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Complete List of Authors:	Oellingrath, Inger; University of South-Eastern Norway, Department of Nursing and Health Sciences De Bortoli, Marit; University of South-Eastern Norway, Department of Nursing and Health Sciences Svendsen, Martin ; Sykehuset Telemark HF, Department of Occupational and Environmental Medicine Fell, Anne Kristin; Sykehuset Telemark HF, Occupational and environmental Medicine

Keywords:	Lifestyle risk factors, Work ability, General working population

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

Inger M. Oellingrath. Department of Nursing and Health Sciences. Faculty of Health- and Social Sciences. University of South-Eastern Norway. E-mail: inger.m.oellingrath@usn.no

Marit Müller De Bortoli. Kjølnes ring 56, 3918 Porsgrunn, Norway. Department of Nursing and Health Sciences. Faculty of Health- and Social Sciences. University of South-Eastern Norway. E-mail: marit.muller@usn.no. Telephone: +47 92626790 *).

Martin Veel Svendsen. Department of Occupational and Environmental Medicine. Telemark Hospital, Skien, Norway. E-mail: martin.svendsen@sthf.no

Anne Kristin Møller Fell. Department of Occupational and Environmental Medicine. Telemark Hospital, Skien, Norway. E-mail: annfel@sthf.no

*) Corresponding author

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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 50000 subjects were invited to answer a self-administered questionnaire, and 16099 responded. Complete data on lifestyle and work ability were obtained for 10355 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 (WAI). To study potential dose-response of lifestyle risk factors on work ability, a lifestyle risk index was constructed. Associations between lifestyle factors/index and work ability were examined using multiple logistic regression analysis.

Results: Decreased 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). A cumulative (dose-response) association was observed between the lifestyle risk index and the likelihood of decreased work ability (moderate risk score: OR_{adj}=1.3; CI 1.1 to 1.6; high risk score: OR_{adj}= 1.9; CI 1.6 to 2.2; very high risk score: OR_{adj}=2.4; CI 1.9 to 3.0). Population attributable risk (PAR) of decreased work ability was 38%. All associations were observed independently of gender, age, education level and occupation.

Conclusions: Lifestyle risk factors were associated with decreased work ability. A cumulative (dose-response) relationship was observed. The findings are considered relevant to occupational intervention programmes aimed at prevention and improvement of decreased work ability.

Key words: Lifestyle risk factors, work ability, general working population

Strengths and limitations of this study

- The study included 10355 subjects from the general working population in Telemark, Norway.
- Inclusion of several lifestyle-related factors allowed for examination of both independent and dose-response 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 nonattendance of older than 50.

BACKGROUND

As in many other European countries (1), Norway's population and workforce are aging. The challenges this presents have given rise to government policies with 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). A person's work ability may be influenced by various work-related and individual factors (10, 11). At the individual level, lifestyle-related factors (such as diet, physical activity, BMI and smoking) are known to have a significant impact on health (12, 13). 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 (14). A corresponding instrument is the first single-item question in the WAI, the Work Ability Score (WAS) (15).

Previous cross-sectional and longitudinal studies have investigated the relationship between different lifestyle factors and work ability (measured by WAI or WAS) (10, 11, 16-23). A systematic review covering 14 cross-sectional and six longitudinal studies of lifestyle and work ability published from 1985 to 2006 has identified low leisure-time physical activity and obesity as important determinants of decreased work ability in different occupational groups (10). Recent studies support these findings (11, 16-22, 24). 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 (10, 23, 24). Non-smoking has also been associated with good work ability in some studies (6, 10, 18), although the results on smoking and work ability remain inconclusive (10, 16). Previous studies have commonly focused on distinct occupational groups, groups with certain job demands, and selected age groups (10, 11, 16-19, 22, 24), rather than on general working populations (20, 21, 23). 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 (25). Previous lifestyle and health studies have shown cumulative (dose-response) effects of lifestyle risk indicators on non-communicable, chronic diseases and all-cause mortality (26), self-rated health (27, 28) and long-term work disability (early retirement) (8). 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 dose-response effect of multiple, simultaneously applicable lifestyle indicators on modification of work ability. In that study, the authors identified a cumulative association between a healthy lifestyle index (incorporating recommended physical activity, normal BMI, non-smoking and fibre intake) and increasing WAI (23). 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 (29), rather than the potential contribution of lifestyle factors.

