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## Review Article

# Occupational Safety and Health Among Young Workers in the Nordic Countries: A Systematic Literature Review



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## ABSTRACT

This review aimed to identify risk factors for occupational accidents and illnesses among young workers in the Nordic countries and to attain knowledge on specific vulnerable groups within the young working force that may need special attention. We conducted a systematic review from 1994 to 2014 using five online databases. Of the 12,528 retrieved articles, 54 met the review criteria and were quality assessed, in which data were extracted focusing on identifying occupational safety, health risk factors, and vulnerable groups among the young workers. The review shows that mechanical factors such as heavy lifting, psychosocial factors such as low control over work pace, and organizational factors such as safety climate are all associated with increased injury risk for young Nordic workers. Results show that exposures to chemical substances were associated with skin reactions, e.g., hand eczema. Heavy lifting and awkward postures were risk factors for low back pain, and high job demands were risk factors for mental health outcomes. The review identified young unskilled workers including school drop-out workers as particularly vulnerable groups when it comes to occupational accidents. In addition, apprentices and young skilled workers were found to be vulnerable to work-related illnesses. It is essential to avoid stereotyping young Nordic workers into one group using only age as a factor, as young workers are a heterogeneous group and their vulnerabilities to occupational safety and health risks are contextual. Politicians, researchers, and practitioners should account for this complexity in the education, training and organization of work, and workplace health and safety culture.

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## 1. Introduction

The global challenge with aging societies increases the need to provide a sustainable working life for the future workforce by reducing the risks of occupational accidents and illnesses among young workers. In 2015, the sixth European Working Condition Survey showed that every fourth worker reported suffering from work-related health risks and that young workers were more likely to have a serious accident at work than older adults [1]. Previous reviews of the literature have shown that young workers have a higher nonfatal accident rate than older workers [2], that most accidents among young workers occur in the retail industry [3],

that handling heavy loads is a risk factor for occupational accidents [4], and that heavy vehicle drivers younger than 27 years have a higher risk of accident involvement than their older colleagues [5]. In addition, young workers have a higher risk of reporting low job control, heavy physical work, and high chemical work exposures than older workers [6]. Previous reviews have mainly focused on age characteristics alone, without taking into account that young workers constitute a heterogeneous group with different levels of exposure, experience, and attachment to working life. In addition, reviews shedding light on young worker's occupational health are scarce [4].

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To secure a sustainable working life and reduce the burden of occupational accidents and illnesses for young workers, there is a need not only to determine the occupational safety and health (OSH) risks but also to identify vulnerable groups within the young working force. Previous research has found that different groups of young workers have different working conditions and exposures to risk factors [7,8]. The heterogeneity of young workers is increasingly emphasized, and it has been argued that different groups of young workers need to be nuanced in ways that include taking into consideration their differences in physical and psychological maturity, experience, status at work, work exposures, and affiliation to the workplace [9,10]. These challenges have resulted in an increased awareness on young worker's OSH worldwide, including the Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden).

Young workers in the Nordic countries are mostly employed in wholesale/retail, accommodation/food/beverage services, health services, and construction. National statistics from each of the five Nordic countries also reveal that young workers have almost twice the risk of experiencing an accident at work compared to their older colleagues. They also face potentially harmful exposures and hazardous work to a greater degree than older workers [6]. In Norway and Finland, the total annual cost of work-related accidents and illnesses is estimated to about €12 and €24 billion, respectively [11].

When the five Nordic countries are referred to in a work life context, they are often presented as the “Nordic model”, sharing similarities regarding the labor market, with collective bargaining and solidarity-based welfare systems [12]. There are also socio-cultural similarities between the five Nordic countries, indicating that young workers face many of the same conditions and challenges. This enables the comparison of literature and facilitates the identification of vulnerable groups within the young working force that may need special attention. The International Labour Organization's definition of young workers is employees aged 15 to 24 years. In this review, we expanded the age interval by including studies of workers aged 15–29 years. This was done to ensure the inclusion of workers with a lengthier education who enter work life after the age of 24 years.

The aim of the present study was to systematically review studies published between 1994 and 2014 concerning OSH risk factors among young workers in the Nordic countries and to identify vulnerable groups of young workers by separating them by their educational and experiential background and exposures to workplace risk factors.

## 2. Materials and methods

### 2.1. Search strategy

A computer-based literature search was conducted in the following five databases: Ovid Medline (1946–), Ovid Embase (1974–), Web of Science (1950–), ProQuest Health and Safety Sciences Abstracts (1981–), and PsycINFO (1967–). All authors of this article selected “must have” articles in the field, and a search was tested concerning if it captured all the “must have” articles. To optimize the search, several test searches were conducted, adapting it to improve its sensitivity and specificity [13]. The final database search was conducted in collaboration with a skilled research librarian in April 2014. The search consisted of a combination of free text terms and the hierarchic controlled vocabulary, which was customized for each database. The free text terms combined three groups of terms (Work, Young, Nordic) using “AND”. The terms in Group 1 included those such as work\*, occupation\*, career, job, employee, and profession\*. Group 2 included terms such as young,

teen\*, apprentice\*, and youth\*. Finally, the third group of terms were in relation to Nordic, Sweden, swed\*, Scandinavia\*, and Danish. The terms in each of the three groups were then combined with “OR”. To help narrow the search, we used index terms only and not keywords. In addition, each of the project members searched through their own archives to add any additional articles that were published in peer-reviewed journals not indexed in the five databases that were consulted. We also did a less systematic backwards reference search, examining the references cited in the articles.

The computer-based literature search resulted in 16,306 articles, and after removing duplicates, 12,528 articles were identified. Two reviewers from the project (authors T.N.H. and M.W.) independently screened these titles against the inclusion criteria (Table 1). Based on the titles agreed upon, they further independently screened 1,767 abstracts. Disagreement between the two reviewers on the inclusion or exclusion of an article was settled by a third reviewer (K.B.V.). In the next step, 131 articles were retrieved in full text and screened by all authors, resulting in only 52 still meeting the inclusion criteria. In addition, two articles were included from the authors' archives. These two articles were published in a new journal not yet indexed in the five databases searched [7,14]. A total of 54 articles were included in the review, and the inclusion process is presented in a flowchart (Fig. 1).

### 2.2. Study quality and data extraction

Of the included articles, 51 articles had a quantitative design and three articles had a qualitative design. A comprehensive checklist of the methodological quality was used to assess the quantitative articles. The checklist was developed by the Norwegian National Institute of Occupational Health based on earlier checklists for epidemiological studies [15,16]. The checklist was constructed to give each article a score based on its internal and external validity. Internal validity assessment concerned five different topics: (1) study population, (2) exposure/risk factor measurements, (3) outcome measurements, (4) analysis and data presentation, and (5) confounders. The three qualitative articles were assessed using a Canadian checklist for evaluating qualitative studies [17]. The assessments were based on (1) clarity of the research question, (2) appropriateness of design, (3) context and sampling, (4) data collection and analysis, and (5) conclusions and reflexivity.

Two reviewers rated the quality of each article independently and then compared notes to achieve consensus. If consensus was not reached, a third reviewer was consulted. The 54 articles were divided evenly between the project members T.N.H., P.K., M.N., S.T., K.A.H., J.V., M.W., and K.B.V. None of the project members assessed articles for which they themselves were authors. Prior to the assessment, quality assessment training was carried out by assessing relevant articles and discussing ambiguities that emerged.

Data from the included articles were extracted by all members of the project, focusing on identifying OSH risk factors among the young workers. To identify vulnerable groups of young workers, we extracted data on risk factors for different groups by separating them by educational and experiential background, focusing specifically on four different groups of young workers: (i) young workers in general (work of various content and unspecified educational background), (ii) young skilled workers (work that requires vocational training), (iii) apprentice workers (work in some kind of training contract during vocational school), and (iv) young unskilled workers (work that requires no vocational training or experience, including school dropouts). The quality assessment was used to weigh the results from the different articles and to

**Table 1**  
Review of young Nordic workers—inclusion and exclusion criteria

Topic	Inclusion	Exclusion
Study type	<ul style="list-style-type: none"> <li>• Qualitative studies</li> <li>• Quantitative studies               <ul style="list-style-type: none"> <li>- Prospective</li> <li>- Cross-sectional</li> <li>- Intervention</li> <li>- Case-control</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Commentary articles</li> <li>• Review articles</li> <li>• Studies that are not peer-reviewed</li> <li>• Reports</li> </ul>
Population of interest: Age	<ul style="list-style-type: none"> <li>• Studies in which one or more of the categorized populations is included in the age range 15–29 years</li> </ul>	<ul style="list-style-type: none"> <li>• Studies in which people aged 15–29 years and are part of a larger population, but not analyzed separately</li> </ul>
Population of interest: Workers	<ul style="list-style-type: none"> <li>• Studies with focus on workers or transition to work</li> <li>• Work includes paid work, apprentices, trainee, part-time work, informal employment, and temporary work</li> </ul>	<ul style="list-style-type: none"> <li>• Studies that focus on young adults with no focus on work</li> <li>• Professional athletes</li> <li>• Military training</li> <li>• Birth cohorts that focus on factors in childhood and work disability</li> </ul>
Population of interest: Countries	<ul style="list-style-type: none"> <li>• Studies that include populations from the five Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden)</li> </ul>	<ul style="list-style-type: none"> <li>• Studies in which populations from the Nordic countries are part of a larger population, but not analyzed separately</li> </ul>
Outcomes	<ul style="list-style-type: none"> <li>• Occupational accidents/injuries</li> <li>• Work-related health</li> </ul>	<ul style="list-style-type: none"> <li>• Outcomes with no relevance to work</li> </ul>
Risk factors	<ul style="list-style-type: none"> <li>• A clearly defined risk factor including safety culture, attitudes, mechanical factors, physical factors, psychosocial factors, gender, industry, sector, profession, family background, etc.</li> </ul>	<ul style="list-style-type: none"> <li>• No risk factors are defined or analyzed in the study</li> <li>• Studies of young workers and wage incitement or economic regression/crises in society as exposure variables</li> </ul>
Language	<ul style="list-style-type: none"> <li>• Studies that are written in English or one of the Nordic languages</li> </ul>	
Publication period	<ul style="list-style-type: none"> <li>• Studies published from 1994 to April 2014</li> </ul>	

ensure that all articles had acceptable quality. Presentation on article quality is presented in Tables 2–5.

