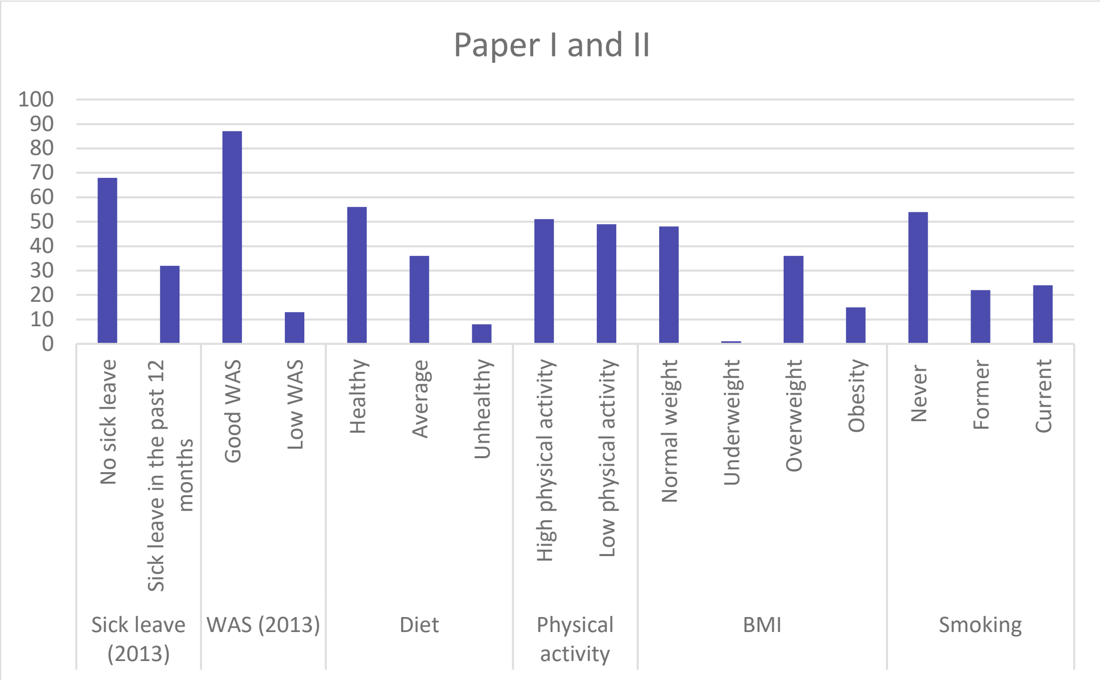
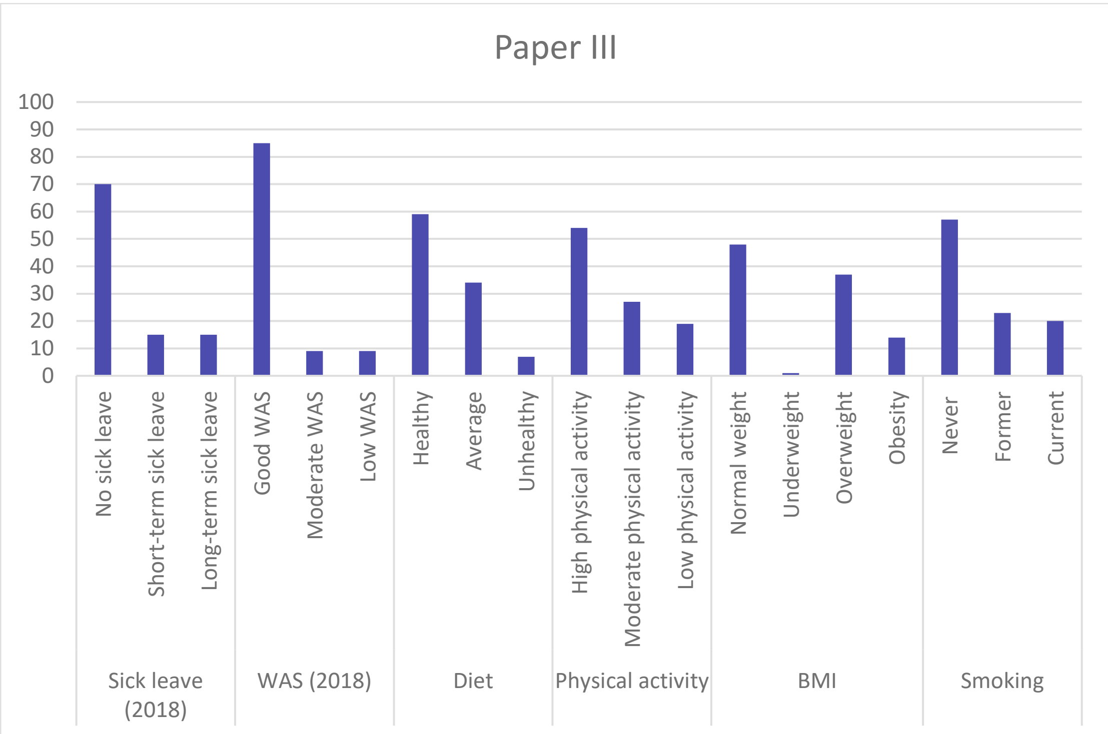


Figure 6. Distribution of sample characteristics independent and dependent variables in Paper III



6.1.2 Interpretation of correlation

In paper I, Spearman's rho showed a weak to moderate correlation between the lifestyle risk factors (diet, physical activity, BMI and smoking). The correlation coefficient ranged from 0.03 for BMI and diet to 0.12 for physical activity and diet, indicating weak correlation. In Paper II, the correlation between work ability score and sick leave yielded a phi coefficient of 0.20. The latter result indicates a weak correlation (117).

6.1.3 Interpretation of association

In paper III, the lifestyle risk factors were included in the model separately in addition to the adjustment variables. The association analysis between the independent and dependent variables showed that lifestyle risk factors were associated. The association was strongest for diet and physical activity (χ^2= 83.86, p<0.05), followed by physical activity and smoking (χ^2= 70.91, p<0.05). Further, there was an association between work ability score and sick leave (trichotomised) (χ^2= 463, p<0.05).

6.2 Population attributable fraction

For the cross-sectional data in Paper I, the overall PAFs of low work ability (WAS 0-7) were 6% for average and unhealthy diet, 16% for low physical activity, 11% for overweight and obesity, and 11% for former and current smoking. The overall PAF for the combined lifestyle risk factors was 38%.

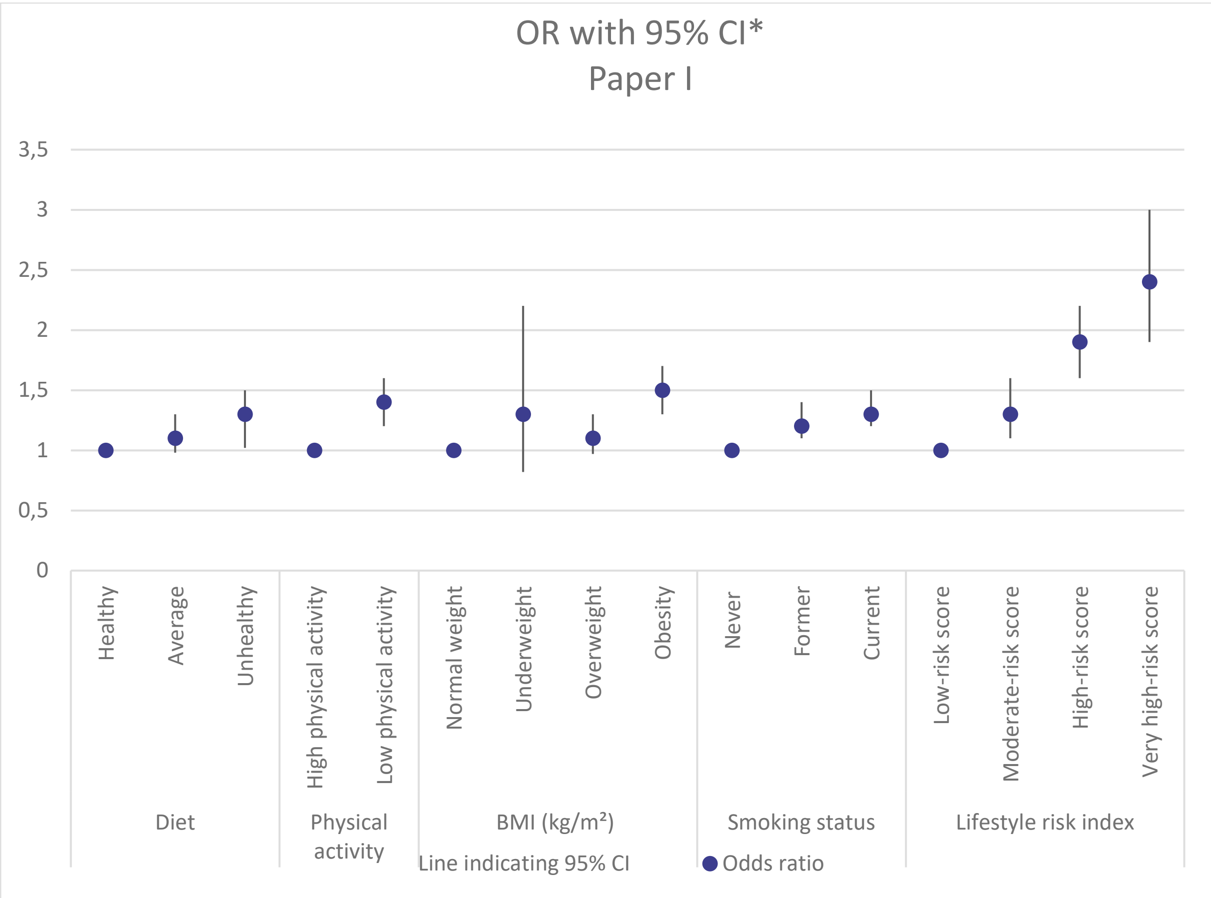
The PAFs for low work ability (WAS 0-5) based on the follow-up data in Paper III were 4% for unhealthy diet, 3% for low physical activity, 4% for obesity and 12% for smoking. The combined lifestyle risk factors for low work ability resulted in a PAF of 21%. The PAFs for long-term sick leave were 2% for unhealthy diet and 0.2% for low physical activity, 8% for obesity, and 11% for smoking. The combined lifestyle risk factors for long-term sick leave resulted in a PAF of 20%.

6.3 Main findings

6.3.1 Associations between lifestyle risk factors and work ability and sick leave in the general working population (Paper I and Paper III)

The multiple logistic regression analysis showed that individual lifestyle risk factors had a statistically significantly association with low work ability (Figure 7). Further, low work ability was associated with a higher lifestyle risk index score.

Figure 7. Statistically significant associations between lifestyle risk factors and WAS (Paper I)



*CI= Confidence interval

Figure 7 shows that obesity was the factor which was most strongly associated with low work ability, with an OR of 1.5 (95%CI 1.3, 1.7). Low physical activity (OR 1.4; 95%CI 1.2, 1.6), current smoking (OR 1.3; 95%CI 1.2, 1.5), former smoking (OR 1.2; 95%CI 1.1, 1.4) and unhealthy diet (OR 1.3; 95%CI 1.02, 1.5) were also associated with low work ability. No significant association was observed between average diet and work ability, or between overweight and work ability. Detailed results can be found in Paper I, Table 3. The results in Figure 7 have been mutually adjusted for the individual lifestyle variables and background variables (sex, age, educational level and occupational group). However, the adjusted OR were not substantially different from the crude OR, indicating that the associations were independent of the background variables.

At follow-up, the multinomial logistic regression analysis showed that unhealthy diet, moderate or low physical activity and former and current smoking were associated with low work ability. In the case of sick leave, overweight and former and current smoking were associated with short-term and long-term sick leave. Obesity was also associated with long-term sick leave.

Furthermore, it was observed a higher odds of low work ability and sick leave by higher lifestyle risk index score.

All of the observed associations were adjusted for age, sex, educational level and dependent variables (work ability score and sick leave) at baseline.

6.3.2 Associations between lifestyle risk factors and work ability and sick leave among persons with physician-diagnosed asthma and other non-communicable diseases (Paper II and Paper III)

The cross-sectional study population used in Paper II comprised a stratified analysis of persons with physician-diagnosed asthma (n=1 110; 11%) and a control group including subjects without physician-diagnosed asthma (n=9 245). The study population characteristics were similar for the two groups, but more persons with physician-diagnosed asthma (41%) reported being on sick leave in the past 12 months than persons without asthma (31%). Also, more persons with physician-diagnosed asthma (18%) reported low work ability, than persons without (13%). The percentages were similar for all the lifestyle risk factors with low physical activity (46% for persons with physician-diagnosed asthma and 49% for persons without) and obesity (20% for persons with asthma and 14% for persons without) being the most dissimilar.

Of the individual lifestyle risk factors, only low physical activity had a statistically significant association with low work ability among persons with physician-diagnosed asthma. Further, high and very high lifestyle risk factor scores had a statistically significant association with low work ability among persons with physician-diagnosed asthma.

The multiple logistic regression analysis showed that obesity and former and current smoking were associated with sick leave among persons with physician-diagnosed asthma. Moreover, moderate, high and very high lifestyle risk factor scores were associated with sick leave in persons with physician-diagnosed asthma. The inclusion of the interaction term in the regression model confirmed the association between moderate and high lifestyle risk scores (Table 4), obesity, smoking and sick leave. This may indicate that asthma is a potential effect modifier between multiple lifestyle risk factors and sick leave.

Table 4. Example of interaction effects when studying the association between lifestyle risk factors and sick leave (Paper II). Model 2 comprises a stratified analysis (Table 2 in Paper II), while Model 3 includes interaction terms. All associations are statistically significant with a p-value <0.05.

	Model 1-Crude	**Model 2* – Stratified analysis**		**Model 3** – Interaction terms included†**
	All participants (n 10 355)	**No physician-diagnosed asthma OR (95% CI)**	**Physician-diagnosed asthma OR (95% CI)**	**Physician-diagnosed asthma*lifestyle risk factors OR (95% CI)**
Lifestyle risk index score				
Moderate risk score	1.3 (1.2, 1.4)	1.2 (1.1, 1.4)	1.7 (1.2, 2.4)	1.4 (1.02, 2.01)
High risk score	1.5 (1.3, 1.6)	1.4 (1.2, 1.6)	2.1 (1.4, 3.0)	1.6 (1.1, 2.3)
Very high risk score	1.8 (1.5, 2.1)	1.8 (1.5, 2.1)	2.6 (1.6, 4.2)	1.6 (0.97, 2.7)

†Illustration showing how the interaction terms were incorporated into the multiple logistic regression model.

$$x_1 = moderate\ risk\ score;\ x_2 = high\ risk\ score;\ x_3 = very\ high\ risk\ score;\ x_4 = asthma;\ x_5\ to\ x_{10} = age, sex, educational\ level\ and\ other\ chronic\ lung\ disease$$

$$log\left(\frac{p}{p-1}\right) = \hat{\beta}_0 + \hat{\beta}_1 * x_1 + \hat{\beta}_2 * x_2 + \hat{\beta}_3 * x_3 + \hat{\beta}_4 * x_4 + \hat{\beta}_5 * x_1 * x_4 + \hat{\beta}_6 * x_2 * x_4 + \hat{\beta}_7 * x_3 * x_4 + \hat{\beta}_8 * x_5 \ldots . + \hat{\beta}_{13} * x_{10}$$

*Model 2 and 3 have been adjusted for age, sex, educational level and other chronic lung diseases.

**The reference group consisted of those who responded negative to the question of whether they had physician-diagnosed asthma

In Paper III, the sample was stratified into two groups with persons with NCD groups or illnesses and persons not reporting having any of the disease groups or illnesses. Initially, each disease group had few cases, so we decided to expand the groups to increase statistical strength. The respiratory disease group was expanded to include asthma, COPD and other chronic respiratory diseases. Further, the CVD group was expanded to include persons with diabetes. The multiple logistic regression analysis revealed few associations, and only former smoking had a statistically significant association with low work ability among persons with mental illness (OR 0.57; 95%CI 0.37, 0.88). Moreover, current smoking was associated with sick leave among persons with CVD, diabetes or mental illness. Finally, a moderate lifestyle risk score was associated with sick leave among persons with respiratory diseases (OR 1.51; 95%CI 1.01, 2.24). The other analyses did not reach statistically significant levels.

7 Discussion

7.1 Main findings and overall consistency of Papers I to III

The overall aim of this thesis was to investigate the relationship between multiple lifestyle risk factors and work ability and sick leave in a general working population. Associations were investigated within specific disease and illness groups, and physician-diagnosed asthma in particular. The main finding was that the lifestyle risk index showed consistent positive association with low work ability and sick leave (Papers I–III). This is also the most novel finding in this thesis, as there is a lack of knowledge about implementing and evaluating a lifestyle risk index in relation to work outcomes. This thesis also demonstrated that smoking was consistently associated with low work ability and sick leave in our study population (Papers I–III). This finding is consistent with previous research on sick leave (124), however information from a Norwegian setting is scarce. Importantly, the association between lifestyle risk index and smoking and work outcomes was identified both through cross-sectional analysis and in the prospective data, lending greater certainty to our results. Lastly, physician-diagnosed asthma was an effect modifier in the association between lifestyle risk factors and sick leave (Paper II). Since this finding was analysed on a cross-sectional basis, however, no causal inference can be drawn. The finding nevertheless adds valuable knowledge, as the evidence in this area is sparse due to the low number of relevant studies.

This discussion section emphasises how the findings contribute to the knowledge base from a public health perspective. The relevance of the findings in terms of improving our understanding of the complex concepts of work ability and sick leave is less clear. Others have shown that factors other than those assessed in our studies (Papers I–III) – such as mental and physical work demands, working conditions, socioeconomic position, labour market conditions and the insurance system – are related to work ability and sick leave (37, 40, 51, 69, 70). As the mean age of the population is increasing, it may be important to investigate factors that could help to increase the duration of work participation. This thesis contributes prospective data on the association between potentially modifiable factors and work ability. It is known that Norway has a very high employment rate (3), which makes the workplace an important arena for measures to promote and achieve a healthy lifestyle among numerous people. This thesis also contributes information on important aspects of physical health that may be vital for achieving improved public health. I therefore discuss possible public health consequences and challenges that may arise from the thesis below.

In Papers I to III, unemployed persons from the study population were excluded to facilitate exploration of outcomes in a working population. However, this choice is not uncontroversial. Our study population consisted of persons who reported being in paid work in the past 12 months, and the findings therefore cannot be generalised to apply to persons who were outside the workforce. A recent Swedish cross-sectional study found that unemployed persons had lower health-related quality of life than employed persons (125). A Dutch longitudinal study with a 10-year follow-up has shown that people in poor health are more likely to leave paid work (126). It can therefore be speculated that the association between lifestyle risk factors and low work ability and sick leave identified in the thesis may have been underestimated due to the exclusion of unemployed persons. This consideration is especially relevant in the Norwegian setting because Norway has relatively high rates of sick leave and the Norwegian government is making efforts to reduce these (e.g. through the IA Agreement). Accordingly, future research should investigate the relationship between lifestyle and work outcomes such as work ability among unemployed persons. Nevertheless, including persons engaged in work has generated important data on a large part of the population. The inclusion of persons aged 16–18 years makes it important to follow these participants over time to assess how risk factors change.

The primary consideration from a public health perspective is that this thesis findings supplement current knowledge on patterns of association that are important for more targeted prevention of sick leave and low work ability. Low work ability are problematic not only for society at large from a cost perspective, but also at the individual level due to the potential for reduced quality of life (127). However, it is important to note that the design of the cross-sectional studies means that no causal relationship can be claimed for some of the findings (Papers I and II) (128).

Below, a presentation and discussion of the specific findings is followed by consideration of potential methodological strengths and limitations.

7.1.1 Co-occurrence of lifestyle risk behaviors

To the best of my knowledge, this thesis is the first to assess relationships between a lifestyle risk index score, work ability and sick leave in a general working population over time. In all three papers included in this thesis, we found higher odds of low work ability by higher lifestyle risk score (see e.g. Figure 7). A similar association was also observed in relation to sick leave at follow-up. The association between lifestyle risk score and work outcomes may be important for public health policy-making in terms of providing new information on the co-occurrence of unhealthy behaviours and the potential consequences of this. Such lifestyle risk factors are theoretically modifiable. Several studies have investigated the relationship between individual lifestyle risk factors and work outcomes (9, 10, 13, 71, 129), but the effects of co-occurring lifestyle factors are less well-known.

In large epidemiological studies, a lifestyle risk index can be helpful when investigating how the co-occurrence of lifestyle risk factors relates to public health challenges (i.e. work outcomes). There are indications that lifestyle risk factors can accumulate, and that they are linked to mortality (CVD) (7). It can be hypothesised that altering a lifestyle risk factor in a positive direction will have a positive effect on other factors. Findings from a recent study among young adults indicate that increasing physical activity may raise awareness of a healthy diet (130). However, these interactions are complex and a Norwegian cohort study found that those who increased their BMI were more likely to be less physical active, but this did not occur bidirectional (131). Despite the observation of a positive association between lifestyle risk index and work outcomes, the thesis results do not indicate which lifestyle risk factors need to be adjusted to achieve the greatest impact on work outcomes. Nevertheless, our results may support future meta-analysis and systematic reviews investigating lifestyle risk factor co-occurrence and work outcomes.

The lifestyle risk index score used in the three papers represents a simplification of a multifactorial concept. It is likely that the results would have differed if different lifestyle risk factors had been included. For example, the lifestyle risk index does not include important factors suggested by others (7, 108), such as alcohol, sedentary behaviour and lack of social participation. These studies reported associations between sedentary behaviour and all-cause mortality (7, 108). At the same time, inconsistent associations with all-cause mortality have been found for diet (108) and alcohol consumption (7). Nevertheless, we acknowledge that including these lifestyle risk factors – and particularly additional socioeconomic factors – could have produced different results.

There is evidence that lifestyle risk factors often co-occur (17, 18). The three papers making up this thesis did not investigate the clustering of different lifestyle risk patterns in relation to the outcomes. However, Paper III found that individual lifestyle risk factors were correlated. Individuals who reported a low level of physical activity were more likely to have an unhealthy diet ($\chi2$ = 83.86, $p<0.05$) than individuals who reported recommended (or higher) levels of physical activity. In addition, persons who reported a low level of physical activity were more likely to smoke ($\chi2$ = 70.91, $p<0.05$). Despite the observation that some of the individual lifestyle risk factors are inter-related, the results do not allow a conclusion as to the underlying mechanism or direction of these relationships. Additional studies are needed to explore these complex relationships.

In our study population, 51% of the subjects in the study population were categorised as overweight or obese at baseline (BMI ≥25 kg/m^2) (2013). This in line with the findings from the recent National Public Health Survey in Norway (2020) showing that 59% of men and 47% of women had a BMI ≥25 kg/m^2 (16). Together with other Norwegian cohort studies, the Telemark Study will continue to expand the knowledge base regarding changes in BMI at the general population level.

Efforts to tackle obesity at the individual level are numerous, but often difficult to implement. Societal efforts are also needed to reduce obesogenic factors in the environment (132). Examples of such factors include less physical demanding work tasks, reduced physical activity during leisure time and the easy availability of processed and high-calorie foods with little nutritional value (15). Moreover, a recent narrative review examining contextual factors in the prevention of obesity (acceptability, costs and equity) found that policies such as front-of-pack nutrition labelling, sweetened beverage taxes and restrictions on advertising targeting children are all potentially effective population-based measures for preventing high BMI (133). The review also acknowledged the need for more research in the field of health promotion policy, for example to examine the effect of marketing on integrated digital platforms (blogs and vlogs, social media, etc.) (133). Interestingly, a recent Norwegian study investigating the impact of an abrupt increase in taxes on sugar and chocolate products and non-alcoholic beverages (implemented in November 2017: an 80% increase in taxes on sugar and chocolate products and a 40% increase in taxes on non-alcoholic beverages) found no decrease in sales of these products (134). The study may indicate that the taxes were still too low to have an impact on sales (134). Norway had a period of taxation on sugar back to 1922, but this tax was levied as of 1.january 2021 (135, 136). Today, the tax system differentiates between sugar and artificial sweeteners, and is regarded as a response to health concerns about high-sugar beverages (137).

A Norwegian study from 2015 has identified socioeconomic differences in consumption patterns for fish and vegetables (138). The same study also found that barriers to the consumption of these food items included perceived quality and knowledge (e.g. of preparation) and – to a lesser degree – price, and that these factors were linked to socioeconomic group (138). It is likely that the debate on public health food policies, including taxation of less healthy dietary components, will continue.

The workplace is a large and important part of a person’s life, but is also important for society at large. Workplace measures therefore have a potential reach beyond the individual employee (139). An important factor in health promotion at the workplace may be the substantial amount of time spent there, as this may make health promotion easier to integrate than elsewhere. Nevertheless, only a limited number of studies have identified effective health-promotion activities for reducing sick leave and enhancing work ability. The evidence in this area is therefore weak (36, 140-142). There are indications that the adult population is spending increasing amounts of time on sedentary activities (15), and further studies are needed. The results of this thesis indicate that efforts to increase physical activity in general may be important. The workplace is one of many potential arenas for increased physical activity both during and after office hours. A recent randomised, controlled trial among persons with obesity and sedentary occupations in Germany found a statistically significant increase in work ability after 12 weeks of low-volume, high-intensity interval training (total session time of 14 minutes), combined with dietary advice, compared to a control group (143). Although this was not a workplace intervention, the findings suggest that short, intense physical activity may increase work ability and motivate facilitation of such activity at work (143). On the other hand, while physical activity is recognised as positive for health (144) the negative effects of 'exercise as medicine' have scarcely been debated in large epidemiological studies. Such effects may include sport-induced injuries (145) or precautions that should be made in regards to specific diseases (144).

Norway has seen positive results of tobacco-control and health-promotion policies (146), and it can be speculated that some of these successes could be replicated by policies focusing on healthy diet, healthy BMI and increased physical activity, thereby improving general population health. A number of considerations arise in this regard. Firstly, these policies took many years to agree and implement (>40 years). Secondly, new technology (like mobile applications – apps) may allow individuals to be reached on a more personal level, and a vast potential remains to be explored in terms of utilising technological advances in both primary and secondary prevention of poor health (147). However, it is important to note that health-promotion campaigns and policies may lead to 'victim blaming' as people experience stigmatisation because of their health choices (148). Public health strategies that concentrate on empowerment rather than behavioural change may therefore achieve higher compliance (148). In this context, 'empowerment' refers to giving people the ability and freedom to make choices in their own lives. These choices may not always coincide with health-promotion measures (148), but it is also important to respect individual freedom. Moreover, the question of whether there is a linear relationship between changes in lifestyle behaviours and better health-related quality of life remains unanswered. For example, no consistent relationship has been found between weight loss and increased health-related quality of life (149).

Although the three papers included in this thesis did not investigate health-promotion interventions at the workplace, it appears important for future research to measure the effectiveness of these types of interventions due to their potential to reach large populations. This is in line with the World Health Organization's emphasis on the workplace as pivotal in health-promotion activities in the 21st century (150, 151). Norway's Public Health Act was implemented in 2012. It incorporates five principles: reduce social inequality, 'health in all policies', sustainable development, the precautionary approach and participation (152, 153). Health-promotion activities, especially from the `health in all policies' perspective, should focus on prevention of unhealthy behaviours while simultaneously encouraging healthy lifestyle changes (147, 154). Further, the 'health in all policies' perspective also suggests that health-promotion activities both at and outside the workplace should not target individual lifestyle risk behaviours but rather aim to promote a range of healthy behaviours (147).

Interestingly, a Dutch study has explored moral issues linked to health promotion in a working environment. The study found that most employees viewed such activities positively, with younger participants being the most positive (139). It has also been suggested that building a better understanding of complex health and work outcomes may require the inclusion of qualitative approaches in future intervention and cohort studies (155), such as sub-sample in-depth interviews or focus group discussions. This would make a valuable contribution to an improved understanding of the complexity of lifestyle behaviours and work outcomes.