The aim of the present study was to investigate the association between multiple lifestyle-related risk factors (unhealthy diet, low leisure-time physical activity, 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 south-eastern part of Norway and has a population of about 170000. A sample of 50000 males and females aged 16 to 50 years, from the approximately 80000 residents in Telemark, was drawn randomly using the services of the Norwegian national population registry. Of the 50000 who received the questionnaire, 1793 had moved, four 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 48142 eligible participants, a total of 16099 answered the questionnaire, resulting in a response rate of 33%. The data collection and recruitment methods and characteristics of the non-responders have been described in detail elsewhere (30).

Participants were asked questions on diet, physical activity, 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, physical activity, smoking habits, height and weight and work ability) were available for 10355 participants.

Work ability

Self-rated work ability was assessed using the first single-item question in the WAI (14), the Work Ability Score (WAS) (15): "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, 20). WAS has been recommended and used as a simple, reliable indicator of work ability in several population studies (5, 9, 16, 20, 31). In this study, work ability was divided into two categories: decreased work ability (score 0–7) and good work ability (score 8-–10) (19, 31).

Diet

Diet was determined using food frequency questions previously used in the Norwegian population-based Nord-Trøndelag Health Study (HUNT3) (2006–2008) (32, 33). The questions were selected from a larger validated food frequency questionnaire used in the Oslo Health Study of 2001 (HUBRO) (34) 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 (35) , 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 (36). The diet score was trichotomised into the categories "unhealthy" (0–1), "average" (2) and "healthy" (3–4) diet.

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 (37). The questionnaire has previously been validated against objective measurement methods and the International Physical Activity Questionnaire (IPAQ), with good internal consistency (37). 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 minutes”, “15–29 minutes”, “30 min–1 hour” and “more than 1 hour”. To reflect recommendations on adult MVPA (≥ 150 minutes/week) (35), the responses to the three questions were combined to give a total MVPA score (37). This was labelled “Physical activity” 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 (37, 38).

BMI categories

BMI categories (underweight, normal weight, overweight, obesity) were calculated based on self-reported height and weight data. Cut-off points were chosen according to the World Health Organization reference values for adults: underweight (<18.5), normal weight (18.5–24.9) , overweight (25–29.9) and obese (≥30) (39).

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

An overall lifestyle risk index was constructed to study the possible cumulative (dose-response) effect of lifestyle risk factors on work ability. To calculate 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”.

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 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 (2013), using the International Standard Classification of Occupations (ISCO-88) coding system (40). The ten occupational groups were further combined into five subgroups for use in the analyses (Table 1).

Statistical analysis

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 decreased work ability (dependent variable). The individual lifestyle variables were mutually adjusted in the respective models. Odds ratios (OR) with 95% confidence intervals were calculated for the likelihood of decreased 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-based attributable risk (PAR) of decreased work ability was calculated (41). PAR is defined as the reduction in incidence that would be observed if the population were entirely unexposed, compared with its actual exposure pattern.

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, version 23.

Patient and Public Involvement

To release the full potential of the study we have involved user-representatives in the study planning, design and transfer of knowledge. Resourceful user representatives are engaged in the dissemination of results to the public, policy makers and to health care workers through regional, national and international media on all platforms (newspapers, internet, radio and television). An user-representative is 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 16099 of the 48142 eligible subjects answered the questionnaire. Of these, 12932 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 10355 respondents. Further background characteristics of the study population are shown in Table 1. The distributions of the main variables are specified in Table 2.

Table 1 Study population characteristics (n = 10355).

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 three to four 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 (n=10355).