### 3. Results

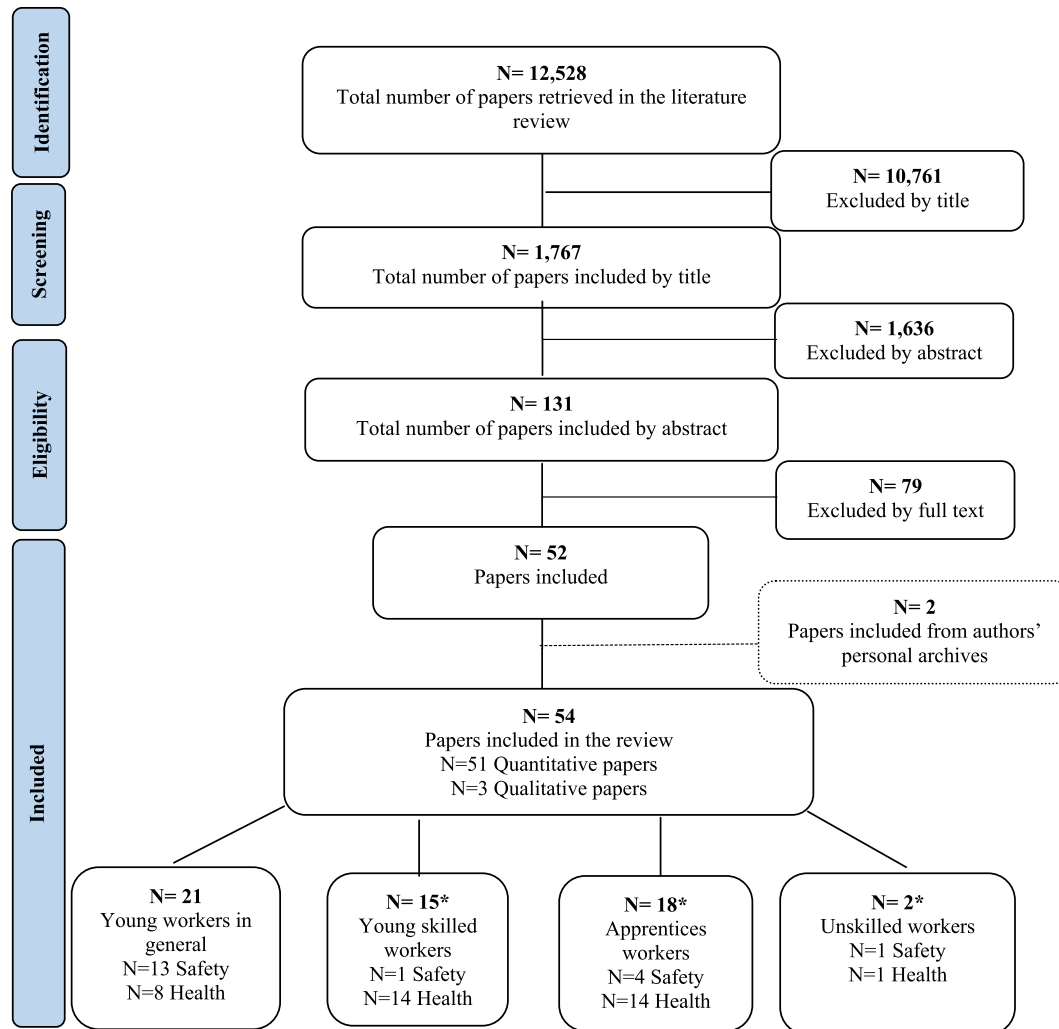
The literature review included 17 articles on occupational safety and 37 on work-related health. All articles are presented in detail in Tables 2–5. Most articles used quantitative methods, whereas only three had a qualitative design. The predominance of studies on safety at work focused on the general population of young workers, whereas the predominance of studies on occupational health outcomes focused on young skilled workers and apprentices. Young unskilled workers were the group of young workers least studied (more information is provided in Fig. 1).

#### 3.1. Young worker's occupational safety

*Young workers in general.* Thirteen quantitative articles assessed occupational safety among the general population of young workers [18–30]. Most articles were based on register data, where only accident rates among age groups were provided. Accident rates were assessed from industries such as fisheries [19], automobile plants [21], nonferrous ore mining [23], assembly work [24,25], iron ore mining [26,27], and various works [18,20,22,28]. All found higher accident rates among young workers than among older workers. Accidents involving falls, cuts, contusions, and crushing accidents were more common among young workers [24,27], as were accidents affecting fingers, hands, and eyes [18–20]. These studies were mainly descriptive and did not control for individual or work-related factors other than age, gender, and occupation. Some authors did argue that the results indicated inequality in risk exposure between age groups [26,27]. Only two of the 13 quantitative articles focused on work-related factors and

their association with occupational accidents. A high-quality prospective study from Denmark found that heavy lifting, high psychological demands, and low social support increased the risk of accidents at work among young workers [29]. A Finnish prospective study found that accidents were more common among young workers and that work tasks involving operating machines were associated with serious accidents [30].

*Specific groups of young workers.* Three qualitative articles based on interviews assessing occupational safety among the general population of young workers were included in the review [7,14,31]. The three studies distinguished in various degrees between different groups of young workers. A Danish qualitative article used focus group interviews among young workers aged 18–24 years in the retail industry and distinguished between young skilled workers, apprentices, unskilled workers, and school drop-out workers [7]. They found that young skilled workers did not regard themselves as “young” or “risk-taking” workers. These skilled workers often worked full-time, had more experience and less heavy and routine work than other young workers, and were therefore perceived as a less vulnerable group of young workers. They also interviewed unskilled and school drop-out workers in the retail industry and found that they often worked part-time and primarily outside “normal” working hours. They often considered themselves as young and risk-taking workers. Furthermore, they often had a high degree of hard physical routine work with little variation. The authors argued that the group of school drop-out workers was particularly vulnerable to occupational accidents as they often were set to do physically heavy, routine, and more hazardous work tasks compared to other groups of young workers [7]. In the same study, five apprentices were interviewed, and they considered themselves also as non-risk-takers. The same authors found in another article that young apprentices' risk behavior did not stem from a desire for risk-orientated work, rather as a way to



**Fig. 1.** Review of young Nordic workers—inclusion of articles. \*One article (Nielsen, 2013 #633) deals with several young working groups and is therefore counted more than once.

adapt to the conditions at work, in which the apprentices' risk behavior was often a reflection of the risk culture in an organization. They also emphasized that youth and risk-taking can be linked to the construction of "acceptable risk" [14].

In another qualitative study, interviews with construction apprentices/workers showed that differences in OSH legislation due to company size had an impact on the OSH training given in the companies, being less formalized in small companies. The authors recommended specific training for the new/young workers and standards for the use of apprentice mentors [31]. The only quantitative study on occupational accidents among construction apprentices/workers showed that physical work demands such as heavy lifting and psychosocial factors such as low control over work pace were associated with increased accident risk [32].

### 3.2. Young worker's work-related health

*Young workers in general.* Eight articles assessed the work-related health in the general population of young workers [33–40]. Four articles focused on musculoskeletal pain outcomes. One study from Sweden showed that musculoskeletal pain reduced

young worker's productivity [38]. The articles also showed that psychosocial working conditions [40], experiencing exhaustion at work [33], and work involving awkward trunk postures were associated with musculoskeletal pain in young workers [35]. The four other studies focused on a variety of work-related health outcomes. One prospective study from Sweden among young workers aged 21–25 years found that psychosocial working conditions were associated with reduced work ability [39]. Another prospective study showed that the sense of coherence was associated with stable labor market position among young workers aged 18–29 years [34]. A Finnish study found that young workers aged 18–30 years had higher probability for sickness absence than the older workers even though they reported better health [36], whereas another cross-sectional study found no differences in self-rated health and quality of life in different occupations for workers aged 20–34 years [37].

*Specific groups of young workers—skilled workers.* Fourteen articles examined work-related health among young skilled workers. Eight were prospective studies [41–48], five had cross-sectional design [49–53], and one was a case–control study [54]. Three of the studies concerned hairdressers. A Norwegian study found that

**Table 2**  
Occupational accidents and work-related illness among young Nordic workers in general

Author (Year)	Data source, population	Industry gender	Exposure	Effect	Results and recommendations	Study design and quality
Occupational accidents among young Nordic workers in general (N = 13)						
Bull et al (1999) Norway	Injury claims from the Daisy database. Injuries in the general working population from the period 1991–1996.	Various work Male and female	Age	Injury claims	Various types of occupational injury claims were found to increase with increasing age. Considering injuries affecting fingers, the highest rate was found among men in the age group 20–24. Injury rates were more than twice among men than among women.	Register study Validity: Internal 8/24 = 33% External 4/5 = 80%
Bull et al (2001) Norway	Injury claims from the Daisy database. Injuries among fisheries workers from 1991–1996.	Fisheries Mostly male workers.	Age	Injury claims	Injury rates are highest among fisheries workers younger than 30 years. Fingers and hands were mostly affected. Bruises and fractures were the most frequent injury types. The authors suggest that young fisheries workers should have better on-the-job training and closer follow-up of experienced workers	Register study Validity: Internal 8/24 = 33% External 5/5 = 100%
Bull et al (2004) Norway	Occupational eye injuries: 1. from a selection of emergency centers to the Norwegian Injury Surveillance System, 1990–2002. 2. from the employers of the National Insurance Administration, 1998–2001.	Various work	Age	Eye injury	Young male workers aged 20–24 years had the highest eye injury incidence. Workers in the metal industry had a high risk of eye injuries. A preventive action could be the use of eye protection.	Register study Validity: Internal 8/24 = 33% External 5/5 = 100%
Döse et al (1994) Sweden	Data on 537 accidents among personnel employed in the period 1986–1987.	Workers at an truck and automobile plant	Age and nationality (people from Finland mostly).	Accidents/injuries	A higher frequency rate of occupational accidents among young workers (16–20 years) than older workers (45–64 years). No increased accident risk for immigrants versus workers with Swedish nationality. For employees younger than 25 years, a tendency for immigrant workers (mostly from Finland) to have higher accident frequency rate.	Register study Validity: Internal 1/24 = 4% External 3/5 = 60%
Gravseth et al (2003) Norway	Occupational injuries (n = 1153) treated by Oslo Emergency Ward over a three-month period (March–June) in 2001	Various work	Age	Occupational injuries treated in an emergency ward	The injury incidence was highest in the youngest age groups (16–19 and 20–24). Men had three times the injury incidence of women. Of those with serious injuries, 30% had a non-Scandinavian language as their first language. Occupations such as electricians and carpenters had the highest observed injury incidences. Need for more in studies on risk factors and possible preventive actions.	Register study Validity: Internal 9/24 = 38% External 5/5 = 100%
Laflamme & Menckel (1996) Sweden	Data were taken from two national sources: ISA (the information system on occupational injuries) and by Statistics Sweden. Accident frequency in the period 1980–1990.	Male nonferrous ore miners	Age	Accident resulting in 1 day's absence from work or more	A higher AR (age-related accident ratio) in younger age groups (16–24 and 25–34) and 35–44 than in the age groups 45–54 and 55–65. For the youngest age group, there was a decrease in the AR in all types of accidents during the time period for all types of accidents, except overexertion. Results suggest the age-related risks are influenced by labor market factors. For example, reduction in personnel may expose young and middle-aged workers to higher risks because of lack of relevant experience.	Register study Validity: Internal 9/24 = 38% External 5/5 = 100%
Laflamme (1996) Sweden	Data were taken from two national sources: ISA (the information system on occupational injuries) and by Statistics Sweden. Accident frequency in the period 1980–1990.	Female assembly workers in the automobile industry	Age	Accident resulting in 1 day's absence from work or more	Higher accident rates were found for female workers aged 16–24 years than for female workers aged 45–54 years. The pattern was similar when split in specific types of accidents (e.g., falls and lifting). Age-related variation between accident types remain worthy of future research attention.	Register study Validity: Internal 9/24 = 38% External 5/5 = 100%