7.1.2 Socioeconomic gradient in smoking and work outcomes

In all three papers, smoking was consistently associated with both work ability and sick leave in the general working population. This is consistent with an earlier study showing that smoking plays a particularly significant role in an unhealthy lifestyle (156). The thesis results are also in line with previous cross-sectional and longitudinal studies revealing an association between smoking and sick leave (68). Smoking has been associated with socioeconomic position (157, 158), and may thus well be an important proxy for socioeconomic status. As Telemark County has some indicators of lower socioeconomic position compared to the Norwegian average, the thesis findings are particularly important. Education is considered to be another important indicator of socioeconomic position. Higher educational level is regarded as a determinant of social and material resources, and may give individuals a better basis for seeking out information and making informed decisions about their own health (27). Of the participants, 51% were classified in the groups that had elementary and upper secondary education as their highest educational level and 24% were current smokers (Paper II, Table 1, baseline data). Further, Paper I reported a PAF of 11% for low work ability attributed to smoking, while Paper III reported a PAF of 12% for low work ability was attributed to smoking. These results indicate the potential of smoking cessation for this specific population.

Further, there are indications (159) that the social gradient in health is not declining in Norway, especially among women. Mackenbach (2017) has proposed three possible explanations of the 'Nordic paradox', i.e. the persistence of social inequalities related to mortality in the Nordic countries. The first is that even though the prevalence of poverty is lower in the Nordics than other European countries, some inequalities still remain in wealth, income, housing and other material conditions. Second, the gap between the occupational classes and persons belonging to lower socioeconomic occupations is widening due to the rise of the service economy and the increasing importance of higher education. Third, the Nordic countries (in this context meaning Denmark, Finland and Norway) have noted a greater health benefit for more highly educated population segments due to reduced use of healthcare services and positive changes in lifestyle behaviour (160). This interesting phenomenon is confirmed by the findings of van der Wel (2011) showing that, of the Nordic countries, Denmark and Norway have the highest prevalence of unemployment among persons reporting either chronic disease or longstanding illness (161). The study found that Finland and Norway have the Nordic region's highest unemployment rates for persons with lower educational qualifications (161). However, the finding that persons who report chronic disease are more likely to be unemployed is not confirmed by the present thesis.

The results, including that smoking is the most consistent individual factor associated with work outcomes, suggest that underlying factors such as low socioeconomic position contribute substantially to the association – and even more than indicated in the three papers. Unfortunately, resilience to smoking cessation is commonplace (162), and while health-promotion campaigns may influence the wider public they may also be perceived as overly paternalistic (148). It is therefore important to note that aggregated results at the population level may not be relevant at the individual level in a real-life setting. Rather, efforts that target underlying causes (such as education, wealth and living conditions), may be more effective than health-promotion activities (148).

In Norway, snuff use has increased over the last 10–15 years as tobacco smoking has declined. Snuff use may also be considered an indicator of socioeconomic position. While 5% of persons aged 16–74 years reported daily snuff use in 2005, this had increased to 13% in 2020 (163). Although research in this area is scarce and the health consequences of snuff are debated, the impact of snuff use on sick leave and work ability may warrant further study. A recent Norwegian cross-sectional study found current smoking to be associated with sick leave, but found no statistically significant association between sick leave and snuff use (164). Moreover, since the questionnaires utilised in the Telemark Study included a question on snuff use, future research based on the Telemark Study could supplement the literature in this area. A recent Norwegian study among university students found associations between snuff use and socioeconomic position, similarly to the pattern previously identified for smoking (165). Since the Telemark Study has followed participants from the age of 16, this is an important topic for future investigation. Due to the observational design, the three papers included in this thesis do not assess the mechanisms behind smoking or snuff use and work outcomes, or how socioeconomic position influences this relationship.

Other factors important for socioeconomic position such as income, wealth and housing conditions (166) – were not assessed in this thesis, but should be considered in future research.

7.1.3 Asthma as a potential effect modifier

In a cross-sectional setting, we hypothesised that persons with physician-diagnosed asthma and unhealthy lifestyle behaviours have a higher likelihood of poor work outcomes (see chapter 2 of this thesis). Asthma is a chronic disease characterised by variable airway obstruction. Obesity is an independent risk factor for asthma, while smoking habits are seen as a risk factor for asthma severity (167, 168). It is therefore unsurprising that Paper II showed that physician-diagnosed asthma modifies both the association between obesity and sick leave and the association between smoking and sick leave. This is in line with a Swedish cross-sectional study of register records which demonstrated that persons with physician-diagnosed asthma have a higher likelihood of sick leave than the general population (169). However, literature on this topic is scarce, and the Telemark Study will continue to improve knowledge about the longitudinal association between lifestyle and work outcomes and the potential effect modifying impact of physician-diagnosed asthma. As regards another common chronic respiratory disease, COPD, this disease group was not assessed in Papers I–III due to the low prevalence of COPD in the sample of participants aged 16–55 years (1%). Misclassification of physician-diagnosed asthma and COPD is a common problem in population-based respiratory epidemiology. However, since the age span of the participants was 16–55 years, misclassification is considered less likely.

Paper II could not demonstrate that asthma is an effect modifier between lifestyle risk factors and low work ability. A recent Finnish cohort study monitored middle-aged persons with asthma for a period of 10 years and found that 68% of the subjects maintained a good WAS. Only 8% of participants who started out with a poor WAS deteriorated further during the follow-up period. These participants were also characterised by more severe asthma and several comorbidities (170).

As the Telemark Study is a large population-based study, the study population probably included many subjects diagnosed with asthma in childhood but free of asthma symptoms in adulthood. Moreover, few participants reported poor WAS. This may be an indication of the conceptual difference between work ability score and sick leave. In other words, the complexity of both measures suggests that even if a person reports sick leave, there is a possibility that their subjective work ability is good. It is also important to acknowledge that the study design included all categories of patients with asthma, and that the patient population was not selected (as would have been the case if e.g. only asthma patients seeking medical care had been included). This may have led to underestimation of effects.

7.2 Methodological considerations

The findings in the three papers are based on data from a general population-based cohort study. This implies that there are important methodological strengths and limitations to consider. Potential error sources are discussed in a more overall and systematic way in the next section. 'Random errors' refers to inaccuracies which are difficult to identify immediately because they are determined by chance (171). 'Systematic errors' arise due to misclassification of variables, in the selection of participants, when variables are measured incorrectly or if confounding is not handled according to best practice (171).

7.2.1 Study design

A cross-sectional design was used in Paper I and Paper II. This study design is useful when the aim is to describe a population or a group by reference to a specific exposure or disease at a certain point in time (115). The advantage of a cross-sectional study is the relative resource efficiency (in terms of both time and financial cost) ensured by collecting many variables at one particular time (115). However, the results of studies with a cross-sectional design should be interpreted with caution, as no causal inference can be claimed, for several reasons. Firstly, the cross-sectional design inherently entails uncertainty about the temporal sequence of events. Secondly, it cannot give more than an indication of a relationship between exposure and outcome. Accordingly, one cannot exclude reverse causation in the sense that exposure (unhealthy lifestyle) may be due to the outcome (work ability/sick leave) (128). For example, does obesity induce low work ability or vice versa? Although the adopted study design does not allow any conclusion to be reached about causality, the findings can generate hypotheses for further investigation.

In Paper III, prospective cohort data were used. The immediate advantage of a cohort study is the possibility of studying changes in exposure and outcome over time. This permits calculation of incidence, not only prevalence. Accordingly, some biases – such as recall bias – are less of a concern or problem. Moreover, the design permits investigation of multiple outcomes over time, although the external validity of such investigations is dependent on the participants' motivation over time. Declining participation has been observed in all of the large cohort studies conducted in Norway, with the HUNT, Tromsø and Oslo studies all reporting decreasing response rates at follow-up (172). Further, while the possibility of monitoring participants over time is a strength, the duration of follow-up will vary depending on the outcome, and it could be argued that a five-year follow-up period may be too short to detect changes in reduced work ability and sick leave. For example, a recent Dutch longitudinal study investigating the association between smoking and sick leave adopted a six-year follow-up date and found no statistically significant differences in associations related to sustained smokers, persons who had quit smoking and persons who had never smoked. The authors pointed out that the time of follow-up may be a possible explanation (124).

7.2.2 Choice of effect measure

As logistic regression analyses were performed, OR was presented as an effect measure. According to Lydersen, Fagerland and Laake (173), the OR is an effect measure that overestimates the risk ratio when the outcome is prevalent. It is often recommended that the cut-off values for outcome prevalence should be somewere in the range 10%–20%. If prevalence is higher, choosing the risk ratio rather than OR is an alternative (174, 175). In our study population, the prevalence of low WAS was 13% (baseline), while the prevalence of sick leave was 32% (baseline; 17% short-term and 15% long-term). Given a cut-off value in the range 10%–20%, we considered it appropriate to use OR as an outcome for WAS. In retrospect, it can be questioned whether the same reasoning should have been applied to sick leave. Importantly, when analysing the OR it cannot be assumed that the measure is equivalent to risk ratio. When the OR is >1, there will be a higher divergence from the risk ratio (174, 175). Further, since the OR for work outcomes in our studies rarely exceeded 2, it can be argued that OR was still a reasonable choice of effect measure (174).

7.2.3 Random error and power calculation

The precision of an epidemiological study is determined by the rate of random errors in the study results (120). Increasing the sample size is one way to reduce the occurrence of random errors (171). The Telemark Study started with a cross-sectional survey in 2013. The primary objective of the cross-sectional study was to estimate the prevalence of self-reported respiratory symptoms and physician-diagnosed asthma and risk factors for asthma in Telemark county. Based on a similar study conducted in western Sweden (176), and taking into account resource constraints, a sample size of 50 000 was deemed sufficient to achieve the primary objective in a situation where response rates were declining. Accordingly, the papers making up this thesis utilise data from a sample considered large enough to allow estimation of the prevalence of respiratory symptoms and disease, and of risk factors in the relevant population.

Based on the available sample, the number of variables that could be included in the multivariable regression analyses in all three studies were estimated. The calculations were done using the "rule of 10" (118) whereby the number of cases in the least frequent group restrict the number of variables which may be included. For example, in Paper I the least frequent outcome group was low WAS (1 379 subjects reported low WAS). The calculation was as follow: 1 379/10 = 137 variables. The study populations in Papers I to III are therefore considered to include a sufficient number of participants, but as stated it is important to remember that the Telemark Study was primarily designed to identify preventive and health-promoting measures related to respiratory disease. In addition, calculation of the sample size was incorporated into the study design, with additional factors such as estimated response rate, possible drop-outs (follow-up) and robustness (missing data) being assessed.

In Paper III, the study population explored in the stratified analysis of disease and illness groups were relative small: respiratory diseases n=688, CVD or diabetes n=348 and mental illness n=948 (total study population n=6 267). The findings must therefore be interpreted with caution. Only former smoking was associated with low work ability among persons who reported a history of mental illness (OR 0.57, 95%CI 0.37–0.88)

(Paper III, Table 5). Further, smoking was found to have a statistically significant association with increased sick leave among persons with CVD, diabetes or mental illness (Paper III, Table 4). Because the sample used in this paper included subjects from the general population with different severities of CVD, diabetes, respiratory diseases and mental illness (as opposed to clinical studies with selected patient groups), it is challenging to make general assumptions regarding how these conditions impact work ability and sick leave. In both Paper II and Paper III, the stratified study population included a larger proportion of highly educated subjects in the disease groups. It can be speculated that many of the persons who reported disease or illness had considerable social and cultural resources. If correct, this would somewhat confirm the results of prior studies showing that highly educated persons are more likely to be in paid employment than their less well-educated counterparts (24, 161). This may have led to underestimation of our results in the stratified analyses.

7.2.4 Systematic errors

The internal validity of a study indicates the extent to which the results are valid for the study population. Potential biases related to internal validity are discussed below. This is followed by a discussion of the generalisability of the results.

Information bias

Bias due to measurement errors in the assessment of exposure or outcome is often referred to as information bias.

The Telemark Study is based on self-reported questionnaires. Such questionnaires represent a relatively affordable, fast and non-invasive method for gathering large amounts of information from each participant. However, this method is prone to misclassification of information, usually in the form of under-reporting of negative factors and over-reporting of positive ones. We sought to obtain information on sensitive matters such as diet, physical activity, BMI and smoking. This raises the potential issue of social desirability bias, i.e. under- or over-reporting of behaviours which subjects believe to be socially appropriate or inappropriate. In Paper III, the range of missing values spanned from 0.5% (smoking) to 17% (weight/height). The relatively large number of subjects with missing data on weight and height (BMI) may indicate that social desirability bias played a role. To explore this issue, we compared some anthropometric measurements from the baseline case-control part of the Telemark Study with self-reported weight and height using a chi-squared test (data not published). This sample included 880 persons, and 89% of those who reported a BMI ≥30 kg/m^2 correlated well with the numbers found when weight and height was measured by a trained researcher. The numbers for other BMI categories were as follows: 73% for BMI 25–29.9 kg/m^2, 77% for BMI 18.5–24.9 kg/m^2 and 42% for BMI <18.5 kg/m^2. However, the last category included only 10 persons. Although this may indicate good comparability of self-reported and actual measurements, no information about the rest of the study population was available (10 355 - 880 = 9 475 persons). Accordingly, we cannot exclude the possibility that our results may have been affected by social desirability bias.

Recall bias

A further possible bias in the three studies is the requirement for participants to remember accurately (Papers I-III). For example, the questions regarding diet require a respondent to remember his or her eating habits and meal frequency. Difficulties in doing so may result in under or overestimation. Register-based records could have been employed to reduce the possibility of recall bias for variables like sick leave. However, an additional analysis comparing the prevalence of sick leave among non-responders and responders in the past 12 months found no significant differences (177). Norway's high rates of sick leave resulted in the introduction of an inclusive working life agreement (the IA Agreement) in 2001. The main objectives of the agreement were to reduce sick leave, reduce withdrawal from working life and increase the number of working years (178). One consequence of this agreement has been that sick leave rates in Norway remained relatively stable from 2006 to 2017 (53). Although the partners initially hoped to reduce these rates, it is considered positive that, at least, no increase has been observed. In our sample, 32% of the subjects reported one or more sick leave days in the past 12 months at baseline (n= 10 355), while five years later (n= 6 267) this percentage was 30%. This confirms the stability of these numbers over time. Unfortunately, no population-based register data were available for lifestyle risk factors like diet, physical activity, BMI and smoking.

Selection bias

This type of bias may arise when a study sample differs from the population in question – in this case the general population of Telemark County. The Telemark Study had a response rate of 33% in 2013. As a consequence, a non-response study was conducted in which 260 non-responders participated (179). This study revealed that non-response was associated with younger age, male sex and living in rural areas. This is consistent with the findings reported in a non-response study for HUNT3, namely that non-responders were more likely to be younger men with a lower educational level and a higher mortality rate (172). The most commonly stated reasons for not participating in the Telemark Study were "no particular reason", "lack of time", and "forgot to answer" (179). Only data on former smoking were significantly different (less common) among responders compared to non-responders in the baseline study (179). The non-response study did not examine the other variables used in the present thesis. To compensate for the missing values in the Telemark Study, weighted analysis was conducted of another part of the Telemark Study (32). However, these weightings had little impact on the investigated associations. Further, since Papers I to III did not investigate disease prevalence, using weightings was considered less relevant.

Interestingly, most participants gave similar answers regarding lifestyle risk factors at both baseline and follow-up (see Table 3). However, no information on the temporality of events was available. For example, if a respondent replied that he or she fulfilled the recommended levels of MVPA at baseline but not at follow-up we would not know when the change occurred. This information would be interesting to investigate, and it appears important to follow trends in lifestyle behaviours both at shorter intervals and over a longer period of time.

A recent Norwegian general population study has found somewhat larger selection bias when participants were recruited via websites such as helsenorge.no (a governmental website providing general health information), compared to traditional recruitment to a general population study such as the Telemark Study (180). This may have affected Paper III, although approximately 42% of participants completed the online questionnaire.

Healthy worker effect

Studies based on working populations have a tendency to include a healthier population than the general population, also called the healthy worker effect (120). It can be hypothesised that this bias arises because people suffering from a severe disease are unable to work, and that working individuals are therefore generally healthier than the population at large. However, this effect may also be linked to the social security system of the country in which a study is conducted. The literature is not entirely conclusive, but there are indications that the social security system of a state may influence the prevalence of sick leave (51, 181, 182) and thereby influence workforce composition. Paper II and Paper III sought to explore the association between lifestyle risk factors and sick leave. Accordingly, persons who had not been in paid work in the past 12 months were excluded, as this would have interfered with the association being investigated. For example, Paper II explored the association between lifestyle risk factors and low work ability and sick leave among persons with and without physician-diagnosed asthma. People with severe asthma may be excluded from the workforce, and thus also from the present study as shown by others (183). It is also likely that a substantial proportion of the participants were diagnosed as children and that the disease was well-managed at the point of inclusion in the study. This may also have been the case for persons with diabetes, other respiratory diseases or mental illness. As a consequence, there may have been some underestimation of effects and the healthy worker effect should be considered when interpreting the results in Papers II and III.

Confounding

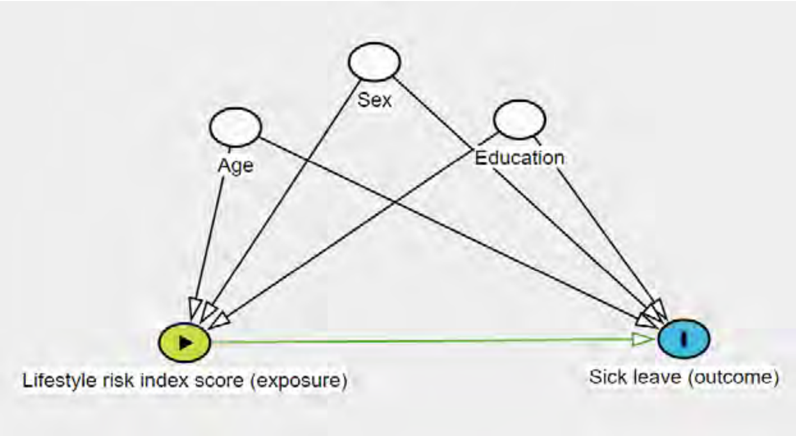
As stated in chapter 5.4.1 (statistical analysis see page 30), confounding occurs when an association of interest is biased by a different exposure than the one of interest. In other words, a confounding factor is associated with both exposure and outcome (Figure 8) (171). One way to conceptualise this bias is to include the adjustment variables in the multiple logistic regression model. For example, age is known to be associated with both physical activity (exposure) and work ability (outcome), and was therefore included in adj_1 and adj_2 in Model 1 in Paper I.

It is known that socioeconomic differences may function as confounders with respect to both lifestyle risk factors and work outcomes (meaning work ability and sick leave in this context). Accordingly, it was important to adjust all models for education and/or occupation, as these are indicators of socioeconomic differences. Further, in Paper I both education and occupation were included as proxies for socioeconomic position. However, this may have entailed unnecessary adjustment, i.e. that adjusting one variable (occupation) does not change the total causal effect between independent and dependent variables (184). This is why Papers II and III only include education as a proxy for socioeconomic positon.

All three papers sought to adjust for potential confounding factors in the analysis. However, the possibility of measurement errors in confounders and resulting residual confounding cannot be excluded.

The directed acyclic graph below, which was also used in preparation for Paper III, explains potential confounding factors in the association between lifestyle risk index score and sick leave.

Figure 8. An example of counfounding factors explained by using a directed acyclic graph (figure developed using DAGitty tool by Textor et al. 2016 (185))



Another form of such confounding is the exclusion of variables previously shown to be associated with the dependent variables. Although the three studies evaluated a considerable number of variables, data on several important factors such as income, psychosocial work environment, workload, stress, sleep, neighbourhood characteristics and health care utilisation were not available (Papers I–III).

Effect modification

As stated in chapter 5.4.2 (statistical analysis see page 31), effect modification refers to a situation where the exposure-associated effect on disease risk is varied by some other factor (120, 121). In Paper II, the focus was on exploring the hypothesis that physician-diagnosed asthma is an effect modifier in the association between lifestyle risk factors and work outcomes. Further, the paper included 'other chronic lung diseases' in the logistic regression model along with age, sex and education (adjustment variables). It was confirmed that 'other chronic lung diseases' were not correlated with physician-diagnosed asthma (variance inflation factor <1.2), and that 'other chronic lung diseases' were associated with both independent and dependent variables. Therefore, the decision to include this as a confounding variable was considered reasonable. Other NCDs such as CVD, diabetes and mental illness were also included in the model to explore these as possible confounders. However, they did not attenuate the results and were therefore not included in the full model.

An alternative method for analysing the potential effect modification of physician-diagnosed asthma involves assessing relative excess risk due to interaction. This was performed for WAS, but the analysis showed no statistically significant interaction between lifestyle risk factors and work ability for persons with physician-diagnosed asthma. The latter analysis was not included in the paper.

Misclassification

Papers I to III employ several categorical variables. A challenge associated with using categorical rather than continuous variables is that subjects may be assigned to an incorrect category due to an observation or measurement error. Further, categorisation of continuous variables may result in a lack of precision (186). On the other hand, a positive aspect of categorising variables in logistic regression analysis is that it does not entail assumption of a linear relationship between the continuous variable and the outcome.

Further, and as mentioned above, education was included due to the importance of adjusting for socioeconomic background. However, categorising education into just three variables may have led to underestimation of its importance. In Paper III, the research group decided against categorisation of the age variable because we considered that it would be better to use a continuous variable rather than a categorical variable (assuming a linear relationship). Also, categorising the outcome variables into rather crude variables could have introduced under- or overestimation of the effects. For example, in Paper II sick leave was dichotomised as either no sick leave days or one or more sick leave days. This crude categorisation does not permit a distinction to be made between short-term and long-term sick leave, and does not reflect the complexity of sick leave. These results therefore have to be evaluated with caution. In addition, some subjects may have interpreted the sick leave question as including ‘self-certified days’. This may have led to an overestimation of sick leave, as since we did not intend to include 'self-certification' as part of sick leave. Moreover, information may be lost if few categories are used. Very few participants reported having a WAS ≤5 (Figure 3). With this in mind, several different cut-offs were analysed in the multinomial logistic regression analysis, but because we wanted to be able to compare our results with prior studies the cut-off was chosen accordingly. In summary, both dichotomous outcome measures of WAS and sick leave must be interpreted cautiously because they may entail misclassification bias.

In Paper III, underweight was included in the category of normal weight. I recognise that this contradicts the rationale underpinning the lifestyle risk index, in which underweight and overweight were both allotted 0.5 points based on their association with morbidity and mortality. We investigated whether we should classify these subjects as either normal weight or overweight, but this did not alter our results as the prevalence of underweight persons was only 1%. Nevertheless, this approach can be challenged in conceptual terms.

7.3 Generalisability

While random errors and systematic errors relate to internal study validity, external validity is determined by the extent to which the study can be generalised to other populations.

The response rate of 33% in the cross-sectional survey makes it challenging to generalise the findings to the general population of Telemark County. The non-response study found that females, the older age group (41–50 years old), more highly educated persons and persons living in urban areas were slightly over-represented among the participants (179). Although the prevalence estimates revealed few differences between responders and non-responders, there was evidence of selection bias in certain exposure-outcome associations such as smoking. Care must therefore be taken when interpreting certain exposure-outcome associations, as they may not be generalisable.

An important limitation of Paper III was the low number of persons included in each disease group. The potential loss of power in the statistical analyses due to the small sample size is important to note. However, the exposures/variables studied – like physical activity, sick leave and work ability score – are quite frequently reported in these types of population-based studies. This would have been more problematic if we had been investigating less common or rare exposures/variables.

In the cross-sectional part of the Telemark Study, the age of participants ranged from 16 to 50. In our analysis, persons aged 16–18 were excluded because few of these are engaged in paid work. Therefore, care must be taken when generalising our results to younger or older age groups.

Prior to the present thesis, few studies had explored the associations between simultaneously occurring lifestyle risk factors, expressed as a lifestyle risk index score, and work ability and sick leave. This thesis supplements existing knowledge on these relationships with both cross-sectional and longitudinal results, and the findings may be applicable to similar contexts.

8 The main results in the light of a person-centred health care perspective

The promotion of healthy lifestyle choices is a multi-faceted concept. When a person-centred health approach is adopted, the guiding principles for health promotion should be person-centred, not disease-oriented (187).

Collectively, the results reported in the three papers making up this thesis suggest a need for individualised lifestyle interventions targeting the working population in general. Moreover, individualised intervention may be needed when people are at risk of sick leave. Although not considered in this thesis, the literature also suggests that encouragement and facilitation at the workplace may reduce the risk of disease. If people adopt a healthier lifestyle, they may increase their wellbeing and thereby improve their work ability and reduce their incidence of sick leave.

Health promotion from a person-centred perspective also encompasses a systematic approach (188). Due to the complexity of preventing unhealthy lifestyle behaviours, health authorities play an important role as issuers of recommendations and regulations which make healthy choices more achievable for the population. The Norwegian government has therefore adopted ambitious goals for creating healthy environments, with a special focus on prevention rather than cure (189). Encouraging results have been achieved in Norway, for example through restrictions on the marketing of tobacco products. At the same time, the government is monitoring tobacco use (189). Since 2017, all packaging of tobacco products has been standardised and now includes clear warnings about the effects of nicotine. The prevalence of smoking has declined steadily in recent decades, and today very few young people (aged 16–24 years) smoke daily (1% in 2020, compared to 12% in 2010) in Norway (146). This is an example of how lifestyle factors may be impacted by governmental decisions.

9 Concluding remarks and future research

This thesis demonstrates a negative impact of lifestyle risk factors on work ability and sick leave in a general working population. Although the study design and limitations means that no causality can be asserted for the first two studies, the thesis elucidates the importance of investigating multiple lifestyle risk factors simultaneously.

Recent demographic changes in Norway – fewer children being born and increasing life expectancy – may present challenges to the Norwegian welfare state, which is dependent on an active workforce. In the future, people will have to work longer than at present. Unhealthy lifestyle behaviours are also a growing concern, with unhealthy dietary habits, declining physical activity and high body mass index being reported for an increasing proportion of the population. This thesis provides new knowledge on associations between unhealthy behaviours, low work ability and sick leave. However, the impact of other factors – such as socioeconomic position and workplace conditions – needs to be investigated further. Further research is also needed into the effects of interventions that help people to make healthier lifestyle choices. Such interventions could focus on employees of different ages, and on persons with and without diseases or illnesses. Promoting a healthy lifestyle represents a potentially substantial contribution to improved public health and increased work ability and work participation.

The WHO has highlighted the workplace as an important arena for promoting mental and physical health (151). An increased focus on the mental and physical health of workers promises to have benefits for individuals and society. Lifestyle risk factors are theoretically possible to modify, and important to assess in the public health context. The relatively high prevalence of physical inactivity, high BMI and smoking found in this thesis suggests greater potential for reducing such risk factors. Since socioeconomic position is associated with both lifestyle and work outcomes, I suggest that future research should focus on this area. Most importantly, health promotion is not an isolated concern for employers, workers or the occupational healthcare sector. It should be a priority for society as a whole.

10 References

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11 Appendices

11 Appendices

11.1 Questionnare baseline (Norwegian version)

Sykehuset Telemark

Astma i Telemark

Astma i Telemark

Spørreskjema for Telemarks befolking

DITT SVAR TELLER!

- **ENKELT**
- **VIKTIG**
- **20 MIN**

Vi henvender oss til deg for å spørre om du vil delta i et forskningsprosjekt som har som mål å finne ut hvilke faktorer i og utenfor arbeid som påvirker luftveiene. Slik kunnskap kan bidra til å hindre at sykdom i luftveiene oppstår og til å gi bedre veiledning til de som er blitt syke. Spørreundersøkelsen vil gi oss mer kunnskap jo flere som svarer. Ditt svar er like viktig, enten du er frisk eller syk. Vi ber deg svare så godt du kan, selv om noen av spørsmålene kan være litt vanskelige. Det tar omtrent 20 minutter å fylle ut skjemaet. Spørreskjemaet sendes til 50 000 tilfeldig utvalgte innbyggere i Telemark. Prosjektet gjennomføres av Sykehuset Telemark i samarbeid med Oslo Universitetssykehus.