	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 (PA)		
Active	5332 (51.5)	(0)
Inactive	5023 (48.5)	(1)
BMI category		
Normal weight	4951 (47.8)	(0)
Underweight (<18,5)	128 (1.2)	(0.5)
Overweight (25–30)	3733 (36.1)	(0.5)
Obese (>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 index risk score		
Low risk score	2592 (25.0)	(0–0.5)
Moderate risk score	4030 (38.9)	(1–1.5)
High risk score	2895 (28.0)	(2–2.5)
Very high risk score	838 (8.1)	(3–4)
Work ability score		
Decreased work ability (0–7)	1379 (13.3)	
Normal/good work ability (8–10)	8976 (86.7)	

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

Table 3 Associations between lifestyle factors and likelihood of decreased 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, 1.3)**	1.1 (0.98, 1.3)	1.1 (0.98, 1.3)
Unhealthy	**1.4 (1.2, 1.7)**	**1.3 (1.1, 1.6)**	**1.3 (1.02, 1.5)**
Physical activity (PA)			
Active (ref.)	1.0	1.0	1.0
Inactive	**1.6 (1.4, 1.8)**	**1.4 (1.3, 1.6)**	**1.4 (1.2, 1.6)**
BMI			
Normal weight (ref.)	1.0	1.0	1.0
Underweight (BMI <18,5)	1.5 (0.91, 2.4)	1.4 (0.86, 2.2)	1.3 (0.82, 2.2)
Overweight (BMI 25–30)	**1.2 (1.01, 1.3)**	1.1 (0.97, 1.3)	1.1 (0.97, 1.3)
Obese (BMI >30)	**1.6 (1.4, 1.9)**	**1.5 (1.3, 1.8)**	**1.5 (1.3, 1.7)**
Smoking status			
Never smoked (ref.)	1.0	1.0	1.0
Former smoker	**1.4 (1.2, 1.6)**	**1.4 (1.2, 1.6)**	**1.2 (1.1, 1.4)**
Current smoker	**1.6 (1.4, 1.9)**	**1.5 (1.3, 1.8)**	**1.3 (1.2, 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, 1.7)**	**1.3 (1.1, 1.6)**
High risk score (2–2.5)	**2.2 (1.8, 2.5)**	**1.9 (1.6, 2.2)**
Very high risk score (3–4)	**2.8 (2.3, 3.5)**	**2.4 (1.9, 3.0)**

* Adjusted for other lifestyle factors.

** Adjusted for other lifestyle factors, gender, age, educational level and occupational group.

*** Population-based attributable risk (PAR) for reduced WA based on lifestyle risk index: 38%.

Multiple logistic regression showed independent associations between individual lifestyle factors and the likelihood of decreased work ability (Table 3, Model 1). Participants in the category "unhealthy diet" were more likely to have decreased work ability than participants with a "healthy diet" (OR_{adj2}=1.3; CI 1.02 to 1.5). Inactive subjects were more likely to have decreased work ability than active individuals (OR_{adj2}= 1.4; CI 1.2 to 1.6). Obese participants had lower work ability than normal-weight subjects (OR_{adj2}= 1.5; CI 1.3 to 1.7). Former and current smokers were more likely to have decreased work ability than those who had never smoked (OR_{adj2}= 1.2; CI 1.1 to 1.4, and adjusted OR_{adj2}= 1.3; 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).

A cumulative (dose-response) effect was observed between the lifestyle risk index and the likelihood of decreased work ability (Table 3, Model 2). The figures were as follows: moderate risk score: OR_{adj2}=1.3; CI 1.1 to 1.6; high risk score: OR_{adj2}= 1.9; CI 1.6 to 2.2; very high risk score: OR_{adj2}=2.4; CI 1.9 to 3.0. The analyses were adjusted for available background variables. PAR of decreased work ability based on the overall risk scores was 38%.

