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Systematic review of factors associated with occupational disease among young people

Full report

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Table of Contents

List of Appendices iii
List of Figures iii
List of Tables iii
Foreword v
1.0 Introduction 7
1.1 Definitions of association 8
1.2 About our conceptual framework for the systematic review 9
Data source 9
Phase of investigation 10
Type of outcome 10
2.0 Methods 11
2.1 Literature search 11
2.2 Inclusion on relevance 11
Study design 11
Population of interest: young people 12
Population of interest: workers 12
Outcomes 12
Exposure: risk factors 12
2.3 Quality appraisal (QA) 13
2.4 Data extraction (DE) 14
2.5 Evidence synthesis (ES) 14
3.0 Findings 17
3.1 Literature search and selection of relevant studies 17
3.2 Methodological quality of relevant studies 18
Selection biases 18
Measurement biases 18
Confounding biases 19
3.3 Characteristics of studies included in evidence synthesis 19
Country of origin 19
Age of workers 20
Work arrangements 20
Types of occupational disease 20
Research designs 20
3.4 Hand dermatitis among young workers 21
Prevalence and incidence of hand dermatitis 21
Factors associated with hand dermatitis 22
Risk factors for hand dermatitis 22
3.5 Toxic exposures among young workers 25
Prevalence and incidence of toxic exposures 25
Factors associated with toxic exposures 25
Risk factors for toxic exposures 25
3.6 Respiratory symptoms among young workers 25
Prevalence and incidence of respiratory symptoms 25
Factors associated with respiratory symptoms 26
Risk factors for respiratory symptoms 26

4.0 Discussion 27
4.1 Summary of evidence 27
Occupational dermatitis 27
Toxic exposure 28
Respiratory conditions 28
4.2 Quality of evidence 29
4.3 Strengths and limitations of the review 29
4.4 Research gaps and future directions 30
5.0 References 32

List of Appendices

Appendix A: Search Terms…….....37
Appendix B: Criteria for inclusion and exclusion of studies……38
Appendix C: Quality Appraisal Form……...39
Appendix D: Background Tables……..49

List of Figures

Figure 1: Conceptual framework for systematic review.....9
Figure 2: Flowchart of literature search.....17
Figure 3: Number of young worker studies by country of origin.....19

List of Tables

Table 1: Summary of multivariate prospective studies on young workers and hand dermatitis……...24

Foreword

In recent years, the Institute for Work & Health has been actively engaged in building relationships with Prevention System agencies and organizations in Ontario.

In these encounters, we often hear that potential research users want more evidence about the effectiveness of interventions aimed at protecting workers' health. We are also told that even when research evidence exists, it is often hard to access, difficult to understand and is not always presented in language and formats suitable to non-scientific audiences.

In response to these needs, the Institute for Work & Health has established a dedicated group to conduct systematic reviews of relevant research studies in the area of workplace injury and illness prevention. In instances where there are too few studies to conduct a full systematic review we may provide our audiences with a narrative review.

- Our systematic review team monitors developments in the international research literature on workplace health protection and selects timely, relevant topics for evidence review.
- Our scientists then synthesize both established and emerging evidence on each topic through the application of rigorous methods.
- We then present summaries of the research evidence and recommendations following from this evidence in formats that are accessible to non-scientific audiences.

The Institute consults regularly with workplace parties to identify areas of workplace health protection that might lend themselves to a systematic review of the evidence.

We appreciate the support of the Ontario Workplace Safety & Insurance Board (WSIB) in funding this four-year Prevention Systematic Reviews initiative. As the major funder, the WSIB demonstrates its own commitment to protecting workers' health by supporting consensus-based policy development that incorporates the best available research evidence.

Many members of the Institute's staff participated in conducting this systematic review. A number of external reviewers in academic and workplace leadership positions provided valuable comments on earlier versions of the report. On behalf of the Institute, I would like to express gratitude for these contributions.

Dr. Cameron Mustard
President, Institute for Work & Health
September, 2006

1.0 Introduction

Work is a common part of the lives of most North American adolescents and young adults (1). Although there is much concern regarding work injury among youth (2), less attention has been paid to the incidence and risk factors for occupational disease and illness among young workers. (In this report we use "disease" to refer to a specific disease state such as dermatitis. Illness refers to adverse health events that are not particular diseases, such as poisoning due to disinfectants. Unless specifically reviewing studies on illness, we will use the term "disease" for convenience.)

There are several reasons to assess the empirical literature on occupational disease among young workers. First, young workers are concentrated in certain industries and jobs, which may lead to different patterns of exposures than adult workers. Second, because young workers also tend to be new workers who are exposed to hazards for the first time, the link between exposure and disease may be clearer. Finally, young workers may be particularly vulnerable to some occupational diseases because early exposures occur during a time of rapid physical development (2).

A previous narrative review from the U.S. included occupational disease among young workers (3). This review highlighted the following occupational exposures relevant to disease among teenage workers:

- noise
- biohazards and blood pathogens
- exposures related to dermatitis
- extreme weather exposure
- chemical burns
- solvents and cleaning agents.

However, the empirical evidence on which this review was based was very limited. Many exposures cited just one relevant study that simply reported the frequency of each exposure. The authors of the review concluded that better surveillance of exposure and occupational disease for young workers should be developed. In addition, they noted that an evaluation of strategies to protect young workers from exposures was an important research need.

Our systematic reviews on the young worker and occupational health literature are in response to the Workplace Safety & Insurance Board's interest in a comprehensive prevention strategy for young workers. The present review is the second report on the young workers' literature. A 2005 systematic review of injuries among young workers was the focus of a previous report from the Institute for Work & Health.

The guiding question for the current review was: *What individual, job, and workplace factors are associated with occupational disease among young people 12 to 24 years of age?* The first objective of this report on occupational disease was to review the

published evidence on both risk and protective factors for occupational disease among young workers. A second objective was to assess the strengths and weaknesses in the methodology of the relevant studies.

The term "young worker" typically refers to teenagers and young adults who work for pay. This age group is of particular interest because this is when entry into the labour force is most common. For our systematic review, we used this broad definition. In some studies, however, workers under 18 years are the primary focus, especially when changes in minimum age regulations in child labour laws are a possible implication, because these laws only apply to this age group.

It should also be noted that the age range encompassed by this review includes a diverse array of young people. Many teen and young adult workers are in school, yet some are not (5). Many are working temporary jobs (6), but some have already established more stable employment. These circumstances mean that young workers face many types of work situations with different risks for occupational disease.

We searched the literature for studies on young workers and occupational health published in English, French, German and Spanish. We did not include studies that were exclusively about young agricultural workers because this group has been the focus of other reviews (7). However, a number of studies selected for review examined several industries, including the agricultural industry.

1.1 Definitions of association

In this review, we refer to “associated factors” when describing variables that are correlated with occupational disease in cross-sectional or univariate studies (8). Even though factors associated with an outcome do not allow one to draw strong causal inferences, they are useful as potential risk factors to be examined more closely in future studies.

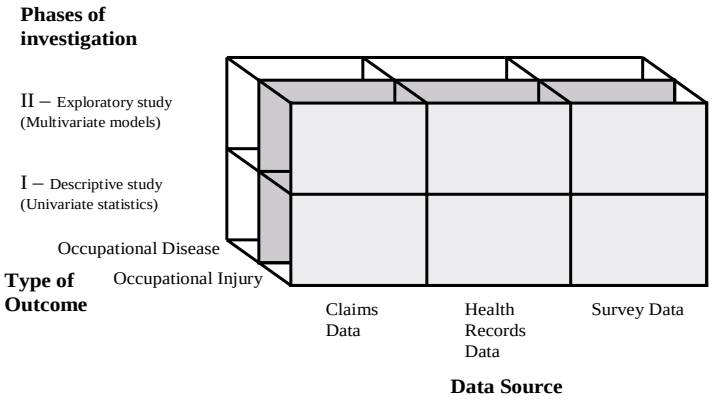
A risk factor refers to an individual characteristic or event that increases the occurrence of occupational disease in a prospective study (8). To be considered an independent risk factor, the variable would have to be included in multivariate analyses with both demographic/individual and workplace/job factors, a procedure that reduces the possibility of confounding.