Riv av omslaget (dette arket) og returner spørreskjemaet ferdig utfylt i vedlagte frankerte konvolutt. På forhånd takk for hjelpen!

For mer utfyllende informasjon om undersøkelsen, se informasjonsskriv side 15 og 16 samt vår nettside www.sthf.no/astma. Du kan også skanne QR-koden under med smarttelefonen din.

Dersom du har spørsmål til spørreundersøkelsen kan du ringe, sende melding eller e-post til en av prosjektmedarbeiderne ved Seksjon for arbeidsmedisin, Sykehuset Telemark, tlf: 953 69 315 e-post: astma@sthf.no

Slik fyller du ut skjemaet.

- Skjemaet vil bli lest maskinelt.
- Det er derfor viktig at du krysser av riktig: Rett ☒ Galt
- Dersom du krysser feil sted, retter du ved å fylle boksen slik: ■
- Skriv tydelige tall: 0 1 2 3 4 5 6 7 8 9
- Skriv ikke utenfor oppmerket område. Dette vil ikke bli lest av maskinen.
- Bruk svart eller blå penn. Ikke bruk blyant eller tusj.

Personopplysninger

Dagens dato (ddmmåå):

Kjønn:
- ☐ Kvinne
- ☐ Mann

Høyde: ☐ *cm*

Vekt: ☐,☐ *kg*

Hva er din sivilstand?
- ☐ Enslig
- ☐ Gift
- ☐ Samboer
- ☐ Skilt/separert
- ☐ Enke/-mann

Hvor mange års skolegang har du?
(Fra og med første klasse på barneskolen til og med siste fullførte skoleår/studieår).
☐ år

Hva er din høyeste ***fullførte*** *utdanning?*
(Går du på videregående/fagskole/høyskole/universitet kryss av for siste fullførte utdanning).
- ☐ Grunnskole/folkeskole
- ☐ Grunnkurs/1-2 årig utdannelse etter grunnskole
- ☐ Videregående/gymnas/yrkesskole (3-årig)
- ☐ Fagbrev
- ☐ Universitet/høyskole på 4 år eller mindre
- ☐ Universitet/høyskole på mer enn 4 år
- ☐ Annet: ____

Vi antar at din arbeidsevne, da den var best, vurderes med 10 poeng. Hvilket poengtall ville du gitt din nåværende arbeidsevne?
(0 betyr at du ikke kan arbeide og 10 at din arbeidsevne er som aller best akkurat nå).

0	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Arbeidsforhold

1. *Har du noen gang vært i arbeid?*

☐ Nei (gå til spørsmål 10)

☐ Ja (gå til spørsmål 2)

2. ***Oppgi dine ulike arbeidsforhold (ansettelser) med arbeidsoppgaver og tidsperiode.*** *Arbeidsforhold kortere enn tre måneder behøver du ikke oppgi.*

Hvis du har hatt svært mange arbeidsgivere, men har hatt liknende arbeidsoppgaver, kan du slå sammen periodene. (Eksempel: Bygg og anlegg, gravemaskinfører hos Selmer/Veidekke/Kruse-Smith, 1993-2009). Med ansettelse menes også arbeid som selvstendig næringsdrivende.

Eksempler:

Yara/Fullgjødselfabrikken	*Prosessoperatør*	*2008*	*2010*
Undervisning	*Lærer på yrkesskole*	*2010*	*2011*
Rådgivning	*Konsulent eget firma*	*2011*	*d.d.*

Bransje/industri	***Yrke(tittel)/arbeidsoppgaver***	***Begynt årstall***	***Sluttet årstall***

3. *Har du vært i arbeid* ***de siste 12 måneder****?*

☐ Nei

☐ Ja

Utfyllende spørsmål om dine arbeidsoppgaver ved ulike ansettelsesforhold: Mange av disse spørsmålene er spesielle for visse yrkesgrupper. Hvis spørsmålet ikke gjelder deg; svar nei og gå videre til neste spørsmål.

4. *Har du* ***noen gang*** *i ditt arbeid vært utsatt for:*

Gass, røyk eller støv?

☐ Nei

☐ Ja

5. *Hvis JA, hvor ofte var du utsatt for gass, røyk eller støv i løpet av de **siste fem årene**? (Ta et gjennomsnitt)*

- ☐ Daglig, store deler av arbeidsdagen
- ☐ Daglig, men kortvarig
- ☐ Ukentlig
- ☐ Sjeldnere

6. *Har du **noen gang** i ditt **arbeid** vært utsatt (eksponert) for:*

	Nei	Ja	Siste år utsatt (eksponert)
Stekeos	☐	☐	☐☐☐☐
Bileksos/motoreksos	☐	☐	☐☐☐☐
Sterke syrer, ammoniakk eller formalin	☐	☐	☐☐☐☐
Steinstøv	☐	☐	☐☐☐☐
Melstøv	☐	☐	☐☐☐☐
Trestøv	☐	☐	☐☐☐☐
Papirstøv	☐	☐	☐☐☐☐
Tekstilstøv	☐	☐	☐☐☐☐
Metallstøv	☐	☐	☐☐☐☐

7. *Har du på arbeidsplassen arbeidet med:*

	Nei	Ja	Siste år utsatt (eksponert)
Rengjøring/desinfeksjonsmidler	☐	☐	☐☐☐☐
Hvis JA, bruker/brukte du spray?	☐	☐	☐☐☐☐
Superlim eller lynlim	☐	☐	☐☐☐☐
Malings- eller lakkeringsarbeid	☐	☐	☐☐☐☐
Sveising eller annen metallrøyk	☐	☐	☐☐☐☐
Kloakk- eller renseanlegg	☐	☐	☐☐☐☐
Hårpleieprodukter	☐	☐	☐☐☐☐
Dyr	☐	☐	☐☐☐☐

Hvis JA, hvilke dyr? ____________________

Gass, støv eller damp som ikke er nevnt over

____ ☐☐☐☐

____ ☐☐☐☐

8.

Har du arbeidet i lokaler med:	Nei	Ja	Siste år utsatt (eksponert)
Synlige fuktskader	☐	☐	
Synlig mugg	☐	☐	
Lukt av mugg (kjellerlukt)	☐	☐	
Kulde (i kjølerom eller utendørs på vinteren)	☐	☐	
Har du hatt fysisk anstrengende arbeid (slik at du har blitt andpusten og svett)	☐	☐	
Har du hatt arbeid med gjentakende tunge løft?	☐	☐	

9. *Har du benyttet åndedrettsvern (verne-/støvmaske) på jobb siste 10 år?*

- ☐ Alltid/nesten alltid
- ☐ Av og til
- ☐ Aldri/nesten aldri

Har du bare brukt verne-/støvmaske ved høy eksponering?

- ☐ Nei
- ☐ Ja

10. *Har du hatt uhell hjemme eller på jobb hvor du har blitt utsatt for høye nivåer av gass, røyk eller støv?*

- ☐ Nei
- ☐ Ja

Hvis JA, fikk du plager fra luftveiene (hoste, tungpust, piping/hvesing) da uhellet skjedde eller like etterpå?

- ☐ Nei
- ☐ Ja

Plager fra luftveiene

11.

		Nei	Ja
11.1	Har du hatt piping eller hvesing i brystet på noe tidspunkt i løpet av **de siste 12 månedene**? Hvis NEI, gå til spørsmål 11.2, hvis JA:	☐	☐
a	Har du i det hele tatt vært andpusten når du har hatt piping eller hvesing i brystet?	☐	☐
b	Har du hatt piping eller hvesing i brystet uten at du har vært forkjølet?	☐	☐
11.2	Har du våknet med en følelse av tetthet i brystet på noe tidspunkt i løpet av **de siste 12 månedene**?	☐	☐
11.3	Har du våknet av anfall med tungpust på noe tidspunkt i løpet av **de siste 12 månedene**?	☐	☐

		Nei	Ja
11.4	Har du våknet av hosteanfall på noe tidspunkt i løpet av **de siste 12 månedene**?	☐	☐
11.5	Har du hatt astmaanfall i løpet av **de siste 12 månedene**?	☐	☐
11.6	Bruker du for tiden medisin (spray, inhalasjonspulver eller tabletter) mot astma?	☐	☐
11.7	Har du allergi som gir symptomer fra nesen, inkludert høysnue?	☐	☐
11.8	Har du i løpet av de siste årene hatt langvarig hoste?	☐	☐
11.9	Pleier du å hoste opp slim eller har du slim i lungene som er vanskelig å få opp? Hvis NEI gå til spørsmål 11.10, hvis JA:	☐	☐
a	Hoster du opp, eller får du opp slim på denne måten, nesten hver dag i minst tre måneder hvert år?	☐	☐
b	Har du hatt perioder med slike symptomer i minst to år etter hverandre?	☐	☐
c	Hvor gammel var du da disse problemene begynte? ☐☐ år	☐	☐
11.10	Har du noen gang hatt piping eller hvesing i brystet?	☐	☐
	Hvis JA, hvor gammel var du da du opplevde piping eller hvesing i brystet første gang? ☐☐ år		
11.11	Har du, eller har du noen gang hatt astma? Hvis NEI gå til spørsmål 11.12, hvis JA:	☐	☐
a	Har du noen gang fått diagnosen astma av lege?	☐	☐
b	Hvor gammel var du da du opplevde astmasymptomer første gang? ☐☐ år		
c	Hvilket år opplevde du sist astmasymptomer? ☐☐☐☐ (åååå)		
11.12	Har en lege noen gang fortalt deg at du har kronisk obstruktiv lungesykdom (KOLS)?	☐	☐
	Hvis JA, hvor gammel var du da du opplevde symptomer på KOLS første gang? ☐☐ år		
11.13	Har du noen gang opplevd nesesymptomer som tett nese, rennende nese eller nyseanfall uten å være forkjølet? Hvis NEI gå til spørsmål 11.14, hvis JA:	☐	☐
a	Hvor gammel var du da du opplevde slike nesesymptomer første gang? ☐☐ år		
b	Har du hatt nesesymptomer **de siste 12 måneder**?	☐	☐
c	Hvilken årstid er dine plager verst? (velg kun ett alternativ) ☐Vår ☐Sommer ☐Høst ☐Vinter ☐Alltid ☐Vet ikke		

		Nei	Ja
11.14	Har du vært tett i nesen **i mer enn 12 uker i løpet av de siste 12 månedene**?	☐	☐
11.15	Har du hatt smerter eller trykk rundt pannen, nese eller øynene **i mer enn 12 uker i løpet av de siste 12 månedene**?	☐	☐
11.16	Har du hatt misfarget nesesekret (snørr) eller misfarget slim i halsen **i mer enn 12 uker i løpet av de siste 12 måneder**?	☐	☐
11.17	Har din luktesans vært nedsatt eller borte **mer enn 12 uker i løpet av de siste 12 månedene**?	☐	☐

Luftveisplager og arbeid

12. *Har du hatt gjentakende luftveisplager (hoste, tungpust, hvesing, piping)* ***på jobb****?*

☐ Nei (gå til spørsmål 15)

☐ Ja

Hvis JA, hvor alvorlige var luftveisplagene?

(0 betyr at du ikke hadde plager og 10 at du hadde svært alvorlige plager).

0	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

13. *Ble plagene bedre:*

	Nei	Ja
- i helgene?	☐	☐
- i feriene?	☐	☐
- ved annet fravær fra jobb?	☐	☐
- ved bytte av jobb/omplassering?	☐	☐

14. *Hvis du bruker/har brukt medisin mot luftveisplager; kan/kunne du redusere bruken/dosen?*

	Nei	Ja
- i helgene?	☐	☐
- i feriene?	☐	☐
- ved annet fravær fra jobb?	☐	☐
- ved bytte av jobb/omplassering?	☐	☐

15. *Har du noen gang byttet jobb fordi jobben har påvirket pusten din?*

☐ Nei

☐ Ja

Hvis JA, når var det (hvilket eller hvilke år)?

Årstall ☐☐☐☐

Årstall ☐☐☐☐

Hvis JA, hvilken arbeidsplass (arbeidsoppgaver) hadde du da?

____

____

16. *Har du noen gang byttet jobb på grunn av: Høysnue eller andre neseproblemer?*

☐ Nei

☐ Ja

Hvis JA, når var det (hvilket eller hvilke år)?

Årstall ☐☐☐☐

Årstall ☐☐☐☐

Hvis JA, hvilken arbeidsplass (arbeidsoppgaver) hadde du da?

____

____

17. *Har du noen gang byttet jobb på grunn av andre helseproblemer/sykdommer?*

☐ Nei

☐ Ja

18. *Har du vært sykemeldt **i løpet av de siste 12 månedene**?*

☐ Nei

☐ Ja

Hvis JA, i hvor mange dager?

Velg kun ett alternativ

☐ 1-7 dager ☐ 8 -14 dager ☐ 15 dager - 12 uker ☐ Mer enn 12 uker

19. *Har du vært sykemeldt **i løpet av de siste 12 månedene** på grunn av pusteproblemer?*

☐ Nei

☐ Ja

Røyke- og snusevaner

20.

	Nei	Ja
Røyker du daglig (gjelder selv om du kun røyker noen få sigaretter, sigarer eller pipe daglig)?	☐	☐
Røyker du bare av og til (ikke daglig, men helger, festrøyking eller liknende)?	☐	☐
Har du røykt tidligere?	☐	☐

Hvis bare NEI-svar på spørsmål 20, gå til spørsmål 25.

21. *Hvor mye røyker/røkte du? (Ta et gjennomsnitt)*

☐ Sigaretter pr **dag** eller ☐ sigaretter pr **uke**

☐ Sigarer pr uke

☐ Pakker rulle-/pipetobakk pr uke

22. *Hvor gammel var du da du begynte å røyke?*

☐ år

23. *Hvor lenge har du røykt (gjelder både nåværende og tidligere røyking)?*

☐ år

24. *Hvis du har røykt tidligere, når sluttet du?*

☐ årstall

25. *Bruker du, eller har du brukt snus?*

Nei, aldri ☐ Ja, av og til ☐

Ja, men jeg har sluttet ☐ Ja, daglig ☐

*Hvis du **aldri** har brukt snus, gå til spørsmål 26.*

Hvis JA:

Hvor gammel var du da du begynte med snus? ☐ *år gammel*

Hvor mange bokser snus bruker/brukte du pr måned? ☐ *bokser snus pr måned*

Dersom du har sluttet å snuse, hvor gammel var du da du sluttet? ☐ *år*

Boligforhold

26. *I hvilken type bolig bor du*

☐ Enebolig

☐ Rekkehus/tomannsbolig

☐ Leilighet/hybel

☐ Annet

27. *Når flyttet du inn i din nåværende bolig?*

☐ årstall

28. *Hvor mange timer pr døgn tilbringer du vanligvis i boligen din?*

Hverdager ☐ timer Helg ☐ timer

29. *Forekommer det tobakksrøyking inne i din nåværende bolig?* Velg kun ett alternativ.

☐ Nesten daglig ☐ 1-4 ganger/uken ☐ 1-3 ganger/mnd ☐ Aldri

30. *Har du hatt noe av følgende i din bolig?*

	Nei	Ja	Antall år	Hvilket år var du sist utsatt for?
Vannskader/fuktskader innvendig i boligen på vegger, gulv eller tak?	☐	☐		
”Bulkete” plastmatter, gulnede plastbelegg eller parkett som har blitt mørk av fukt?	☐	☐		
Synlig mugg på vegger, gulv eller tak?	☐	☐		
Har du noen gang i løpet av de siste 10 årene sett tegn på fuktskader, vannlekkasje eller mugg i din bolig?	☐	☐		

31. *Ligger ditt soveromsvindu nær en gate (mindre enn 20 m)? Velg kun ett alternativ*

☐ Nei
☐ Ja, med lite trafikk
☐ Ja, med moderat trafikk
☐ Ja, med mye trafikk

32. *Hvor mye tid tilbringer du vanligvis på å gå eller ferdes langs en moderat-mye trafikkert vei i løpet av en vanlig hverdag?*

Ca ☐ min pr dag

33. *Hvilke(n) av følgende oppvarmingsmåter ble mye brukt i ditt hjem da du var fem år gammel?* Flere enn ett alternativ kan være aktuelt.

☐ Vedfyring
☐ Kull
☐ Parafin
☐ Elektrisitet
☐ Gass
☐ Olje
☐ Vannbåren-/ fjernvarme

34. *Hvilket ord beskriver best det stedet du bodde størstedelen av tiden da du var under fem år gammel?* Velg kun ett alternativ

- ☐ Bondegård med dyr
- ☐ Bondegård uten dyr
- ☐ Bygd/tettsted
- ☐ Småby/bynært
- ☐ Storby

35. *Har du (siste 12 måneder) brukt sprayprodukter regelmessig ved rengjøring hjemme?*

- ☐ Nei
- ☐ Ja

Barndom og familie

36.

	Nei	Ja	Vet ikke
Hadde du som barn alvorlig luftveisinfeksjon før 5-års alder?	☐	☐	☐
Røkte din mor regelmessig da du var barn?	☐	☐	☐
Røkte din far regelmessig da du var barn?	☐	☐	☐
Røkte noen annen i ditt hjem regelmessig da du var barn?	☐	☐	☐

37.

Har du foreldre som har, eller har hatt, følgende sykdommer (oppgi også for evt. avdøde foreldre)? Sett kryss hvis JA

	Mor	Far
Astma	☐	☐
Kronisk bronkitt, emfysem eller KOLS	☐	☐
Hjertesykdom	☐	☐
Høyt blodtrykk	☐	☐
Hjerneblødning/hjerneslag	☐	☐
Diabetes (sukkersyke)	☐	☐
Kreft	☐	☐

Fysisk aktivitet og kosthold

38. *Hvor ofte mosjonerer/trener du?* *(Ta et gjennomsnitt)*

- ☐ Aldri
- ☐ Mindre enn 1 gang pr uke
- ☐ 1 gang pr uke
- ☐ 2-3 ganger pr uke
- ☐ Omtrent daglig (4-7 ganger pr uke)

39. *Hvis du trener 1 gang pr uke eller mer:*
Hvor hardt mosjonerer/trener du?

- ☐ Tar det rolig uten å bli andpusten eller svett
- ☐ Tar det så hardt at jeg blir andpusten og/eller svett
- ☐ Tar meg nesten helt ut

40. *Hvor lenge pleier du å trene?* *(Ta et gjennomsnitt)*

- ☐ Mindre enn 15 minutter
- ☐ 15-29 minutter
- ☐ 30 minutter til 1 time
- ☐ Mer enn 1 time

41. *Har du vanligvis minst 30 minutter fysisk aktivitet daglig?*

☐ Nei ☐ Ja

42. *Hvor ofte spiser du vanligvis disse matvarene?* *(Sett kun ett kryss pr linje)*

	0-3 ganger pr mnd	1-3 ganger pr uke	4-6 ganger pr uke	1 gang pr dag	2 ganger eller mer pr dag
Frukt/bær	☐	☐	☐	☐	☐
Grønnsaker	☐	☐	☐	☐	☐
Sjokolade/smågodt	☐	☐	☐	☐	☐
Kokte poteter	☐	☐	☐	☐	☐
Pasta/ris	☐	☐	☐	☐	☐
Pølser/hamburgere	☐	☐	☐	☐	☐
Fet fisk (laks, ørret, sild, makrell, uer som pålegg/middag)	☐	☐	☐	☐	☐

43. *Bruker du følgende kosttilskudd?* *(Sett kun ett kryss pr linje)*

	Ja, daglig	Av og til	Nei
Tran	☐	☐	☐
Omega-3-kapsler	☐	☐	☐
Vitamin- og/eller mineraltilskudd	☐	☐	☐

Andre sykdommer og plager

44. *Hvis JA på spørsmålene under, ber vi deg om å fylle inn alder lengst til høyre.*

(Kryss enten nei eller ja på alle spørsmålene)

	Nei	Ja	Hvis JA, hvor gammel var du **første** gang?
Har du fått beskjed av lege om at du har høyt blodtrykk?	☐	☐	☐ år
Bruker du medisiner mot høyt blodtrykk?	☐	☐	☐ år
Har lege sagt at du har sukkersyke (diabetes)?	☐	☐	☐ år
Bruker du medisiner mot diabetes?	☐	☐	☐ år
Har du vært innlagt på sykehus med hjerteinfarkt eller hjertekrampe (angina)?	☐	☐	☐ år
Har lege noen gang sagt at du har hjertesvikt (svakt hjerte, vann i lungene, hovne ben)?	☐	☐	☐ år

45. *Har du, eller har du noen gang hatt noen av disse sykdommene/plagene?*

(Kryss enten nei eller ja på alle spørsmålene)

	Nei	Ja	Hvis JA, hvor gammel var du **første** gang?
Hjerneslag/hjerneblødning?	☐	☐	☐ år
Hjerteflimmer?	☐	☐	☐ år
Eksem på hendene (med unntak av psoriasis)?	☐	☐	☐ år
Annen kronisk lungesykdom enn astma eller KOLS?	☐	☐	☐ år
Har du noen gang hatt psykiske plager som du har søkt hjelp for?	☐	☐	☐ år

Samtykke til deltakelse i studien

Jeg er villig til å delta i studien.

(**Navn med blokkbokstaver**, signatur, dato)

Noen få ganger kan det være aktuelt å kontakte den som har fylt ut skjemaet for å avklare et eller flere spørsmål. Hvis du synes det er i orden, ber vi deg om å fylle ut feltene under (for å sikre din anonymitet blir disse opplysningene **ikke** lagret i databasen):

Mobil:_____________

Annen tlf. dagtid:_____________

Annen tlf. kveldstid:_____________

Takk for hjelpen!

Astma i Telemark

Bakgrunn og hensikt

Vi henvender oss til deg for å spørre om du vil delta i et forskningsprosjekt som har som mål å finne ut hvilke faktorer i og utenfor arbeid som påvirker luftveiene. Slik kunnskap kan bidra til å hindre at sykdom i luftveiene oppstår og til å gi bedre veiledning til de som er blitt syke. I denne type undersøkelse er hver deltaker viktig, enten du er frisk eller syk. Prosjektet gjennomføres av Sykehuset Telemark i samarbeid med Oslo Universitets-sykehus.

Hva innebærer studien?

I prosjektet sender vi ut et spørreskjema til 50 000 tilfeldig utvalgte innbyggere i alderen 16-50 år i Telemark fylke. Vi spør deg og de andre mottakerne om luftveisplager og hva dere utsettes for i arbeid og på fritiden. Vi planlegger å kontakte noen av de som har astma og noen friske deltagere på et senere tidspunkt, for å spørre om de kan tenke seg å være med i en oppfølgende studie. Deltagelse i senere studier er frivillig.

Mulige fordeler og ulemper

Fordeler ved deltakelse i studien: Det er viktig å vite noe om hvor mange som har plager fra luftveiene og som utvikler astma. Enda viktigere er det å vite mer om hvilke faktorer i og utenfor arbeid som kan gi plager fra luftveiene for å kunne forebygge sykdom i fremtiden. Dette kan du bidra til ved å delta i studien. I tillegg vil studien også kunne være til hjelp for politikere og helsepersonell til bedre å kunne planlegge og gjennomføre nødvendige tiltak i Telemark og landet for øvrig, for å møte de behov og kostnader som følger av astma.

Mulige ulemper ved deltakelse i studien: Det hender at noen deltagere blir bekymret av å fylle ut et spørreskjema. Hvis dette gjelder deg, er vi tilgjengelige på telefon for å kunne svare på spørsmål og gi råd.

Hva skjer med informasjonen om deg?

Opplysningene som registreres skal kun brukes slik som beskrevet i hensikten med studien. Informasjonen om deg, vil bli viderebehandlet uten navn, fødselsnummer eller andre direkte gjenkjennende opplysninger. Dine opplysninger vil bli knyttet til en kode gjennom en løpenummerliste som kun autorisert personell som er tilknyttet prosjektet har adgang til. Det vil ikke være mulig å identifisere deg i resultatene av studien når disse publiseres.

Frivillig deltakelse

Deltakelse i prosjektet er frivillig og du kan trekke deg når som helst uten å oppgi noen grunn. Dersom du senere ønsker å trekke deg vil alle opplysninger om deg bli slettet. Dersom du ønsker å delta, undertegner du samtykkeerklæringen, besvarer spørreskjemaet og returnerer det i vedlagte ferdig frankerte svarkonvolutt. Dersom du senere ønsker å trekke deg eller har spørsmål til studien, kan du kontakte en av prosjektmedarbeiderne på Sykehuset Telemark, tlf: 953 69 315 (kl. 08.00-16.00). Mer informasjon om personvern og forsikring finnes under tilsvarende avsnitt nedenfor.

Personvern, økonomi og forsikring

Personvern

Opplysninger som registreres om deg vil bli oppbevart i låste arkiver og i datasystem som er beskyttet av Sykehuset Telemarks IT-rutiner. Ved publisering av resultatene vil alle opplysninger være anonymisert. Opplysningene fra spørreskjemaet vil bli slettet når prosjektet avsluttes, og senest i 2035. Sykehuset Telemark HF ved administrerende direktør er databehandlingsansvarlig.

Utlevering av materiale og opplysninger til andre

Hvis du sier ja til å delta i studien, gir du også ditt samtykke til at avidentifiserte opplysninger utleveres til prosjektmedarbeidere tilknyttet prosjektet ved Sykehuset Telemark HF og Oslo Universitetssykehus HF.

Rett til innsyn og sletting av opplysninger om deg og sletting av prøver

Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Du har videre rett til å få korrigert eventuelle feil i de opplysningene vi har registrert. Dersom du trekker deg fra studien, kan du kreve å få slettet innsamlede opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Økonomi

Studien er finansiert gjennom forskningsmidler fra Sykehuset Telemark HF.

Forsikring

Alle deltakerne i studien er forsikret gjennom Norsk pasientskadeerstatning.

Informasjon om utfallet av studien

Resultatene av prosjektet vil bli formidlet gjennom offentlige medier lokalt og nasjonalt og gjennom vitenskapelige artikler internasjonalt. Du vil finne oppdatert informasjon om prosjektet på prosjektets hjemmeside: www.sthf.no/astma

Med vennlig hilsen

Regine Abrahamsen
Lege, Sykehuset Telemark
Seksjon for arbeidsmedisin

Anne Kristin Møller Fell
Overlege, Sykehuset Telemark
Seksjon for arbeidsmedisin

Dersom du har spørsmål, kan du ringe, sende melding eller e-post til en av prosjektmedarbeiderne ved Seksjon for arbeidsmedisin, Sykehuset Telemark tlf: 953 69 315
e-post: astma@sthf.no

11.2 Questionnaire baseline (English version)

Astma in Telemark

- A health research project

We address to you to ask if you want to participate in a research project whose goal is to find out which factors inside and outside of work that affects the respiratory system. Such knowledge can help to prevent the disease of the respiratory tract occurs and to provide better guidance to those who have been sick. The survey will give us more knowledge, the more people who respond. Your response is just as important, whether you are healthy or sick. We ask that you answer as best you can, even if some of the questions may be a bit difficult. It takes about 20 minutes to fill out the form. The questionnaire will be sent to 50,000 randomly selected residents in Telemark county, Norway. The project is carried out of the hospital, Norway in cooperation with Oslo University Hospital.

Tear off the cover (this sheet) and return the questionnaire filled in in the attached envelope.

Thank you in advance for your help!

All who respond to the questionnaire have the chance to win an iPad or a travel gift certificate. The two winners will be drawn and both can choose one of the two Prize options. Premium choice for the one Grand Prize winner does not affect the options to the other. That is, for example, two iPad can be handed out.

For more complete information about the study, see the information type page 15 and 16 as well as our Web site www.sthf.no/astma. You can also scan the QR code below with your Smartphone.

If you have questions about the survey, you can call, send message or email to one of the team members by the Division of occupational medicine, Telemark Hospital, Norway, Tel: 953 69 315 e-mail: astma@sthf.no

Personal information

Today's date (ddmmyy):

☐☐☐☐☐☐

Gender:

☐ Female

☐ Male

Height: ☐☐☐ *cm*

Weight: ☐☐☐,☐ *kg*

What is your marital status?