(continued on next page)

Table 2 (continued)

Author (Year)	Data source, population	Industry gender	Exposure	Effect	Results and recommendations	Study design and quality
Laflamme (1996) Sweden	Data were taken from two national sources: ISA (the information system on occupational injuries) and by Statistics Sweden. Accident frequency in the period 1980–1990.	Male assembly workers in the automobile industry	Age	Accident resulting in 1 day's absence from work or more	Higher accident rates were found for young male assembly workers (aged 16–24 years) regardless of accident type (nonspecific vs. specific). Inequalities in risk exposure, labor market factors, and early deselection from the occupation are emphasized as significant external factors in the age-related difference observed.	Register study Validity: Internal 9/24 = 38% External 5/ = 100%
Laflamme et al (1996) Sweden	Data were taken from two national sources: ISA (the information system on occupational injuries) and by Statistics Sweden. Accident frequency in the period 1980–1990.	Male iron ore miners	Age	Accident resulting in 1 day's absence from work or more	The tendency is higher accident rates in younger age groups (16–24 and 25–34), than in the age group of 45–54 and 55–65. Tendency that there is lower median number of lost days among younger workers than among older indicates more severe accidents. Results may indicate inequality in risk exposure between age groups. Age may be a good predictor of accident severity provided that differences in risk exposure are controlled for.	Register study Validity: Internal 10/24 = 42% External 5/5 = 100%
Laflamme & Blank (1996) Sweden	Data on accidents were taken from ISA (the information system on occupational injuries) and data registered by the companies.	Male iron ore miners all working at the underground level.	Age	Accident resulting in 1 day's absence from work or more	Accident rate ratios were higher in younger age categories (<30) than in the oldest age group (50+) for sprain/strain because of overexertion and cuts/contusions/crushing injuries. The possibility that young workers were more exposed than their older colleagues to workload and injury risks is supported to some extent by the findings	Register study Validity: Internal 13/24 = 54% External 3/5 = 60%
Lindqvist et al (1999) Sweden	Data on injuries were taken from inpatient and outpatient facilities from a Swedish municipality (n = 41.000) during a period of 1 year.	Various work Females and males.	Age	Work-related injuries treated by a doctor.	Young (aged 15–24 years) men showed the highest rate of injury. Gender difference in work-related injury was found among young workers (men 67 per 1000, women 14 per 1000). More attention to the gender aspect of work-related injuries.	Register study Validity: Internal 10/24 = 42% External 5/5 = 100%
Rasmussen et al (2011) Denmark	Birth cohort comprising all adolescents in the county of Ringkjøbing, Denmark, born in 1989. Young workers were followed up from 15 to 18 years of age. N = 2181 (answered at both time points).	Various work Females and males.	A variety of work environment factors	Experienced a work accident	Heavy lifting, high psychological demands, and low social support increased the risk of experiencing work accidents among young workers. Encourages more cohort studies of risk factors for accidents among adolescents.	Prospective study Validity: Internal 21/33 = 64% External 6/8 = 75%
Salminen (1996) Finland	Data from 99 serious occupational accidents in the provinces of Uusimaa and Southern Häme in the period of Sep 1988 to Dec 1989. Interview of 73 workers with serious accidents. The second data set was based on a representative sample of the Finnish population aged >14 years. 87% (n = 13.762)	Various work Females and males.	Work task	Accident at work (frequency and type)	Both data sets showed that the accident frequency was slightly higher among young workers (15–24 years) than among older workers. Incautiousness was an important accident factor for young workers. Feeding and cleaning machines were the main work tasks related with accidents for young workers. To prevent accidents of young workers, companies should introduce training programs for new employees.	Register study Validity: Internal 5/24 = 21% External 5/5 = 100%
Work-related illness among young Nordic workers in general (N = 8)						
Boström et al (2008) Sweden	Young adults aged 18–25 years with musculoskeletal symptoms followed up for 1 year for assessing conditions at school and work (n = 2914)	Various work	Computer use and individual conditions	General productivity due to MSD.	The main risk factors for reduced productivity due to musculoskeletal symptoms among young adults were chronic symptoms and widespread symptoms in the neck and upper extremity.	Prospective study Validity: Internal 21/39 = 54% External 6/8 = 75%

Boström et al (2012) Sweden	Swedish young workers aged 21–25 years (n = 1311) sampled from a larger population study. Baseline (2007) and 1-year follow-up (2008).	Various workers	Physical and psychosocial work factors	Work ability (WAI)	Decreased job control and increased job demands on private life over time was found as the most important work factors associated with reduced work ability among young male and female workers. No difference in work ability by gender. This study proposes the importance of intervention strategies aimed toward influencing work situations that may affect workers work ability.	Prospective study Validity: Internal 24/39 = 62% External 5/8 = 63%
Khatun et al (2004) Sweden	Young men and women followed up from 16 to 30 years of age.	Various work	Individual factors: aged 16 years. Psychosocial work factors: aged 30 years.	MSD at 30 years	School grades at age 16 years were associated with MSD for men and women. Psychosocial working conditions at age 30 years were associated with MSD for men and women. The accumulation of adverse behavioral and social circumstances from adolescents to early adulthood might be an explanation for the class differentials in MSD for both men and women. Gender difference in MSD found.	Prospective study Validity: Internal 29/39 = 74% External 8/8 = 100%
Korpinen & Paakkonen (2011) Finland	A sample of adult men and women aged ≤30 years from a bigger cohort in 2002.	Various work	Use of mobile phones and computers	Symptoms such as ache, pain, or numbness in different body parts the past year.	Computer use at leisure time was associated with symptoms in different body parts, and exhaustion at work had associations with some physical symptoms. It is essential in future research to note the ergonomic reasons and exhaustion at work when young adults experience pain, numbness, or aches. Gender difference in physical symptoms was found.	Cross-sectional study Validity: Internal 13/26 = 50% External 5/8 = 63%
Liukkonen et al (2010) Finland	Nonpermanent employees (n = 1898) and sample of the national workforce (n = 9623). Analyses grouping by age (one of the groups aged 18–29 years)	Various work	Employment status. Labor market position patterns	Sense of coherence	Provides evidence that stabilization of sense of coherence associates with stabilization of the labor market position. The effects of employment trajectory on sense of coherence are particularly strong among individuals aged ≤30 years.	Prospective study Validity: Internal 321/39 = 54% External 5/8 = 63%
Mikkonen et al (2012) Finland	Sample of adolescents aged 16 years followed up at the age 18 years after 2 years of work (n = 1984) from the Northern Finland 1986 birth cohort.	Various work	Physical workload	Low back pain Incidence and persistence	Among females, work exposure was associated with incident low back pain. Awkward trunk posture was associated with low back pain in both genders. No association between workload and persistent pain. Physical workload factors constitute a risk for low back pain even in adolescents.	Prospective study Validity: Internal 24/39 = 62% External 7/8 = 88%
Taimela et al (2007) Finland	Blue-collar workers (n = 1341 aged 18–61 years). Separate analyses of workers in the age group 18–30.	Construction and maintenance workers Males and females	Age and self-reported health problems	Archival data of sickness absence	The young age group (18–30) had higher propensity for (any) sickness absence than the older workers. Young workers reported better health than their older colleagues but had higher probability for sickness absence.	Cross-sectional study Validity: Internal 21/26 = 81% External 5/8 = 63%
Vaez et al (2004) Sweden	In paid employment aged 20–34 years (n = 863).	Various work Males and females	Occupation and educational level	Self-rated health and perceived quality of life.	No education-based difference and few differences based on occupation were found. Among young working adults, health status and quality of life are not strongly conditional on socioeconomic position.	Cross-sectional study Validity: Internal 12/26 = 46% External 6/8 = 75%

MSD, musculoskeletal disorder.

**Table 3**  
Occupational accidents and work-related illness among young Nordic skilled workers

Author, (Year)	Data source, population	Industry gender	Exposure	Effect	Results	Study design and quality
Occupational accidents among young Nordic skilled workers (N = 1)						
Nielsen et al (2013) Denmark	Single and group interviews with 26 young adult workers from 6 various sized supermarkets (aged 18–24 years).	Retail industry N = 5 skilled workers	Skilled workers and other groups of young workers	How safety and risk are experienced and practiced	Skilled workers do not regard themselves as “young risk-taking workers”. They work full-time, and experience is an essential factor when dealing with “skilled workers.” Their sense of risk is described as an integral part of their ways of positioning themselves as experienced employees who master practices. They have less routine work than other young workers. They also might have responsibilities for others—also in relation to risk and safety.	Focus group interviews Qualitative 16/20 = 80%
Work-related illness among young Nordic skilled workers (N = 14)						
Gerhardsson et al (2013) Sweden	Male machine shop and construction workers (n = 142) with mean age 20.9 years and non-vibration-exposed workers (n = 41) of same age.		Exposure to hand-arm vibration at work	Early neurosensory effects tested by vibrotactile perception thresholds (VPTs): Semmes–Winstein monofilament test (cutaneous sensation level)	Despite a short cumulative vibration exposure, elevated vibrotactile perception thresholds and abnormal results from the cutaneous sensation test were observed in the exposed group of young workers.	Cross-sectional study Validity: Internal 16/26 = 62% External 5/8 = 63%
Gustavsson et al (2010) Sweden	A sample of nurses three years after they graduated n = 933, median age 31 years, 90% women.		Psychosocial work factors (job stress, work attitudes, and job performance)	Early career burnout (the Oldenburg Burnout Inventory)	Results show that low mood, low levels of job performance, and health problems were associated with early career burnout. The consequences of burnout and the relative importance of different predictors are less discussed.	Cross-sectional study Validity: Internal 8/26 = 31% External 7/8 = 88%
Hoffmann et al (2003) Denmark	All male former farmers. (n = 14). Cases: Former farmers, mean age 26 years, who had stopped working because of lower airway symptoms Controls: Former farmers of mean age 27 years.		Respirable dust exposure working in swine confinement buildings	Inflammatory response and plasma C3D levels (before exposure, 1 hour, 4 hours, and 1 day after exposure start.)	There was complement activation in response to respiratory dust, more so among cases than controls. Acute exposure with work-related levels of organic dust containing endotoxin leads to a weak systemic inflammatory response.	Case-control study Validity: Internal 26/38 = 61% External 3/8 = 38%
Hollund et al (2001) Norway	Female hairdressers (n = 100) of mean age 33 years, female office workers (n = 95) of mean age 44 years. Age separate analyses done with only those aged <30 years (n = 45 hairdressers and n = 15 office workers).		Chemical exposure in hairdressing	Airway symptoms (wheezing, runny eyes and nose, and breathlessness)	Hairdressers aged >30 years reported more airway symptoms the past year than the control group. Hairdressers are exposed to low levels of various irritating chemicals every day. The acute symptoms related to the exposure to hairdressing chemicals are very high.	Cross-sectional study Validity: Internal 15/26 = 58% External 7/8 = 88%
Hultell & Gustavsson (2011) Sweden	Newly educated teachers (n = 1290) of mean age 32 years for men and women. A 2-year follow-up from the last year of education till the first year of work (2006–2008).		Psychosocial work factors (job demands and job resources)	Burnout and work engagement	Job demands were strongly associated with burnout, whereas job resources were more strongly related to work engagement. The predictors with greatest relative influence on both burnout and work engagement were unmet expectations and mastery of skills. No significant gender difference in work engagement or burnout was found	Prospective study Validity: Internal 25/39 = 64% External 5/8 = 63%