Our systematic review reflects the degree to which the relevant studies have probed more deeply into the link between certain risk factors and occupational disease. For prevention, risk factors that show significant associations with occupational disease, especially when other possible risk factors are controlled, are worthy of attention from researchers and stakeholders. However, it should be understood that this review of risk factors is tentative, since future research may provide a more detailed understanding of risk factors and clarify the causal relationships.

1.2 About our conceptual framework for the systematic review

The framework used to organize the systematic review is seen in Figure 1. It reflects three methodological features: data source, phase of investigation and type of outcome. This conceptual framework, adapted from a previous review of observational studies of whiplash (9), was used because the young worker literature currently consists of observational studies.

Figure 1: Conceptual framework for systematic review



Data source

For this review we identified three data sources: insurance claims, health care visits and surveys (i.e. collections of self-report measures and clinical assessments). Surveys that we located typically employed self-report measures, but some also included diagnostic assessments by trained personnel.

The framework allowed us to distinguish between these data sources. Each has particular method biases for matters such as reporting of occupational disease. For example, studies that rely on workers' compensation claims often fail to capture all occupational disease (10), because of underreporting and the difficulty in demonstrating that the condition was work-related. Such underreporting of claims could affect our ability to identify risk factors if a certain young worker subgroup or industry were particularly unlikely to report occupational disease to the compensation system.

Relying on health records (i.e. health care visits) as a data source can also be problematic and lead to reporting bias. Research shows that 34% of occupational injuries and illnesses

such as poisonings are treated in hospital emergency departments (11). This low percentage is partly due to the fact that not all occupational diseases require a visit to an emergency department. This data source may also fail to capture all occupational diseases if hospital staff are unable to correctly assess whether the condition is work-related (12).

Relying on self-report measures from surveys as a data source has its limitations. People who report they have experienced an occupational disease may not accurately recall its onset or severity. However, in principle, a longitudinal study that recruits young workers when occupational exposures first commence (e.g. in apprenticeships) and objectively assesses health outcomes should be better able to determine the timing and severity of the disease.

In sum, issues in methodology specific to each data source raise the possibility that not all occupational diseases have been accurately identified. However, when we see patterns in risk factors across several studies with different measures, such consistency suggests that the association is robust despite differences in methodology.

Phase of investigation

A second issue in methodology involves the need to account for the influence of other potential risk factors. For example, to what extent is having dermatitis due to individual susceptibility, a certain workplace exposure or a combination of these factors? Many occupational diseases have a multifactor etiology and a part of each type of disease is exacerbated or caused by workplace exposures.

The descriptive and exploratory phases of research reflect a hierarchy of knowledge. Descriptive studies explore the associations between potential associated factors and occupational disease in a simple, univariate way. Exploratory, cross-sectional studies that use multivariate analyses to assess the independent associations of factors with an outcome are useful in identifying potential risk factors. Longitudinal studies that use multivariate analyses to examine which risk factors have independent predictive value are considered to have the strongest causal inference. Nevertheless, in the absence of other studies, descriptive and cross-sectional studies provide emerging evidence of potential associations worthy of further investigation.

Type of outcome

The final aspect of the studies we considered in the conceptual framework for our review involved type of outcome. Specifically, were we looking at studies about occupational disease.

2.0 Methods

2.1 Literature search

Seven electronic databases were searched for studies published between 1980 until March 2005. These were: MEDLINE, EMBASE, PsycINFO, CCINFOWeb (Canadian Centre for Occupational Health and Safety), Dissertation Abstracts International, the library catalogue of the Workers' Compensation Board of British Columbia and IDEAS (University of Connecticut Department of Economics). In addition, we searched through research projects listed on the web sites of the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST) and the Association of Workers' Compensation Boards of Canada (AWCBC). The reference lists of papers selected for review were also manually checked. Finally, we contacted researchers who had published relevant studies and asked them to suggest any additional articles they had published on young workers.

The search terms we used to locate studies in the electronic databases were customized for each database (see Appendix A). The search strategy typically combined three groups of terms using "AND." Group 1 terms pertained to employment risk factors, Group 2 terms pertained to occupational illness, and Group 3 terms encompassed youth aged 12 to 24. The terms within each group were linked with "OR." In order for a study to be considered for this review, it had to contain at least one term from each group in its source reference material.

Articles considered for this study included peer-reviewed papers, reports and dissertations. In all instances, searches were limited to studies published in English, French, Spanish and German.

2.2 Inclusion on relevance

Two reviewers independently screened the title and abstract of each paper based on our inclusion/exclusion criteria (see Appendix B). When reviewers could not agree about whether a study met the criteria, they met to discuss their decision and rationale. A third reviewer was consulted if consensus could not be reached. Once the titles and abstracts were screened, the full articles of eligible studies were assessed to ensure that they met the inclusion/exclusion criteria. A similar consensus method was used for the article screening stage as well (outlined below).

Study design

This review included only quantitative studies reporting original research. We excluded qualitative studies, conceptual articles and case studies. To categorize study design, we adapted the algorithm and definitions developed by Briss and colleagues (13). We found two general types of study designs in this research area. One was cross-sectional, in which participants were observed at one point in time and compared on demographics, or with other occupational groups. The other type was longitudinal, in which participants were observed at more than one point in time.

Population of interest: young people

It was important for each study we included to have conducted specific analyses on subjects (the sample) within our target age range. We included studies where the majority of the sample was aged 12 to 24 years. In some cases the age range in a particular sample overlapped with our targeted range. We rated such studies as eligible for inclusion when the sample age range and our target age range overlapped by more than 50%. When the study reported a mean age and standard deviation, an imputed age range was derived by calculating the age two standard deviations below and two standard deviations above the mean.

We also included studies where young workers in our target age range were part of a larger sample of workers. However, the study had to provide separate risk factors or subgroup analyses for workers in our target age range (i.e. stratified analyses). Studies were excluded if there was insufficient information to determine whether the sample met our age criterion.

Population of interest: workers

Given the different forms of economic activity young people engage in as they enter the workforce, we chose to define work quite broadly. We did not limit our interest to studies where young workers were engaged in paid work for employers. We also included studies of young people involved in more informal kinds of work – self-employment (e.g. odd jobs, yard work, baby sitting), volunteer jobs, and students learning a trade (e.g. hairdressers).

Outcomes

The focus of this report is on occupational disease. Because occupational cancer and heart disease do not typically manifest during this life stage, these outcomes were excluded in this review of young workers. We also excluded those studies that evaluated biological precursors of a potential health outcome, such as liver function tests as a marker for future potential liver damage.

Exposure: risk factors

For a study to be included in this systematic review, at least one risk factor affecting a sample of young workers had to be analyzed.

Studies of interventions aimed at reducing the occurrence of occupational disease were also in the scope of this review. Interventions were defined as a planned, systematically applied program to reduce workplace exposures for occupational disease.

We categorized risk factors as follows: a) demographic/individual factors (e.g. age, gender, visible minority); b) job characteristics and workplace factors (e.g. occupation, physical work environment); c) behavioural factors (e.g. hand washing) (14).

The first category listed above relates to the subgroups of young workers who might face an elevated risk for occupational disease. The second category relates to work conditions that might be associated with elevated risk for young workers. The last category concerns

behaviour, which may also influence the risk of occupational disease. Behaviour is the product of individual and workplace environment factors.

2.3 Quality appraisal (QA)

Our approach to appraising the methodological quality of studies has been used in previous reviews (9;15;16).

The quality of the methodology of each full study was rated independently by the lead investigator and one of four other reviewers. After this initial assessment, the author and the reviewer met to reach consensus for each study. If consensus could not be reached, experts involved in previous systematic reviews were consulted in order to reach consensus.

The studies were assessed using 31 criteria in the areas of: selection bias, measurement bias, confounding bias and "other methodological issues" (see Appendix C for the quality appraisal form). These criteria were judged to be relevant to the internal validity of epidemiological studies (17).