DISCUSSION

In the present study, consistent associations were found between several lifestyle risk factors and self-rated work ability in a general working population in Norway. Obesity was the factor which was most strongly associated with decreased work ability, followed by low physical activity, current smoking and unhealthy diet/former smoking. Further, a cumulative (dose-response) effect was observed between risk factors and work ability. Increasing scores on a multiple lifestyle risk index were associated with increasing likelihood of decreased work ability. A PAR of 38% indicated a substantial contribution of lifestyle to work ability. 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 decreased work ability (10, 23, 24). 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 (42-46). Work ability has previously been strongly associated with mental and physical health (16). 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 physical activity helps to prevent various chronic diseases and improve health-related quality of life (47-49). It is therefore likely that physically 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 (10, 16-19, 23, 24), low leisure-time physical activity was associated with decreased work ability in the present sample from the general working population. Earlier studies indicate that the benefits of and need for physical activity differ between job types. A recently published Danish study focusing on workers performing physically demanding tasks concluded that physical activity must be of high intensity and long duration to increase work ability (22). 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 (16). A Swedish prospective study of healthcare workers found that leisure-time physical activity at the recommended level or higher improved work ability both immediately and in the longer term (17). Correspondingly, the results in the present study show that achieving the recommended level of weekly leisure time MVPA reduces the likelihood of decreased work ability, indicating a beneficial effect across occupations and ages. Further, recent research indicates that physical activity at the workplace may have an additional favourable impact on work ability due to positive effects on social relationships and psychological wellbeing (50).

In line with previous studies (10, 16, 18, 19, 23, 24), a significant association was observed between obesity and decreased work ability. Obese respondents had a 50% higher likelihood of decreased 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 (10). A recent Danish study of a general working population of 10000 adults has shown that increasing BMI above normal range is associated with lower work ability (21). 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 (51).

Smokers (both current and former) showed a higher likelihood of decreased work ability than non-smokers. However, there is no unanimous agreement on this association. While some studies have failed to demonstrate a significant difference (16, 20, 24), other studies support our findings (18, 19, 23). A Dutch study of workers with common diseases found significance only for participants with respiratory diseases (19), while another study found significance for women only (23). In contrast, the effect of occasional smoking on work ability has been found to be more evident for men than for women (52). 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 (52). The results indicate that former smokers may also be at risk of decreased work ability, emphasising the importance of assessing this group as well.

As suggested by others (23), a dose-response effect 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 decreased work ability than those with a low risk score. The effect seems to be cumulative 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 (19). Moreover, additional analyses of the most prevalent risk-factor combinations did not show any significant synergetic effects either (data not shown).

A PAR of 38% indicates a substantial contribution of multiple lifestyle risk to decreased 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 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 dose-response effects. Further, the study has employed validated questions for diet (53), leisure time MVPA (37) and self-assessed work ability (9, 20). The dichotomisation of the total MVPA score into “active” and “inactive” gives good information on MVPA by reference to current recommendations on physical activity (35, 37, 38). The dietary score appears to be a comprehensive indicator of healthy dietary behaviour, compared to previous studies in which the “diet” variable was either not fully elucidated (24) or consisted only of single nutrients or single food items (10, 23). The first single-item question of the WAI, the WAS (15) – “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, 20), often replacing complete WAI in clinical practice and research (54, 55) and increasingly used in population studies (5, 9, 16, 20, 31).

Several individual and environmental factors have previously been associated with decreased work ability and/or lifestyle (10, 16, 56-58). 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. 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 (10, 16, 19, 29, 57).

The present study did not include workers older than 50 years of age. Therefore, it cannot be concluded that the findings are generalizable 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 (10, 16). 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 (13, 56).

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 (37, 53). 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 (59). As regards to self-reported smoking history, previous studies have indicated high reliability of self-reporting (60). 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 underreport (61).

Another limitation of the study is the low response rate (33%), which may have caused bias due to non-response (30). There was a predominance of participants from older age groups and women. Further, only participants with complete data on lifestyle indicators and work ability were analysed. However, non-response to the postal questionnaire has been assessed (30), showing that responders and non-responders had similar frequencies of respiratory symptoms and asthma, but that young males and past smokers were somewhat underrepresented 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 decreased work ability in a general working population. Moreover, a dose-response effect of multiple lifestyle risk factors on decreased 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 decreased work ability. A follow-up study is planned to investigate the observed associations over time, with a particular focus on workers with diagnosed chronic diseases.

Footnotes

List of abbreviations

WAI: work ability index; WAS: work ability score; MVPA: moderate to vigorous physical activity; PAR: population based attributable risk.