Laflamme et al (1997) Finland	Male and female nursing auxiliaries aged 16–65 years (n = 148773). Separate analyses for the age group 16–24 years. Follow-up period of 10 years.	Age (time in the nursing auxiliary profession)	Overexertion injuries (sprains and strains that occurred in conjunction with activity at work, i.e., lifting of patients)	Injuries of all types are more severe with increasing age. Younger female auxiliaries are however at greatest risk of sustaining the most frequent kind of overexertion injury associated with the occupation, namely, back injuries due to heavy lifting. Few injuries were sustained by males, limiting the conclusion for male nurses. The results suggest that preventive programs should be targeted so as to address several different overexertion injury patterns, depending on age group and gender.	Prospective study Validity: Internal 25/39 = 64% External 8/8 = 100%
Lind et al (2007) Sweden	Female hairdressing graduates from vocational school in the period 1970–1995 (n = 3665, median age 29). Controls from the general population (n = 5034, median age 31 years).	Chemical exposures. The number of hair treatments per week	Hand eczema and skin atopy	Hairdressers are highly exposed to skin-damaging substances. A higher incidence of hand eczema was found in hairdressers than in controls. Measures to prevent the development of hand eczema among hairdressers should be given high priority.	Cross-sectional study Validity: Internal 15/26 = 58% External 6/8 = 75%
Lysdal et al (2011) Denmark	Hairdressing graduates from 1985 to 2007 (n = 5324). Men 4%, women 96%. Age 22 years and above, some analyses separately for the age group 22–32.	Hand eczema and atopic dermatitis	Career change	75% of the hairdressers were of the age group 15–24 at the onset of hand eczema. 45.5% gave hand eczema as a reason for career change. Important to implement preventive measures as information and training to raise awareness of their occupational exposures and to promote the use of suitable gloves and proper skin care.	Cross-sectional study Validity: Internal 16/26 = 62% External 6/8 = 75%
Skogstad et al (2005) Norway	Male divers (n = 47) mean age 25.6 years). Followed up over a 6-year period.	Pressure effects and noise under occupational diving	Impaired hearing and changes in hearing threshold	Mild increase in hearing thresholds and reduction in the divers hearing were found. There was no significant difference in hearing changes between high- and low-exposure groups. The result suggests that a mild hearing impairment can occur in young professional divers.	Prospective study Validity: Internal 31/39 = 79% External 4/8 = 50%
Tyssen et al (2000) Norway	Medical students graduating in 1993–94 were followed up in their last year of school and first year of work. (n = 371, mean age 29 years, 56% women).	Work-related factors in hospital the first year in the profession.	Mental health problems	Job stress (OR, 1.05) is related to mental health problems among young doctors even when previous mental problems and personality traits were controlled for. The results suggest that more support during internship is needed. No gender difference in mental health among junior doctors.	Prospective study Validity: Internal 24/39 = 62% External 7/8 = 88%
Tyssen et al (2001) A Norway	Medical students graduating in 1993–94 were followed up in their last year of school and first year of work. (n = 371, mean age 29 years, 56% women).	Work-related factors (study stress and job stress) and personality	Suicidal thoughts and attempts	Suicidal thoughts and vulnerability (neuroticism and personality) as students predicted postgraduate suicidal ideation. Preventive efforts should be directed both at the students' abilities to cope with stress and at mental health services for young doctors. No gender difference in suicidal thoughts among junior doctors.	Prospective study Validity: Internal 24/39 = 62% External 7/8 = 88%
Tyssen et al (2001) B Norway	Medical students graduating in 1993–94 were followed up in their last year of school and first years (3–4) of work. (n = 396 mean age 31 years, 56% women).	Factors in medical school	Postgraduate mental health problems	In multivariate analyses, the medical school variables were inadequate for predicting mental health deterioration. The medical school stress instrument may however be used for selecting students suitable for group-oriented interventions. No gender difference in mental health problems.	Prospective study Validity: Internal 26/39 = 67% External 6/8 = 75%

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Table 3 (continued)

Author, (Year)	Data source, population	Industry gender	Exposure	Effect	Results	Study design and quality
Tyssen et al (2005) Norway	Medical students graduating in 1993–94 were followed up in their last year of school and first year of work. (n = 371, mean age 29 years, 56% women).		Individual (personality) and organizational factors (sleep deprivation and learning environment)	Work-related stress	The predictors of job stress were personality trait (neuroticism), perceived skills, number of hours sleep when on call, and learning environment. In terms of prevention, both individual and organizational factors should be considered. No gender difference in work-related stress among junior doctors.	Prospective study Validity: Internal 24/39 = 62% External 6/8 = 75%
Wahlström et al (2008) Sweden	Male students graduated from vocational school in 2001–2003 (n = 586, mean age 20.7 years). Follow-up period 6–12 months.		Work-related hand and arm vibration and ergonomic stressors	Musculoskeletal symptoms in the neck and upper limbs	Daily vibration exposure duration >1 h at baseline increased the risk of neck pain at follow-up.	Prospective study Validity: Internal 24/39 = 62% External 6/8 = 75%

OR, odds ratio.

hairdressers younger than 30 years reported more airway symptoms than those in a control group [51]. In a Swedish study, they found that young hairdressers had a higher incidence of hand eczema than controls [52], whereas in a Danish study, 45% of the hairdressers gave hand eczema as a reason for their career change [53]. In a study on young former farmers, it was found that acute exposure to organic dust leads to weak systemic inflammatory response [54]. Among young male construction workers and vocational school graduates, vibration exposures were associated with elevated vibrotactile perception threshold [49] and neck pain [48]. One article showed that psychological job demands were associated with burnout among newly educated teachers [41], whereas among nurses, low mood and low levels of job performance and health problems were associated with early career burnout [50]. A study among young nursing assistants found that heavy lifting was associated with back injuries [42]. In another study among young male occupational divers, pressure effects and noise were found to be associated with a mild reduction of hearing [43]. Four articles by the same authors assessed the mental health among young newly educated medical doctors and found that both job stress and personality traits were related to mental health problems among junior doctors [44–47].

*Specific groups of young workers—apprentice workers.* Fourteen articles assessed work-related health among apprentice workers. Five articles had prospective designs [55–59], whereas six were cross sectional [60–65]. Three articles evaluated the effect of an intervention [66–68], and apprentices in hairdressing were studied in three articles. One study showed that hairdressing apprentices were more exposed to allergens than matched controls from the general population [61], whereas another showed that fewer hairdressing apprentices had hand and wrist eczema than controls [60]. However, the latter result was claimed by the authors to indicate a healthy worker effect [60]. Furthermore, an intervention study among hairdressing apprentices showed positive effects of a skin protection program on eczema [66]. A positive effect on hand eczema by reducing the use of hand disinfectants was also found among student auxiliary nurses [68]. Baker apprentices were studied in two of the articles, in which no increase in atopy or lung symptoms were found compared to the general working population [63] and sensitization to occupational allergens among the baker apprentices was rare [58]. Apprentice farmers were studied in two of the articles, and both found no association between farming exposures and lung symptoms [64,65]. Four articles focused on musculoskeletal pain outcomes: One prospective study found an increase of neck and shoulder pain during vocational school [56]; another found increased low back pain during nursing training, and twisted and bent postures were found as risk factors for low back pain for young adults in nursing training [59]; one article found increased wrist/hand pain for increasing instrumental practice for training musicians [62]; and in a prospective study, mechanical workload such as elevated arms was associated with neck/shoulder pain for young adults in vocational training [57]. The effect of a low back pain prevention program among nursing assistant students did not have any effect [67]. One article examined occupational noise and auditory symptoms among young unskilled male workers in the military services and showed that minor hearing deterioration was associated with the occupational noise exposure in this group [69].