Selection bias distorts the representativeness of the study sample to the target population of interest. We recorded the following study features related to selection bias: sampling design, the description of sample characteristics, inclusion/exclusion criteria, the amount of data missing due to partial responses, recruitment methods, recruitment rates (for survey and intervention studies) and follow-up rates (for longitudinal studies).

Measurement bias distorts the reliable and valid assessment of the risk factors and outcomes. "Reliability" refers to either the degree to which a group of questions assesses the same construct (internal reliability) or the degree to which a group of questions accurately measures a construct over time (test-retest reliability). "Validity" refers to the accuracy with which the measure assesses the risk factor or the outcome.

We recorded the following study features related to measurement bias: nature of the outcome (i.e. were only illness frequency counts measured, or rates in a population?), outcome definition, evidence on the reliability and validity of the outcome measure, risk factor definition, and evidence on the reliability and validity of the risk factor measure.

Confounding bias distorts the attribution of an effect to a specific risk factor. We determined whether the associations between a risk factor and an outcome were adjusted for other potential risk factors. We also assessed whether the set of risk factors used in multivariate models included both demographic/individual factors and job/workplace factors.

Other methodological matters we considered in our quality appraisal included the presence of variance estimates (e.g. confidence intervals), the adequacy of sample size, the presence of information necessary to interpret any regression analysis, the presence of any interpretation of the findings, and whether there was any discussion of methodological limitations in the study.

We developed additional criteria for intervention studies, but because no intervention study met our relevance conditions, we did not use these additional criteria.

Quality appraisal decisions

Through discussions with reviewers and experts in systematic reviews, we identified two methodological features as potentially serious flaws in the 31 methodological criteria we assessed for these studies. These two methodological features were chosen as the most critical criteria to be met to ensure adequate internal validity.

First, claim and health record studies were excluded if they reported only counts of occupational disease and not rates. Simple counts, such as the number of young males versus young females having a condition, were not acceptable because high counts might simply reflect greater numbers of workers in a subgroup. For example, more young males may have been exposed. The *likelihood* of an occupational disease examined in multivariate studies met this criterion because the computation of likelihood would also require information on the occupational disease counts and the number of workers at risk.

A second focus of our quality appraisal was whether studies provided some description of the type of occupational disease examined. The outcome also needed to indicate a clinically relevant occupational disease state, and not a precursor of possibly developing a disease (e.g. urine analysis to determine the physiological consequences of toxic exposures). Such information provided some basic evidence of the quality of the outcome measures.

Other study features related to selection, measurement and confounding biases are shown in the tables describing each study (Appendix D).

2.4 Data extraction (DE)

We extracted methodological information and data from studies that met our quality appraisal criteria. One reviewer summarized each study's findings and the methodology used. The lead author checked the extracted findings information against the original article and the extracted methodological information against the data obtained in the quality appraisal stage.

2.5 Evidence synthesis (ES)

The diversity of study designs, measures and statistical analyses precluded the use of meta-analyses to synthesize the findings across relevant studies.

Univariate studies provided descriptive information on the prevalence and incidence of occupational disease and hypotheses for potential risk factors to be assessed in future research (8). Univariate studies were not included because these studies, by definition, have not attempted to account for other potential risk factors – i.e. confounding bias is not addressed at all.

By factoring in the issue of confounding bias, multivariate studies do account for other potential risk factors. We therefore used multivariate studies to estimate the independent contribution of a specific risk factor to an outcome. We used the most complete multivariate regression analysis presented in the study. From this multivariate analysis, we categorized each potential risk factor in the model as follows: no association with an occupational disease; a significant positive association; or a significant negative (i.e. inverse) association.

We adapted guidelines that were used in a systematic review of observational studies examining the influence of regulatory and inspection mechanisms on occupational health and safety (16). These guidelines state that quality, quantity and consistency need to be considered when deciding whether evidence is "sufficient."

Quality refers to having no serious methodological flaws. Quantity refers to the number of studies examining the risk factor. Consistency refers to the degree to which studies converge on the same result.

The level of evidence for each risk factor was ranked as follows:

- Sufficient evidence

  Minimum quality: met two methodological criteria described in section 2.3

  Minimum number of studies: at least two multivariate studies

  Consistency: The majority of studies indicated an association or no association with occupational disease.

- Preliminary evidence

  Minimum quality: met two methodological criteria described in section 2.3

  Minimum number of studies: at least two multivariate studies

  Consistency: The majority of studies indicated an association or no association with occupational disease, but findings may not generalize to other jurisdictions. For example, a study of illness rates in a particular ethnic population in the United States may not generalize to Canada.

- Insufficient evidence

  Minimum quality: met two methodological criteria described in section 2.3

  Minimum number of studies: at least two multivariate studies

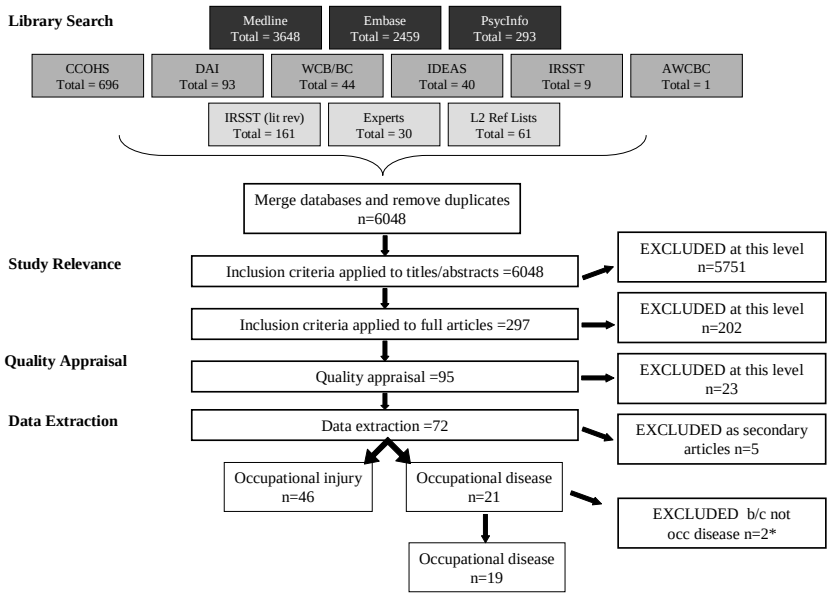
Consistency: If there were two studies, they did not converge. If there were more than two studies, they showed a mix of positive, negative and no association.

3.0 Findings

3.1 Literature search and selection of relevant studies

Our literature search found a total of 6,048 citations (see Figure 2). Of these abstracts, 5,751 were excluded at the initial selection phase because the citations did not: a) refer to a quantitative study; b) focus on a population in our age range; c) have samples engaged in work; or d) look at health outcomes of interest for this review (disease).

Figure 2: Flowchart of literature search



*Two toxic exposure studies were excluded post hoc by expert consensus, to be precursors of possible disease

This left a total of 297 citations. We then reviewed the full paper for each of these remaining citations. Another 202 articles were subsequently excluded because: a) upon reading the full article, it did not meet the four relevance criteria listed above; b) the article did not assess a risk factor among the young worker sample; or c) the study related to agricultural or military training injuries, which were deemed beyond the scope of our review.

This left a total of 95 studies. Of these, 23 did not meet our quality appraisal criteria (see next section) and five were deemed companion articles that were redundant to the primary article that we had already reviewed (n=72). Another 46 studies were not included because they focused on work injuries, which is the subject of a separate report.

These exclusions left us with a total of 19 studies on risk factors of occupational disease for young workers. Only one of these 19 studies was in a language other than English (18).

3.2 Methodological quality of relevant studies

All 19 studies were deemed to be of sufficient quality to contribute to evidence synthesis. All provided demographic information on the sample (e.g. age, gender), the jurisdiction and time period of the study, as well as descriptions of the measures and statistical analyses used (e.g. type of regression, rate computation approach).