Declarations

Authors' contribution

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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Competing interests

The authors declare that they have no competing interest.

Ethics approval

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 and the Norwegian Data Protection Authority (REC 2012/1665).

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Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due to individual privacy regulations, but are available from the corresponding author on reasonable request

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	0
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	16
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	4 and 8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	12 (multiple logistic regression)
		(*e*) Describe any sensitivity analyses	

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 (page 9)
		(b) Indicate number of participants with missing data for each variable of interest	Table 1 (page 9)
Outcome data	15*	Report numbers of outcome events or summary measures	Table 2 (page 10)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 3 (page 11)
		(*b*) Report category boundaries when continuous variables were categorized	Table 2 (page 10), page 5-7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7 (PAR)
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15-16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Footnotes page 18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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

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

Inger M. Oellingrath. Department of Nursing and Health Sciences. Faculty of Health- and Social Sciences. University of South-Eastern Norway. E-mail: inger.m.oellingrath@usn.no

Marit Müller De Bortoli. Kjølnes ring 56, 3918 Porsgrunn, Norway. Department of Nursing and Health Sciences. Faculty of Health- and Social Sciences. University of South-Eastern Norway. E-mail: marit.muller@usn.no. Telephone: +47 92626790 *).

Martin Veel Svendsen. Department of Occupational and Environmental Medicine. Telemark Hospital, Skien, Norway. E-mail: martin.svendsen@sthf.no

Anne Kristin Møller Fell. Department of Occupational and Environmental Medicine. Telemark Hospital, Skien, Norway. E-mail: annfel@sthf.no

*) Corresponding author

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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 50000 subjects were invited to answer a self-administered questionnaire, and 16099 responded. Complete data on lifestyle and work ability were obtained for 10355 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 (WAI). To study 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; CI 1.1 to 1.6; high risk score: OR_{adj}= 1.9; CI 1.6 to 2.2; very high risk score: OR_{adj}=2.4; 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, BMI 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.

Key words: Lifestyle risk factors, work ability, general working population

Strengths and limitations of this study

- The study included 10355 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 nonattendance 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 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 midlife 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, 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 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 six longitudinal studies of lifestyle and work ability published from 1985 to 2006 has identified low leisure-time physical activity 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 physical activity, 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 physical activity, 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 south-eastern part of Norway and has a population of about 170000. A sample of 50000 males and females aged 16 to 50 years, from the approximately 80000 residents in Telemark, was drawn randomly using the services of the Norwegian national population registry. Of the 50000 who received the questionnaire, 1793 had moved, four 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 48142 eligible participants, a total of 16099 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, physical activity, 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, physical activity, smoking habits, height and weight and work ability) were available for 10355 participants.

Work ability

Self-rated work ability was assessed using the first single-item question in the WAI (15), the Work Ability Score (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 (HUBRO) (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" (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 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 (IPAQ), 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 minutes", "15–29 minutes", "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 "Physical activity" 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, obesity) were calculated based on self-reported height and weight data. Cut-off points were chosen according to the World Health Organization reference values for adults: underweight (<18.5), normal weight (18.5–24.9) , overweight (25–29.9) and obese (≥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) and1 (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 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 (2013), using the International Standard Classification of Occupations (ISCO-88) coding system (44). The ten occupational groups were further combined into five subgroups for use in the analyses.

Statistical analysis

Spearman's rho was used to assess 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. Odds ratios (OR) with 95% confidence intervals 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 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, version 23.

Patient and Public Involvement

To release the full potential of the study we have involved user-representatives in the study planning, design and transfer of knowledge. Resourceful user representatives are engaged in the dissemination of results to the public, policy makers and to health care workers through regional, national and international media on all platforms (newspapers, internet, radio and television). An user-representative is 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 16099 of the 48142 eligible subjects answered the questionnaire. Of these, 12932 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 10355 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.

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 three to four 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 (PA)		
Active	5332 (51.5)	(0)
Inactive	5023 (48.5)	(1)
BMI category		
Normal weight	4951 (47.8)	(0)
Underweight (<18,5)	128 (1.2)	(0.5)
Overweight (25–30)	3733 (36.1)	(0.5)
Obese (>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.