☐ Single

☐ Married

☐ Partner

☐ Divorced/separated

☐ Widow

How many years of school do you have?

(Starting with the first class of primary school up to the last fully completed academic year).

☐☐ Years

What is your highest level education?
(Are you currently in secondary/vocational school/college/university? Please cross off your highest completed level of formal education).

☐ Elementary school/grade school

☐ Basic courses/1-2 year(s) of education after elementary school

☐ Secondary/high school/vocational school (3-years)

☐ Certificate

☐ University/College - 4 years or less

☐ University/College - more than 4 years

☐ Other: ____

We assume that your work ability, when it was at its best would rate 10 points. How many points would you give your current work ability? (0 means that you cannot work and 10 that your work ability is at its best right now).

0	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Working conditions

1. *Have you ever been in work?*

☐ No (go to question 10)

☐ Yes (go to question 2)

2. ***Describe your employment and work tasks with their associated time frames.*** *If you have worked less than three months you do not need to respond.*

If you have had many employers with similar works tasks merge them into one and proceed through the questionnaire. (Example: Building and construction, excavator driver with Selmer/Pavement/Ripper-Smith, 1993-2009). If you have been self-employed consider this as employment and proceed through the questionnaire.

Examples:

Yara/ Fertilizer Manufacturer	*Process operator*	*2008*	*2010*
Teaching	*Teacher at the vocational school*	*2010*	*2011*
Consulting	*Consultant company*	*2011*	*present day*

Sector/industry	***Profession (title)/work tasks***	***Year started***	***Year ended***

3. *Have you been in work for **the past 12 months**?*

☐ No

☐ Yes

Supplementary questions about your work tasks in various employment situations: Many of these questions are specific to certain professions. If the question does not apply to you; answer no and move on to the next question.

4. *Have you in your work been subjected to: Gas, smoke or dust?*

☐ No

☐ Yes

5. *If you have been exposed to the gas, smoke or dust over the course of* ***the last five years*** *- how often? (Cross off an average)*

- ☐ Daily, for large parts of the working day
- ☐ Daily, but for short periods
- ☐ Weekly
- ☐ Less often

6. *Have you* ***ever,*** *in your* ***work,*** *been exposed to:*

	No	Yes	Last year of exposure
Smoke from frying	☐	☐	
Car/engine exhaust	☐	☐	
Strong acids, ammonia or formalin	☐	☐	
Stone dust	☐	☐	
Flour dust	☐	☐	
Wood dust	☐	☐	
Paper dust	☐	☐	
Textile dust	☐	☐	
Metal dust	☐	☐	

7. *At work have you worked with:*

	No	Yes	Last year of exposure
Cleaning/disinfection agents	☐	☐	
If YES, do/did you use spray?	☐	☐	
Superglue or similar	☐	☐	
Painting or varnishing work	☐	☐	
Welding or other metal smoke	☐	☐	
Sewage or treatment plants	☐	☐	
Hair care products	☐	☐	
Animals	☐	☐	

If YES, which animals? ____________________

Gas, dust or damp not mentioned above

____

8.

Have you worked in offices with:	No	Yes	Last year of exposure
Visible moisture damage	☐	☐	
Visible mold	☐	☐	
Smell of mildew (basement smell)	☐	☐	
Cold (in the cold room or outdoors in winter)	☐	☐	
Have you had physically strenuous work (so that you have been out of breath and sweaty)	☐	☐	
Have you had work with repetitive heavy lifting?	☐	☐	

9. *Have you used respiratory protection (safety/dust mask) at work during* ***the last 12 months?***

☐ Always/almost always

☐ From time to time

☐ Never/almost never

Have you only used respiratory protection in cases of high exposure?

☐ No

☐ Yes

10. *Have you had an accident at work or in your leisure time where you have been exposed to high levels of gas, smoke or dust?*

☐ No

☐ Yes

If YES, did you experience respiratory problems (coughing, shortness of breath, wheezing/rasping) when the accident happened or immediately afterwards?

☐ No

☐ Yes

Respiratory symptoms

11.

		No	Yes
11.1	Have you had wheezing or whistling in the chest at some point over the course **of the last 12 months**?	☐	☐
	If NO, go to question 11.2, if YES:		
a	Have you ever felt out of breath due to wheezing or whistling in your chest?	☐	☐
b	Have you had whistling or wheezing in your chest without having a cold?	☐	☐
11.2	Have you woken up with a feeling of tightness in your chest at any time in **the last 12 months**?	☐	☐
11.3	Have you woken up with breathing difficulties over the course of **the last 12 months?**	☐	☐
11.4	Have you woken up due to coughing attacks during **the last 12 months?**	☐	☐
11.5	Have you experienced an asthma attack in **the last 12 months**?	☐	☐
11.6	Do you currently use any medication (spray, inhalation powder or tablets) for asthma?		
11.7	Do you have allergies that cause nasal symptoms, including hay fever?	☐	☐
11.8	Have you during the last years had a prolonged cough?	☐	☐
11.9	Do you usually cough up phlegm or have mucus in the lungs that is hard to get up?	☐	☐
	If NO go to question 11.9, if YES:		
a	Do you cough up or bring up phlegm in this way nearly every day for at least three months each year?	☐	☐
b	Have you had periods with similar symptoms for at least two consecutive years?	☐	☐
c	How old were you when these problems started? ☐ Years		
11.10	Have you ever had whistling or wheezing in the chest?	☐	☐
	If Yes, how old were you when you experienced whistling or wheezing in the chest the first time? ☐ Years		

11.11	Do you have, or have you ever had asthma?		☐	☐
	If NO go to question, 11.11, if YES:			
	a	Has a physician ever diagnosed you with asthma?	☐	☐
	b	How old were you when you first experienced asthma symptoms? ☐☐ years		
	c	What year did you last experience asthma symptoms? ☐☐☐☐ (yyyy)		
11.12	Has a physician ever told you that you have chronic obstructive pulmonary disease (COPD)?		☐	☐
	If Yes, how old were you when you first experienced symptoms of COPD? ☐☐ years			
11.13	Have you ever experienced nasal symptoms such as stuffy nose, runny nose or sneeze attacks without having a cold?		☐	☐
	If NO go to question 11.13, if YES:			
	a	How old were you when you first experienced these nasal symptoms? ☐☐ years		
	b	Have you had nasal symptoms over **the course of the last 12 months?**	☐	☐
	c	During which season are your symptoms worse? (select only one option) ☐Spring ☐Summer ☐Autumn ☐Winter ☐Always ☐Don't know		
11.14	Have you ever had a blocked nose **for more than 12 weeks over the course of the last 12 months?**		☐	☐
11.15	Have you had pain or pressure around the forehead, nose, or eyes **for more than 12 weeks over the course of the last 12 months?**		☐	☐
11.16	Have you had discolored nose secretions (snot) or discolored mucus in the throat for **more than 12 weeks over the course of the last 12 months?**		☐	☐
11.17	Has your sense of smell been impaired or lost for **more than 12 weeks over the course of the last 12 months?**		☐	☐

Respiratory symptoms and work

12. *Have you ever had recurring respiratory symptoms (cough, heavy breathing, wheezing, whistling) while on the job?*

- ☐ No (go to question 15)
- ☐ Yes
- ☐ Yes, in the last 12 months

How serious were the respiratory symptoms?

(0 means that you did not have ailments and 10 that you had very serious ailments.)

0	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

13. *Were your complaints better:*

	No	Yes
- on weekends?	☐	☐
- during the holidays?	☐	☐
- during other absence from work?	☐	☐
- when changing your job/workplace?	☐	☐

14. *If you use/have used medicine to treat respiratory symptoms; can/could you reduce its use/dosage?*

	No	Yes
- on weekends?	☐	☐
- during the holidays?	☐	☐
- during other absence from work?	☐	☐
- when changing your job/workplace?	☐	☐

15. *Have you ever changed your job because the job has affected your breathing?*

☐ No

☐ Yes

If Yes, when was it (in which year)?

Year [_ _ _ _] Year [_ _ _ _]

If YES, which place of work (work tasks) did you have at that time?

____

16. *Have you ever changed your job because of: Hay fever, or other nasal problems?*

☐ No

☐ Yes

If Yes, when was it (what or which year)?

Year [_ _ _ _] Year [_ _ _ _]

If YES, which place of work (work tasks) did you have at that time?

____

17. *Have you ever changed job due to other health problems/illnesses?*

☐ No

☐ Yes

18. *Have you been on sick leave during* ***the past 12 months*****?**

☐ No

☐ Yes

If YES, for how many days? Choose only one option

☐ 1-7 days ☐ 8 -14 days ☐ 15 days - 12 weeks ☐ More than 12 weeks

19. *Have you been off work due to breathing problems in* ***the last 12 months****?*

☐ No

☐ Yes

Smoking and snuff habits

20.

	No	Yes
Do you smoke daily (even if you only smoke a few cigarettes, cigars or a pipe daily)?	☐	☐
Do you smoke only occasionally (not daily, but weekends, party smoking or the like)?	☐	☐
Did you use to smoke?	☐	☐

If the answer is NO to question 20, go to question 25.

21. *How much did you smoke? (Give an average)*

☐ Cigarettes per day or ☐ cigarettes per **week**

☐ Cigars per week

☐ Packs of rolling tobacco-/pipe tobacco per week

22. *How old were you when you started smoking?*

☐ Years

23. *How long have you been smoking (this applies to both current and former smoking)?*

☐ Years

24. *If you smoked in the past, when did you quit?*

☐ Year

25. *Do you use, or have you used snuff?*

☐ No, never ☐ Yes from time to time

☐ Yes, but I stopped ☐ Yes, daily

*If you have **never** taken snuff, go to question 26.*

If YES:

How old were you when started to take snuff? ☐ *years*

How many tins of snuff do/did you use per month? ☐ *tins*

If you have stopped taking snuff, how old were you stopped? ☐ *years*

Living conditions

26. *What type of residence do you live in? (Choose two options)*

☐ Detached house ☐ Apartment/lodgings

☐ Row house/Semi-detached ☐ Other

27. *When did you move into your current residence?*

☐ year

28. *How many hours per day do you normally spend in your home?*

Weekdays ☐ hours Weekends ☐ hours

29. Is tobacco smoked inside your current residence? Choose only one option.

☐ Almost daily ☐ 1-4 times/week ☐ 1-4 times/week ☐ Never

30. Have you had any of the following in your residence?

	No	Yes	The number of years	The last year you were exposed.
Water damage/damage from damp inside the dwelling on walls, floors or ceilings?	☐	☐		
"Warped" plastic mats, yellowed plastic coating or wood flooring that has become dark due to moisture?	☐	☐		
Visible mold on walls, floors or ceilings?	☐	☐		
Have you at any time over the course of the last 10 years seen signs of moisture damage, water leakage or mildew in your home?	☐	☐		

31. *Is your bedroom window near a street (less than 20 m)? Choose only one option*

☐ No ☐ Yes, with moderate traffic
☐ Yes, with light traffic ☐ Yes, with a lot of traffic

32. *How much time do you usually spend travelling along a moderate-to very busy road in the course of a normal day?*

About ☐ minutes/day

33. *Which of following heating methods were used in your home when you were five years old?* Select more than one option if applicable.

- ☐ Wood
- ☐ Coal
- ☐ Paraffin
- ☐ Electricity
- ☐ Gas
- ☐ Oil
- ☐ Water-borne/district heating

34. *What word best describes the place you lived most of the time when you were under five years old? Choose only one option* Choose only one option

- ☐ Farm with animals
- ☐ Farm without animals
- ☐ Hamlet/village
- ☐ Small town/close to a town
- ☐ Large city

35. *Have you over the past 12 months used spray products regularly for cleaning at home?*

- ☐ No
- ☐ Yes

Childhood and family

36.

	No	Yes	Do not know
Did you as a child, have a severe respiratory infection before the age of 5?	☐	☐	☐
Did your mother smoke regularly when you were a child?	☐	☐	☐
Did your father smoke regularly when you were a child?	☐	☐	☐
Did anyone else in your home smoke on a regular basis when you were a child?	☐	☐	☐

37. *Do you have parents who have, or have had, the following diseases (provide a response for deceased parents)?* Use a cross mark if the answer is YES

	Mother	Father
Asthma	☐	☐
Chronic bronchitis, emphysema or COPD	☐	☐
Heart disease	☐	☐
High blood pressure	☐	☐
Brain hemorrhage/stroke	☐	☐
Diabetes (diabetic)	☐	☐
Cancer	☐	☐

Physical activity and diet

38. *How often do you train? (Give an average)*

☐ Never
☐ Less than 1 time per week
☐ 1 time per week
☐ 2-3 times per week
☐ About daily (4-7) times per week)

39. *If you train once per week or more:*
How hard do you exercise?

☐ Take it easy without getting out of breath or sweaty
☐ Take it so hard that I get out of breath and/or sweaty
☐ I am almost exhausted

40. *How long do you usually work out? (Give an average)*

☐ Less than 15 minutes
☐ 15-29 minutes
☐ 30 minutes to 1 hour
☐ More than 1 hour

41. *Do you usually have at least 30 minutes of physical activity daily?*

☐ No ☐ Yes

42. *How often do you usually eat these foods?* *Make a cross in the box*

	0-3 times per month	1-3 times per week	4-6 times per week	1 time per day	2 times or more per day
Fruit/berries	☐	☐	☐	☐	☐
Vegetables	☐	☐	☐	☐	☐
Chocolate/candy	☐	☐	☐	☐	☐
Boiled potatoes	☐	☐	☐	☐	☐
Pasta/rice	☐	☐	☐	☐	☐
Sausages/hamburgers	☐	☐	☐	☐	☐
Fatty fish (salmon, trout, herring, mackerel, redfish as toppings at dinner)	☐	☐	☐	☐	☐

43. *Do you use the following supplements?* *Make a cross in the box*

	Yes, daily	Occasionally	No
Cod liver oil	☐	☐	☐
Omega-3 capsules	☐	☐	☐
Vitamin-and/or mineral supplements	☐	☐	☐

Other diseases and illnesses

44. If you answer YES to the questions below, fill in your age on the far right.

(Cross either no or yes to all questions)

	No	Yes	If Yes, how old were you the **first** time?
Have you been told by a physician that you have high blood pressure?	☐	☐	☐ year
Has a physician told you that you have diabetes?	☐	☐	☐ year
Have you been hospitalized with a heart attack or heart cramp (angina)?	☐	☐	☐ year
Has a physician ever told you have heart failure (weak heart, water on the lungs or swollen legs)?	☐	☐	☐ year

45. *Do you have, or have you ever had any of these diseases/complaints?*

Make a cross to indicate either no or yes to all the questions)

	No	Yes	If Yes, how old were you on the **first** occurrence?
Stroke/aneurism	☐	☐	☐ year
Atrial fibrillation?	☐	☐	☐ year
Eczema on the hands (with the exception of psoriasis)?	☐	☐	☐ year
Chronic lung disease other than asthma or COPD?	☐	☐	☐ year
Have you ever had mental problems that you have sought help for?	☐	☐	☐ year

11.3 Questionnaire 5-year follow-up (English version)

SYKEHUSET TELEMARK

Ola Nordmann

Address

0000 Place

Final reminder

You can ignore this letter if you have already replied.

For preventive health measures and research

A request to you

This is a request to you as a resident or former resident of Telemark to participate in a population survey – a health research project. We would like to ask you to complete this questionnaire. It takes approximately 20 minutes. You can decide whether you prefer to reply online (electronic questionnaire) or return the paper form in the enclosed stamped envelope. The survey is being conducted by Telemark Hospital in cooperation with the University of Oslo. The information will be used for research and preventive health measures. Researchers will only have access to anonymised data, meaning that the results cannot be traced back to individual persons.

The questionnaire was previously sent out in 2013, although some people are now receiving it for the first time. This follow-up research will provide new, updated knowledge.

Tear off the first page (this page) before returning the questionnaire. Postage has been paid.

For electronic responses

Go to: **resp.nsd.no**

UserID: XXXXXXXX
Password: XXXX

How to complete the form

TELEMARK STUDIEN

- The form will be read automatically.
- It is therefore important that you cross off correctly: **Correct** ☒ **Incorrect** ☐✗ ☑
- If you cross off wrongly, you can correct your entry by shading the box like this: ■
- Write numbers clearly: 0 1 2 3 4 5 6 7 8 9
- Do not write outside the marked area. This will not be read automatically.
- Use a black or blue pen. Do not use a pencil or marker pen.

If you wish to participate, please complete the form and post it as soon as possible.

If you have any questions, you can call us or send a text message to tel.: 953 69 315,
or send an email to: astma@sthf.no

Results of the first round of the Telemark study

The Telemark study has been ongoing since 2013 and has provided new knowledge and many interesting findings. Some of these are described below. Thank you for participating. Your answers are supporting more effective prevention of health complaints in our region.

Fewer smokers

The Telemark study has shown that there are fewer daily smokers in Telemark than before. In 2013, 15% in the 16–50 age group stated that they smoked. We do not have updated figures for Telemark, but the national average has fallen to 12%. However, many people are exposed to passive smoking. Six percent of adults in Telemark who have never smoked have been exposed to passive smoking at home. These people were at an increased risk of chronic coughing and waking up at night with breathing difficulties.

Link: http://erj.ersjournals.com/content/48/suppl_60/PA4290

Damp and mildew

In 2013, one out of five persons in Telemark stated that they had experienced damp or mildew damage in their home. Exposure to damp and mildew at home increases the risk of respiratory problems and asthma. In addition, 15% had observed such damage at work. If you have damp and mildew in your home, you should remove the damaged materials as soon as possible and ventilate well for many weeks.

Chronic sinusitis

In Telemark, almost one in ten participants reported suffering from chronic sinusitis. We know from other studies that sinus problems have a negative impact on quality of life. The Telemark study has shown that people who are exposed to metal dust, cleaning agents and smoke from frying at work are at increased risk of chronic sinusitis. We also found that asthmatics and smokers suffered from sinusitis more often than other people. This knowledge is important for efforts to prevent this common and troublesome condition.

Having to change jobs due to breathing problems

The people who completed the Telemark study questionnaire in 2013 have contributed to groundbreaking work. For the first time, we now know which occupations can affect breathing so much that employees have to change jobs. Two percent of persons from Telemark stated that they had changed jobs because their work was affecting their breathing. The occupations presenting the highest risk of a job switch were cook, sheet-metal worker, welder, gardener, hairdresser, cleaner and worker on a large farm. Measures which would allow most people to remain in these occupations are reducing dust levels, offering alternative work tasks to people with problems and making better use of protective equipment.

Link: http://oem.bmj.com/content/oemed/73/9/600.full.pdf

Occupations and respiratory problems

Eleven percent of adults in Telemark have stated that they suffer from asthma diagnosed by a physician. This figure is not higher than the national average, but when one in ten people have this chronic lung disease, more should be done. More knowledge is needed to prevent more people becoming ill and to ensure that more people receive treatment. The Telemark study shows that the industries with an increased risk of respiratory problems are agriculture, fisheries, trades and retail. Exposure to substances such as flour dust, isocyanates, welding fumes and exhaust gases also increases the risk of certain respiratory problems. These findings have improved our knowledge of where measures should be targeted.

Link: http://bmjopen.bmj.com/content/bmjopen/7/3/e014018

Date of completion: / 2018

Day Month Year

PERSONAL INFORMATION

Gender:

☐ Female ☐ Male

Height ☐ cm Weight ☐ kg

What is your marital status?

☐ Single

☐ Married

☐ Partner

☐ Divorced/separated

☐ Widow/er

How many years of school/education do you have?

(Starting with the first class of primary school up to the last fully completed academic year). ☐ years

What is your highest **completed** level of education? (Are you currently in secondary/vocational school/college/university? Please cross off your highest completed level of education).

☐ Elementary school/grade school

☐ Basic courses/1-2 year(s) of education after elementary school

☐ Secondary/high school/vocational school (3 years)

☐ Certificate

☐ University/College - 4 years or less

☐ University/College - more than 4 years

☐ Other: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

We assume that your work ability, when it was at its best would rate 10 points. How many points would you give your current work ability? (0 means that you cannot work and 10 that your work ability is at its best right now).

0	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Total gross household income

☐ Under 500 000

☐ Over 500 000

☐ Over 1 000 000

WORKING CONDITIONS

1 Have you ever been in work?

☐ No (go to question 11)

☐ Yes (go to question 2)

2 **Describe your employment and work tasks with their associated time frames.** If you have worked less than three months you do not need to respond.

If you have had very many employers where you have performed similar works tasks, you can merge the work periods into one. (Example: Building and construction, excavator driver for Selmer/Veidekke/Kruse-Smith, 1993–2009). If you have been self-employed, treat this as employment.

Example:
Sector/industry: Yara/compound fertilizer factory

Occupation (title)/work tasks: Process operator

Year started 2008 *Year ended* to date

Sector/industry ________________ Occupation (title)/work tasks ____________

Year started [ ] Year ended [ ]

Sector/industry ________________ Occupation (title)/work tasks ____________

Year started [ ] Year ended [ ]

Sector/industry ________________ Occupation (title)/work tasks ____________

Year started [ ] Year ended [ ]

Sector/industry ________________

Occupation (title)/work tasks ____________

Year started [ ] Year ended [ ]

Sector/industry ________________

Occupation (title)/work tasks ____________

Year started [ ] Year ended [ ]

---

3 Have you been engaged in paid work for **the past 12 months?**

☐ No ☐ Yes

Supplementary questions about your work tasks in various employment situations: Many of these questions are specific to certain professions. If the question does not apply to you, answer no and move on to the next question.

4 Have you in your work been subjected to: gas, smoke or dust? If NO, proceed to question 6

☐ No ☐ Yes ☐ Yes, the past 12 months

5 If you have been exposed to gas, smoke or dust over the course of **the last 12 months** - how often? (Cross off an average)

☐ Daily, for large parts of the working day

☐ Daily, but for short periods

☐ Weekly

☐ Less often

6 Have you**,** in your work**,** been exposed to:

	No	Yes	Yes, last 12 months
Smoke from frying	☐	☐	☐
Car/engine exhaust	☐	☐	☐
Strong acids, ammonia or formalin	☐	☐	☐
Stone dust	☐	☐	☐
Flour dust (baker, confectioner, cook, miller)	☐	☐	☐
Wood dust	☐	☐	☐
Dust from paper production	☐	☐	☐
Metal dust	☐	☐	☐

7 At work have you worked regularly with:

	No	Yes	Yes, last 12 months (exposed)
Cleaning/disinfection agents	☐	☐	☐
If YES, do/did you use spray?	☐	☐	☐
Glue (superglue, glue for nails/lashes)	☐	☐	☐
Painting or varnishing work	☐	☐	☐
Welding or other metal smoke	☐	☐	☐
Sewage or treatment plants	☐	☐	☐
Hair care products	☐	☐	☐
Animals	☐	☐	☐
Biological dust (plants, organic materials, etc.)	☐	☐	☐
Gas, dust or damp not mentioned above	☐	☐	☐

8 Have you worked in offices with:

	No	Yes	Yes, last 12 months (exposed)
Visible moisture damage	☐	☐	☐
Visible mildew	☐	☐	☐
Smell of mildew (basement smell)	☐	☐	☐
Cold (in a cold room or outdoors in winter)	☐	☐	☐
Have you engaged in physically strenuous work (so that you have been out of breath and sweaty)?	☐	☐	☐
Have you done work involving repetitive heavy lifting?	☐	☐	☐

9 Have you used respiratory protection (safety/dust mask) at work during **the last 12 months?**

☐ Always/almost always ☐ From time to time ☐ Never/almost never

10 Have you had an accident at work or in your leisure time where you have been exposed to high levels of gas, smoke or dust?

Work:	☐ No	☐ Yes	☐ Yes, last 12 months
Leisure time:	☐ No	☐ Yes	☐ Yes, last 12 months

If YES, did you experience respiratory problems (coughing, shortness of breath, wheezing/rasping) when the accident happened or immediately afterwards?

Work:	☐ No	☐ Yes	☐ Yes, last 12 months
Leisure time:	☐ No	☐ Yes	☐ Yes, last 12 months

RESPIRATORY SYMPTOMS

11 Have you ever experienced wheezing or rasping in your chest?

☐ No ☐ Yes

If YES, how old were you when you experienced wheezing or rasping in your chest for the first time?

☐ years

12 Have you experienced wheezing or rasping in your chest at some point over the course of **the last 12 months**?

	No	Yes
If NO, go to question 13	☐	☐
If YES:		
a) Have you ever been out of breath when you have experienced wheezing or rasping in your chest?	☐	☐
b) Have you experienced whistling or rasping in your chest without having a cold?	☐	☐

13 Have you been out of breath at some point over the course of **the last 12 months**?

☐ No ☐ Yes

If NO, go to question 15. **If YES:**

	No	Yes
a) Have you had breathing difficulties while you were at rest at some point over the course of **the last 12 months**?	☐	☐
b) Have you had breathing difficulties after being exposed to cold at some point over the course of **the last 12 months**?	☐	☐

14 Have you woken up with breathing difficulties at some point over the course of **the last 12 months**?

☐ No ☐ Yes

15 Have you woken up with a feeling of tightness in your chest at some point over the course of **the last 12 months**?

☐ No ☐ Yes

16 Have you woken up due to a coughing attack at some point over the course of **the last 12 months**?

☐ No ☐ Yes

17 Have you been out of breath without having a cold?

☐ No ☐ Yes

18 Have you had a persistent cough **in recent years**?

☐ No ☐ Yes

19 Do you usually cough up phlegm or have mucus in the lungs that is hard to get up?

☐ No ☐ Yes

If NO go to question 20.
If YES:

	No	Yes
a) Do you cough or bring up phlegm in this way nearly every day for at least three months each year?	☐	☐
b) Have you had periods with similar symptoms for at least two consecutive years?	☐	☐

c) How old were you when these problems started?

☐☐ years

20 Do you have, or have you ever had asthma?

☐ No ☐ Yes

If NO go to question 21.
If YES:

	No	Yes
a) Has a physician ever diagnosed you with asthma?	☐	☐
b) How old were you when you first experienced asthma symptoms?	☐☐ years	
c) Have you experienced an asthma attack in **the last 12 months**?	☐	☐

d) What year did you last experience asthma symptoms? ☐☐☐☐ (yyyy)

21 Has a physician ever told you that you have chronic obstructive pulmonary disease (COPD)?

☐ No ☐ Yes

If YES, how old were you when you first experienced COPD symptoms? ☐☐ years

22 Do you have an allergy which has nasal symptoms, including hay fever?`

☐ No ☐ Yes

23 Have you ever experienced nasal symptoms such as stuffy nose, runny nose or sneeze attacks **without having a cold**?

☐ No ☐ Yes

If NO go to question 24.
If YES:

a) How old were you when you first experienced these nasal symptoms? ☐☐ years

b) Have you had nasal symptoms in **the last 12 months**?

☐ No ☐ Yes

c) During which season are your symptoms the worst? (select only one option)

☐ Spring ☐ Summer ☐ Autumn ☐ Winter ☐ Always ☐ Do not know

24 Have you had a blocked nose for **more than 12 weeks over the course of the last 12 months**?

☐ No ☐ Yes

25 Have you had pain or pressure around the forehead, nose, or eyes for **more than 12 weeks over the course of the last 12 months**?

☐ No ☐ Yes

26 Have you had discoloured nasal secretions (snot) or discoloured mucus in the throat for **more than 12 weeks over the course of the last 12 months**?

☐ No ☐ Yes

27 Has your sense of smell been impaired or lost for **more than 12 weeks over the course of the last 12 months**?

☐ No ☐ Yes

28 Have you had tonsils or adenoids removed?

☐ No ☐ Yes

If YES, approximately how old were you **the first time**?

☐☐ years

29 Have you had breathing difficulties after exerting yourself at some point over the course of **the last 12 months**?

☐ No ☐ Yes

30 Have you consulted a general practitioner, specialist, accident and emergency unit or hospital due to acute breathing difficulties at some point over the course of **the last 12 months**?