However, even among studies that met our quality appraisal standards, certain methodological issues remained, which we felt were relevant to interpreting the findings. In this section, we briefly highlight the selection, measurement and confounding issues in these studies.

Selection biases

To evaluate possible selection biases in primary data collection studies as opposed to administrative data, it is useful if researchers describe the methods of recruitment and the study response rate – e.g. the number of people who completed a self-report questionnaire compared to the number of people eligible or available to be surveyed. Our review included 17 survey studies. Of those, 13 reported some details of how they recruited their sample of young workers (see background tables in Appendix D). The most common omission was reporting the number of people eligible or available to be surveyed.

Only nine of the self-report survey studies obtained participants from multiple sites or recruited probabilistic samples of youth (18-25). On the positive side, only one study had response rates below 40% on one or more follow-ups (26). Although low response rates were not a common problem, convenience samples can also lead to selection biases (e.g. having proportionally more females in the study sample than in the target population). This, in turn, can distort the strength of a risk factor-outcome association.

Measurement biases

Different measures were used to assess skin conditions (e.g. hand dermatitis), respiratory problems (e.g. asthma) and health consequences of toxic exposure. Therefore some of the variability in prevalence and incidence may be attributed to measurement diversity (27). To reduce the range of measurement variability, we report on clinically significant health outcomes such as hand dermatitis and asthma.

One of the key limitations in the methodology of survey studies is the reliability and validity of the measures. Among the 17 survey studies listed in Appendix D, 12 studies reported some degree of internal reliability of their measures, test-retest reliability of their measures, and/or provided evidence of measurement validity.

Confounding biases

Confounding bias occurs when a factor is associated with other potential risk factors as well as the outcome. None of the studies based on compensation claims or health records in our review used standardization techniques or regression analyses to determine the independent contribution of risk factors to observed occupational disease rates.

Of the 17 survey studies in this review, five studies (23;25;26;28;29) used multivariate regressions to assess the independent contribution of each factor to the risk of occupational disease (Appendix D).

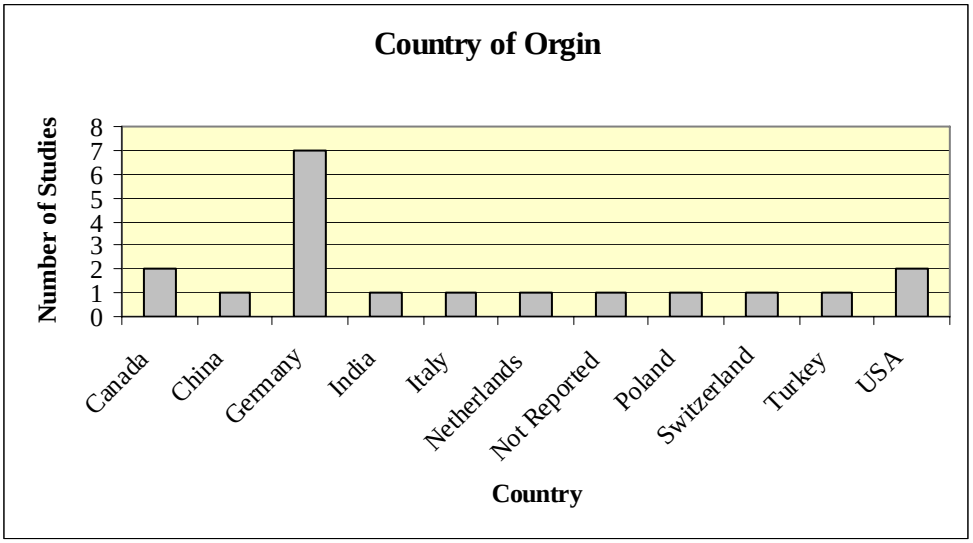
In sum, the methodological limitations described here apply to many of the studies that were included in our systematic review. This suggests that even the best evidence in this literature to date should be viewed as tentative. However, in the absence of other evidence, the existing findings provide some initial guidance on targeting resources for occupational disease prevention.

3.3 Characteristics of studies included in evidence synthesis

Country of origin

Eleven studies took place in European countries and four studies were from North America (see Figure 3). Single studies came from Turkey, China and India, and one study did not report on country of origin.

Figure 3: Number of young worker studies by country of origin



Age of workers

Of the 19 studies, 32% reported on workers in the teenage years only (e.g. age 15 to 17). Sixty-eight per cent included samples of both teenagers and young adults (age 20 to 24). No studies included both pre-teens (age 12 to 14) and teenagers.

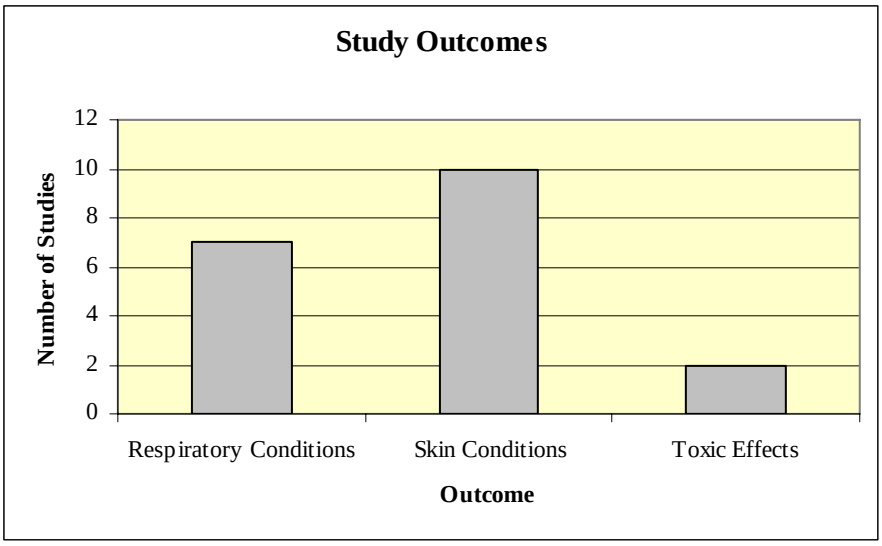
Work arrangements

Of the 19 studies, 79% reported on workers in trainee or apprenticeship arrangements. The remaining 21% were on young people in paid employment.

Types of occupational disease

We found 10 studies reporting on skin conditions such as dermatitis (see Figure 4). Seven studies examined respiratory conditions and two studies reported on toxic exposures such as poisonings.

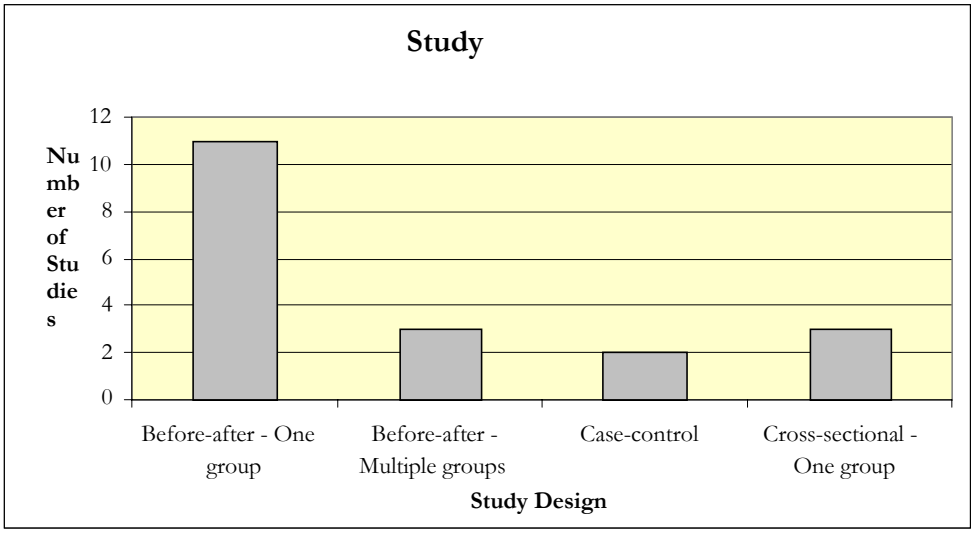
Figure 4: Types of occupational disease



Research designs

The majority of studies included in our review assessed one or more groups of participants multiple times (Figure 5). Case-control studies and cross-sectional studies were also represented.