## 4. Discussion

### 4.1. Main findings

This review shows that young workers in the Nordic countries are more at risk of occupational accidents than older colleagues and

**Table 4**  
Occupational accidents and work-related illness among young Nordic apprentice workers

Author, (Year)	Data source, population	Industry gender	Exposure	Effect	Results	Study design and quality
Occupational accidents among young Nordic apprentice workers (N = 4)						
Holte & Kjestveit (2012) Norway	Convenience sampling. Interviews with 11 construction workers/apprentices (aged 18–23 years) and four other levels—coworker, supervisor, manager, & safety deputy.	Construction apprentices. No gender given.	Company size	Initial OSH training and introductory courses Formal vs informal training. Mentors	Large companies, more formalized systems and structures. Smaller companies, more “learning by doing” and external courses. Interpretations: OSH legislative differences based on company size. Recommendations: Specific requirements for OSH training of new/young workers. Establish standards for use of mentors—and a joint education and certification of mentors	Interviews Qualitative 12/20 = 60%
Kjestveit et al (2011) Norway	Convenience sampling. Construction industry. 456 respondents (98 % response rate). 30% of respondents = aged 18–24 years No gender given.		Age, company size, and profession. Safety climate and work factors.	Injury involvement in the last 6 months—“stop working for one hour or more”	Young workers have a higher risk of injury (controlled for company size and profession). Physical work demands (heavy lifting, vibrations, etc.) & control over work pace—associated with increased injury risk. Safety climate not associated with increased injury risk. Need for focus on the distribution of work tasks	Cross-sectional survey. Validity: Internal 15/29 = 52% External 6/8 = 75%
Nielsen (2012) Denmark	Five focus group interviews with 4–5 people from different workplaces. In total, 23 employees/apprentices employed in retail, industrial work, hotel, and restaurants were interviewed (aged 15–24 years).	Retail industry and apprentices	Examines the organizational relations among youth and risks.	“Accidents” How safety is experienced and practiced among young employees	Young employers risk behavior does not stem from a desire for risk-orientated work, but it is rather a way to fit in, to adapt, and to master the conditions of the trade. The risk behavior in the young employees often reflects the risk culture in the organization. Youth and risk-taking can be linked to the constructions of: “acceptable risk” and “organizational deviances.”	Focus group interviews Qualitative 9/20 = 45%
Nielsen et al (2013) Denmark	Single and group interviews with 26 young adult workers from 6 various sized supermarkets (aged 18–24 years).	Retail industry N = 5 apprentices	Apprentices and other groups of young workers	How safety and risk are experienced and practiced	Apprentices do not regard themselves as “young risk-taking workers.” The apprentice talks about adapting to what is recognized as the “right way” to practice risk and safety from the perspective of the manager. Apprentices are typically trying to live up to the demands of the manager, e.g., even though the apprentice knows that it implies taking risks.	Focus-group interviews Qualitative 16/20 = 80%
Work-related illness among young Nordic apprentice workers (N = 14)						
Bregnhøj et al (2011) A Denmark	Hairdressing apprentices (n = 382) and control group (n = 1870) mean age 17.5 years. Enrollment in the period 2008–2009.		Hairdressing (2 weeks into training).	Hand eczema	Significantly fewer hairdressers reported hand and arm wrist eczema than control group from the general population. Results indicate a healthy worker effect among the hairdressing apprentices.	Cross-sectional study Validity: Internal 16/26 = 62% External 6/8 = 75%

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Table 4 (continued)

Author, (Year)	Data source, population	Industry gender	Exposure	Effect	Results	Study design and quality
Bregnhøj et al (2011) B Denmark	Hairdressing apprentices (n = 382) and control group (n = 1870) mean age 17.5 years. Enrollment in the period 2008–2009.		Exposure to chemical substances both at work and at leisure (hair dyes and perfumed products)	Adverse skin reactions (rash and eczema)	The hairdressing apprentices are more exposed to the allergens investigated and report more adverse reactions to products containing hair dyes than their matched controls. Regulations of exposure need to be considered to prevent primary sensitization and elicitation. Young hairdressing apprentices need information concerning the potential risk of extensive exposure to chemical substances.	Cross-sectional study Validity: Internal 16/26 = 62% External 6/8 = 75%
Bregnhøj et al (2012) Denmark	Hairdressing apprentices (n = 502) mean age 17.5 years. Intervention group vs. control group. Baseline, 8-month, 18-month follow-up.		Exposure to chemical substances in the hairdressing profession	The intervention was based on educating the teachers in training schools (2-day course of special training in skin physiology, allergy, and skin protection.)	More apprentices from the intervention group used gloves during wet work procedures and significantly fewer developed hand eczema than apprentices in the control group. The study shows that evidence-based education may be an effective approach for the prevention of occupation hand eczema among hairdressing apprentices.	Intervention study Validity: Internal 28/45 = 62% External 8/8 = 75%
Dahlin et al (2010) Sweden	Junior doctors followed up from medical school (2002 and 2005) and first year of work (2003 and 2006). (n = 253) At follow-up, mean age was 27.4 years.		Factors at medical school (higher Education Stress Inventory and performance self-esteem)	The exhaustion dimension of burnout at work (Oldenburg-Burnout Inventory)	Worries about future capacity predicted postgraduate exhaustion. A positive learning climate was negatively associated with exhaustion. No difference in exhaustion by gender when controlled for study conditions	Prospective study Validity: Internal 25/39 = 64% External 4/8 = 50%
Hagberg et al (2005) Sweden	Musician students enrolled at the University of Gothenburg between 1980 and 1995 (n = 407). Mean age of men = 35 years; mean age of women = 34 years.		Instrument type, instrument years, practice for >20 h per week.	Impaired hearing, tinnitus, and musculoskeletal disorders	Association between the number of hours of instrumental practice and impaired hearing. There was more than 2 times higher incidence of MSD in the wrist, hand, and elbow of musicians who practiced for 20 h or more per week than those with less practice. The incidence of tinnitus was 10.6 1000 practicing years, impaired hearing was 6.5 1000 practicing years, and musculoskeletal disorders was 2.3–4.6 1000 practicing years. Female gender was a risk factor for low back pain and elbow/forearm pain.	Cross-sectional study Validity: Internal 15/26 = 58% External 5/8 = 63%
Hanvold et al (2010) Norway	173 technical school students aged 16–21 Males 34%, females 66% 13 schools.		Mechanical exposure	Neck, shoulder, upper-back pain stress	High prevalence of any pain (female 78%, male 47%), fewer report moderate/severe pain (female 32%, male 14%). High and moderate level of mechanical exposure and high stress were not risk factors for pain. High leisure physical activity associated with lower risk for pain. Experiencing pain in adolescence can persist into working life. Uncertainty about factors leading to musculoskeletal pain. Females reports more neck and shoulder pain than men.	Prospective study Validity: Internal 26/39 = 67% External 7/8 = 88%

Hanvold et al (2013) Norway	40 young technical students aged 21-25 Male 42%, female 58% Electricians, hairdressers, various work & students.	Sustained trapezius muscle activity (>4 minutes for more than half of the working day)	Neck and shoulder pain	High level of sustained muscle activity have higher rates (x3) of pain compared to low levels of muscle activity. No recommendations. Gender difference in pain (female).	Prospective study Validity: Internal 27/39 = 69% External 2/8 = 25%
Held et al (2001) Denmark	Sample of n = 107 student auxiliary nurses (n = 61 intervention group, n = 46 in control group). Follow-up after 10 weeks of practical training.	Intervention included an educational programme (class a 2 x 2 h course with an interval of 14 days. Included an information video and a booklet.	Clinical examination by a doctor on hand eczema/skin irritation. Transepidermal water loss (TEWL) and patch testing was also used	The use of hand disinfectants were significantly lower in the intervention group. The use of hand disinfectant agents was found significantly associated with aggravation of skin problems. A significant increase on TEWL for the control group was found. The intervention shows promising results from the use of an educational programme.	Intervention study Validity: Internal 19/45 = 42% External 4/8 = 50%
Skjold et al (2007) Denmark	Female and male baker apprentices (n = 187, mean age 22). Recruited in 1998-199 and followed over a 3 year period	Occupational baker exposures (i.e. flour dust)	Respiratory symptoms and atopy/allergy	The prevalence of atopy and lung symptoms was of the same magnitude as the general population. Atopy prevalence 32%, lung symptoms 20%	Cross-sectional study Validity: Internal 18/26 = 63% External 5/8 = 63%
Omland et al (1999) Denmark	Female farming students (n = 210 mean age 19), male farming students (n = 1691, mean age 18) and male controls (n = 407 mean age 18).	Occupational farming exposure	Lung function (FEV1 and FVC) and Lung symptoms (self-reported asthma)	No association was found between occupational farming exposure at a young age and lung symptoms or lung function	Cross-sectional study Validity: Internal 21/26 = 81% External 7/8 = 88%
Sigsgaard et al (1997) Denmark	Female farming students (n = 230 mean age 19.7), male farming students (n = 1734 mean age 18) and male controls (n = 407 mean age 18.5)	Occupational farming exposure	Respiratory symptoms and atopy/ allergy	The prevalence of atopy and lung symptoms was of the same magnitude as the general population. Atopy prevalence 32%, lung symptoms 20%	Cross-sectional study Validity: Internal 18/26 = 63% External 5/8 = 63%
Skjold et al (2008) Denmark	Female and male baker apprentices (n = 114, mean age 23) Followed over a 20 month period.	Occupational baker exposures (allergens i.e. flour dust)	Respiratory symptoms and allergic sensitization	Rhinitis and asthma-like symptoms were found to develop commonly in Danish baker apprentices. Sensitization to occupational allergens was rarely observed.	Prospective study Validity: Internal 25/39 = 64% External 5/8 = 63%
Svensson et al (2009) Denmark	Female nursing assistants students (n = 668) were randomized into intervention group (n = 389, mean age 32) and control group (n = 279, mean age 33).	Intervention: Low back prevention programme; physical training (48 h), patient transfer technique training (20 h), stress management (22 h).	Sickness absence during the last 14 days (at baseline and at 14 months follow-up).	Sickness absence increased in both groups but the increase was significantly lower in the intervention group. No significant difference in the prevalence of low back pain at follow-up was found between the two groups. The results suggest that introducing prevention programs in the curriculum may be beneficial.	Intervention study Validity: Internal 27/45 = 60% External 8/8 = 100%

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**Table 4** (continued)

Author, (Year)	Data source, population	Industry gender	Exposure	Effect	Results	Study design and quality
Videman et al (2005) Finland	Female nursing students (n = 174, mean age 22) were followed over a 7.5 years (2.5 years in school and 5 years in nursing profession).		Physical loading and psychological characteristics	Back pain and disability	Lifetime prevalence of back pain increased sharply during nursing school and back pain in school was a strong predictor for back pain and related disability as a nurse. Working in twisted and bent postures was associated with back pain and related disability as a nurse. The high prevalence of back pain before entering nursing and the irregular nature of back pain suggest that symptoms may well be exacerbated during nursing.	Prospective study Validity: Internal 27/39 = 69% External 6/8 = 75%

MSD, musculoskeletal disorder; OSH, occupational safety and health.