☐ No ☐ Yes ☐ Number of times

If YES

☐ General practitioner ☐ Specialist

☐ Accident and emergency unit ☐ Hospital

If hospital:

Have you been admitted to hospital due to acute breathing difficulties at some point over the course of **the last 12 months**?

☐ No ☐ Yes ☐ Number of times

31 Have you increased your use of or been prescribed new medicines due to lung or respiratory symptoms at some point over the course of **the last 12 months**?

☐ No ☐ Yes

If YES	Number of times
Antibiotics only	☐
Cortisone only	☐
Antibiotics and cortisone	☐

RESPIRATORY SYMPTOMS AND WORK

32 Have you ever experienced recurring respiratory symptoms (cough, breathing difficulties, wheezing, rasping) **at work**?

☐ No (go to question 35)

☐ Yes

☐ Yes, last 12 months

How serious were the respiratory symptoms?
(0 means that you did not have ailments and 10 that you had very serious ailments.)

0	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

33 Did your ailments improve:	No	Yes
- on weekends?	☐	☐
- during the holidays?	☐	☐
- during other absence from work?	☐	☐
- when changing your job/workplace?	☐	☐

34 If you use/have used medicine to treat respiratory symptoms, can/could you reduce its use/dosage?

	No	Yes
- on weekends?	☐	☐
- during the holidays?	☐	☐
- during other absence from work?	☐	☐
- when changing your job/workplace?	☐	☐

35 Have you ever changed your job because the job has affected your breathing?

☐ No ☐ Yes

If YES, when was this (which year or years)?

☐ (Year) ☐ (Year)

If YES, which place of work (work tasks) did you have at that time?

_ _

36 Have you ever changed your job due to: hay fever or other nasal problems?

☐ No ☐ Yes

If YES, when was this (which year or years)?

[| | |] (Year) [| | |] (Year)

If YES,
which place of work (work tasks) did you have at that time?

_ _

37 Have you been on sick leave **during the past 12 months**?

☐ No ☐ Yes

If YES, for how many days? (Choose only one option.)

☐ 1–7 days ☐ 8–14 days

☐ 15 days–12 weeks ☐ More than 12 weeks

38 Have you been off work due to breathing problems over the course of **the last 12 months**?

☐ No ☐ Yes

MEDICINES

39 Have you used the following over the course of **the last 12 months**?

	No	Yes
Cortisone tablets		
Astringent nasal spray (Rhinox, Dexyl, Nazaren, Otrivin, Zymelin, Zycomb)	☐	☐
Nasal spray containing cortisone (Budesonid, Rhinocort, Flutide, Mometasone, Nasonex, Hasacort, Dymista)	☐	☐
Allergy tablets (anti-histamines) e.g. Zyrtec, Aerius, Cetirizine	☐	☐
Medicines against high blood pressure	☐	☐
Medicines against diabetes	☐	☐
Medicines against high cholesterol	☐	☐

40 Are you currently using medicine (spray, inhalation powder or tablets) against asthma?

☐ No (go to question 43)

☐ Yes

41 Have you used one or more of the following lung medicines over the course of **the last 12 months**?

	No	Yes, regularly	Yes, as needed
Cortisone tablets			
Airomir, Buventol, Ventoline, Bricanyl, Seritide, Oxis, Onbrez, Striverdi	☐	☐	☐
Airflusal, Seretide, Salmeterol/ fluticasone, Duoresp, Symbicort, Inuxair, Relvar, Flutiform	☐	☐	☐
Anoro, Ultibro, Duaklir, Spiolto	☐	☐	☐
Airobec, Giona, Pulmicort, Flutide, Flutikason, Asmanex, Alvesco	☐	☐	☐
Seebri, Incruse	☐	☐	☐

42 Have you **increased** your inhalation of cortisone at any point over the course of **the last 12 months**?

☐ No

☐ Yes

SMOKING AND SNUFF HABITS

	No	Yes
43 Do you smoke daily (even if you only smoke a few cigarettes, cigars or a pipe daily)?	☐	☐
Do you smoke only occasionally (not daily, but weekends, party smoking or the like)?	☐	☐
Did you smoke previously?	☐	☐

If all the answers to question 43 are NO, go to question 48.

44 How much do/did you smoke? (Give an average)

☐ Cigarettes per day or ☐ cigarettes per week

☐ Cigars per week

☐ Packs of rolling/pipe tobacco per week

45 How old were you when you started smoking?

☐ years

46 How long have you smoked (applies to both current and former smoking)?

☐ years

47 If you smoked in the past, when did you quit?

☐ year

48 Do you use, or have you used, snuff?

☐ No, never (go to question 50)

☐ Yes, from time to time

☐ Yes, but I have stopped

☐ Yes, daily

49 How long have you used snuff (applies to both current and former snuff use)?

☐ years

LIVING CONDITIONS

50 What type of residence do you live in? (**Choose two options**.)

☐ Detached house

☐ Apartment/lodgings

☐ Terraced house/Semi-detached

☐ Other

AND

☐ Owner-occupier/co-ownership

☐ Tenant in privately owned residence

☐ Tenant in publicly owned residence

51 When did you move into your current residence?

☐ year

52 Is tobacco smoked inside your current residence? (Choose only one option.)

☐ Daily/almost daily ☐ 1–4 times/week

☐ 1–3 times/month ☐ Never

53 Have you had any of the following in your residence?

Last year of exposure

Water damage/damage from damp on walls, floors or ceilings inside the residence? (yyyy)

☐ No ☐ Yes ☐ Number of years ☐

"Warped" plastic mats, yellowed plastic coating or wood flooring that has become dark due to moisture? (yyyy)

☐ No ☐ Yes ☐ Number of years ☐

Visible mildew on walls, floors or ceilings? (yyyy)

☐ No ☐ Yes ☐ Number of years ☐

Have you at any time over the course of the last 10 years seen signs of damage from damp, water leakage or mildew in your residence? (yyyy)

☐ No ☐ Yes ☐ Number of years ☐

54 Is your bedroom window near a street (less than 20 m)? Choose only one option

☐ No ☐ Yes, with moderate traffic

☐ Yes, with light traffic ☐ Yes, with a lot of traffic

55 How much time do you usually spend walking or travelling (bicycle, etc.) along a moderate-to-very busy road in the course of a normal day?

About ☐ minutes/day

56 Have you used spray products regularly for cleaning at home **over the past 12 months**?

☐ No ☐ Yes

57 Do you have a wood-burning stove in your residence?

☐ No ☐ Yes

If YES, what type:

☐ New or clean-burning wood burner

☐ Old wood burner

☐ Open fireplace

If YES, how often do you use wood to heat your home in the cold season?

☐ Daily ☐ 2–3 times/week ☐ Less often than this

58 When you are sleeping, do you normally have the window of the bedroom open or closed? (Cross off on each line.)

Summer: ☐ Open ☐ Closed

Winter: ☐ Open ☐ Closed

CHILDHOOD AND FAMILY

59 Do you have parents who have, or have had, the following diseases (also provide a response for deceased parents)?

	Mother	Father
Asthma	☐	☐
Chronic bronchitis, emphysema or COPD	☐	☐
Heart disease	☐	☐
High blood pressure	☐	☐
Brain haemorrhage/stroke	☐	☐
Diabetes (diabetic)	☐	☐
Cancer	☐	☐

PHYSICAL ACTIVITY AND DIET

60 How often do you exercise?

☐ Never
☐ Less than once per week
☐ Once per week
☐ 2-3 times per week
☐ Daily/almost daily (4-7) times per week

61 If you exercise once per week or more:
How hard do you exercise?

☐ I take it easy without getting out of breath or sweaty
☐ I exercise so hard that I am out of breath and/or sweaty
☐ I am almost exhausted afterwards

62 For how long do you usually exercise? (Give an average)

☐ Less than 15 minutes
☐ 15–29 minutes
☐ 30 minutes to 1 hour
☐ More than 1 hour

63 Do you usually engage in at least 30 minutes of physical activity every day which leaves you sweaty and out of breath?

☐ No
☐ Yes

64 How often do you usually eat these foods? (Only put one cross per line.)

	0–3 times per month	1–3 times per week	4–6 times per week	Once a day	2 times or more per day
Whole-wheat bread or other whole-grain products	☐	☐	☐	☐	☐
Chocolate/candy	☐	☐	☐	☐	☐
Sugary carbonated drinks or other cold drinks containing sugar	☐	☐	☐	☐	☐
Sausages/hamburgers	☐	☐	☐	☐	☐
Fatty fish (salmon, trout, mackerel, herring, redfish as a topping/for dinner	☐	☐	☐	☐	☐

65 How many portions of vegetables or fruit/berries do you eat in the course of a day? A portion can be e.g. 1 medium-sized fruit or 1 carrot, 1 slice of turnip or a portion-sized bowl of salad.

Number of portions: (cross off below)

	0	½	1	2	3	4	5 or more
Vegetables (excluding potatoes)	☐	☐	☐	☐	☐	☐	☐
Fruit or berries (including juice, max. 1 glass)	☐	☐	☐	☐	☐	☐	☐

66 How often do you eat breakfast?

- ☐ Rarely/never
- ☐ Once or twice a week
- ☐ 3–4 times a week
- ☐ 5–6 times a week
- ☐ Every day

OTHER DISEASES AND SYMPTOMS

67 **If you answer YES to the questions below**, please fill in your age on the far right. (Cross off either no or yes for all questions.)

	No	Yes	**If YES,** how old were you the first time?
Have you been told by a physician that you have high blood pressure?	☐	☐	☐ years
Has a physician told you that you have diabetes?	☐	☐	☐ years
Have you been hospitalized with a heart attack or heart cramp (angina)?	☐	☐	☐ years
Has a physician ever told you that you have heart failure (a weak heart, water in the lungs or swollen legs)?	☐	☐	☐ years

68 Do you have, or have you ever had any of these diseases/complaints? (Cross off either no or yes for all questions.)

	No	Yes	**If YES,** how old were you the first time?
Stroke/aneurism?	☐	☐	☐ years
Atrial fibrillation?	☐	☐	☐ years
Eczema on the hands (with the exception of psoriasis)?	☐	☐	☐ years
Chronic lung disease other than asthma or COPD?	☐	☐	☐ years
Mental problems you have sought help for?	☐	☐	☐ years
Heartburn	☐	☐	☐ years

Thank you for your contribution!

MORE INFORMATION ABOUT THE STUDY AND THE REQUEST TO PARTICIPATE IN THE TELEMARK STUDY HEALTH RESEARCH PROJECT

This is a request to you to participate in a large population survey in Telemark County. The Telemark study is a health research project. The study was previously called Asthma in Telemark, but has now been renamed the Telemark study. We are asking about different illnesses and conditions, but have a special focus on allergies, asthma and COPD. The aim is to investigate how what we are exposed to at work and in our environment affects health and quality of life. This knowledge helps prevent illness and provides better guidance and treatment for people who are ill. The more people who reply, the more knowledge the questionnaire will provide. Your reply is equally important regardless of whether you are healthy or ill. Please answer as best you can, even though some of the questions may be a little difficult. Completing the form takes about 20 minutes. You can decide whether you prefer to reply online (electronic questionnaire) or return the paper form in the enclosed stamped envelope.

The questionnaire was also sent to 50,000 randomly selected residents of Telemark County aged 16–50 in 2013. **You were one the of the people who responded.** We are now following up with a new questionnaire, among other things to see whether there have been any changes in your health or the factors which impact you in your work or environment. This time, we are also sending the questionnaire to some of the residents of Telemark County who did not receive a request to participate in 2013. Some of the results from the previous survey are discussed on the front page of the questionnaire.

The project is being run by Telemark Hospital in cooperation with the University of Oslo.

For more detailed information on the survey, see our website www.sthf.no/Telemarkstudien. If you have questions about the questionnaire, you can call, send a text message or send an email to one of the project staff in the department of occupational medicine at Telemark Hospital, tel.: 953 69 315, email: astma@sthf.no.

WHAT DOES THE PROJECT ENTAIL?

This part of the Telemark study builds on the answers in returned questionnaires. We are using internationally recognised questions to survey the occurrence of illnesses and symptoms, and exposure during and outside of work.

In the project, we will gather and register information about you which will be anonymised (see further information below). By agreeing to participate in the study, you are also agreeing to the linking of information from the questionnaire with information from the National Registry, the Norwegian Prescription Database, the national quality registers, the Cause of Death Registry, the FD-Trygd database and the KUHR (Norway Control and Payment of Health Reimbursement) database.

POSSIBLE BENEFITS AND DRAWBACKS

Benefits of participating in the study: It is important to gather information about how many people suffer from respiratory problems and develop respiratory illnesses. It is even more important to know what factors at work and outside work may cause respiratory problems, so that illness can be prevented in future. Increased knowledge can also help prevent deterioration among people who already have problems. You can help with this by participating in the study. In addition, the study may help politicians and health personnel to improve their planning and introduction of necessary measures in Telemark and elsewhere in Norway to meet the needs and cover the costs associated with respiratory illnesses. Possible drawbacks of participating in the study: Some participants may become worried when filling out the questionnaire. We are available by telephone to answer questions and give advice if this applies to you.

VOLUNTARY PARTICIPATION AND RIGHT TO WITHDRAW

Participation in the project is voluntary, and you can withdraw at any time without saying why. If you wish to withdraw at a later date, all information about you will be deleted. If you wish to participate, you need to complete the questionnaire and return it in the enclosed stamped envelope. By returning the questionnaire, you are agreeing to participate in the study.

If you change your mind and wish to withdraw from the project, you can request the deletion of collected samples and information, unless the information has already been included in analyses or been used in scientific publications. If you later wish to withdraw or have questions about the project, you can contact one of the project staff at Telemark Hospital on tel. 953 69 315 (08:00–15:00).

HOW WILL THE INFORMATION ABOUT YOU BE USED?

The information which is registered about you may only be used as described in the study objectives. You are entitled to know what information is registered about you, and to have any errors in the registered information corrected.

All of the information will be processed without including your name, your national identity number or other information which identifies you directly. In other words, the information will be anonymised. A code will link you with your information through a list of names which will only be available to a small number of project staff at Telemark Hospital. All information will be anonymised when results are published.

Your information will be kept confidential. The technical administration of the online questionnaire is being handled by the Norwegian Centre for Research Data (NSD). Data which NSD provides to researchers will not be linked with any email or IP addresses.

The project manager is responsible for the day-to-day running of the research project, and for ensuring that information about you is processed securely. Information which is registered about you will be stored in locked archives and in a computer system protected by Telemark Hospital's IT procedures. The data processor is Telemark Hospital Health Authority c/o the managing director. Information about you will be anonymised or deleted no later than five years after the end of the project in 2035.

INSURANCE

All participants in the study are insured through the Norwegian System of Patient Injury Compensation (NPE).

SHARING OF INFORMATION WITH THIRD PARTIES

By participating in the project, you are also agreeing that anonymised information may be shared with project staff working on the project at Telemark Hospital or Oslo University Hospital. You are also agreeing that anonymised information may be shared with our partners in Sweden and the USA. The laws of these countries may not be in line with European data protection laws. The code which links you with your personal information will not be shared.

FOLLOW-UP PROJECT

We plan to carry out a non-responder study in which we will contact some of the people who have not filled out the questionnaire to ask them a few simple questions. The aims include finding out whether the replies are unevenly distributed. It is important to be sure that the replies we receive are representative.

In 2018 and 2019, we will invite a group of selected persons who have filled out the questionnaire to attend a research clinic at which we will carry out additional examinations such as taking blood samples and performing breath tests. Those who are invited will be provided with more information about the examination.

Information on the study results: The results of the project will be communicated through local and national public media, and internationally through scientific articles. You can find updated information on the project on the project website: www.sthf.no/Telemarkstudien.

FUNDING

The study is being financed by research funds from Telemark Hospital Health Authority.

APPROVAL

The project has been approved by the Regional committee for medical and health research ethics, case number 2012/1665.

Paper I

Oellingrath IM, De Bortoli MM, Svendsen MV, Fell AKM (2019)."Lifestyle and work ability in a general working population in Norway – a cross-sectional study". BMJ Open. 2019 Apr 3;9(4):e026215. doi: 10.1136/bmjopen-2018-026215

BMJ Open

Lifestyle and work ability in a general working population in Norway: a cross-sectional study

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ABSTRACT

Objectives The aim of this study was to investigate the association between multiple lifestyle-related risk factors (unhealthy diet, low leisure-time physical activity, overweight/obesity and smoking) and self-rated work ability in a general working population.

Setting Population-based cross-sectional study, in Telemark County, Norway, 2013.

Participants A random sample of 50 000 subjects was invited to answer a self-administered questionnaire and 16 099 responded. Complete data on lifestyle and work ability were obtained for 10 355 participants aged 18–50 years all engaged in paid work during the preceding 12 months.

Outcome measure Work ability was assessed using the Work Ability Score (WAS)—the first question in the Work Ability Index. To study the association between multiple lifestyle risk factors and work ability, a lifestyle risk index was constructed and relationships examined using multiple logistic regression analysis.

Results Low work ability was more likely among subjects with an unhealthy diet (OR_{adj} 1.3, 95% CI 1.02 to 1.5), inactive persons (OR_{adj} 1.4, 95% CI 1.2 to 1.6), obese respondents (OR_{adj} 1.5, 95% CI 1.3 to 1.7) and former and current smokers (OR_{adj} 1.2, 95% CI 1.1 to 1.4 and 1.3, 95% CI 1.2 to 1.5, respectively). An additive relationship was observed between the lifestyle risk index and the likelihood of decreased work ability (moderate-risk score: OR_{adj} 1.3; 95% CI 1.1 to 1.6; high-risk score: OR_{adj} 1.9; 95% CI 1.6 to 2.2; very high risk score: OR_{adj} 2.4; 95% CI 1.9 to 3.0). The overall population attributable fraction (PAF) of low work ability based on the overall risk index was 38%, while the PAFs of physical activity, smoking, body mass index and diet were 16%, 11%, 11% and 6%, respectively.

Conclusions Lifestyle risk factors were associated with low work ability. An additive relationship was observed. The findings are considered relevant to occupational intervention programmes aimed at prevention and improvement of decreased work ability.

Strengths and limitations of this study

- ► The study included 10 355 subjects from the general working population in Telemark, Norway.
- ► Inclusion of several lifestyle-related factors allowed for examination of both independent and additive associations between lifestyle and work ability.
- ► The study is strengthened by inclusion of several adjustment variables/possible confounders (age, gender, educational level and occupation) in the regression analyses.
- ► Potential study limitations are selection bias due to non-response, the cross-sectional design, lifestyle and weight self-reports and non-attendance of older than 50.

BACKGROUND

As in many other European countries,[1] Norway's population and workforce are ageing. The challenges this presents have given rise to government policies with a stronger emphasis on work ability promotion and extension of working life. Work ability is a multifactorial concept encompassing the worker's health status, physical capacity and psychological resources[2] and may be defined as the balance between the self-perceived physical and mental capacity and work demands.[2 3]

Promoting and maintaining good work ability in all phases of working life is vital, as poor work ability has been linked with increased risk of reduced work quality,[4] sickness absence,[5–7] long-term disability,[7 8] early retirement[5 9] and long-term unemployment.[7] Good mid-life work ability may also protect against old-age mobility limitation, regardless of type of retirement.[10] A person's work ability may be influenced by various work-related and individual factors.[11 12] At the individual level, lifestyle-related factors (such as diet, physical activity [PA], body mass index [BMI] and smoking) are known to have a significant impact on health.[13 14] However, the contribution of lifestyle to variation in work ability is not fully understood. The most commonly used method for assessing self-rated work ability is the Work Ability Index (WAI), developed by researchers of the Finish Institute of Occupational Health.[15] A corresponding

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instrument is the first single-item question in the WAI, the Work Ability Score (WAS).[16]

Previous cross-sectional and longitudinal studies have investigated the relationship between different lifestyle factors and work ability (measured by WAI or WAS).[11 12 17–26] A systematic review covering 14 cross-sectional and 6 longitudinal studies of lifestyle and work ability published from 1985 to 2006 has identified low leisure-time PA and obesity as important determinants of decreased work ability in different occupational groups.[11] Recent studies support these findings.[12 17–23 25–27] A limited number of studies have indicated a positive association between healthy diet indicators (high intake of fibre/fruits and vegetables) and good work ability.[11 24 27] Non-smoking has also been associated with good work ability in some studies,[6 11 19] although the results on smoking and work ability remain inconclusive.[11 17] Previous studies have commonly focused on distinct occupational groups, groups with certain job demands and selected age groups,[11 12 17–20 23 26 27] rather than on general working populations.[21 22 24] Additional studies assessing large general working populations are warranted to investigate whether lifestyle changes could enhance work ability across occupations and ages.

Lifestyle-related risk factors are often observed together.[28] Previous lifestyle and health studies have shown associations between multiple lifestyle risk indicators on non-communicable, chronic diseases and all-cause mortality,[29] self-rated health,[30 31] long-term work disability (early retirement)[8] and sickness absence due to several diseases.[32] However, few studies have focused on associations between multifactorial lifestyle risk and work ability. It appears that only one small (n=187) Polish study conducted among professionally active subjects has investigated the additive relationship between multiple, simultaneously applicable lifestyle indicators and modification of work ability. In that study, the authors identified an additive association between a healthy lifestyle index (incorporating recommended PA, normal BMI, non-smoking and fibre intake) and increasing WAI.[24] Given the lack of larger studies exploring multifactorial associations between lifestyle and work ability, supplementary studies are needed. Available Norwegian studies have mainly investigated the effect of psychosocial, social and mechanical work exposure on work ability,[33] rather than the potential contribution of lifestyle factors.

The aim of the present study was to investigate the association between lifestyle-related risk factors (unhealthy diet, low leisure-time PA, obesity and smoking) and self-rated work ability in a large general population of employed adults in Norway.

METHODS

Study population and design

The cross-sectional 'Telemark Study' was carried out from February to August 2013 in Telemark County, which is located in the Southeastern part of Norway and has a population of about 170 000. A sample of 50 000 males and females aged 16–50 years, from the approximately 80 000 residents in Telemark, was drawn randomly using the services of the Norwegian national population registry. Of the 50 000 who received the questionnaire, 1793 had moved, 4 were deceased, 13 were unable to answer due to disease or disability, 23 could not answer due to language problems and 25 were ineligible for other reasons. Of the 48 142 eligible participants, a total of 16 099 answered the questionnaire, resulting in a response rate of 33%. Participation was highest among the older age groups, women and participants from urban areas. The data collection and recruitment methods and characteristics of the non-responders have been described in detail elsewhere.[34]

Participants were asked questions on diet, PA, height and weight, and background variables at baseline. Employees were defined as subjects engaged in paid work during the preceding 12 months. Participants aged 16–17 years were excluded from the study due to low work engagement in this group. Complete data for the present analyses (diet, PA, smoking habits, height and weight and work ability) were available for 10 355 participants.

Work ability

Self-rated work ability was assessed using the first single-item question in the WAI,[15] the WAS[16]: 'Current work ability compared with the lifetime best', where a score of 0 represents complete work disability and a score of 10 represents work ability at its best. Previous studies have demonstrated a strong association between WAS and the complete WAI.[9 21] WAS has been recommended and used as a simple, reliable indicator of work ability in several population studies.[5 9 17 21 35] In this study, work ability was divided into two categories: low work ability (score 0–7) and good work ability (score 8–10).[20 21 25 35]

Diet

Diet was determined using food frequency questions previously used in the Norwegian population-based Nord-Trøndelag Health Study (HUNT3) (2006–2008).[36 37] The questions were selected from a larger validated food frequency questionnaire used in the Oslo Health Study of 2001[38] and covered habitual intake of fruits/berries, vegetables, boiled potatoes, pasta/rice, fat fish, sausages/hamburgers and chocolate/candies, with the response options '0–3 times/month', '1–3 times/week', '4–6 times/week', '1 time/day' and '≥2 times/day'. To reflect general dietary advice for improved health,[39] the following indicators and cut-off points were used: intake of fruits/berries and vegetables (≥2 times/day), fat fish (1–3 times/week) and sausages/hamburgers and chocolate/candies (≤1–3 times/week). The responses were coded 0 (not meeting general dietary recommendations) or 1 (meeting general dietary recommendations). A diet sum score for each participant (scale 0–4) was calculated by summarising their scores for the four indicators, reflecting the number of recommendations met.[40] The diet score was trichotomised into the categories 'unhealthy' (total score 0–1),

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'average' (total score 2) and 'healthy' (total score 3-4) diet, to indicate different levels of health risk.

Physical activity

Moderate to vigorous leisure-time physical activity (MVPA) was assessed using questions covering frequency, intensity and duration of exercise used in the HUNT1 (1984–1986) and HUNT3 (2006–2008) studies.[41] The questionnaire has previously been validated against objective measurement methods and the International Physical Activity Questionnaire, with good internal consistency.[41] The participants reported average weekly frequency of exercise by answering the question, 'How frequently do you exercise?', which had the following answer options: 'never', 'less than once a week', 'once a week', '2–3 times a week' and 'almost every day (4–7 times a week)'. Average intensity was reported by answering the question, 'If you exercise once or more a week, how hard do you exercise?', which had the following answer options: 'I do not become sweaty or breathless', 'I become sweaty or breathless' and 'I become almost exhausted'. Average duration was reported by answering the question, 'For how long are you normally physically active?', which had the following answer options: 'less than 15 min', '15–29 min', '30 min–1 hour' and 'more than 1 hour'. To reflect recommendations on adult MVPA (≥150 minutes/week),[39] the responses to the three questions were combined to give a total MVPA score.[41] This was labelled 'PA' and dichotomised into 'active' and 'inactive'. The weighted scores used to calculate the total score and the cut-off point reflecting recommended MVPA were set according to the values used in the HUNT1 and HUNT3 studies.[41 42]

BMI categories

BMI categories (underweight, normal weight, overweight and obesity) were calculated based on self-reported height and weight data. Cut-off points were chosen according to WHO reference values for adults: underweight (<18.5), normal weight (18.5–24.9), overweight (25–29.9) and obesity (≥30).[43]

Smoking

Smoking was measured by asking three questions. The first was, 'Do you smoke every day?' Two follow-up questions were then asked: 'Do you smoke occasionally?' and 'If not, have you smoked in the past?' Smoking habits were divided into three categories labelled 'current smoker' (every day and occasional smoking combined), 'former smoker' and 'never smoked'.

Lifestyle risk index

Based on current knowledge of associations between lifestyle, health and non-communicable diseases, an overall lifestyle risk index was constructed to study the possible association between multiple lifestyle risk factors and low work ability. To indicate overall lifestyle risk, the individual lifestyle factors were given weighted risk scores: 0 (low health risk), 0.5 (intermediate health risk) and 1 (high health risk), and then summed into an overall index ranging from 0 to 4. To study different levels of lifestyle risk, the lifestyle risk index was divided into four categories: 'low-risk score' (total score 0–0.5), 'moderate-risk score' (total score 1–1.5), 'high-risk score' (total score 2–2.5) and 'very high risk score' (total score 3–4). The index was labelled 'lifestyle risk index'.

Adjustment variables

Age

The participants were all between 18 and 50 years of age, and were grouped into three categories: '18–30 years', '31–40 years' and '41–50 years'.

Educational level

The participants' educational level was categorised as follows: 'primary and lower secondary education' (10 years or less), 'upper secondary education' (an additional 3–4 years) and 'university or university college'.

Occupational group

The participants were classified by a trained research assistant based on self-reported current occupation (2013), using the International Standard Classification of Occupations-88 coding system.[44] The 10 occupational groups were further combined into five subgroups for use in the analyses.

Statistical analysis

Spearman's r was used to assess the correlation between the individual lifestyle risk factors. Multiple logistic regression analysis was used to assess associations between the four individual lifestyle factors and the multifactorial lifestyle risk index (independent variables), as well as the likelihood of low work ability (dependent variable). The individual lifestyle variables were mutually adjusted in the respective models. ORs with 95% CIs were calculated for the likelihood of low work ability. Forward conditional selection was applied to include available adjustment variables (gender, age, educational level and occupational group) associated with the respective independent variables in the models. The population attributable fraction (PAF) of low work ability was calculated for each lifestyle risk factor and the index.[45] PAF is defined as the fraction of all cases of a particular disease or other adverse condition in a population that is attributable to the specific exposure.