Figure 5: Types of research design by data source



3.4 Hand dermatitis among young workers

Prevalence and incidence of hand dermatitis

Hand dermatitis is a descriptive term because it can be due to a variety of causes generally classified as either irritant or allergic reactions (30). Even though it is preferable to know the occurrence of new cases of a disease over time when identifying risk factors (i.e. incidence rates), it is also useful to know the overall prevalence across occupational groups (10).

Four studies described the prevalence of hand dermatitis in samples of apprentices, including bakers/confectioners, hairdressers and office workers. The prevalence of hand dermatitis varied across occupational groups. The available evidence indicates that apprentice bakers/confectioners and hairdressers have the highest rates of hand dermatitis.

In a study of apprentice bakers/confectioners in Germany, the point prevalence of hand dermatitis was 27.5% at the three-year follow-up (21). The point prevalence of hand dermatitis for apprentice hairdressers in Germany was 14.7% after eight weeks of training (18) and 23.9% at the three-year follow-up (27). Among office apprentices in Germany, the point prevalence of hand dermatitis was 7.4% at the three-year follow-up (24).

Seven cohort studies reported the *incidence* of hand dermatitis in apprenticeship programs. Below, we report the incidence at the last follow-up. The apprentice

programs studied include: metal workers, auto manufacturing, hairdresser, nurses and office workers. Overall the evidence suggests that the average annual incidence of hand dermatitis is highest among hairdressers.

Among Swiss trainee metal workers, the 2.5-year incidence of hand dermatitis was 23% (29). In Germany, auto manufacturing apprentices had a three-year incidence of hand dermatitis of 14.1% (22). Among nurses in the Netherlands, the eight-year incidence of hand dermatitis was 33% (31). In Germany, office apprentices developed hand dermatitis at a rate of 4.1% per year (24).

Two German studies of hairdresser apprentices reported hand dermatitis occurring at a rate of 21.1% (28) and 15.2% per year (27). Among hairdresser apprentices in the Netherlands, the annual incidence of hand dermatitis was somewhat higher at 27.9% (32).

Factors associated with hand dermatitis

In a cross-sectional study of German hairdresser apprentices, hand dermatitis was more common among those with the following characteristics: previous hand dermatitis, participation in the apprenticeship for nine to 12 weeks, doing wet work without gloves and smoking (18).

Risk factors for hand dermatitis

Three prospective studies reported unadjusted associations between risk factors and hand dermatitis. Among German baker/confectioners, skin atopy, previous flexural dermatitis, previous hand dermatitis, wet work combined with frequent hand washing, and leisure time habits such as house building/renovation were associated with hand dermatitis (21). Of the several types of apprenticeships in a German auto manufacturing firm, metal workers and other blue-collar workers had twice the risk of hand dermatitis compared to white-collar or clerical occupations (22). In the same study, after breaking down the rates by occupation and gender, female apprentices in the German auto manufacturing firm were more likely to develop hand dermatitis than males in similar occupations (22).

A study of German office apprentices showed previous hand dermatitis was associated with the development of hand dermatitis during the study period (24).

Four prospective studies reported multivariate regressions between risk factors and hand dermatitis (see Table 1). For Swiss metal work apprentices, the occurrence of hand dermatitis was associated with previous flexural dermatitis, adjusting for other atopic symptoms (29). Among Dutch nurse apprentices, atopic mucosal symptoms increased the likelihood of hand dermatitis (32). Atopy symptoms suggest a genetic predisposition to an allergic reaction and/or previous exposure (10).

A large study of German hairdresser apprentices reported a significant decline in risk of subclinical and clinical symptoms of hand dermatitis (i.e. any skin changes) among apprentices older than 19 years of age. (25). In addition, unprotected wet work for longer than two hours and low humidity in the workplace were positively associated with

adverse skin changes, especially when gloves were used infrequently for this wet work. Of that large cohort, hand dermatitis was specifically examined in a subsample of 92 German hairdresser apprentices. Findings showed that previous flexural dermatitis was an independent risk factor (28). Among Dutch hairdresser apprentices, dry skin was strongly associated with the occurrence of hand dermatitis (32).

Table 1. Summary of multivariate prospective studies on young workers and hand dermatitis*

Risk factor	Metal workers	Nurses		Hairdressers		
	Berndt 1999	Smit 1994		Smit 1994	Uter 1999a	John 2000
Demographic / individual						
Gender		0		0	0	
Age					0	
Skin-related						
History of flexural eczema	+				0	+
History of other eczemas		0		0	0	0
Atopic features		+		0	+	
Trans-epidermal water loss		0		0		0
Relative skin moisture						0
Skin type		0		+		
Allergen reactivity	+ (six-month f/u)	0		0		
Behavioural						
Smoker						
Hand washing					0	
Emollient use					0	
Job / workplace						
Wet work					+	
Absence of humidity					+	

*(+) positive association with health outcome; 0 no association; inverse association (-) and blank means not assessed
f/u = follow-up

3.5 Toxic exposures among young workers

Prevalence and incidence of toxic exposures

One study provided information about the incidence of occupational disinfectant-related illness among American 15- to 17-year olds (33). In the U.S., the annual incidence rate was 16.8 per billion hours worked. Separate estimates in California, however, put the incidence rate at 50.1 per billion hours worked. This difference was attributed to the fact that the U.S. estimate was based on calls to poison control centres, while California has a state-based surveillance system that could identify more cases.

With regard to acute pesticide-related illnesses, the annual incidence rate among 15- to 17-year old workers was 20.4 per billion hours worked, according to one study using poison control centre data from eight U.S. states. (34).

It should be noted that the identification of cases in these studies relied on the judgment of trained poison control specialist on whether the case had signs and symptoms consistent with the type of exposure. That is, there were no standardized criteria to make this determination.

Factors associated with toxic exposures

In the study on pesticide-related illnesses (34), young workers aged 15 to 17 years in the agricultural industry were 28 times more likely to develop this illness than those working in non-agricultural sectors.

Disinfectant-related illnesses in California were more common among 15- to 17-year olds working in eating/drinking places and in entertainment/recreation services than across all industries (33). In the U.S. overall, rates of disinfectant-related illnesses were slightly lower during the summer months than the rest of the year (33).

Risk factors for toxic exposures

No studies meeting our inclusion criteria reported on risk factors associated with rates of toxic exposures.

3.6 Respiratory symptoms among young workers

Prevalence and incidence of respiratory symptoms

Three studies described the prevalence of respiratory symptoms among young workers in certain occupational groups. Among Turkish furniture decoration students, the most common respiratory complaints were coughing (23%), history of rhinitis (34.4%) and history of conjunctivitis (34.4%) (35). Young Chinese cotton workers reported symptoms such as cough with phlegm (19%), chest tightness (18%) and nasal irritation (13%) (36). In India, teenage diamond mine workers had a higher prevalence of restrictive respiratory impairment than teenage wool and pencil factory workers (37). Using the pulmonary function test, obstructive respiratory impairment was diagnosed

more frequently among the diamond mine and pencil factory workers than the wool workers.

Three cohort studies reported the incidence of respiratory conditions among young workers in specific occupational groups. Among Canadian animal health technology apprentices, the four-year incidences of occupational rhinoconjunctivitis and asthma were 5.7% and 2.7% respectively (19).

Italian baking apprentices developed respiratory symptoms such as rhinitis, coughing and wheezing at an incidence rate of 9% over 30 months (26). In Poland, apprentice bakers had a two-year incidence of chest symptoms (e.g. chronic cough), rhinitis and conjunctivitis of 12.5%, 16.5% and 5.7%, respectively (38).

Factors associated with respiratory symptoms

No studies meeting our inclusion criteria reported on factors associated with rates of respiratory symptoms.