**Table 5**  
Occupational health and work-related illness among young Nordic unskilled workers

Author, (Year)	Data source, population	Industry gender	Exposure	Effect	Results	Study design and quality
Occupational health among young Nordic unskilled workers (N = 1)						
Nielsen et al (2013) Denmark	Single and group interviews with 26 young adult workers from 6 various sized supermarkets (aged 18–24 years).	Retail industry N = 4 sabbatical year workers	Sabbatical year workers and other groups of young workers; retail industry N = 4 school dropout workers	How safety and risk are experienced and practiced	Sabbatical year workers regard themselves as “young risk-taking workers.” It is generally the responsibility that separates the work of the sabbatical year workers from the work of the “working students” and “school dropouts.” The work of the “sabbatical year workers” is often given greater importance although routine work and hard physical work dominate all the categories. School drop-out workers regard themselves as “young risk-taking workers.” Physical strength is regarded as the primary reason why they work in retail. They accepted the job because they often can see no other alternatives, except unemployment benefits. They are positioning themselves within a dominating sense of resignation. This group of young employees is a particularly a vulnerable group because they are assigned particularly arduous tasks more often than other working adolescents. Several expressed that they perceive the work as stressful, but at the same time, they appear to accept this as a necessary condition if they want a job. This group of employees often works in retail for longer periods than other groups of young employees because they have limited opportunities for getting other jobs within or outside the retail sector.	Focus group interviews Qualitative 16/ 20 = 80%
Work-related illness among young Nordic unskilled workers (N = 1)						
Muhr & Rosenhall (2010) Sweden	Men aged 19–22 years (n = 839) doing military service.		Ototraumatic factors (occupational noise, playing loud music, and genetic factors)	Auditory symptoms (tinnitus, hearing impairment, and sensitivity to noise)	Occupational noise was reported by more than 50%. Bivariate: significant associations between occupation noise and all auditory symptoms Multivariate: association between occupational noise and hearing deterioration.	Cross-sectional Study Validity: Internal 19/ 26 = 73% External 5/ 8 = 63%

that mechanical factors (e.g., heavy lifting), psychosocial factors (e.g., low control over work pace), and organizational factors (e.g., poor safety culture) are associated with increased accident risk. Exposures to chemical substances, heavy lifting, awkward postures, and high job demands are found to be risk factors for diverse health outcomes among young workers. The review also indicates that the literature on specific groups of young workers is sparse and that most articles are descriptive studies, only assessing age as an explanatory factor. In spite of limited literature on specific groups of young workers, our findings indicate that young skilled workers and apprentices are prone to hazardous work exposures and are at greater risk of accidents and illnesses than their older coworkers. At the same time, our findings suggest that young unskilled workers are particularly vulnerable to occupational hazards that may lead to occupational accidents. This was also the group of young workers most scarcely studied.

#### 4.2. Identification of risk factors

Most articles on occupational accidents in our review on Nordic studies were on young workers in general. There is consistent evidence from the current and earlier international reviews that being young—or individual characteristics of being young such as physical, cognitive, and psychosocial maturity level and level of experience—contribute to young workers being at greater risk for accidents in the workplace than their older colleagues [2,4,70]. Age is found to be important when it comes to occupational safety, and an article from Canada showed that workers aged 15–18 years report even more accidents, are less safety compliant, and are with more safety neglect than workers aged 19–22 years [71]. At the same time, it is constantly argued that the increased risk for young workers are partly explained by the inequality in (i) exposure to hazardous work tasks, (ii) quality of health and safety instruction and training, and (iii) the level of temporary work and working outside normal working hours [72,6]. To prevent occupational accidents and work-related illnesses among young workers, there is also a need to focus more on organizational risk factors, as these factors are more easily targeted and have greater impact than focusing on characteristics of being young. In continuation of this, it is important to identify risk factors for specific groups of young workers that are particularly vulnerable. In our review, mechanical work demands such as heavy lifting and psychosocial factors such as low control over work pace were found to be associated with increased accidents risk among young workers in all working groups. This is in concordance with an earlier review covering the global literature, which found evidence that “perceived work overload” and “feeling rushed” were correlated with work accidents among young workers [70]. Our review also shows that risk behavior and poor safety culture are possible factors for occupational accidents among young workers. Two of the included studies in our review emphasized that the risk behavior of young employees often reflects the risk culture in the organization [7,14]. In studies from Canada, it has similarly been shown that young people may not be aware of workplace hazards, or they may assess them differently [73], and that young people’s work experiences are important in shaping their future work-related values, attitude, and risk behavior [74]. Furthermore, a study by Westaby and Lowe [75] indicated that coworker risk-taking is a relatively strong predictor of youths’ risk-taking orientation at work. These results imply that interventions targeting organizational factors such as safety norms, safety culture, and climate may influence attitudes and behavior and consequently also the injury risk of young workers.

In contrast to occupational accidents, young workers have been found to have a lower risk of developing work-related illnesses than older workers [36]. For work-related illnesses, our review shows

that most studies deal with apprentices and young skilled workers, showing that cumulative exposure to chemical work exposure, psychosocial exposures, and heavy physical workload may have adverse health effects over time for the young workers. Our review shows an association between heavy lifting and low back pain among young workers, which is supported by findings from a study on young American construction workers [76] and among young Dutch workers in physically demanding work [77]. We found an association between psychosocial work factors and musculoskeletal symptoms and mental health. Our review further suggests an association between occupational chemical substance exposure among young hairdressers and skin reactions, e.g., hand eczema. This is in line with international studies, such as a German study among hairdresser apprentices, in which unprotected wet work was associated with adverse skin changes [78]. Our review showed a weak association between occupational dust exposure and respiratory symptoms among young farmers and bakers. International studies among Italian and Polish baker apprentices have found exposure to flour dust as a risk factor for respiratory conditions such as asthma [79,80].

#### 4.3. Identification of vulnerable groups of young workers

Young workers in the Nordic countries are exposed to handling heavy loads, chemical exposures, and work distress at an early age to a greater degree than their older colleagues [6]. However, most occupational diseases require cumulative risk exposure and have a latency period to develop, and there are very few studies tracking the effect of cumulative risk exposure for young workers. Handling heavy loads is an example of a work task that has high prevalence among young workers. It was also found to be associated with both work-related health and occupational accidents among both young and older workers. This may suggest that young workers are at a greater risk because of the work tasks they are assigned to do.

Young workers are also traditionally perceived as a vulnerable group in regard to occupational accidents as they are inexperienced and lack training and OSH risk awareness and perception. These factors also need to be understood in the context of the transition process from “youth to adulthood,” and the risk socialization process young people undergo as they enter the job market, e.g., perceptions of others’ expectations of one’s safety-related conduct, has associations with work-related risk-taking behaviors of young workers [81]. Young workers may also be “skill overemployed”, which means that the work can be too demanding as young workers may not yet have the necessary physical and cognitive maturity nor sufficient professional skills. This emphasizes the importance of OSH initiatives targeting the workplace where the young workers enter. Knowing that educational background is connected with work safety training and work-related hazards [82], we hope to identify vulnerable groups within the young working force that may need special attention and facilitate practitioners to target OSH problems related to these specific groups. The four groups of young workers identified in the present review are assigned to different types of work tasks that may lead to different exposures to risk. For example, young skilled workers and apprentices do not often regard themselves as “young or risk-taking workers.” Young unskilled workers and school drop-out workers are more prone to greater hazardous work exposures, and many young workers are increasingly facing employment that is part-time or temporary and outside normal working hours—when there are fewer leaders present [6]. Based on a meta-analysis of the literature (covering all age groups), one study found that there is evidence that temporary employment provides great uncertainty with regard to the work duration and work content and also results in an increased risk of health problems [83]. Uncertain income,

poorer training opportunities, and exposure to other working conditions are exposures believed to contribute to accidents and poorer health among temporary employees. Precarious work such as part-time and temporary work have been associated with adverse OSH outcomes across a range of studies [84–87]. Temporary workers are particularly vulnerable, with studies showing that they experience a higher incidence of workplace accidents and a greater likelihood of more severe injuries than all other employment types and risk factors including poorer supervision [84], inadequate training and experience [84,85], a younger workforce with fewer qualifications [86], and exposure to higher risk tasks [85].

In a recent article evaluating work-related safety knowledge in the European workforce [87], they found that across all countries, younger workers, lower educated workers, and those workers with less job experience or temporary contracts were more likely to report low levels of safety knowledge. Basic knowledge of OSH risk at the workplace can be seen as a necessity to decrease occupational accidents and illnesses. A previous study showed that pupils in vocational schools have limited knowledge in the prevention of health risks at work [88] and that teachers and supervisors did not have a systematic approach when organizing OSH training in school or in the workplace [89]. Furthermore, previous studies also indicate that learning disabilities among young workers are associated with increased risk of work accidents [90]. Therefore, individual differences should be also taken into account in promoting safety of young workers and developing safety skills in schools.

In a Danish study [91] of young workers in retail, nursing homes, and metal industry workplaces, they found a wide variety of OSH induction processes varying from “none or limited” to “*ad hoc*,” “fast track,” “prepared and planned,” and “reflective.” Regardless of what education and training the young workers met with when they first started in their job, it was the introduction to the current workplace practices with existing employees in the workplace that was crucial for the young worker’s OSH. In the present review, we emphasize that safety behavior and safety culture at the workplace are of particular importance to ensure the OSH of young workers. Young workers have to adjust to the safety culture at the workplace, and this makes the organizational factors at the workplace important when it comes to the young worker’s OSH.

#### 4.4. Interventions

The present review shows that there is a lack of scientific studies and knowledge concerning the effects of preventive actions regarding young workers and occupational accidents in the Nordic countries. However, a Finnish study published in 2018 evaluated the efficacy of safety training based on social cognitive theory [92,93] using a randomized-controlled trial [94]. Their results indicated a positive effect on safety preparedness and safety attitudes of students finishing their vocational training. There are quite a number of intervention studies on occupational accidents among workers in general. A recent review by Danish researchers evaluating the effects of different safety interventions characterizes six main types of safety interventions: 1) changes in knowledge and attitudes; 2) physiological changes and use of personal protective equipment; 3) changes in behavior; 4) changes in norms, safety culture, and climate; 5) structural changes such as physical or organizational environment; and 6) an integrated intervention with combinations of the changes in the aforementioned factors [95]. Findings from the review showed that structural safety measures and integrated safety measures seem to be most effective in reducing accidents at work. These findings are not based on young workers in particular, yet they may nevertheless be relevant when

discussing interventions for young workers and in planning intervention studies among young adults.

The present review shows that there are some studies and knowledge concerning the effects of preventive actions regarding young workers and work-related health. There is evidence suggesting a possible effect of an educational skin protection program on skin reactions and hand eczema among young workers in the Nordic countries [66,68]. There is insufficient evidence of the effect of a low back pain prevention program on musculoskeletal symptoms among young Nordic workers [96].

In further studies on young workers, the understanding of the term “young” as a biological age category may be a hindrance for improving the OSH of young workers. There is a need for more explorative and analytic studies on occupational accidents and work-related health among young workers, assessing the efficiency of different interventions in increasing young workers’ OSH. An increase in facilitating experimental research is therefore recommended.

#### 4.5. Methodological considerations

One of the strengths of this review was the thorough literature search that was conducted, and literature covering the Nordic countries was reviewed, giving the opportunity to compare studies on young workers with similar (Nordic) sociocultural conditions. The “Nordic model” distinguishes the Nordic countries from other welfare states as it emphasizes maximal labor force participation, which increases work participation among young workers. Owing to this, it may also be a strength that the review focuses on studies from countries having similar educational systems and working life contexts.