Only participants with complete data for all main variables (lifestyle variables and WAS) were included in the analyses. Respondents with missing values for adjustment variables were included with 'missing' as a separate adjustment variable category. For all tests, $p<0.05$ was considered significant. The questionnaires were scanned by Eyes and Hands (Read-soft Forms, Helsingborg, Sweden), while the statistical analyses were carried out using IBM SPSS Statistics for Windows, V.23.

Patient and public involvement

To release the full potential of the study, we have involved user-representatives in the study planning, design and

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Table 1 Study population characteristics (n=10 355)

Population characteristics	N (%)
Gender	
Males	4774 (46.1)
Females	5581 (53.9)
Age group	
18–30	2708 (26.2)
31–40	2964 (28.6)
41–50	4683 (45.2)
Educational level	
Primary school and lower secondary education (10 years or less)	1018 (9.8)
Upper secondary education (an additional 3–4 years)	4242 (41.0)
University or university college	4794 (46.3)
Missing	301 (2.9)
Occupational group	
Legislators, senior officials and managers and professionals and armed forces (groups 0–I–II only)	2674 (25.8)
Technicians and associated professionals (group III)	2646 (25.6)
Clerks and service workers and shop and market sales workers (groups IV–V)	1383 (13.4)
Skilled agriculture and fishery workers and craft and related trade workers (groups VI–VII)	1219 (11.8)
Plant and machine operators and assemblers and elementary occupations (groups VIII–IX)	1024 (9.9)
Missing	1409 (13.6)

Table 2 Study population, distribution of main variables and risk scores (n=10 355)

	Total (n=10 355) n (%)	Lifestyle index risk score*
Diet		
Healthy	5851 (56.5)	(0)
Average	3700 (35.7)	(0.5)
Unhealthy	804 (7.8)	(1)
Physical activity		
Active	5332 (51.5)	(0)
Inactive	5023 (48.5)	(1)
BMI category		
Normal weight (BMI 18.5-24.9)	4951 (47.8)	(0)
Underweight (BMI <18.5)	128 (1.2)	(0.5)
Overweight (BMI 25–29.9)	3733 (36.1)	(0.5)
Obesity (BMI ≥30)	1543 (14.9)	(1)
Smoking status		
Never smoked	5555 (53.6)	(0)
Former smoker	2298 (22.2)	(0.5)
Current smoker	2502 (24.2)	(1)
Lifestyle risk index		
Low risk (0–0.5)	2592 (25.0)	
Moderate risk (1–1.5)	4030 (38.9)	
High risk (2–2.5)	2895 (28.0)	
Very high risk (3–4)	838 (8.1)	
Work Ability Score		
Low work ability (0 – 7)	1379 (13.3)	
Good work ability (8–10)	8976 (86.7)	

*The numbers in brackets are the risk scores used for each variable when calculating the lifestyle risk index.
BMI, body mass index.

transfer of knowledge. Resourceful user-representatives are engaged in the dissemination of results to the public, policy-makers and to healthcare workers through regional, national and international media on all platforms (newspapers, internet, radio and television). An user-representative is the member of the steering committee and has given valuable contributions in development of questionnaires. In addition user-representatives are involved in piloting the questionnaire.

RESULTS

A total of 16 099 of the 48 142 eligible subjects answered the questionnaire. Of these, 12 932 had been employed during the preceding 12 months and were aged 18 or older. Complete data on lifestyle variables and work ability were obtained for 10 355 respondents. Further background characteristics of the study population are shown in table 1. The distributions of the main variables are specified in table 2. The associations between multiple and independent associations between individual lifestyle factors and the likelihood of low work ability are presented in table 3.

Spearman's r correlations between individual lifestyle-related risk factors were ranging from 0.027 between BMI and diet to 0.117 between PA and diet. Multiple logistic regression showed independent associations between individual lifestyle factors and the likelihood of low work ability (table 3, model 1). Participants in the category 'unhealthy diet' were more likely to have low work ability than participants with a 'healthy diet' (OR_{adj2} 1.3; 95% CI 1.02 to 1.5). Inactive subjects were more likely to have low work ability than active individuals (OR_{adj2} 1.4; 95% CI 1.2 to 1.6). Obese participants had lower work ability than normal-weight subjects (OR_{adj2} 1.5; 95% CI 1.3 to 1.7). Former and current smokers were more likely to have low work ability than those who had never smoked (OR_{adj2} 1.2; 95% CI 1.1 to 1.4 and OR_{adj2} 1.3; 95% CI 1.2 to 1.5, respectively). All associations were observed independently of other lifestyle factors and available background variables (gender, age, educational level and occupational group).

An association was observed between the lifestyle risk index and the likelihood of low work ability (table 3, model 2). The figures were as follows: moderate-risk score: OR_{adj2} 1.3; 95% CI 1.1 to 1.6; high-risk score: OR_{adj2} 1.9;

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Table 3 Associations between lifestyle factors and likelihood of low work ability (n=10 355)

Model 1	OR_{crude}	OR_{adj1}*	OR_{adj2}†
Diet			
Healthy (ref.)	1.0	1.0	1.0
Average	1.2 (1.03 to 1.3)	1.1 (0.98 to 1.3)	1.1 (0.98 to 1.3)
Unhealthy	1.4 (1.2 to 1.7)	1.3 (1.1 to 1.6)	1.3 (1.02 to 1.5)
Physical activity			
Active (ref.)	1.0	1.0	1.0
Inactive	1.6 (1.4 to 1.8)	1.4 (1.3 to 1.6)	1.4 (1.2 to 1.6)
BMI (kg/m²)			
Normal weight (ref.)	1.0	1.0	1.0
Underweight (BMI <18.5)	1.5 (0.91 to 2.4)	1.4 (0.86 to 2.2)	1.3 (0.82 to 2.2)
Overweight (BMI 25-29.9)	1.2 (1.01 to 1.3)	1.1 (0.97 to 1.3)	1.1 (0.97 to 1.3)
Obesity (BMI ≥30)	1.6 (1.4 to 1.9)	1.5 (1.3 to 1.8)	1.5 (1.3 to 1.7)
Smoking status			
Never smoked (ref.)	1.0	1.0	1.0
Former smoker	1.4 (1.2 to 1.6)	1.4 (1.2 to 1.6)	1.2 (1.1 to 1.4)
Current smoker	1.6 (1.4 to 1.9)	1.5 (1.3 to 1.8)	1.3 (1.2 to 1.5)
Model 2	OR_{crude}		OR_{adj2}†
Lifestyle risk index			
Low-risk score (0–0.5)	1.0		1.0
Moderate-risk score (1–1.5)	1.4 (1.2 to 1.7)		1.3 (1.1 to 1.6)
High-risk score (2–2.5)	2.2 (1.8 to 2.5)		1.9 (1.6 to 2.2)
Very high risk score (3–4)	2.8 (2.3 to 3.5)		2.4 (1.9 to 3.0)

*Adjusted for other lifestyle factors.
†Adjusted for other lifestyle factors, gender, age, educational level and occupational group.
BMI, body mass index.

95% CI 1.6 to 2.2; very high risk score: OR_{adj2} 2.4; 95% CI 1.9 to 3.0. The analyses were adjusted for available background variables. The overall PAF of low work ability based on the overall risk scores was 38%, while the PAFs of PA, smoking, BMI and diet were 16%, 11%, 11% and 6%, respectively.

DISCUSSION

In the present study, consistent associations were found between several lifestyle risk factors and self-rated low work ability in a general working population in Norway. Obesity was the factor which was most strongly associated with low work ability, followed by low PA, current smoking and unhealthy diet/former smoking. Further, an additive relationship was observed between multiple risk factors and work ability. Increasing scores on a multiple lifestyle risk index were associated with increasing likelihood of low work ability. An overall PAF of 38% indicated a substantial contribution of lifestyle to work ability. Of the individual lifestyle factors, low PA had the highest observed PAF (16%). All associations were observed independently of gender, age, educational level and occupation.

A direct comparison with other studies is difficult, due to heterogeneity of study design, definition and measurement of lifestyle indicators, varying population sizes and varying use of complete WAI or WAS. However, some similarities and differences can be noted.

The results agree with previous studies in which unhealthy diet indicators were linked with low work ability.[11 24 27] Unhealthy diet, characterised by low consumption of healthy foods or nutrients, has previously been associated with low mental and physical health in a number of population studies.[46–50] Work ability has previously been strongly associated with mental and physical health.[17] One possible explanation for the findings is that an unhealthy diet may influence self-perceived work ability through decreased physical and mental capacity related to job demands.[2] Currently, little information is available on how measures to promote healthy eating at the workplace can have positive impact in this context. However, the results indicate that a diet close to the recommended composition could improve work ability.

There is convincing evidence that regular PA helps to prevent various chronic diseases and improve health-related quality of life.[51–53] It is, therefore, likely that physically

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active individuals are better equipped to meet physical and psychological demands at work and to achieve better work ability. In accordance with previous occupation-specific studies,[11 17–20 24 26 27] low leisure-time PA was associated with low work ability in the present sample from the general working population. Earlier studies indicate that the benefits of and need for PA differ between job types. A recently published Danish study focusing on workers performing physically demanding tasks concluded that PA must be of high intensity and long duration to increase work ability.[23] In contrast, it has also been suggested that mentally demanding jobs do not necessarily require good physical condition to meet work demands, at least not among younger workers.[17] A Swedish prospective study of healthcare workers found that leisure-time PA at the recommended level or higher improved work ability both immediately and in the longer term.[18] Correspondingly, the results in the present study show that achieving the recommended level of weekly leisure-time MVPA reduces the likelihood of low work ability, indicating a beneficial effect across occupations and ages. Further, recent research indicates that PA at the workplace may have an additional favourable impact on work ability due to positive effects on social relationships and psychological well-being.[54]

In line with previous studies,[11 17 19 20 24 27] a significant association was observed between obesity and low work ability. Obese respondents had a 50% higher likelihood of low work ability than respondents with a normal weight. In a systematic review published in 2009, five out of seven studies (mainly concentrating on Finnish municipal workers and caregivers) reported an association between obesity and low work ability in different occupational groups.[11] A recent Danish study of a general working population of 10 000 adults has shown that increasing BMI above normal range is associated with lower work ability.[22] A similar trend was observed in the present study, with the likelihood of decreased work ability increasing gradually as BMI rises. However, the results for the overweight respondents did not reach significance in the adjusted models. There are several possible explanations for the observed association, ranging from individual health problems due to obesity to psychosocial problems and physical limitations at the workplace.[55]

Smokers (both current and former) showed a higher likelihood of low work ability than non-smokers. However, there is no unanimous agreement on this association. While some studies have failed to demonstrate a significant difference,[17 21 27] other studies support our findings.[19 20 24] A Dutch study of workers with common diseases found significance only for participants with respiratory diseases,[20] while another study found significance for women only.[24] In contrast, the effect of occasional smoking on work ability has been found to be more evident for men than for women.[56] Contradictory findings may be explained by the fact that earlier studies have examined different occupational groups, not the general working population. A possible explanation for the observed association is impaired health status or chronic conditions due to current or former smoking, which in turn may have impaired work ability.[56] The results indicate that former smokers may also be at risk of low work ability, emphasising the importance of assessing this group as well.

Although the individual lifestyle risk factors appeared to be slightly correlated, independent associations with low work ability were observed for each factor. The individual factors were added up to compose a lifestyle risk index. Lifestyle risk indexes can be used as indicators of overall or cumulative risk of non-communicable diseases.[29] As suggested by others,[24] an additive association was observed between lifestyle risk factors and work ability. Participants with a high or very high risk score on the lifestyle risk index were more than twice as likely to have low work ability, than those with a low-risk score. The effect seems to be additive rather than synergetic as the strength of the associations of more than one risk factor was not stronger than the sum of the risks of the underlying factors.[20] Moreover, additional analyses of the most prevalent risk factor combinations did not show any significant synergetic effects either (data not shown). As the relative importance of the lifestyle risk factors to good health, non-communicable diseases and low work ability has not been fully determined, we decided to weight each factor equally in the lifestyle risk index. The decision to weight the single risk factors equally was further supported by the comparable effects of the individual factors on observed WAS (table 3).

A PAF of 38% indicates a substantial contribution of multiple lifestyle risk to low work ability. According to the lifestyle risk index, a considerable proportion (36%) of the participants had a high or very high risk score. Knowing that an unhealthy lifestyle increases the risk of various non-communicable diseases, it can be assumed that lifestyle changes in line with current health recommendations would improve the prognoses of these diseases and indirectly improve work ability. Although PA had the highest PAF, all four risk factors contributed significantly to low work ability, underlining the importance of targeting multiple lifestyle changes.

Although no causality can be claimed based on the present results, the associations indicate that occupational health promotion strategies should target multiple lifestyle changes to reduce the likelihood of decreased work ability. Lifestyle is theoretically modifiable, but often considered a personal matter with no formal responsibility resting with the employer. However, facilitating lifestyle changes through workplace measures may be beneficial for both employers and employees in terms of improved work ability.

The present study has strengths, but also limitations that should be recognised. An important strength is the large study sample, which covers all types of occupational groups and a broad age range. Simultaneous assessment of several lifestyle-related factors has allowed mutual adjustment and examination of both independent and additive

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relationships. Further, the study has employed validated questions for diet,[57] leisure-time MVPA[41] and self-assessed work ability.[9 21] The dichotomisation of the total MVPA score into 'active' and 'inactive' gives good information on MVPA by reference to current recommendations on PA.[39 41 42] The dietary score appears to be a comprehensive indicator of healthy dietary behaviour, compared with previous studies in which the 'diet' variable was either not fully elucidated[27] or consisted only of single nutrients or single food items.[11 24] The first single-item question of the WAI, the WAS[16]—'Current work ability compared with lifetime best'—was used to assess work ability. This item has become established as a practical, simple and valid indicator of work ability,[9 21] often replacing complete WAI in clinical practice and research[58 59] and increasingly used in population studies.[5 9 17 21 35] In accordance with these studies, work ability was considered to be good when the score was between 8 and 10.

Several individual and environmental factors have previously been associated with decreased work ability and/or lifestyle.[11 17 60–62] To investigate independent relationships between lifestyle and work ability, several adjustment variables (age, gender, educational level and occupation) were included in the regression analyses. However, the adjustment did not alter the estimates substantially, indicating independent associations and limited risk of overadjustment. Nevertheless, the possibility cannot be excluded that other individual and environmental characteristics such as poor musculoskeletal capacity, chronic disease, psychosocial factors at work and high physical or mental work demands may have attenuated the associations.[11 17 20 33 61]

The present study did not include workers older than 50 years of age. Therefore, it cannot be concluded that the findings are generalisable to older age groups. Previous research has indicated that lifestyle may be even more important to older workers than younger in terms of good work ability.[11 17] Moreover, promoting good work ability through a healthy lifestyle early on may reduce the risk of non-communicable chronic diseases and consequent impaired work ability later in life.[14 60]

Participants' self-reported diet and PA data may have caused bias due to under-reporting of unhealthy habits and/or over-reporting of healthy habits, or bias due to deficient recollection. However, the applied questions on food items and PA have demonstrated good reliability and validity when compared with objective measures and other validated questionnaires.[41 57] Self-reported weight and height is known to be prone to bias, and misreporting may have influenced the observed associations. Nevertheless, the proportion of participants in the overweight and obese categories was in line with national BMI data for adults.[63] As regard to self-reported smoking history, previous studies have indicated high reliability of self-reporting.[64] In addition, occasional smokers were included in the current smoker category to capture all at-risk respondents, as infrequent and occasional smokers may still have a nicotine dependency and may under-report.[65]

Another limitation of the study is the low response rate (33%), which may have caused bias due to non-response.[34] There was a predominance of participants from older age groups, women and participants from urban areas. Further, only participants with complete data on lifestyle indicators and work ability were analysed. However, non-response to the postal questionnaire has been assessed,[34] showing that responders and non-responders had similar frequencies of respiratory symptoms and asthma, but that young males and past smokers were somewhat under-represented and that weighting according to inverse probability of non-response did not alter the results substantially (data not shown).

Data collection was limited to one Norwegian county, and the results are therefore not necessarily representative of the national population. Finally, the study's cross-sectional design makes it impossible to identify causal relationships between lifestyle indicators and work ability.

CONCLUSION

In the present study, significant associations have been identified between several lifestyle risk factors and low work ability in a general working population. Moreover, an additive relationship between multiple lifestyle risk factors and low work ability has been observed. The results indicate that employees in general may benefit from interventions targeting multiple lifestyle changes. Further, the results appear relevant to occupational intervention programmes aimed at preventing and improving low work ability. A follow-up study is planned to investigate the observed associations over time, with a particular focus on ageing and workers with chronic diseases.

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Contributors AKMF and MVS were involved in the conception, design and data collection. IMO was involved in selection of research questions and planning of the statistical analyses. MVS was responsible for the statistical analyses. All authors were involved in the interpretation of the results. IMO drafted the manuscript with the assistance from MMDB. All authors revised the manuscript critically and approved the final manuscript.

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Paper II

De Bortoli MM, Fell AKM, Svendsen MV, Henneberger PK, Kongerud J, Oellingrath IM (2020) "Lifestyle, sick leave and work ability among Norwegian employees with asthma—A population-based cross-sectional survey conducted in Telemark County, Norway". PLOS One. 2020 Apr 17: doi: 10.1371/journal.pone.0231710

PLOS ONE

RESEARCH ARTICLE

Lifestyle, sick leave and work ability among Norwegian employees with asthma—A population-based cross-sectional survey conducted in Telemark County, Norway

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Abstract

Objective

To investigate whether physician-diagnosed asthma modifies the associations between multiple lifestyle factors, sick leave and work ability in a general working population.

Methods

A cross-sectional study was conducted in Telemark County, Norway, in 2013. A sample of 16 099 respondents completed a self-administered questionnaire. We obtained complete data on lifestyle, work ability and sick leave for 10 355 employed persons aged 18–50 years. We modelled sick leave and work ability using multiple logistic regression, and introduced interaction terms to investigate whether associations with lifestyle factors were modified by asthma status.

Results

Several lifestyle risk factors and a multiple lifestyle risk index were associated with sick leave and reduced work ability score among persons both with and without physician-diagnosed asthma. A stronger association between lifestyle and sick leave among persons with asthma was confirmed by including interaction terms in the analysis: moderate lifestyle risk score * asthma OR = 1.4 (95% CI 1.02–2.1); high lifestyle risk score * asthma OR = 1.6 (95% CI 1.1–2.3); very high lifestyle risk score * asthma OR = 1.6 (95% CI 0.97–2.7); obesity * asthma OR = 1.5 (95% CI 1.02–2.1); past smoking * asthma OR = 1.4 (95% CI 1.01–1.9); and current smoking * asthma OR = 1.4 (95% CI 1.03–2.0).

data, and also potentially identifiable individuals. Sharing restrictions on the minimal data set are imposed from: The Regional Committee for Medical and Health Professional Research Ethics in South-east Norway (Study ID: REC 2012/1665), The Norwegian Data Inspectorate and the Telemark Hospital Department of Research and Development. However, data may be shared for researchers who meet the criteria for access to confidential data upon request to the head of the Telemark-Study steering committee: Dr. Trude K. Fossum, Department of Occupational and Environmental Medicine, Telemark Hospital, Post box 2900 Kjøbekk, 3710 Skien. E-mail: fotr@sthf.no The minimal data set identification: Minimal. Lifestyle.WAS.SL.asthma.sav.

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Competing interests: The authors have declared that no competing interests exist.

There was no significant difference in the association between lifestyle and work ability score among respondents with and without asthma.

Conclusions

In the present study, we found that physician-diagnosed asthma modified the association between lifestyle risk factors and sick leave. Asthma status did not significantly modify these associations with reduced work ability score. The results indicate that lifestyle changes could be of particular importance for employees with asthma.

Introduction

Asthma is a common respiratory disease, and one of the most common chronic diseases worldwide [1]. In Norway, asthma prevalence has increased markedly in the last 20 years [2], and was estimated at 11.5% in 2013 [3]. Although a large proportion of patients diagnosed with asthma are young [4], asthma is also common among persons of working age [5]. Potential consequences for employees and employers, the health care system and wider society include low work ability [6–8] and loss of working days [9–15].

A person's lifestyle is known to have significant impact on health and well-being [16]. Good health is essential for work participation and endurance until retirement [17]. Limited studies have been conducted of modifiable lifestyle factors which may reduce sick leave and increase work ability among persons with asthma. A recent Dutch study explored the association between several chronic diseases, including respiratory diseases, selected lifestyle factors, sick leave and work ability among health care workers [18]. The study suggests that smoking and obesity negatively influence work ability, especially among persons with respiratory disease [18]. Another European study suggests that low physical activity and smoking are associated with sick leave among persons with respiratory diseases [19]. However, these studies focused on respiratory diseases in general, and did not specifically assess asthma.

Lifestyle risk factors often occur simultaneously [20]. Previous studies of associations between lifestyle factors and sick leave/work ability have largely examined a limited number of lifestyle factors. We have previously reported independent and additive relationships between multiple lifestyle risk factors (obesity, smoking, unhealthy diet and low physical activity) and low work ability in a large sample taken from the general working population in Norway [21]. However, few general population studies have examined multiple lifestyle risk factors and absence from work, and we are unaware of any studies which link these associations with asthma status.

The aim of this study was therefore to investigate whether physician-diagnosed asthma modifies associations of multiple lifestyle factors with sick leave and work ability in a general working population.

Material and methods

Study sample and population

The Telemark Study is a longitudinal population-based study conducted in south-eastern Norway. The initial cross-sectional part of the study was carried out in 2013, and consisted of a postal questionnaire mailed to a random sample (18–50 years of age) of the general population. The total population is approximately 170 000. Out of 48 142 eligible participants, 16 099 responded to the questionnaire. The response rate of 33% has occasioned a study on non-response [22].

For the present study, participants (18–50 years of age) were included if they had been employed in the past 12 months and had provided complete data on lifestyle risk factors (diet, physical activity, body mass index and smoking habits), and reported information about sick leave and work ability score. Complete data were available for 10 355 participants. Of these, 1 110 (11%) reported having physician-diagnosed asthma (Fig 1).

Dependent variables

Sick leave. Sick leave was defined as one or more days on sick leave in the previous 12 months, confirmed by an affirmative answer to the question: "Have you been on sick leave over the course of the last 12 months?"

Work ability score (WAS). The work ability score derives from the work ability index developed by the Finnish Institute of Occupational Health [23]. We decided to use the first-item question of the work ability index, the work ability score (WAS): "Current work ability compared with the lifetime best", where a score of 0 represents complete work disability and a score of 10 represents work ability at its best. The WAS has been validated by previous studies [24, 25]. We dichotomised the variable into poor (0–7) and good (8–10) WAS.

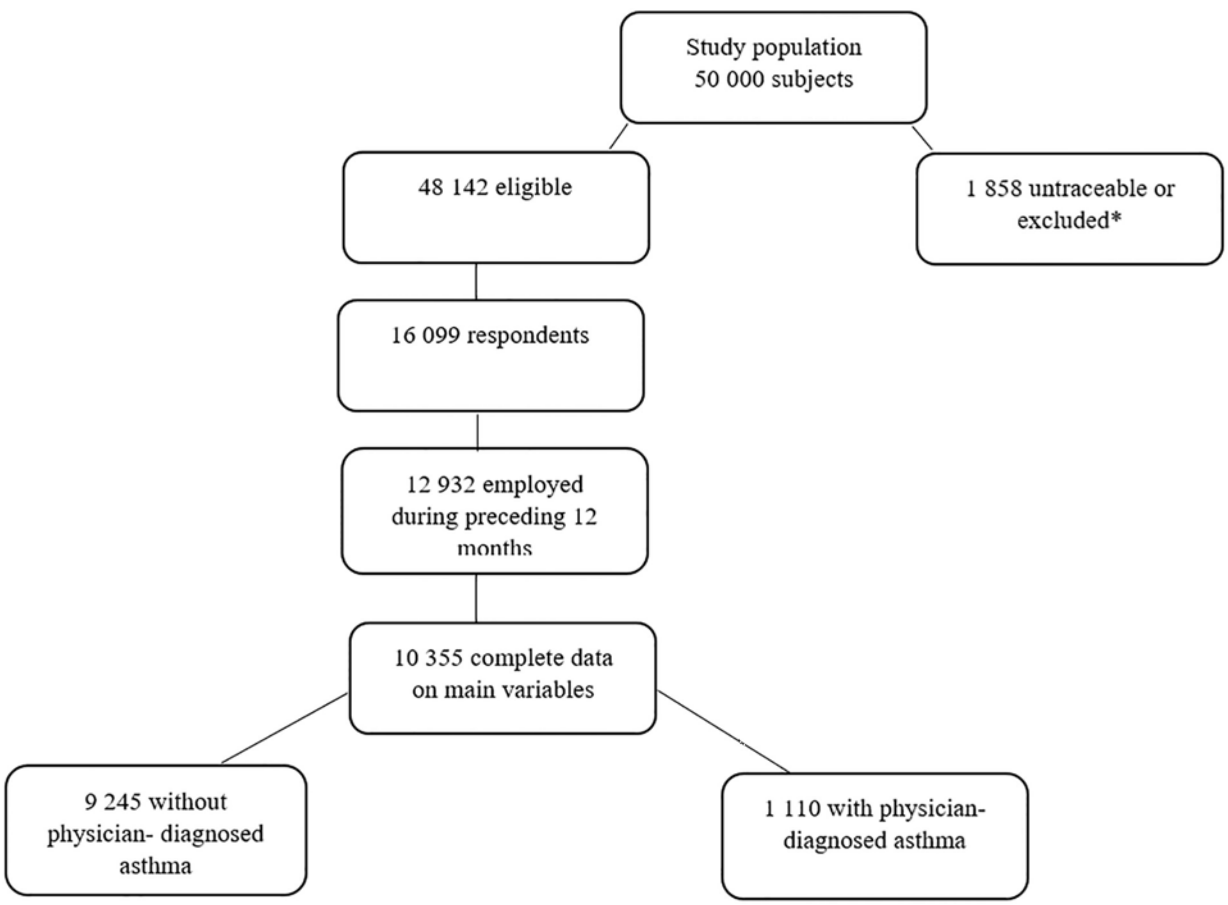

Fig 1. Unknown address or language problems.

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Independent variables

Physician-diagnosed asthma. Participants were defined as having asthma if they responded affirmatively to the question: "Has a physician ever diagnosed you with asthma?"

Lifestyle risk factors

Diet. Diet was defined using food frequency questions previously validated and used in the Norwegian population-based Nord-Trøndelag Health Study (HUNT3) (2006–2008) [26, 27]. To reflect general dietary advice for improved health [28], a dietary sum score was constructed based on intake of fruits/berries and vegetables, fatty fish, sausages/hamburgers and chocolate/candies [21]. The sum score for each participant (scale 0–4) was calculated by summing their scores for the four indicators, reflecting the number of recommendations met [29]. The diet score was trichotomised into the categories low (0–1), moderate (2) and high (3–4) adherence to the general dietary recommendations. The three categories were labelled "unhealthy diet", "average diet" and "healthy diet", respectively.

Physical activity. Moderate to vigorous leisure-time physical activity (MVPA) was assessed using validated questions and cut-off points covering frequency, intensity and duration of exercise as used in the HUNT1 (1984–1986) and HUNT3 (2006–2008) studies [30]. To reflect recommendations on adult MVPA ($\geq$ 150 minutes/week) [28], the responses to the questions regarding frequency, intensity and duration were combined to give a total MVPA score [30]. This was labelled "physical activity" and dichotomised into "active" and "less active". The weighted scores used to calculate the total score and the cut-off point emulating recommended MVPA were set according to the values used in the HUNT1 and HUNT3 studies [30, 31].

Body mass index. Body mass index (BMI) was measured in accordance with the World Health Organization's cut-offs for different weight groups [32]. These were labelled "underweight" ($<$ 18.5 kg/m^2), "normal weight" (18.5–24.9 kg/m^2), "overweight" (25–29.9 kg/m^2) and "obesity" ($\geq$30 kg/m^2).