Risk factors for respiratory symptoms

Two studies on apprentice bakers showed that skin sensitization to an occupational allergen (i.e. wheat) was a significant risk factor for work-related respiratory conditions such as asthma and allergic rhinitis (26;38).

4.0 Discussion

This review systematically assessed the evidence on prevalence, incidence and potential risk factors for three types of occupational disease and illnesses: hand dermatitis, respiratory conditions and toxic exposures.

The number of studies examining occupational disease in young workers is limited. With a starting point of over 6,000 potentially relevant articles, we only found 19 published studies on occupational disease among young workers. Only two of these were from Canada. This lack of research makes it difficult to increase the level of awareness and knowledge of the impact of occupational diseases among young people.

Even though occupational diseases receive less attention than acute injuries among young workers, our review showed that some occupational disease such as hand dermatitis and respiratory conditions are prevalent among young workers in certain occupations.

4.1 Summary of evidence

Occupational dermatitis

Cross-sectional and longitudinal studies generally showed that apprentice metal workers, bakers, nurses and hairdressers had higher prevalence and incidence rates of occupational hand dermatitis than apprentice office workers.

Using the best evidence criteria laid out at the beginning of the study, we found that constitutional factors such as history of flexural eczema and atopy were risk factors for hand dermatitis among apprentice nurses and hairdressers. These review findings converge with previous reviews of hand dermatitis that were focused on adult workers (10;30).

Another question that requires an examination of the broader literature on occupational disease is whether these incidence rates are comparable to those found among adult workers in similar jobs. For example, a study of surveillance data among all workers in Germany showed that hairdressers/barbers had an overall incidence rate of 97.4 per 10,000 workers per year (39), where barbers constituted less than 5% of the cases.

The annual incidence rates for apprentices in those occupations were 15 to 20 times higher than this (see the section *Prevalence and incidence of hand dermatitis*). This discrepancy may be partly due to higher reporting of these health issues in the context of a defined apprenticeship program that has resources devoted to follow-up contacts to identify cases. These procedures are in contrast to the underreporting that is common in large surveillance systems (10). More direct comparisons would be needed to examine

the possibility that certain occupational diseases are more frequent early in the work-life or among new workers.

There is a lack of other identified risk factors for occupational dermatitis among young workers. This may be due to the fact that relatively few studies examine a particular occupation. The ability to detect risk factor associations may also be reduced by the difficulty in disaggregating irritant versus allergic hand dermatitis in these studies, and the possible differences in risk factors between these two types of dermatitis. Finally, only one study obtained measures of specific hazard exposures (e.g. wet work) and potential behavioural risk factors (e.g. emollient use)(25). This rules out the possibility of assessing consistency across studies. This is particularly problematic in terms of prevention because it has been noted that even if the association between wet work and hand dermatitis is weak, wet work is very common. The number of cases it probably generates outstrips the constitutional risk factors, which have stronger associations but are rarer (i.e. this is also known as population attributable risk)(40).

Toxic exposure

Generally, only descriptive statistics are reported for toxic exposures, which precludes confirmation of demographic or work characteristics as risk factors. The studies did show that young workers in the agriculture industry were at higher risk for pesticide poisoning than their counterparts in other industries. In addition, illnesses due to disinfectant use were higher in eating/drinking establishments and in the entertainment/recreation industries than in other industries. Toxic exposures such as pesticides are of particular concern because of the enhanced sensitivity among young workers who have not yet reached full developmental maturity (34).

Respiratory conditions

Studies indicated that the baking trade as well as industries where dust occurs as part of production — manufacturing carpets, pencils, furniture and textiles — have a substantial prevalence and incidence of respiratory conditions such as asthma.

In terms of risk factors, we found sufficient evidence that skin sensitization to wheat among bakers was positively associated with respiratory conditions such as occupational asthma (26;38). However, both studies concluded that the association was not strong enough to recommend such skin sensitization testing as a screening tool for baking programs or apprenticeships. This is because many sensitized workers did not develop symptoms in these prospective studies.

The broader literature on occupational asthma identifies two types of etiological agents associated with increased risk of occupational asthma. One type was the high molecular weight compounds from organic sources (e.g. wheat), which were identified in our review from studies of apprentice bakers. Another set of agents linked to asthma, for which we did not find relevant young worker studies, was low molecular weight chemicals (e.g. amines, metal salts, acids). However, some of these agents are found in

industries where young people work such as construction, health care and the service sector (41).

4.2 Quality of evidence

These summaries of evidence need to be considered in the light of some of the methodological weaknesses of the studies reviewed.

One strength of the methodology in the occupational disease literature for young workers was that there were several prospective studies that recruited apprentices at the beginning of their program, not after years of occupational exposures. Indeed, we found more prospective studies in this literature than in the injury literature on young workers (42). However, because relatively few prospective studies for each occupational disease included multivariate analyses, very few risk factors can be considered "well established."

The following recommendations on methodology would improve the quality of the evidence on risk factors for young workers' occupational disease:

- Across all three occupational diseases, there is a need for more standardized measures for both the potential risk factors and the outcome measures.
- Improve methodological aspects of intervention studies by increasing the use of concurrent comparison groups and ensuring adequate sample size for field studies.
- Conduct multivariate analyses where possible. In addition, include a comprehensive range of demographic/individual, job/workplace and behaviour predictors. Examining hypothesized mechanisms thought to underlie broad, descriptive variables (e.g. gender) should be considered.

4.3 Strengths and limitations of the review

A strength of this systematic review (compared to traditional narrative reviews) is that we aimed to make our search and evaluation procedures explicit and reproducible. Following explicit procedures helps eliminate bias in the selection and synthesis of evidence. In addition, we used a consensus process with multiple reviewers involved in the selection, appraisal and extraction procedures. Another strength of this particular review was that we involved stakeholders in formulating the research question to ensure it would be as relevant to workplace parties as possible.

Nevertheless our findings must be viewed in light of certain limitations. Although we searched several databases for dissertations and unpublished reports, we concentrated mainly on the peer-reviewed, published literature in major electronic databases and in the reference sections of selected studies. Our review was also limited to articles in English, French, German and Spanish.

Also, this review focused only on occupational disease studies of young workers. We did provide some general comparisons between our findings and those of literature reviews of adult workers and certain occupational diseases (see section 4.1). However, we are not able to make direct comparisons between age groups on incidence rates and risk factors. In addition, we are also unable to assess the extent to which our findings are unique to young workers or would apply to new workers of any age.

Finally, studies that focused only on agricultural occupational exposures and diseases among young workers were excluded from this review. There is a recent descriptive review on this issue (43). To determine the number of empirical studies on agricultural occupational exposures and diseases among young workers, we searched through the original 6,048 titles and abstracts for relevant studies. We only found one relevant study that examined predictors of allergic diseases and respiratory conditions among young farm workers (44).

4.4 Research gaps and future directions

We found three significant gaps in the literature of risk factors for young workers and occupational disease. One was that no intervention studies met our relevance criteria. Though such studies would require large samples, the ability to provide evidence-based recommendations on reducing occupational disease (e.g. through training or administrative procedures) would be invaluable.

Future studies should pay attention to interactions between demographic/individual and job/workplace risk factors. For example, some individual factors may enhance vulnerability only after a certain threshold of exposure time.

In a related vein, research should take into account the interrelationships between occupational diseases. For example, young hairdressers who have dermatitis may also absorb a greater amount of chemicals such as dyes or solvents into their bloodstream. This may increase the risk for other occupational diseases later in life (e.g. neoplasms)(45).

Another gap was that almost no studies examined safety practices such as the use of protective equipment (for an exception see no. 25). Finding associations between behaviour patterns and occupational disease would suggest possible training interventions.

Finally, we found no study that examined the influence of organizational factors such as workplace safety culture. A review of organizational factors for work injury suggested that empowerment of employees on general matters and safety activities specifically, as well as an active role of top management, were associated with reduced injury rates (46). Reduced occupational disease rates may also be reasonably expected to occur in

workplace with strong safety cultures, but this needs to be documented along with possible interventions to improve safety climate.