Future reviews may include the global literature and focus either on occupational safety or work-related health. In the present literature review, we present the results by taking into account the heterogeneity of the young workers by categorizing young workers into four groups. To our knowledge, this has not been conducted previously and is an important step to gain more insights into which types of young workers are vulnerable and which groups need to be targeted to reduce occupational accidents and illness. Nevertheless, a limitation is that there are large variations in study groups, exposures, and outcomes, and thus, it is difficult to draw conclusions from, e.g., only a single or few studies on each topic.

The present review also revealed a low number of scientific studies among young workers, and it is evident that there is a need for more studies with a specific focus on young workers and not just as a part of a larger cohort. It is also evident that there are some occupations more often studied than others, such as junior doctors, farmers, and hairdressers. Future studies may therefore need to study populations from a wider variety of occupations, in which young workers are employed, e.g., within retail, hotel, construction, transport, and the service sector. It is, at the same time, evident to emphasize that young workers comprise a heterogeneous group and that their vulnerabilities to OSH risks are highly contextual. This means that politicians, practitioners, and researchers should try to capture this complexity when targeting risk factors or initiating integrated interventions to improve young workers’ OSH.

## 5. Conclusion

To better understand and prevent occupational accidents and work-related illnesses among young workers, there is a need to target specific groups of young workers that are particularly vulnerable. Taken into account the methodological limitations of this review, the findings show that unskilled workers including school drop-out workers are particularly vulnerable groups when it



comes to occupational accidents. In addition, apprentices and young skilled workers were found to be vulnerable to work-related illnesses. The present review demonstrates that in future studies on young workers, it is essential to avoid stereotyping them into one group using only age as a factor. This review may additionally facilitate prioritization in future research and hopefully also facilitate practitioners to target OSH issues among the different groups of young workers. Finally, it is crucial to have focus on the OSH culture in the workplaces where young workers enter into because the espoused and enacted behavior of leaders and workers in everyday settings set the norm that young workers strive for.

### Conflicts of interest

None of the authors have any conflicts of interest.

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### Appendix A. Supplementary data

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### References

- [1] Parent-Thirion A, Biletta I, Cabrera J, Vargas O, Vermeylen G, Wilczyńska A, et al. Sixth European working conditions Survey – overview report. Eurofound 2016;162. No.EF1634.
- [2] Salminen S. Have young workers more injuries than older ones? An international literature review. *J Saf Res* 2004;35:513–21.
- [3] West C, de Castro AB, Fitzgerald ST. The youth work force: unique occupational health considerations and challenges. *AAOHN* 2005;53:297–305.
- [4] Laberge M, Ledoux E. Occupational health and safety issues affecting young workers: a literature review. *Work* 2011;39:215–32.
- [5] Duke J, Guest M, Boggess M. Age-related safety in professional heavy vehicle drivers: a literature review. *Accident* 2010;42:364–71.
- [6] Hanvold TN, Kines P, Nykänen J, Ólafsdóttir S, Thomeé S, Holte KA, et al. Young workers and sustainable work life. Special emphasis on Nordic conditions. *TemaNord* 2016;512.
- [7] Nielsen ML, Dyreborg J, Kines P, Nielsen KJ, Rasmussen K. Exploring and expanding the category of "Young Workers" according to situated ways of doing risk and safety - a case study in the retail industry. *Nordic J Working Life Stud* 2013;3:219–43.
- [8] Nielsen ML, Dyreborg J. Young people in the labor market. A new precariat - or just in transition? In: Sørensen U, Pless M, editors. *Brydninger i ungdomslivet*. Aalborg: Aalborg Universitetsforlag; 2015 [In Danish].
- [9] Tannock S. Youth at work. The unionized fast-food and grocery workplace. Philadelphia: Temple University Press; 2001.
- [10] Tannock S. Why do working work where they do? In: Rouleau-Berger L, editor. *Youth and work in the post-industrial city of North America and Europe*. Brill Academic Publishers; 2003.
- [11] Hem KG, Dahl Ø, Rohde T, Øren A. Costs of work-related illnesses and injuries [In Norwegian]. *SINTEF* 2016;27. No.A27430.
- [12] Hasle P, Sørensen OH. Employees as individually and collectively acting subjects—key contributions from nordic working life research. *Nordic J Working Life Stud* 2013;3:9–30.
- [13] Verbeek J, Salmi J, Pasternack I, Jauhiainen M, Laamanen I, Schaafsma F, et al. A search strategy for occupational health intervention studies. *Occup Environ Med* 2005;62:682–7.
- [14] Nielsen ML. Adapting "The Normal" - examining relations between youth, risk and accidents at work. *Nordic J Working Life Stud* 2012;2:71–85.
- [15] Ariens GA, van MW, Bongers PM, Bouter LM, van der WG. Physical risk factors for neck pain. *Scand J Work Environ Health* 2000;26:7–19.
- [16] Hoogendoorn WE, van Poppel MNM, Bongers PM, Koes BW, Bouter LM. Physical load during work and leisure time as risk factors for back pain. *Scand J Work Environ Health* 1999;25:387–403.
- [17] Kmet PR, Lee CR, Cook SL. Standard quality assessment criteria for evaluating primary research papers from a variety of fields. Canada: Alberta Heritage Foundation for Medical Research; 2004. 22 p. No.HTA#13.
- [18] Bull N, Høvdig G, Riise T, Moen EB. Can work-related eye damage be avoided? [In Norwegian]. *Tidsskr Nor Lægeforen* 2004;21:2776–9.
- [19] Bull N, Riise T, Moen BE. Occupational injuries to fisheries workers in Norway reported to insurance companies from 1991 to 1996. *Occup Med (Lond)* 2001;51:299–304.
- [20] Bull N, Riise T, Moen BE. Occupational injuries reported to insurance companies in Norway from 1991 to 1996. *J Occup Environ Med* 1999;41:788–93.
- [21] Döös M, Laflamme L, Backström T. Immigrants and occupational accidents: a comparative study of the frequency and types of accidents encountered by foreign and Swedish citizens at an engineering plant in Sweden. *Saf Sci* 1994;18:15–32.
- [22] Gravseth HM, Lund J, Wergeland E. Occupational injuries treated by the Norwegian emergency office in oslo and the ambulance service. *Tidsskr Nor Lægeforen* 2003;15:2060–4 [in Norwegian].
- [23] Laflamme L, Menckel E. Age and occupational accidents in the light of fluctuations on the labor market: the case of Swedish non-ferrous ore miners. *Work* 1996;6:97–105.
- [24] Laflamme L. Age-related accident ratios in assembly work: a study of female assembly workers in the Swedish automobile industry. *Saf Sci* 1996;23:27–37.
- [25] Laflamme L. Age-related accident risks among assembly workers: a longitudinal study of male workers employed in the Swedish automobile industry. *J Saf Res* 1996;27:259–68.
- [26] Laflamme L, Menckel E, Lundholm L. The age-related risk of occupational accidents: the case of Swedish iron-ore miners. *Accid Anal Prev* 1996;28:349–57.
- [27] Laflamme L, Blank VLG. Age-related accident risks: longitudinal study of Swedish iron ore miners. *Am J Ind Med* 1996;30:479–87.
- [28] Lindqvist K, Schelp L, Timpka T. Gender aspects of work-related injuries in a Swedish municipality. *Saf Sci* 1999;31:183–96.
- [29] Rasmussen K, Hansen CD, Nielsen KJ, Andersen JH. Incidence of work injuries amongst Danish adolescents and their association with work environment factors. *Am J Ind Med* 2011;54:143–52.
- [30] Salminen S. Work-related accidents among young workers in Finland. *Int J Occup Saf Ergon* 1996;2:305–14.
- [31] Holte KA, Kjestveit K. Young workers in the construction industry and initial OSH-training when entering work life. *Work* 2012;41:4137–41.
- [32] Kjestveit K, Tharaldsen J, Holte KA. Young and strong: what influences injury rates within building and construction? *Saf Sci Monitor* 2011;1–15.
- [33] Korpinen L, Paakkonen R. Physical symptoms in young adults and their use of different computers and mobile phones. *Int J Occup Saf Ergon* 2011;17:361–71.
- [34] Liukkonen V, Virtanen P, Vahtera J, Suominen S, Sillanmaki L, Koskenvuo M. Employment trajectories and changes in sense of coherence. *Eur J Public Health* 2010;20:293–8.
- [35] Mikkonen P, Viikari-Juntura E, Remes J, Pienimäki T, Solovieva S, Taimela S, et al. Physical workload and risk of low back pain in adolescence. *Occup Environ Med* 2012;69:284–90.
- [36] Taimela S, Läärä E, Malmivaara A, Tiekso J, Sintonen H, Justèn S, et al. Self-reported health problems and sickness absence in different age groups predominantly engaged in physical work. *Occup Environ Med* 2007;64:739–46.
- [37] Vaez M, Kristenson M, Laflamme L. Perceived quality of life and self-rated health among first-year university students - a comparison with their working peers. *Soc Indicators Res* 2004;68:221–34.
- [38] Boström M, Dellve L, Thomée S, Hagberg M. Risk factors for generally reduced productivity—a prospective cohort study of young adults with neck or upper-extremity musculoskeletal symptoms. *Scand J Work Environ Health* 2008;34:120–32.
- [39] Boström M, Sluiter JK, Hagberg M. Changes in work situation and work ability in young female and male workers. A prospective cohort study. *BMC Public Health* 2012;12:694.
- [40] Khatun M, Ahlgren C, Hammarstrom A. The influence of factors identified in adolescence and early adulthood on social class inequities of musculoskeletal disorders at age 30: a prospective population-based cohort study. *Inter J Epidem* 2004;33:1353–60.
- [41] Hultell D, Gustavsson JP. Factors affecting burnout and work engagement in teachers when entering employment. *Work* 2011;40:85–98.
- [42] Laflamme L, Menckel E, Stromberg A. Age-related overexertion injuries among Swedish nursing auxiliaries over a 10-year period. *Work* 1997;8:139–48.
- [43] Skogstad M, Haldorsen T, Arnesen AR, Kjuus H. Hearing thresholds among young professional divers: a 6-year longitudinal study. *Aviation Space Environ Med* 2005;76:366–9.
- [44] Tyssen R, Vaglum P, Gronvold NT, Ekeberg O. The relative importance of individual and organizational factors for the prevention of job stress during internship: a nationwide and prospective study. *Med Teach* 2005;27:726–31.
- [45] Tyssen R, Vaglum P, Gronvold NT, Ekeberg O. Factors in medical school that predict postgraduate mental health problems in need of treatment. A nationwide and longitudinal study. *Med Educ* 2001;35(2):110–20.
- [46] Tyssen R, Vaglum P, Gronvold NT, Ekeberg O. Suicidal ideation among medical students and young physicians: a nationwide and prospective study of prevalence and predictors. *J Affective Disord* 2001;64:69–79.
- [47] Tyssen R, Vaglum P, Gronvold NT, Ekeberg O. The impact of job stress and working conditions on mental health problems among junior house officers. A nationwide Norwegian prospective cohort study. *Med Educ* 2000;34:374–84.