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, 1.3)**	1.1 (0.98, 1.3)	1.1 (0.98, 1.3)
Unhealthy	**1.4 (1.2, 1.7)**	**1.3 (1.1, 1.6)**	**1.3 (1.02, 1.5)**
Physical activity (PA)			
Active (ref.)	1.0	1.0	1.0
Inactive	**1.6 (1.4, 1.8)**	**1.4 (1.3, 1.6)**	**1.4 (1.2, 1.6)**
BMI			
Normal weight (ref.)	1.0	1.0	1.0
Underweight (BMI <18,5)	1.5 (0.91, 2.4)	1.4 (0.86, 2.2)	1.3 (0.82, 2.2)
Overweight (BMI 25–30)	**1.2 (1.01, 1.3)**	1.1 (0.97, 1.3)	1.1 (0.97, 1.3)
Obese (BMI >30)	**1.6 (1.4, 1.9)**	**1.5 (1.3, 1.8)**	**1.5 (1.3, 1.7)**
Smoking status			
Never smoked (ref.)	1.0	1.0	1.0
Former smoker	**1.4 (1.2, 1.6)**	**1.4 (1.2, 1.6)**	**1.2 (1.1, 1.4)**
Current smoker	**1.6 (1.4, 1.9)**	**1.5 (1.3, 1.8)**	**1.3 (1.2, 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, 1.7)**	**1.3 (1.1, 1.6)**
High risk score (2–2.5)	**2.2 (1.8, 2.5)**	**1.9 (1.6, 2.2)**
Very high risk score (3–4)	**2.8 (2.3, 3.5)**	**2.4 (1.9, 3.0)**

* Adjusted for other lifestyle factors.

** Adjusted for other lifestyle factors, gender, age, educational level and occupational group.

Spearman's rho correlations between individual lifestyle-related risk factors were ranging from 0.027 between BMI and diet to 0.117 between physical activity 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; CI 1.02 to 1.5). Inactive subjects were more likely to have low work ability than active individuals (OR_{adj2}= 1.4; CI 1.2 to 1.6). Obese participants had lower work ability than normal-weight subjects (OR_{adj2}= 1.5; 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; CI 1.1 to 1.4, and adjusted OR_{adj2}= 1.3; 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; CI 1.1 to 1.6; high risk score: OR_{adj2}= 1.9; CI 1.6 to 2.2; very high risk score: OR_{adj2}=2.4; 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 physical activity, 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 physical activity, 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 physical activity 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 physical activity helps to prevent various chronic diseases and improve health-related quality of life (51-53). It is therefore likely that physically 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 physical activity 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 physical activity differ between job types. A recently published Danish study focusing on workers performing physically demanding tasks concluded that physical activity 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 physical activity 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 physical activity at the workplace may have an additional favourable impact on work ability due to positive effects on social relationships and psychological wellbeing (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 10000 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 physical activity 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 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 physical activity (39, 41, 42). The dietary score appears to be a comprehensive indicator of healthy dietary behaviour, compared to 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 over-adjustment. 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 generalizable 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 regards 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 underreport (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 underrepresented 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.

Footnotes

List of abbreviations

WAI: work ability index; WAS: work ability score; MVPA: moderate to vigorous physical activity; PAF: population based attributable fraction.

Declarations

Authors' contribution

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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Competing interests

The authors declare that they have no competing interest.

Ethics approval

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 and the Norwegian Data Protection Authority (REC 2012/1665).

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Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due to individual privacy regulations, but are available from the corresponding author on reasonable request

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	0
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	16
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	4 and 8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	12 (multiple logistic regression)
		(*e*) Describe any sensitivity analyses	

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 (page 9)
		(b) Indicate number of participants with missing data for each variable of interest	Table 1 (page 9)
Outcome data	15*	Report numbers of outcome events or summary measures	Table 2 (page 10)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 3 (page 11)
		(*b*) Report category boundaries when continuous variables were categorized	Table 2 (page 10), page 5-7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7 (PAF)
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15-16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Footnotes page 18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.