Addressing these kinds of substantive research issues is critical in detailing the risk profile for various occupations and giving indications of how to reduce that risk.

In terms of prevention of occupational disease, some general conclusions can be drawn. Entering the workforce brings exposure to a new set of biological and chemical hazards, some of which affect some young workers relatively quickly (e.g. hand dermatitis). Some occupations such as hairdressing and metal/wood work have specific exposures that could be reduced through a combination of better personal protection, and where possible, use of less toxic materials.

The following implications and recommendations flow from our findings:

- The occupational health and safety system should look for opportunities to further educate employers and young workers about occupational diseases that can occur in their workplace, and what measure can be taken to decrease that risk. For example, research conducted in Ontario on adult workers supports a message that early detection and intervention for occupational asthma improves health outcomes (47). Also, information on occupational disease could be considered when the prevention system develops future educational and safety training materials for young and new workers.

- Current monitoring and surveillance tools should be assessed to determine ways to improve the identification of occupational diseases among young and new workers.

- Research funding should be provided to undertake a survey of the state of affairs for young workers in Ontario. Among the occupational groups that could be examined are construction workers and other formal trades with apprenticeships.

- The WSIB might want to consider producing a report of occupational disease claims among young workers using its relevant administrative data. It must be acknowledged, however, that these data have many limitations, especially the potential of underreporting of occupational diseases.

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Appendices A-D

Appendix A: Search Terms

Group 1: **Employment risk factor terms**
Accident prevention
Adolescent development
Agriculture
Apprenticeship
Equipment safety
Family business
Fatigue
Hazard
Health education
Health knowledge attitudes practice
Health promotion
Heavy lifting
Industry
Inexperience
Job boredom
Job characteristics
Job repetition
Occupational exposure
Organizational culture
Organizational factors
Parenting
Peer pressure
Predictors
Primary prevention
Psychology
Restaurant
Risk
Risk factors
Social influence
Substance use
Supervision/supervisor
Training
Tenure
Voluntary worker
Work pace
Work-school conflict
Workload
Workplace

Group 2: Occupational injury terms
Accidents (occupational)
Agricultural workers' disease
Allergies
Occupational dermatitis
Occupational disease
Occupational health
Wounds/Injuries

Group 3: Age terms
Adolescent
Age
Student
Young adult

Appendix B: Criteria for inclusion and exclusion of studies

	Inclusion	Exclusion

Study Type	• Quantitative studies
	  • Observational studies
	  • Intervention studies
	  • Self reports
	  • Empirical studies
		• Qualitative studies
		• Conceptual studies
		• Theoretical studies
		• Case studies (n < 10)

Population of interest: Age	• Studies where the majority of the sample is aged 12 to 24 years • Studies that include a stratified population of 12- to 24-year olds	• Studies where people aged 12 to 24 years are part of the sample but are not analyzed separately • Studies where 12- to 24-year olds are not part of the sample

Population of interest: Work	• Study sample(s) engaging in work.
	• The definition of work includes:
	  • Paid work
	  • Volunteer
	  • Informal employment
	  • Self employment
	  • Medical/nursing/dental students
	  • Apprentices
		• Studies looking at a mixture of work and non-work settings
		• Not included in our definition of work:
		  • Homemakers
		  • Agriculture
		  • Military

Health outcomes	• Injuries/Accidents
	  • Falls
	  • Burns
	  • Acute trauma
	  • Proximal injuries
	• Illness
	• Disease
	• Musculoskeletal disorders
	  • Repetitive strain
	• Respiratory disorders
	• Hearing loss
	• Heat strain
	• Toxic exposure
	• Allergies
		• Fatalities
		• Mental health
		• Fibromyalgia
		• Diseases of the circulatory system
		• Reproductive outcomes
		• Violence
		• Cancer

Presence of risk factors	• A clearly defined occurrence or characteristic associated with the increased rate of a subsequently occurring disease must be presented
	• Examples of risk factors include:
	  • Gender
	  • Industry group
	  • Workplace hazards
		• No risk factors are presented/considered in the study

Languages	• English • French • Spanish • German	

Appendix C: Quality Appraisal Form

Quality Assessment Guidelines

The following guidelines should be used in making decisions regarding the quality assessment criteria.

Please keep in mind questions regarding measure and confounding bias refer to the risk factor information (e.g., table) that will be extracted for the review

1. Are there any supplementary articles needed to process this article in DE?

Yes, please provide details
No

2. What type of research design is being used?

- Choose the one design that best fits the study:

Cross-sectional – One group
A cross-sectional study (data taken at one point in time), looking at only one group
Cross-sectional – More than one group
A cross-sectional study (data taken at one point in time), looking at more than one group
Before-after (Pre-post)
One group studied, data taken at two (or more) points in time.
Case control
More than one group studied, where the groups are defined by the outcome
Cohort study
More than one group studied, where the groups are defined by the exposure (can retrospective or prospective)
Other design with concurrent comparison groups
Randomized trial
More than one group studied, where the exposure is assigned randomly by the investigators
Non-randomized trial
More than one group studied, where the exposure is assigned by the investigators, but was not assigned randomly
Unclear/unknown

SECTION I: Selection Bias

Selection bias refers to the degree to which study participants are dissimilar to non-participants with regards to background characteristics and potential risk factors. This can occur because individuals self-select to participate in an intervention or survey.

3. Is it an intervention study?

- The intervention should be systematically applied/implemented program
- May include studies focusing on the evaluation of an organizational, educational or engineering change

Yes
No

4. Does the author clearly define what counts as work/employment?

Yes
No
Unclear

- For administrative data, compensation claims = work
- A description such as dental student, apprentice etc is also a sufficient description of work.

5. Were background characteristics of participants/data described?

Yes
No
Unclear

- Descriptions need to report specifically on those who are working.
- For administrative data, are descriptive statistics of claimants (i.e. percentages) for demographic info (age, gender) and/or distribution by industry, provided? Please make reference to any tables describing the data.
- For surveys, data to look for include: basic demographics (age, gender), types of jobs held, job tenure
- For survey and intervention studies, were study participants and non-participants similar with regards to risk factors?

6. Are inclusion/exclusion criteria stated?

- If certain workers or data were excluded this can affect the estimate of risk of the study results. It is therefore important that these be mentioned.

Yes
No
Unclear

7. Was there < 10% of cases excluded due to missing data?

Yes
No
Not reported
Unclear

8. What type of sampling strategy was used?

Entire population
Probability sample
Convenience sample
Not Reported
Unclear

- For administrative data, the use of compensation claims = sampling the entire population.
- If coverage is approaching entire population (i.e. >90%) the it can be considered ‘Entire Population’
- One would code "probability sample" only if there is explicit reference to a target population, and that there was some method of randomly selecting the sample from that population. If this is not mentioned then the respondents are most likely part of a convenience sample.

9. Is proportion of workforce and/or type of industries covered stated?

Yes
Not reported
Unclear
Not Applicable – Study is an intervention or survey

10. For survey and intervention studies: Was recruitment rate of individual > 40%

- In relation to each level of recruitment, please indicate whether the number of eligible participants from the study population that refused to participate in the study are identified. Greater rate of participation (or recruitment) reduces non-response bias.
- Goes to determining internal and external validity.

Yes
No
Unclear
Not applicable – Not a survey or intervention study

- If the study recruits participants through advertising, recruitment rate could be based on the # of people meeting the inclusion/exclusion criteria / # of people who called about the ad. Author could also report on number of young people in the organization/area they recruited from (e.g., number of students in high school).

11. For survey and intervention studies: Was the loss to follow up < 50%?

- There should be adequate follow up rate for each level of recruitment. If the lost to follow up is substantial (i.e. more than 50 per cent), it introduces the potential for exclusion bias, reduces the available sample size, and reduces the confidence in the results obtained.