Smoking. Smoking was assessed by three questions. The first was: "Do you smoke every day?" Two follow-up questions were then asked: "Do you smoke occasionally?" and "If not, have you smoked in the past?" Smoking habits were divided into three categories labelled "current smoker" (every day and occasional smoking combined), "former smoker" and "never smoked".

Lifestyle risk index. An overall lifestyle risk index was calculated to investigate the possible additive effect of lifestyle risk factors on work ability [21]. To estimate relative health risk, the individual lifestyle factors were given weighted risk scores: 0 (low health risk), 0.5 (intermediate health risk) and 1 (high health risk), and then summed into an overall index ranging from 0 to 4 (Table 1). To study different levels of lifestyle risk, the lifestyle risk index was divided into four categories: "low risk score" (total score 0–0.5), "moderate risk score" (total score 1–1.5), "high risk score" (total score 2–2.5) and "very high risk score" (total score 3–4). The index was labelled "Lifestyle risk index".

Background variables

Age. Age was categorised as "18–30", "31–40" and "41–50" years of age.

Educational level. Educational level was categorised into three subgroups: "primary school + 1–2 years", "upper secondary and certificate" and "university/university college".

Other chronic lung diseases. Participants were defined as having a chronic lung disease if they responded affirmatively to at least one of the following questions: "Has a physician ever

Table 1. Study population characteristics, distribution of main variables and risk scores.

	Total	Without asthma	Asthma	
	n = 10 355 (100%)	n = 9 245 (100%)	n = 1 110 (100%)	
Gender				
Male	4 774 (46)	4 276 (46)	498 (45)	
Female	5 581 (54)	4 969 (54)	612 (55)	
Age groups				
18–30	2 708 (26)	2 378 (26)	330 (30)	
31–40	2 964 (29)	2 647 (29)	317 (29)	
41–50	4 683 (45)	4 220 (45)	463 (41)	
Educational level				
Primary school and lower secondary education (10 years or less)	1 018 (10)	923 (10)	95 (9)	
Upper secondary education (an additional three to four years)	4 242 (41)	3 781 (41)	461 (41)	
University or university college	4 794 (46)	4 272 (46)	522 (47)	
Missing	301 (3)	269 (3)	32 (3)	
Other chronic lung diseases				
Yes	223 (2)	112 (1)	111 (10)	
No	10 132 (98)	9 133 (99)	999 (90)	
Sick leave				
No sick leave in the previous 12 months	7 023 (68)	6 365 (69)	658 (59)	
Sick leave in the previous 12 months	3 332 (32)	2 880 (31)	452 (41)	
WAS				
Good WAS (8–10)	8 976 (87)	8 064 (87)	912 (82)	
Low WAS (0–7)	1 379 (13)	1 181 (13)	198 (18)	
Lifestyle risk factors				Lifestyle index risk score*
Diet				
Healthy	5 851 (56)	5 246 (57)	605 (55)	(0)
Average	3 700 (36)	3 287 (36)	413 (37)	(0.5)
Unhealthy	804 (8)	712 (7)	92 (8)	(1)
Physical activity				
Active	5 332 (51)	4 732 (51)	600 (54)	(0)
Less active	5 023 (49)	4 513 (49)	510 (46)	(1)
BMI category				
Normal weight (18.5–24.9 kg/m^2)	4 951 (48)	4481 (49)	470 (42)	(0)
Underweight (<18.5 kg/m^2)	128 (1)	113 (1)	15 (1)	(0.5)
Overweight (25–30 kg/m^2)	3 733 (36)	3 327 (36)	406 (37)	(0.5)
Obese (>30 kg/m^2)	1 543 (15)	1 324 (14)	219 (20)	(1)
Smoking status				
Never smoked	5 555 (54)	4 973 (54)	582 (52)	(0)
Former smoker	2 298 (22)	2 033 (22)	265 (24)	(0.5)
Current smoker	2 502 (24)	2 239 (24)	263 (24)	(1)
Lifestyle risk score				
Low risk (0–0.5)	2 592 (25)	2 322 (25)	270 (24)	
Moderate risk (1–1.5)	4 030 (39)	3 600 (39)	430 (39)	
High risk (2–2.5)	2 895 (28)	2 592 (28)	303 (27)	
Very high risk (3–4)	838 (8)	731 (8)	107 (10)	

* The numbers in brackets are the risk scores used for each variable when calculating the lifestyle risk index.

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diagnosed you with chronic obstructive lung disease?" or "Has a physician ever diagnosed you with any chronic lung disease other than chronic obstructive lung disease or asthma?"

Statistical analyses

The phi coefficient was used to assess the correlation between sick leave and low work ability, while Spearman's rho was used to assess the correlation between the individual lifestyle risk factors. We used a multiple logistic regression analysis to explore the association between individual lifestyle risk factors (diet, physical activity, body mass index and smoking), the multiple-lifestyle index (independent variables), and sick leave and work ability (dependent variables). Odds ratios (OR) with 95% confidence intervals were calculated for the likelihood of sick leave and low work ability. The individual lifestyle risk factors were adjusted for each other in the respective models. Age, gender, educational level and other chronic lung diseases were included as adjustment variables. In addition, sensitivity analyses were performed to adjust for other chronic diseases (cardiovascular disease, diabetes and mental illness).

To investigate whether asthma was a potential effect modifier, we decided to assess associations between independent and multiple lifestyle risk factors and sick leave and work ability stratified by asthma status.

It might be hypothesized that the effect of the combination of multiple lifestyle risk factors with asthma is greater than the sum of their separate effects (Fig 2). For further exploration of the data, interaction terms were included in logistic regression models (asthma multiplied

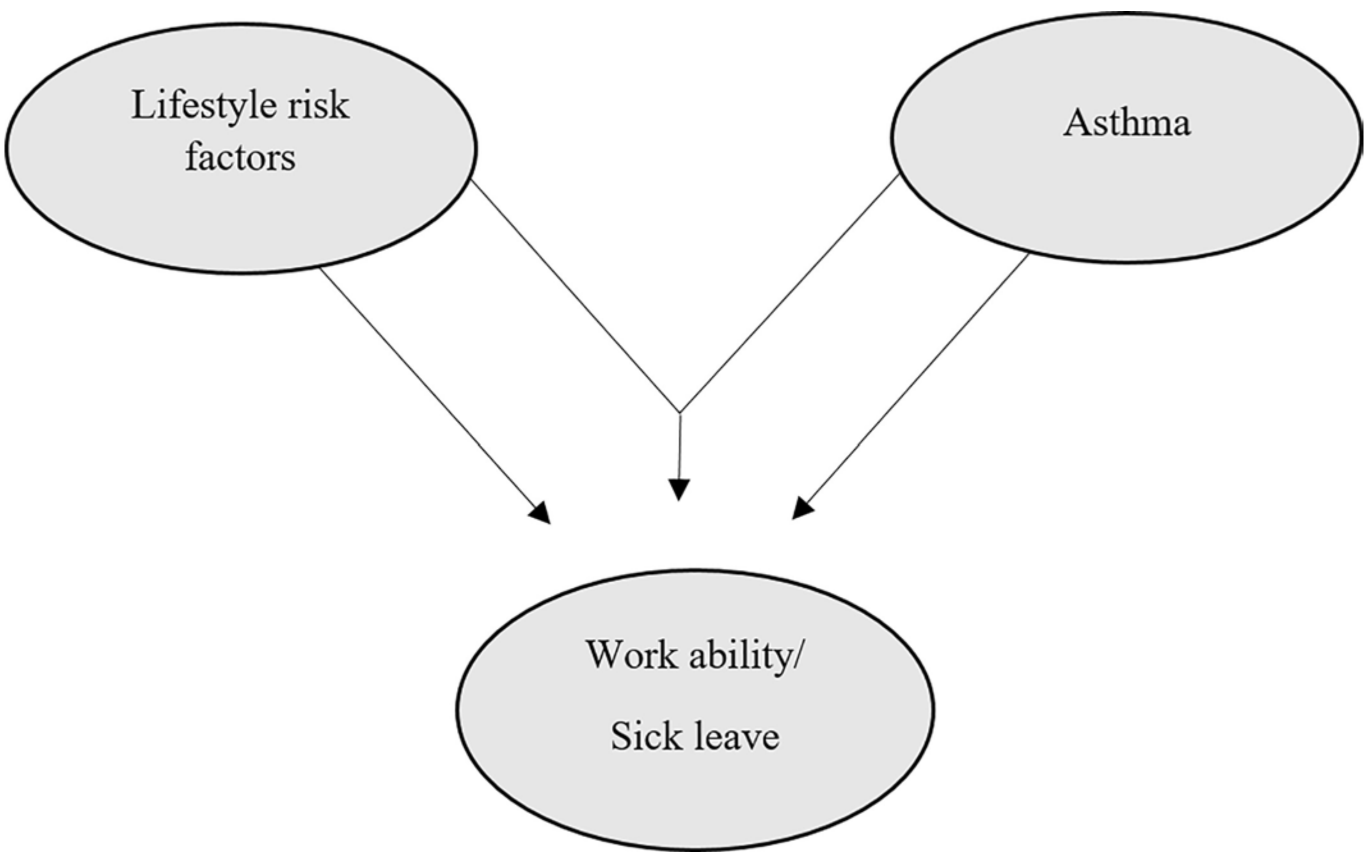

Fig 2. Hypothesized interaction of lifestyle risk factors and asthma on sick leave/work ability. Figure is inspired by Tonnon et al [33].

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with each lifestyle risk factor and the lifestyle risk index, respectively) to reveal any multiplicative interaction.

The statistical analyses were carried out using IBM SPSS Statistics for Windows, version 24–2017. In all analyses, statistical significance was defined as $p < 0.05$ or a 95% confidence interval that did not include the null value.

Ethical considerations

Written informed consent was obtained from all the participants. The study was conducted in accordance with the guidelines laid down in the Declaration of Helsinki, and were approved by the Regional Committee for Ethics in Medical Research (REC 2012/1665) and the Norwegian Data Protection Authority.

Patient and public involvement

This study consulted user representatives from the Norwegian Asthma and Allergy Association in relation to study planning, study design and knowledge transfer. User representatives were included in the communication of results to health care workers, policy makers and the public on various media platforms (newspapers, internet, radio and television). One user representative served as a member of the study steering committee, and made important contributions to questionnaire development.

Results

The study population characteristics are presented in Table 1. The sample consisted of 10 355 persons from the general working population of Telemark County (aged 18–50; slightly more female than male participants (54% vs 46%)). One-third of the subjects reported sick leave days in the past 12 months (32%). Most participants reported a good work ability (68%). Finally, 11% reported physician-diagnosed asthma.

Sick leave and work ability were weakly correlated (phi correlation 0.20). Spearman's rho correlations between individual lifestyle-related risk factors ranged from 0.03 between BMI and diet to 0.12 between low physical activity and diet.

Multiple logistic regression analysis showed that lifestyle risk score, BMI category and smoking status were all significantly associated with sick leave in the past 12 months, among persons both with and without asthma (Table 2). All associations were observed to be stronger among persons with asthma than persons without asthma. A stronger positive association between lifestyle and sick leave among persons with asthma was confirmed by including interaction terms in the analysis: (Lifestyle risk score (moderate) * asthma OR = 1.4 (95% CI 1.02–2.1); Lifestyle risk score (high) * asthma OR = 1.6 (95% CI 1.1–2.3); Lifestyle risk score (very high) * asthma OR = 1.6 (95% CI 0.97–2.7); Obesity * asthma OR = 1.5 (95% CI 1.02–2.1); Past smoking * asthma OR = 1.4 (95% CI 1.01–1.9); and Current smoking * asthma OR = 1.4 (95% CI 1.03–2.0).

Lifestyle risk score and physical activity were significant associated with WAS among persons both with and without asthma (Table 3). The associations were observed to be somewhat stronger among persons with asthma than among persons without asthma. A model including interaction terms between lifestyle and asthma showed that the trend of stronger association between lifestyle and WAS among persons with asthma, compared to persons without asthma, was not statistically significant.

Table 2. Associations between lifestyle factors and sick leave by asthma status (n = 10 355).

	Without asthma	Asthma
Lifestyle risk index	OR[a] (95% C.I.)	OR[a] (95% C.I.)
Low risk score (0–0.5)	1.0	1.0
Moderate risk score (1–1.5)	**1.2 (1.1, 1.4)**	**1.7 (1.2, 2.4)**
High risk score (2–2.5)	**1.4 (1.2, 1.6)**	**2.1 (1.4, 3.0)**
Very high risk score (3–4)	**1.8 (1.5, 2.1)**	**2.6 (1.6, 4.2)**
Lifestyle risk factor	OR[a] (95% C.I.)	OR[a] (95% C.I.)
Diet		
Healthy	1.0	1.0
Average	1.0 (0.92, 1.1)	1.0 (0.79, 1.4)
Unhealthy	1.1 (0.92, 1.3)	0.93 (0.57, 1.5)
Physical activity		
Active	1.0	1.0
Less active	1.1 (0.97, 1.2)	1.1 (0.85, 1.4)
Body mass index		
Normal weight	1.0	1.0
Underweight (<18.5 kg/m^2)	1.1 (0.76, 1.7)	1.8 (0.60, 5.2)
Overweight (25–30 kg/m^2)	**1.2 (1.1, 1.3)**	1.2 (0.92, 1.7)
Obese (>30 kg/m^2)	**1.6 (1.4, 1.8)**	**2.2 (1.5, 3.1)**
Smoker		
Never smoked	1.0	1.0
Former smoker	**1.3 (1.2, 1.5)**	**1.7 (1.3, 2.4)**
Current smoker	**1.3 (1.2, 1.5)**	**1.7 (1.3, 2.4)**

[a] Adjusted for gender, age, educational level and other chronic lung diseases.

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Discussion

In the present study, multiple lifestyle risk factors were associated with sick leave and reduced work ability among persons both with and without physician-diagnosed asthma. Most importantly, the association between multiple lifestyle risk factors and sick leave was modified by physician-diagnosed asthma. For persons with asthma, the lifestyle risk factors obesity, former smoker and current smoking were associated with sick leave, while low physical activity was associated with low WAS.

A direct comparison with other studies is challenging due to differences in study design and study populations, as well as this study's focus on asthma. Nonetheless, some similarities and differences should be acknowledged.

In the present study, we observed an association between increasing lifestyle risk scores and sick leave, especially among persons with asthma. To the best of our knowledge, no previous study has assessed the association between a multiple lifestyle risk index and sick leave in a general working population. However, two recent European studies [18, 19] have assessed individual lifestyle risk factors and associations with sick leave among health care workers. A multi-cohort study found that lifestyle factors such as smoking and low physical activity were associated with sickness absence linked to respiratory disease [19], while a Dutch study did not find any significant associations between individual lifestyle factors and sick leave among persons with respiratory diseases [18]. Unlike the present study, however, these studies did not specify which respiratory diseases were under investigation, and did not assess the strength of possible interactions with lifestyle factors. This makes comparison challenging.

Table 3. Associations between lifestyle factors and work ability score by asthma status (n = 10 355).

	Without asthma	Asthma
Lifestyle risk index	OR[a] (95% C.I.)	OR[a] (95% C.I.)
Low risk score (0–0.5)	1.0	1.0
Moderate risk score (1–1.5)	**1.3 (1.1, 1.6)**	1.5 (0.91, 2.4)
High risk score (2–2.5)	**1.9 (1.5, 2.2)**	**2.2 (1.3, 3.6)**
Very high risk score (3–4)	**2.3 (1.8, 3.0)**	**2.7 (1.5, 5.0)**
Lifestyle risk factor	OR[a] (95% C.I.)	OR[a] (95% C.I.)
Diet		
Healthy	1.0	1.0
Average	1.1 (0.99, 1.3)	0.99 (0.71, 1.4)
Unhealthy	**1.3 (1.02, 1.6)**	1.2 (0.65, 2.0)
Physical activity		
Active	1.0	1.0
Less active	**1.4 (1.2, 1.6)**	**1.6 (1.2, 2.2)**
Body mass index		
Normal weight	1.0	1.0
Underweight (<18.5 kg/m^2)	1.3 (0.79, 2.2)	1.6 (0.41, 5.9)
Overweight (25–30 kg/m^2)	1.1 (0.94, 1.3)	1.2 (0.81, 1.7)
Obese (>30 kg/m^2)	**1.4 (1.2, 1.7)**	1.4 (0.89, 2.1)
Smoking		
Never smoked	1.0	1.0
Former smoker	**1.2 (1.03, 1.4)**	1.3 (0.85, 1.9)
Current smoker	**1.3 (1.1, 1.5)**	1.4 (0.97, 2.1)

[a] Adjusted for gender, age, educational level and other chronic lung diseases.

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The observed modification by asthma status on the association between lifestyle risk score and sick leave was confirmed through the inclusion of interaction terms between lifestyle factors and asthma, suggesting the presence of multiplicative interactions. Our results indicate that persons with asthma could be more susceptible to sick leave due to lifestyle. This in turn suggests that lifestyle changes may be of particular importance to prevent sick leave among persons with asthma, even when few lifestyle risk factors are present.

As regards the individual lifestyle risk factors studied, our findings indicate that obesity is more strongly associated with sick leave among persons with asthma than among persons without asthma. This is consistent with previous literature [11, 15, 34]. Some studies have shown improvement in asthma outcomes following weight reduction, indicating potential benefits for the working life of these respondents [35, 36].

We also found that former and current smoking were more strongly associated with sick leave among subjects with asthma compared to persons without asthma. This is consistent with Swedish and Danish study results linked to current smoking [9, 15]. Interestingly, a Spanish cross-sectional study of persons with asthma [10] found that former smoking was associated with sick leave, but could not confirm an association between current smoking and sick leave [10]. The authors suggest the "healthy smoker effect" as a possible explanation for the results, implying that persons who smoke and have few respiratory symptoms continue smoking [10]. However, our study indicates that both past and current smoking may increase the likelihood of sickness absence, especially among persons with asthma.

Others have shown that factors such as age [6, 9, 13], occupation [8, 9], socio-economic status [14] and severity of asthma [10] are important predictive variables with regard to sick leave and low work ability among persons with asthma. We therefore adjusted for age and education, but this did not significantly influence our results.

No significant modification by asthma status on the association between lifestyle and WAS was observed. However, statistically significant associations between lifestyle risk score and low WAS were observed among respondents both with and without asthma. Of the individual lifestyle factors, only low physical activity was significantly associated with low WAS among workers with asthma. Recent studies suggest that physical activity improves asthma control and lung function among adults with asthma [37, 38]. One possible explanation for our findings may be that low physical activity has an opposite, adverse effect and may therefore reduce self-perceived work ability. Moreover, a non-significant trend of decreased WAS was observed among smokers. Our results are consistent with a longitudinal Finish study of men diagnosed with asthma from youth, in which current smoking was associated with low work ability [7]. Moreover, a Dutch study [18] suggested a stronger association between smoking and low WAS among health care workers with respiratory diseases than among healthy individuals. However, as mentioned above, this study did not distinguish between different respiratory diseases or assess interactions [18]. Our findings provide additional insight into the association between multiple lifestyle factors and work ability among persons with asthma.

Our study indicates that persons with asthma may have greater benefits from lifestyle improvements than persons without asthma. According to our results, moderate lifestyle improvements could potentially decrease the likelihood of sick leave for this group of employees. Lifestyle is theoretically modifiable, and our findings imply that workplace measures targeting lifestyle changes may have a beneficial impact on persons both with and without asthma.

This study has strengths but also limitations that should be considered.

Important strengths are the inclusion of multiple lifestyle risk factors and the large study sample from the general working population. Other studies have focused on individual lifestyle risk factors in selected groups, such as subjects with asthma [10, 13], subjects in a specific occupation [18] and, often, male-only cohorts [7]. A further strength of this study is the use of validated questions which have also been used in other Norwegian cohort studies, for both independent (lifestyle risk factors) and dependent variables (sick leave).

Furthermore, several adjustment variables (age, gender, educational level and other chronic lung diseases) were included in the regression analyses. This adjustment did not alter the estimates substantially, indicating independent associations and limited risk of mistaken adjustment for intermediate variables in relevant causal pathways. Moreover, adjustment for other medical conditions (cardiovascular disease, diabetes and mental illness) did not significantly alter the results linked to sick leave and WAS.

The possibility cannot be excluded that we have underestimated the associations between lifestyle risk factors and sick leave and work ability due to the inclusion of all subjects with physician-diagnosed asthma, without differentiation based on severity or time of onset. Further, we did not analyse treatment parameters or medication use for persons with asthma, which may have influenced the associations. Studies have shown that persons on daily oral corticosteroids have less absenteeism than persons without such treatment [10].

Female, older age groups (41–50 years old) and more highly educated persons were slightly over-represented among the questionnaire respondents, indicating a possible selection bias. However, all regression analyses were adjusted for these variables. Generalisation of the results may be challenging due to the low response rate (33%). Nevertheless, analyses of non-responders indicate similar results to those of responders [22], and the associations appear less likely to be influenced by selection bias [39, 40].

One limitation of the study may be the use of self-reported physician-diagnosed asthma, which does not allow for verification of the diagnosis. Nevertheless, self-reported physician-diagnosed asthma has been shown to have high specificity [41]. Lifestyle-related factors may be perceived as sensitive information. This could introduce a social desirability bias which obscures associations, for example due to underreporting of bodyweight [42]. The study design does not permit objective confirmation of respondent answers. However, the use of validated questions should reduce the likelihood of such bias.

Given the uncertainty about the temporal sequence of events that is inherent to the cross-sectional design, this study cannot claim causal relationships between lifestyle factors and sick leave or work ability.

Conclusion

In the present study, we found that physician-diagnosed asthma modified the association between lifestyle risk factors and sick leave. Asthma status did not significantly modify these associations with reduced WAS. The results indicate that lifestyle changes may be particularly important for employees with asthma. These findings are significant for public health promotion and occupational intervention programmes aimed at preventing sick leave and improving work ability, especially among persons with asthma. Longitudinal studies should be conducted to explore these associations further.

Supporting information

S1 Data. Questionnaire Norwegian.
(PDF)

S2 Data. Questionnaire English.
(DOCX)

S1 Checklist. STROBE statement—Checklist of items that should be included in reports of *cross-sectional studies*.
(DOCX)

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Paper III

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BMJ Open

Influence of lifestyle risk factors on work ability and sick leave in a general working population in Norway: a 5-year longitudinal study

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ABSTRACT

Objectives The aim of this study is to assess (1) whether lifestyle risk factors are related to work ability and sick leave in a general working population over time, and (2) these associations within specific disease groups (ie, respiratory diseases, cardiovascular disease and diabetes, and mental illness).

Setting Telemark county, in the south-eastern part of Norway.

Design Longitudinal study with 5 years follow-up.

Participants The Telemark study is a longitudinal study of the general working population in Telemark county, Norway, aged 16 to 50 years at baseline in 2013 (n=7952) and after 5-year follow-up.

Outcome measure Self-reported information on work ability (moderate and poor) and sick leave (short-term and long-term) was assessed at baseline, and during a 5-year follow-up.

Results Obesity (OR=1.64, 95% CI: 1.32 to 2.05) and smoking (OR=1.62, 95% CI: 1.35 to 1.96) were associated with long-term sick leave and, less strongly, with short-term sick leave. An unhealthy diet (OR=1.57, 95% CI: 1.01 to 2.43), and smoking (OR=1.67, 95% CI: 1.24 to 2.25) were associated with poor work ability and, to a smaller extent, with moderate work ability. A higher lifestyle risk score was associated with both sick leave and reduced work ability. Only few associations were found between unhealthy lifestyle factors and sick leave or reduced work ability within disease groups.

Conclusion Lifestyle risk factors were associated with sick leave and reduced work ability. To evaluate these associations further, studies assessing the effect of lifestyle interventions on sick leave and work ability are needed.

Strengths and limitations of this study

- The study included 6267 subjects from the general working population in Telemark, Norway, with information on work ability and sick leave at baseline and 5-year follow-up.
- Inclusion of several lifestyle-related factors (diet, physical activity, body mass index and smoking) allowed to explore the association between both the exposure to a single lifestyle risk factor as well as to multiple lifestyle risk factors and work ability and sick leave.
- The study reflects the general working population, and thus included participants both from a broad spectre of adults with different sociodemographic backgrounds.
- The study relies on self-reports which can introduce information bias in the study.

BACKGROUND

As in most European countries, the old-age dependency ratio is expected to increase in Norway. It is projected that by 2030 every person of working age will have to support almost 0.4 persons aged over 65 years.[1] The Norwegian authorities are therefore seeking to increase the duration of participation in paid employment.[2] The Norwegian welfare state is known for its generous insurance coverage. At the same time, Norway has a high level of sick leave compared with other northern European countries (2.4% of gross domestic product allocated to sick leave).[3] Low work ability, defined as the degree to which a worker is physically and mentally able to cope with the demands at work,[4] has also been related to long-term sickness absence and disability benefits.[5] Unhealthy lifestyle behaviours are potentially modifiable risk factors. Hence, promoting a healthy lifestyle among workers may enhance work ability and the potential to stay in work, and thereby promote longer work participation.[6]

Several longitudinal studies have explored the association between lifestyle-related risk factors and sick leave. Concerning sick leave, there is convincing evidence of an association between high body mass index (BMI) and sick leave.[7 8] Further, prospective studies have indicated an association between low physical activity and sick leave[9–11] and between

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smoking and sick leave.[12–14] Few longitudinal studies have assessed the association between lifestyle risk factors and work ability. The available studies have shown associations between high BMI and low work ability.[15–17] Moreover, a systematic review of six longitudinal studies (all Finnish) found that overweight, obesity, physical activity and smoking were associated with low work ability in a wide range of occupational groups.[6] Lastly, a systematic evaluation of interventions aimed at improving physical activity among workers reported increased work ability compared with control groups.[18]

Despite evidence that lifestyle risk factors tend to cluster,[19 20] only a limited number of studies have explored the association between exposure to several lifestyle risk factors and sick leave and work ability in a general working population. We have previously reported on an association between multiple lifestyle risk factors and low work ability in a cross-sectional study.[21] Moreover, few studies have explored the relationship between lifestyle risk factors and work ability or sick leave within specific chronic disease groups.[22 23] Non-communicable disease such as mental illness, respiratory diseases and cardiovascular diseases are among the leading causes of sickness absence in Norway.[24] Insight into the associations between an unhealthy lifestyle, sick leave and reduced work ability both within the general population and within specific common chronic disease groups is needed in order to design effective interventions to increase work ability and reduce sick leave.

The aim of this longitudinal study is (1) to assess whether lifestyle risk factors are related to work ability and sick leave in a general working population over time, and (2) to study these associations within specific disease groups (ie, respiratory diseases, cardiovascular disease and diabetes, and mental illness).

METHODS

Study design and population

The study is based on data from the longitudinal, general population based, Telemark study conducted in south-eastern Norway in 2013 (baseline). A random sample of 50000 residents aged 16 to 50 years in Telemark received a postal questionnaire in 2013 (baseline). In total, 16099 persons responded (33% response), and 7952 (49%) also completed the questionnaire at 5-year follow-up (2018). Of these, 7510 respondents answered the questions regarding sick leave and work ability score (WAS) and were included in the study. Persons who were not engaged in paid work at baseline or follow-up were excluded. This resulted in a study sample of 6267 subjects.

Dependent variables

Sick leave: Sick leave was defined at baseline and follow-up as one or more days of sick leave in the previous 12 months (‘Have you been on sick leave during the past 12 months?’). A follow-up question was also asked: ‘If yes, for how many days?’ (1–7 days, 8–14 days, 15 days–12 weeks, more than 12 weeks). A dichotomous variable was constructed to assess the presence of sick leave (at least 1 day of sick leave in the past 12 months vs no sick leave). Finally, the duration of sick leave was categorised as ‘none’ (0 days), ‘short-term’ (1–14 days) and ‘long-term’ (≥15 days).