- [48] Wahlström J, Burström L, Hagberg M, Lundström R, Nilsson T. Musculoskeletal symptoms among young male workers and associations with exposure to hand-arm vibration and ergonomic stressors. *Inter Arch Occup Environ Health* 2008;81:595–602.
- [49] Gerhardsson L, Burstrom L, Hagberg M, Lundstrom R, Nilsson T. Quantitative neurosensory findings, symptoms and signs in young vibration exposed workers. *J Occup Med Toxicol* 2013;8:8.
- [50] Gustavsson JP, Hallsten L, Rudman A. Early career burnout among nurses: modelling a hypothesized process using an item response approach. *Intern Nurs Stud* 2010;47:864–75.
- [51] Hollund BE, Moen BE, Lygre SH, Florvaag E, Omenaas E. Prevalence of airway symptoms among hairdressers in Bergen, Norway. *Occup Environ Med* 2001;58:780–5.
- [52] Lind ML, Albin M, Brisman J, Kronholm Diab K, Lillienberg L, Mikoczy Z, et al. Incidence of hand eczema in female Swedish hairdressers. *Occup Environ Med* 2007;64(3):191–5.
- [53] Lysdal SH, Sosted H, Andersen KE, Johansen JD. Hand eczema in hairdressers: a Danish register-based study of the prevalence of hand eczema and its career consequences. *Contact Dermat* 2011;65:151–8.
- [54] Hoffmann HJ, Iversen M, Brandslund I, Sigsgaard T, Omland O, Oxvig C, et al. Plasma C3d levels of young farmers correlate with respirable dust exposure levels during normal work in swine confinement buildings. *Ann Agric Environ Med* 2003;10:53–60.
- [55] Dahlin M, Fjell J, Runeson B. Factors at medical school and work related to exhaustion among physicians in their first postgraduate year. *Nordic J Psychiatry*.
- [56] Hanvold TN, Veiersted KB, Wærsted M. A prospective study of neck, shoulder and upper back pain among technical school students entering working life. *J Adolesc Health* 2010;46:488–94.
- [57] Hanvold TN, Wærsted M, Mengschoel AM, Bjertness E, Stigum H, Twisk J, et al. The effect of work-related sustained trapezius muscle activity on the development of neck and shoulder pain among young adults. *Scand J Work Environ Health* 2013;39:390–400.
- [58] Skjold T, Dahl R, Juhl B, Sigsgaard T. The incidence of respiratory symptoms and sensitisation in baker apprentices. *Euro Respir J* 2008;32:452–9.
- [59] Videman T, Ojajärvi A, Riihimäki H, Troup JDG. Low back pain among nurses: a follow-up beginning at entry to the nursing school. *Spine* 2005;30:2334–41.
- [60] Bregnhøj A, Sosted H, Menne T, Johansen JD. Healthy worker effect in hair-dressing apprentices. *Contact Dermat* 2011;64:80–4.
- [61] Bregnhøj A, Sosted H, Menne T, Johansen JD. Exposures and reactions to allergens among hairdressing apprentices and matched controls. *Contact Dermat* 2011;64(2):85–9.
- [62] Hagberg M, Thiringer G, Brandstrom L. Incidence of tinnitus, impaired hearing and musculoskeletal disorders among students enrolled in academic music education—a retrospective cohort study. *Inter Arch Occup Environ Health* 2005;78:575–83.
- [63] Skjold T, Nielsen SC, Adoff K, Hoffmann HJ, Dahl R, Sigsgaard T. Allergy in bakers' apprentices and factors associated to non-participation in a cohort study of allergic sensitization. *Int Arch Occup Environ Health* 2007;80:458–64.
- [64] Omland O, Sigsgaard T, Hjort C, Pedersen OF, Miller MR. Lung status in young Danish rurals: the effect of farming exposure on asthma-like symptoms and lung function. *Eur Respir J* 1999;13:31–7.
- [65] Sigsgaard T, Hjort C, Omland Ø, Miller MR, Pedersen OF. Respiratory Health and Allergy among young farmers and non-farming rural males in Denmark: the SUS study. *J Agro Med* 1997;4:63–73.
- [66] Bregnhøj A, Menne T, Johansen JD, Sosted H. Prevention of hand eczema among Danish hairdressing apprentices: an intervention study. *Occup Environ Med* 2012;69:310–6.
- [67] Svensson AL, Strøyer J, Ebbenhøj NE, Schultz-Larsen K, Marott JL, Mortensen OS, et al. Multidimensional intervention and sickness absence in assistant nursing students. *Occup Med* 2009;59:563–9.
- [68] Held E, Wolff C, Gyntelberg F, Agner T. Prevention of work-related skin problems in student auxiliary nurses: an intervention study. *Contact Dermat* 2001;44:297–303.
- [69] Muhr P, Rosenhall U. Self-assessed auditory symptoms, noise exposure, and measured auditory function among healthy young Swedish men. *Int J Audiol* 2010;49:317–25.
- [70] Breslin FC, Day D, Tompa E, Irvin E, Battacharyya S, Clarke J, et al. Systematic review of risk factors for work injury among youth. Toronto: Institute for Work & Health; 2005.
- [71] Turner N, Tucker S, Kelloway EK. Prevalence and demographic differences in microaccidents and safety behaviors among young workers in Canada. *J Saf Res* 2015;53:39–43.
- [72] Bena A, Giraudo M, Leombruni R, Costa G. Job tenure and work injuries: a multivariate analysis of the relation with previous experience and differences by age. *BMC Public Health* 2013;13:869.
- [73] Loughlin CF MR. Young workers' occupational safety. In: Barling J, editor. *The psychology of workplace safety*. Washington, DC, US: American Psychological Association; 2004.
- [74] Loughlin C, Barling J. Young workers' work values, attitudes, and behaviours. *J Occup Organizational Psychol* 2001;74:543–58.
- [75] Westaby JD, Lowe JK. Risk taking orientation and injury among youth workers: examining the social influence of supervisors, coworkers, and parents. *J Appl Psychol* 2005;90:1297–305.
- [76] Merlino LA, Rosecrance JC, Anton D, Cook TM. Symptoms of musculoskeletal disorders among apprentice construction workers. *Appl Occup Environ Hyg* 2003;18:57–64.
- [77] de Zwart BCH, Broersen JPP, Frings-Dresen MHW, van Dijk FJH. Musculo-skeletal complaints in The Netherlands in relation to age, gender and physically demanding work. *Int Arch Occup Environ Health* 1997;70:352–60.
- [78] Uter W, Pfahlerberg A, Gefeller O, Schwanitz HJ. Hand dermatitis in a prospectively-followed cohort of hairdressing apprentices: final results of the POSH study. Prevention of occupational skin disease in hairdressers. *Contact Dermat* 1999;41:280–6.
- [79] De Zotti R, Bovenzi M. Prospective study of work related respiratory symptoms in trainee bakers. *Occup Environ Med* 2000;57:58–61.
- [80] Walusiak J, Hanke W, Gorski P, Palczynski C. Respiratory allergy in apprentice bakers: do occupational allergies follow the allergic march? *Allergy* 2004;59:442–50.
- [81] Pek S, Turner N, Tucker S, Kelloway EK, Morrish J. Injunctive safety norms, young worker risk-taking behaviors, and workplace injuries. *Accid Anal Prev* 2017;106:202–10.
- [82] Breslin FC, Tompa E, Zhao R, Pole JD, Amick III BC, Smith PM, et al. The relationship between job tenure and work disability absence among adults: a prospective study. *Accid Anal Prev* 2008;40:368–75.
- [83] Virtanen M, Kivimäki M, Joensuu M, Virtanen P, Elovainio M, Vahtera J. Temporary employment and health: a review. *Int J Epidemiol* 2005;34:610–22.
- [84] Rebitzer JB. Job safety and contract workers in the petrochemical industry. *Ind Relat* 1995;34:40–57.
- [85] Paoli P, Merliè D. Third European Survey on working conditions 2000. Eurofound 2001;73. No. EF00/21.
- [86] Underhill E. Double jeopardy: occupational injury and rehabilitation of temporary agency workers. University of New South Wales; 2008 (Thesis).
- [87] Dragano N, Lunau T, Eikemo TA, Toch-Marquardt M, van der Wel KA, Bamra C. Who knows the risk? A multilevel study of systematic variations in work-related safety knowledge in the European workforce. *Occup Environ Med* 2015;72:553–9.
- [88] Andersson IM, Gunnarsson K, Rosen G, Mostrom Aberg M. Knowledge and experiences of risks among pupils in vocational education. *SHAW* 2014;5:140–6.
- [89] Andersson IM, Gunnarsson K, Rosén G. Role of headmasters, teachers, and supervisors in knowledge transfer about occupational health and safety to pupil in vocational education. *SHAW* 2015;6:317–23.
- [90] Breslin FC, Pole JD. Work injury risk among young people with learning disabilities and attention-deficit/hyperactivity disorder in Canada. *Am J Public Health* 2009;99:1423–30.
- [91] Nielsen M, Jørgensen A, Grytnes R, Dyreborg J, Nielsen K. Safe work for young people through learning and instruction (SFAU learning) [In Danish]. Copenhagen. Det Nationale Forskningscenter for Arbejdsmiljø, NFA; 2017. 120 p. No.41-2014-09.
- [92] Bandura A. Self-efficacy. The exercise of control. NY: W.H. Freeman and company; 1997.
- [93] Rotter JB. The development and applications of social learning theory. New York: Praeger; 1982.
- [94] Nykänen M, Sund R, Vuori J. Enhancing safety competencies of young adults. A randomized field trial (RCT). *J Saf Res* 2018;67:45–56.
- [95] Dyreborg J, Nielsen K, Kines P, Dziekanska A, Frydendall KB, Bengtsen E, et al. Review of accident prevention - review of existing scientific literature on the impact of different types of occupational accident prevention. [In Danish]. Copenhagen. Det Nationale Forskningscenter for Arbejdsmiljø, NFA; 2013. 146 p. No.48-2010-09.
- [96] Svensson AL. The effectiveness of a multidisciplinary intervention program on low back pain and sickness absence (Thesis): faculty of Health Sciences. University of Copenhagen; 2009.