Work ability: The first item of the work ability index, the work ability score,[25] was used to assess self-rated current work ability at baseline and follow-up. The participants answered the question: ‘How do you rate your current work ability compared with your lifetime best’, where a score of 0 represents complete work disability and a score of 10 represents work ability at its best.[25] First, the outcome was dichotomised, defining a WAS of 7 or lower as low work ability and a WAS of 8 or higher as good work ability.[25] Second, the level of work ability was categorised as ‘poor’ (WAS 0–5), ‘moderate’ (WAS 6–7) or ‘good’ (WAS 8–10).[26]

Independent variables

Lifestyle risk factors

Self-reported information on lifestyle risk factors was collected at baseline.

Diet

Dietary information was collected using validated food frequency questions previously used in the Norwegian population-based Nord-Trøndelag Health Study (HUNT3) (2006–2008).[27 28] To reflect adherence to general dietary advice, a dietary sum score was calculated for each participant based on the recommended intake of fruit and vegetables, fat fish, sausages/hamburgers and chocolate/candies.[21] The total score for each participant (scale 0–4) was calculated by summarising their scores on the four indicators, reflecting the number of dietary recommendations met.[29] The responses were coded 0 (not meeting the recommendations) and 1 (meeting the recommendations). The diet score was further divided into three categories: ‘unhealthy diet’ (0–1), ‘average diet’ (2) and ‘healthy diet’ (3–4).

Physical activity

Moderate to vigorous leisure-time physical activity (MVPA) was determined using questions and cut-off points covering frequency, intensity and duration of exercise, previously validated and used in the HUNT1 (1984–1986) and HUNT3 (2006–2008) studies.[30] To reflect recommendations on adult MVPA (≥150 min/week),[31] the responses regarding frequency, intensity and duration were combined into a total MVPA score, according to which ‘low MVPA’ was defined as less than 60 min per week, ‘moderate MVPA’ as between 60 min and 150 min per week and ‘high MVPA’ as 150 min or more weekly.

Body mass index

Body mass index was calculated based on self-reported height and weight and divided into BMI categories in accordance with the WHO’s cut-offs for adults:[32] ‘underweight’ (<18.5 kg/m^2), ‘normal weight’ (18.5–24.9 kg/

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m^2), 'overweight' (25–29.9 kg/m^2) and 'obese' (≥30 kg/m^2). Due to the low prevalence of underweight persons (1%), these participants were combined with the participants in the normal weight group.

Smoking

Smoking habits were divided into three categories, denoted 'current smoker' (every day and occasional smoking combined), 'former smoker' and 'never smoked'.

Lifestyle risk index

An overall lifestyle risk index was constructed combining multiple lifestyle risk factors (including BMI). The individual lifestyle factors were given weighted risk scores: 0 (low health risk; healthy diet, ≥150 min/week physical activity, normal weight and never smoked), 0.5 (intermediate health risk; average diet, overweight, between 60 and 150 min physical activity per week and former smoker) and 1 (high health risk; unhealthy diet,<1 hour/weekly physical activity, obesity and current smoker). The sum of these scores provided a total index ranging from 0 to 4. This lifestyle risk index was divided into four categories: 'low risk score' (total score 0–0.5), 'medium risk score' (total score 1–1.5), 'high risk score' (total score 2–2.5) and 'very high risk score' (total score 3–4).

Disease groups

Information on specific diseases was collected by self-reporting at baseline.

Respiratory disease

Participants were defined as having respiratory disease if they responded affirmatively to any of the following questions: 'Has a physician ever diagnosed you with asthma?'; 'Has a physician told you that you have chronic obstructive pulmonary disease?'; 'Do you have, or have you ever had, any of disease/complaints: other chronic respiratory disease other than asthma or chronic obstructive pulmonary disease?'.

Cardiovascular disease and diabetes

Participants were defined as having cardiovascular disease (CVD) if they answered yes to the following question: 'Do you have, or have you ever had, any of disease/complaints: heart attack/angina pectoris, congestive heart failure, stroke/brain haemorrhage or heart arrhythmia atrial fibrillation?'. Participants were defined as having diabetes if they responded affirmatively to the question, 'Has a physician ever diagnosed you with diabetes?'. Further, diabetes and cardiovascular disease were combined due to the close links between the two diseases.[33]

Mental illness

Participants were categorised as having had a mental illness if they responded affirmatively to the question, 'Have you ever had mental problems that you have sought help for?'.

Covariates

At baseline, information was obtained on sex, age and educational level. Age was treated as a continuous variable. Educational level was categorised as 'low' (primary school or lower secondary education), 'intermediate' (upper secondary and certificate) and 'high' (university or university college).

Statistical analysis

Descriptive statistics were presented as frequencies, with a proportion for categorical data and a mean with SD for continuous variables. Missing values for independent variables (diet, physical activity, BMI and smoking) and education were dealt with by a multiple imputation procedure which generated five imputed data sets. The percentage of missing values ranged from 0.5% for smoking to 17% for BMI. The imputation model included the covariates (age; sex), disease groups and dependent variables (sick leave and WAS at baseline) as predictors for independent variables to improve the imputation.

χ^2 tests were used to assess whether there were statistically significant associations between the independent variables. χ^2 tests were also used to explore whether sickness absence and work ability were associated.

To explore the association between lifestyle-related factors at baseline and duration of sick leave and level of WAS at follow-up, multinomial logistic regression analyses were performed. No sick leave and a WAS of 8 to 10 were used as reference categories, respectively. Separate models were used for each of the five lifestyle risk factors (diet, physical activity, BMI, smoking and lifestyle risk index score). All models were adjusted for age, sex, educational level and the dependent variable at baseline.

Similar analyses were performed to study the associations among participants in the disease groups. Due to lack of statistical power, sick leave and WAS were dichotomised as presence of (vs no) sick leave and low (vs good) work ability, respectively. Binary logistic regression analyses were performed to assess the association between lifestyle-related factors and, separately, presence of sick leave or a low WAS within each disease group. All analyses were adjusted for age, sex, educational level and the dependent variables at baseline. Results of multinomial and binary logistic regression analyses were presented as ORs with 95% CIs.

Population attributable fractions (PAF) were calculated to estimate the contribution of lifestyle risk factors to sick leave and low work ability.[34]

As a sensitivity analysis, the analyses were repeated for individuals with complete information on all the independent variables, dependent variables and employment status (n=5206).

In all analyses, statistical significance was defined as $p<0.05$. The statistical analyses were carried out using IBM SPSS Statistics for Windows, V.26.

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Patient and public involvement

The Telemark study includes user-representatives in the study planning, design and transfer of knowledge. Also an user-representative is member of the steering committee and has yielded valuable insights in development of questionnaires. All the results from the Telemark study is distributed to both study participants and the wider public (newspapers, radio, television and Internet).

RESULTS

The majority of the 6267 included participants was women (57%), and the mean age was 39 years (SD 8.7) (table 1). In total, 15% had a mental illness, 11% a respiratory disease and 6% CVD or diabetes. Persons having one of the chronic diseases had a higher prevalence of sick leave and poor work ability (table 1).

Individual lifestyle risk factors were inter-related. Persons who reported an unhealthy diet were more likely to have low physical activity (χ^2=83.86, p<0.05) than persons with a healthy diet. Further, persons who did not engage in physical activity were more likely to smoke (χ^2=70.91, p<0.05) than persons who engaged in physical activity.

Persons who reported sick leave were more likely to have poor work ability than persons having a good work ability (χ^2=463, p<0.05).

Unhealthy lifestyle and sick leave: general population

In the general population, overweight and obesity and former and current smoking at baseline were associated with duration of sick leave at follow-up, after adjusting for demographics and sick leave at baseline (table 2). These associations were strongest for long-term sick leave. Persons with obesity were 1.64 (95% CI: 1.32 to 2.05) times more likely to have long-term sick leave than individuals with a healthy body weight. In addition, former and current smoking was statistically significantly associated with both moderate sick leave and long-term sick leave. Further, exposure to multiple unhealthy risk factors was associated with a higher likelihood of sick leave. A higher score on the unhealthy lifestyle risk score was associated with a higher risk of long-term sickness absence compared with individuals with a low lifestyle risk score. Unhealthy diet and low physical activity were not associated with a higher risk of sick leave.

As regards to individual lifestyle risk factors, the highest PAF for long-term sick leave was found in relation to current smoking (11%). The other PAFs were 8% for obesity, 2% for unhealthy diet and 0.2% for low physical activity. The combined PAF for long-term sick leave showed that 20% of long-term sick leave could be attributed to unhealthy lifestyle risk factors.

Unhealthy lifestyle and reduced work ability: general population

Persons with an unhealthy diet, who do not achieve the recommended level of physical activity, or who smoke or smoked were more likely to have a low WAS than those who have a healthy diet, achieve physical activity recommendations or have never smoked. Further, a statistically significant association was found between a high or very high lifestyle risk score and moderate or poor WAS (table 3).

In the case of poor WAS, current smoking yielded the highest PAF (12%). The PAFs for unhealthy diet and obesity, and low physical activity were 4%, 4% and 3%, respectively. The combined PAF showed that 21% of poor WAS could be attributed to unhealthy lifestyle risk factors.

Unhealthy lifestyle, sick leave and reduced work ability within disease groups

As regards to persons with specific diseases, those who smoke or persons being overweight or obese, and persons with a higher lifestyle risk index were more likely to have one or more days off work due to sick leave. However, only a few of these associations were statistically significant (table 4).

Among workers with specific diseases, the associations between moderate MVPA, current smoking and low WAS had ORs above 1. However, only the association between former smoking and low WAS was statistically significant among persons with a mental illness (n=322 with low WAS) (table 5).

A sensitivity analysis on the complete data set without any missing values (n=5206) yielded similar results to the analyses with imputed data (online supplemental file).

DISCUSSION

This longitudinal study of a general working population found associations between unhealthy lifestyle factors on one hand and sick leave and reduced work ability on the other hand. Unhealthy diet, moderate and low physical activity, and current smoking were consistently associated with low work ability. Sick leave, and long-term sick leave in particular, was associated with smoking and BMI. Exposure to multiple unhealthy lifestyle factors increased the risk of sick leave and poor work ability. The combined PAFs for long-term sick leave (20%) and poor WAS (21%) indicate that an unhealthy lifestyle contributes substantially to sick leave and low work ability. Moreover, unhealthy lifestyle factors—in particular overweight, smoking and exposure to multiple lifestyle risk factors—were found to be associated with sick leave in groups with a specific disease. However, no consistent associations were found between lifestyle risk factors and low WAS in the specific disease groups.

We have previously reported an additive association between multiple lifestyle risk factors and low work ability in a cross-sectional study of a general working population in Norway.[21] A small Polish cross-sectional study indicated a similar additive association between unhealthy lifestyle risk factors and low work ability.[35] To the best of our knowledge, no other studies have explored the association between a multiple lifestyle risk index and sick leave

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Table 1 Baseline characteristics of the total study population (n=6267) and workers with respiratory disease (n=688), CVD or diabetes (n=348) and mental illness (n=948)

	Total n=6267	Respiratory disease n=688	CVD or diabetes n=348	Mental illness n=948
Age in years (m, SD)	39 (SD 8.7)	38 (SD 8.8)	42 (SD 7.9)	39 (SD 8.7)
Sex				
Female	3583 (57)	412 (60)	174 (50)	671 (71)
Male	2684 (43)	276 (40)	174 (50)	277 (29)
Education				
Low	683 (11)	66 (10)	46 (13)	95 (10)
Intermediate	2244 (36)	244 (36)	150 (43)	312 (33)
High	3340 (53)	378 (54)	152 (44)	541 (57)
Diet				
Healthy	3708 (59)	395 (57)	205 (59)	525 (55)
Average	2128 (34)	254 (37)	122 (35)	341 (36)
Unhealthy	431 (7)	39 (6)	21 (6)	82 (9)
Physical activity				
High MVPA	3358 (54)	387 (56)	174 (50)	515 (54)
Moderate MVPA	1709 (27)	177 (26)	102 (29)	249 (26)
Low MVPA	1200 (19)	124 (18)	72 (21)	184 (20)
Body mass index				
Under and normal weight	3086 (49)	289 (42)	127 (36)	492 (52)
Overweight	2294 (37)	268 (39)	134 (39)	328 (34)
Obese	887 (14)	131 (19)	87 (25)	128 (14)
Smoking				
Never	3535 (57)	389 (57)	153 (44)	427 (45)
Past	1453 (23)	167 (24)	105 (30)	261 (28)
Current	1279 (20)	132 (19)	90 (26)	260 (27)
Lifestyle risk index				
Low risk score (0–0.5)	2001 (32)	213 (31)	68 (20)	246 (26)
Medium risk score (1–1.5)	2739 (44)	297 (43)	166 (47)	447 (47)
High risk score (2–2.5)	1268 (20)	146 (21)	87 (25)	206 (22)
Very high risk score (3–4)	259 (4)	32 (5)	27 (8)	49 (5)
Sick leave duration (follow-up)				
No sick leave (0 days)	4387 (70)	419 (61)	219 (63)	559 (59)
Short-term sick leave (1–14 days)	960 (15)	118 (17)	51 (15)	165 (17)
Long-term sick leave (15+days)	920 (15)	151 (22)	78 (22)	224 (24)
Work ability score (follow-up)				
Good (8–10)	5362 (85)	559 (81)	255 (73)	716 (75)
Moderate (6–7)	554 (9)	76 (11)	52 (15)	131 (14)
Poor (0–5)	351 (6)	53 (8)	41 (12)	101 (11)

Numbers are frequencies and proportions unless otherwise specified. Missing: smoking (0.5%), education (2%), diet (3%), physical activity (3%), BMI (17%).
CVD, cardiovascular disease; MVPA, moderate to vigorous leisure-time physical activity.

or work ability over time. Data from four European cohort studies indicate that co-occurrence of lifestyle risk factors such as physical inactivity, high BMI and smoking leads to reduced life-years lived in good health.[20] Although limited literature is available on the effectiveness of health promotion activities with regard to work ability

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Table 2 Associations between lifestyle-related factors at baseline and short-term and long-term sick leave in the general population (n=6267)

	Short-term sick leave* 1–14 days (n=960) OR (95% CI)	Long-term sick leave* 15+ days (n=920) OR (95% CI)
Diet		
Average	1.05 (0.90 to 1.23)	1.00 (0.85 to 1.18)
Unhealthy	1.09 (0.82 to 1.46)	1.32 (0.99 to 1.74)
Physical activity		
Moderate MVPA	1.02 (0.86 to 1.21)	1.15 (0.97 to 1.37)
Low MVPA	1.14 (0.94 to 1.38)	1.01 (0.82 to 1.24)
Body mass index		
Overweight	**1.24 (1.04 to 1.47)**	**1.27 (1.06 to 1.52)**
Obese	1.25 (0.99 to 1.56)	**1.64 (1.32 to 2.05)**
Smoking		
Former	**1.31 (1.10 to 1.57)**	**1.28 (1.06 to 1.54)**
Current	**1.50 (1.25 to 1.80)**	**1.62 (1.35 to 1.96)**
Lifestyle risk index		
Medium risk score	1.09 (0.91 to 1.30)	**1.31 (1.08 to 1.59)**
High risk score	**1.26 (1.02 to 1.56)**	**1.59 (1.28 to 1.99)**
Very high risk score	**1.89 (1.32 to 2.71)**	**1.89 (1.27 to 2.81)**

Adjusted for age, sex, education and sick leave at baseline.
*Reference category is 0 sick leave days.
MVPA, moderate to vigorous leisure-time physical activity.

Table 3 Associations between unhealthy lifestyle-related factors at baseline and the level of WAS at follow-up in the general population (n=6267)

	Moderate WAS (6–7)* (n=554) OR (95% CI)	Poor WAS (0–5)* (n=351) OR (95% CI)
Diet		
Average	1.15 (0.94 to 1.41)	1.18 (0.91 to 1.54)
Unhealthy	**1.42 (1.01 to 2.00)**	**1.57 (1.01 to 2.43)**
Physical activity		
Moderate MVPA	**1.35 (1.09 to 1.69)**	1.29 (0.98 to 1.71)
Low MVPA	**1.41 (1.11 to 1.79)**	1.17 (0.85 to 1.61)
Body mass index		
Overweight	1.16 (0.93 to 1.44)	1.17 (0.86 to 1.58)
Obese	1.12 (0.83 to 1.50)	1.30 (0.92 to 1.84)
Smoking		
Former	1.03 (0.82 to 1.30)	**1.36 (1.01 to 1.83)**
Current	**1.36 (1.09 to 1.71)**	**1.67 (1.24 to 2.25)**
Lifestyle risk index		
Medium risk score	1.18 (0.92 to 1.50)	1.32 (0.94 to 1.85)
High risk score	**1.52 (1.16 to 1.99)**	**1.58 (1.11 to 2.62)**
Very high risk score	**1.93 (1.25 to 2.98)**	**2.54 (1.49 to 4.31)**

Adjusted for age, sex, education and WAS at baseline.
*Reference category is 8–10 WAS.
MVPA, moderate to vigorous leisure-time physical activity; WAS, work ability score.

and sick leave,[36] our study provides support for focussing on multiple lifestyle risk factors as a means of reducing sick leave and enhancing work ability. Our finding that persons with multiple lifestyle risk factors are more likely to have a lower work ability and higher sickness absence may imply that an unhealthy lifestyle will incur costs for the employer. A recent Finnish cohort study following sick leave over a 14-year long period (2002–2016) found that individuals having ≥3 lifestyle risk factors (high alcohol consumption, low fruit or vegetable intake, being physical inactive, currently smoker or having sleep disruption) resulted in an additional expense for the employer of 3266 €, compared with those with no risk factors.[37]

In this study, we found that some 20% of long-term sick leave could be attributed to unhealthy lifestyle factors. This is consistent with Virtanen *et al* (2018), who found that 15% to 30% of sick leave could be attributed to lifestyle risk factors.[38] Our study also shows that obesity and smoking are associated with sick leave, and long-term sick leave particularly. This is in line with the results of the Virtanen study.[14] Moreover, recent systematic reviews have found BMI and smoking to be associated with sick leave.[7 12 13] Amiri have shown that workers who are overweight or obese have a 1.2 to 1.3 times higher risk of sick leave than workers with a healthy body weight.[7] Troelstra *et al* have reported that smoking is associated with a 31% increase in risk of sick leave.[13] Obesity and smoking are risk factors with respect to several diseases, including mental illness and cardiovascular disease, which are themselves risk factors for sick leave.[7 12 13] Moreover, smokers are more susceptible to respiratory problems and a reduced immune system, which could increase the risk of short-term sick leave due to, for example, the common cold/influenza.[13] Importantly, encouraging results have been reported regarding workplace intervention of smoke cessation.[13]

Our study could not confirm associations between an unhealthy diet or insufficient physical activity and sick leave. In a systematic review, Kerner *et al*[11] have shown that 11 out of 15 included studies reported an association between lower leisure-time physical activity and sick leave. It is important to note, however, that comparison of results in this area is challenging because different studies employ different measures of leisure-time physical activity and different cut-offs for sick leave days.

Concerning work ability, we did find an association between unhealthy diet, moderate and low MVPA and former and current smoking at baseline and low work ability after 5 years. Unfavourable baseline levels of physical activity were also associated with moderate and poor WAS at follow-up. This is consistent with a scoping review

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Table 4 Associations between unhealthy lifestyle-related factors at baseline and the presence of sick leave at follow-up among workers with respiratory diseases (n=688), cardiovascular diseases or diabetes (n=348) or mental illness (n=948)

	Sick leave (yes vs no)		
	Respiratory disease n=269/688 OR (95% CI)	**CVD or diabetes n=129/438 OR (95% CI)**	**Mental illness n=389/948 OR (95% CI)**
Diet			
Average	1.04 (0.74 to 1.48)	0.87 (0.52 to 1.46)	1.10 (0.82 to 1.47)
Unhealthy	1.16 (0.57 to 2.34)	1.30 (0.49 to 3.41)	1.28 (0.78 to 2.09)
Physical activity			
Moderate MVPA	1.17 (0.80 to 1.71)	0.89 (0.51 to 1.53)	0.76 (0.55 to 1.06)
Low MVPA	0.74 (0.47 to 1.17)	1.06 (0.58 to 1.94)	0.99 (0.69 to 1.42)
Body mass index			
Overweight	1.31 (0.87 to 1.95)	0.99 (0.52 to 1.89)	1.45 (0.98 to 2.16)
Obese	1.45 (0.87 to 2.43)	1.25 (0.60 to 2.60)	1.34 (0.81 to 2.21)
Smoking			
Former	1.33 (0.89 to 1.98)	1.58 (0.91 to 2.75)	1.10 (0.79 to 1.53)
Current	1.31 (0.85 to 2.00)	**1.81 (1.01 to 3.25)**	**1.42 (1.02 to 1.98)**
Lifestyle risk index			
Medium risk score	**1.51 (1.01 to 2.24)**	1.24 (0.63 to 2.45)	1.40 (0.99 to 1.99)
High risk score	1.24 (0.77 to 1.99)	1.48 (0.67 to 3.31)	1.46 (0.95 to 2.24)
Very high risk score	1.25 (0.54 to 2.91)	1.52 (0.56 to 4.18)	1.42 (0.71 to 2.84)

Adjusted for age, sex, education and sick leave at baseline. No sick leave is the reference category.
CVD, cardiovascular disease; MVPA, moderate to vigorous leisure-time physical activity.

Table 5 Associations between unhealthy lifestyle-related factors at baseline and the presence of a low WAS at follow-up among workers with respiratory diseases (n=688), cardiovascular diseases or diabetes (n=348) or mental illness (n=948)

	WAS (0–7 vs ≥8)		
	Respiratory disease n=129/688 OR (95% CI)	**CVD or diabetes n=93/348 OR (95% CI)**	**Mental illness n=332/948 OR (95% CI)**
Diet			
Average	0.91 (0.57 to 1.44)	1.01 (0.56 to 1.81)	1.06 (0.74 to 1.51)
Unhealthy	0.85 (0.32 to 2.27)	0.67 (0.19 to 2.40)	0.96 (0.52 to 1.76)
Physical activity			
Moderate MVPA	1.21 (0.73 to 2.01)	1.11 (0.57 to 2.15)	1.35 (0.90 to 2.03)
Low MVPA	0.87 (0.47 to 1.51)	0.97 (0.47 to 2.03)	1.15 (0.73 to 1.80)
Body mass index			
Overweight	1.29 (0.78 to 2.16)	0.93 (0.47 to 1.82)	0.95 (0.64 to 1.41)
Obese	1.20 (0.60 to 2.40)	1.00 (0.47 to 2.14)	0.97 (0.50 to 1.88)
Smoking			
Former	1.04 (0.62 to 1.74)	1.10 (0.57 to 2.11)	**0.57 (0.37 to 0.88)**
Current	1.17 (0.67 to 2.05)	1.08 (0.55 to 2.15)	0.95 (0.64 to 1.41)
Lifestyle risk index			
Medium risk score	1.21 (0.67 to 2.18)	1.49 (0.65 to 3.41)	0.82 (0.54 to 1.25)
High risk score	1.03 (0.53 to 2.00)	1.08 (0.42 to 2.80)	0.87 (0.53 to 1.45)
Very high risk score	0.72 (0.22 to 2.35)	0.87 (0.25 to 3.03)	1.41 (0.67 to 2.96)

Adjusted for age, sex, education and WAS at baseline. WAS of 8–10 is the reference.
CVD, cardiovascular disease; MVPA, moderate to vigorous leisure-time physical activity; WAS, work ability score.

focussing on worksite physical activity interventions.[18] Further, a recent randomised controlled trial among workers at the Volkswagen factory in Germany found that participants with metabolic syndrome benefited from activity-monitored and supported exercise (face-to-face meetings and a smartphone application). Not only did the participants improve on metabolic syndrome parameters, but the intervention group also increased its work ability compared with the control group after the 6 month intervention.[39] Although the intervention period was limited, the results are promising in terms of reducing disease risk and improving work ability. Many workers spend most of their working lives in sitting or other sedentary positions.[40] Increasing efforts to enhance leisure-time physical activity therefore seems warranted.

The PAFs of 20% and 21% observed in our study, indicate that interventions focussed on lifestyle risk factors could in theory work ability and reduce sickness absence. However, further evidence is needed on health-promotion programmes to prevent low work ability.[41] It could be hypothesised that healthy behaviours would improve physical and mental health[42] and decrease BMI, and thereby increase work ability and reduce sick leave in a general working population.

To the best of our knowledge, few studies have explored these relationships among persons with chronic diseases.

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Although not statistically significant, our results show ORs above 1 for the associations between obesity and smoking and sick leave within the specific disease groups. A Dutch cross-sectional study of 8364 healthcare employees[22] found statistically significant associations between smoking, obesity and low work ability among persons with respiratory diseases. The same study also found smoking to be associated with sick leave among persons with a mental illness.[22] Partly due to low numbers in each disease category and a resulting lack of statistical power, our hypothesis regarding an increased risk of sick leave and work ability among persons with common chronic diseases and an unhealthy lifestyle was not confirmed. Although few statistically significant associations were found in the specific disease groups, our results did show ORs above 1 for the associations between overweight, obesity, smoking, the lifestyle risk index and sick leave in these groups. As regards the chronic disease groups, we cannot exclude a healthy worker effect entailing exclusion of workers with more severe chronic diseases and unhealthy lifestyles from the workforce.

Strengths and limitations

The 5-year follow-up period is a strength of this study. Most available studies have a cross-sectional design or a shorter follow-up period. Another strength is that this study was performed on the general working population, and thus included participants both from a broad spectre of adults with different sociodemographic backgrounds. Further, this study used validated questions to assess the independent variables. These questions have previously been used in the HUNT1 and HUNT 3 studies.[28 30] This allows comparison in the Norwegian context.

An important limitations of the study is the low number of persons in each disease group. The lack of statistical power makes it difficult to draw conclusions regarding these groups. Furthermore, due to the low response (33%) generalisation is challenging. Nevertheless, analyses of non-responders indicate comparable results to those of responders.[43] Due to the high number of missing values, missing values were imputed. As mentioned, the results are comparable with complete case analyses. However, we cannot rule out the possibility of selection bias in this study. Moreover, this study relies on self-reporting by participants. This may entail underestimation or overestimation of unhealthy behaviours. Nevertheless, the questions on both diet and physical activity have previously proven to be valid and reliable measures when compared with objective measures.[30 44]

Given that this study only included persons engaged in paid work during the past 12 months or below the age of 50 years at baseline, the results cannot be generalised to persons who are not engaged in paid work, or to older age groups. Prior research indicates that employment status and high age could both be indicators of poor work ability.[6] However, other factors which may be important were not available in our study, such as family income, productivity or reasons for sickness absence. Moreover, we do not have detailed information on remission or severity of disease which might have altered our results.

Due to the different follow-up periods reported in the different longitudinal studies, cross-study comparison is difficult. A 5-year follow-up period may also be too short to detect changes in work ability and sick leave due to lifestyle changes. As a result, our findings could underestimate the relationship between lifestyle risk factors and work ability and sick leave.

CONCLUSION

In this longitudinal study, statistically significant associations were found between lifestyle risk factors and long-term sick leave and poor work ability. Further, exposure to multiple lifestyle risk factors was associated with subsequent more sick leave and reduced work ability. The findings related to specific disease groups were less consistent. However, based on the results of our work, we would encourage employers to facilitate—in addition to a healthy work environment—healthy lifestyles. The results indicate that studies assessing lifestyle interventions are needed to investigate the effect on sick leave and work ability.

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Contributors AKMF was involved in conception, design and data collection. MMDB, IMO, AKMF, SJWR and AB were involved in the selection of research questions. MMDB was responsible for the statistical analyses. MMDB, IMO, AKMF, SJWR and AB were involved in the interpretation of the results. MMDB drafted the manuscript with the assistance of SJWR. MMDB, IMO, AKMF, SJWR and AB revised the manuscript critically and approved the final manuscript.

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Competing interests None declared.

Patient consent for publication Not required.

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Data availability statement Data are available upon reasonable request. The data sets generated and/or analysed during the current study are not publicly available due to individual privacy regulations. However, data may be shared with researchers who meet the criteria for access to confidential data upon request to the head of the Telemark study steering committee.

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