Yes
No
Unclear
Not applicable – Cross-sectional

12. For survey and intervention studies: What level of recruitment occurred?

- Differences in recruitment strategies for individual/groups/workplaces could lead to differences in characteristics of the participants. For virtually all survey or intervention studies we will be examining, there will be data at the individual level. However, sometimes there may be another level to the recruitment structure, for example multiple high schools. When recruitment takes place at more than one "organization" (e.g., multiple schools), then indicate org/workplace level.

Organization/workplace
Work groups
Employees/individuals
Other, please detail
Not applicable – Not a survey or intervention study

- The focus of this question is on how recruitment occurred, not now the data was analyzed.
- If multiple workplaces studied = Organization/Workplace

13. For intervention studies: Was the intervention allocation described?

- Inadequate description of the exposure/intervention allocation strategy makes it impossible to reproduce the intervention in another population. This should be clearly stated in the study to allow for interventions to be reproducible by others.

Yes – Self selection
In this specific allocation strategy, the researchers normally do not have much control over who receives the intervention in the study, the allocation of the intervention is not random (not due to chance), therefore participants are self-selected or selection is determined by another individual (supervisor, employer etc.).
Yes – Matched
Intervention recipients were described as being matched based on certain criteria, such as based on belonging to a particular department within the plant or based on their work role function.
Yes – Random
Study participants are described as randomly receiving the intervention. Randomization of intervention conditions is typically preferred because it avoids systematic confounding by known and unknown factors.
No
Unclear
Not applicable – Not an intervention study

14. What is your overall quality appraisal of the selection criteria?

High
Moderate
Low
Very low

SECTION II: Measure Bias

Measurement bias refers to the reliability and validity of the measures used to assess the risk factors and outcomes.

15. Are injury rates/mean values/ regression coefficients reported for subgroups of young workers?

- Between groups differences in number of injures/illness could be due to more total workers with a certain characteristic in one subgroup compared to those in another subgroup. Therefore, one needs to know how many workers with the certain characteristic did not get injured, i.e. how many people in the whole population have that characteristic? This number is the denominator.
- Examples of denominators might be number of workers in a jurisdiction, or number of man hours worked.
- The more details provided regarding the number of hours worked per week and the number of weeks worked per month help in estimating exposure times.

Yes
No – Reports frequency of injuries only
Unclear

16. If injury rates are reported, what type of denominators were used to calculate them?

Number of workers
Individual-level hours information
Subgroup-level hours information

Other – Please provide detail
Unclear
Not applicable – Injury rates not reported

17. Were risk factors/exposure described?

- A risk factor is a clearly defined occurrence or characteristic that has been associated with the increased rate of a subsequently occurring disease.
- Some examples of risk factors/exposures include: gender, industry group, workplace hazards. Rates need to be provided.

Yes – All
Yes - Some
No
Unclear

18. Is evidence of reliability/validity/standard categorization of risk factors/confounders presented?

Yes – All
Yes – Some
No
Unclear

- For administrative data this may include SIC (Standard Industrial Classification) codes, or SOC (Standard Occupation Codes)
- Some risk factor, such as gender, years in school etc, are adequately expressed/ reliable, and hence do not need to be validated or standardized.

19. Were injury/illness outcome(s) described?

- Goes to determining internal validity

Yes
No
Unclear

- For administrative data: does the study describe what a claim is? Do they mention the number of days lost to make a claim? Is there any mention of the severity of injuries, medical benefits or wage replacement? Are there any details on whether only lost-time claims were included or whether they included no lost-time (e.g., medical only claims) as well?
- For survey data: outcomes may include burden of injury index, severity of injuries

20. Is evidence of reliability/validity/standard categorization of outcomes presented?

Yes – All
Yes – Some
No
Unclear

- For administrative this may include, standard classification codes for injury (i.e. ICD-9 codes).
- Does the author provide information regarding the nature of injuries (i.e. cuts) or illness (i.e. dermatitis) that the claims included?

21. **For intervention studies: Was the intervention process described?**
    - Inadequate description of the intervention strategy makes it impossible to reproduce the intervention in another population. The setting of the intervention, i.e. where it was carried out, and specifically what was changed and how, are important aspects to document.

    Yes
    All or most aspects of the intervention are clearly described.
    No
    The intervention process is not described.
    Unclear
    There is not enough information provided, the intervention process is not clearly described.
    Not applicable – Not an intervention study

22. **For intervention studies: Was the participation in the intervention documented?**

    Yes
    No
    Unclear
    Not applicable – Not an intervention study

23. **What is your overall quality appraisal of the attempt to reduce bias in the measures?**

    High
    Moderate
    Low
    Very low

SECTION III: Confounding Bias

Confounding refers to a situation where other variables such as individual characteristics are correlated with another risk factor (e.g., occupation) and the outcome (i.e., injury). A failure to control for sources of confounding could lead to a mis-estimation of the influence of a risk factor on injury.

24. **Were potential risk factors adjusted for?**

    Yes – Multivariate analysis
    Yes – Mulitfactorial tables
    No (unifactorial tables)
    Unclear

25. **Were risk factors across more then one key domain adjusted for?**

    Yes – Greater than one key domain
    No – One key domain
    Unclear
    Not Applicable – No adjustment for any potential risk factors

- In order to answer Yes, the authors must analyze more than two risk factors simultaneously, i.e. Age, gender, and occupation
- Domains include: sociodemographic variables such as gender, socio-economic status, education; job characteristics such as industry type, job hazards; or workplace characteristics including work safety climate, firm size, geographic region, type of firm

26. Were there any differences across groups at baseline?

- If there are no major significant differences between the groups on baseline characteristics or other demographic variables, one can be confident that selection bias to participate in the study was minimal and that the results obtained are not likely affected by these differences.
- This also provides information on potential confounders

Yes
No
Unclear
Not applicable – No comparison groups

27. **For intervention studies: Were concurrent comparison group(s) used?**

- Inadequate comparison groups, or not utilizing controls at all, is an important problem which may undermine the conclusions drawn from a study. Therefore, it is important for a study to provide adequate description of the types of comparison groups used, if any.

Yes – Single control
One comparison group was used against which intervention effects were evaluated.
Yes – Multiple controls
More than one comparison group was used to evaluate intervention effects. Control groups can be within the same workplace (such as different departments), or outside the intervention workplace (such as a similar company in the same industry, etc.) and may have received no interventions, or some interventions that differ from those of the study group.
No
Unclear
Not applicable – Not an intervention study

28. **For intervention studies: Were co-intervention(s) described or documented in the study?**

- Co-interventions are any other changes either deliberately or inadvertently applied to study participants. Effects that are due to co-interventions may be falsely attributed to the intervention. If co-interventions were disproportionately taken by one group but not the other, then the observed effect cannot be easily ascribed to the tested intervention.

Yes
No
Unclear
Not applicable – Not an intervention study

29. **For intervention studies: Was contamination between groups documented?**

- Contamination can occur when the interventions assigned to participants in one group are also used by some or all members of the other groups. This can introduce bias in the results if comparison groups, for example, have been exposed to some of the interventions intended for the study group, unbeknownst to the researchers. This is an issue particularly when a study uses controls from the same workplace as the intervention group.

Yes – Documented but not measured
Yes – Documented and described/measured
No
Unclear
Not applicable – Not an intervention study

30. What is your overall quality appraisal of the attempt to reduce confounding bias?
High
Moderate
Low
Very low

SECTION IV: Other analytic questions

31. **Is there a method of assessing whether the risk factor is significantly associated with the outcome?**
    Yes
    No
    Unclear

    - This would include confidence intervals and other variance estimates

32. **Were subgroups large enough to have confidence in any subgroup differences**

    Yes – All/most
    Yes - Some
    No
    Unclear

    - Subgroups smaller than 10 should raise warning flags in regards to how the data is used.

33. **If a regression model was used, did the authors test or provide evidence that the data met the assumptions of the model?**

    Yes
    No
    Unclear
    Not applicable – Regression not used

    - For example, did they test for collinearity of predictors?
    - Did they check or do anything about possible skewed distribution in outcome variable?
    - For logistic regressions, is there an indication of frequency or prevalence of the risk factor?
    - Are the effects of continuous predictor measures linear?

34. **If a regression model was used, was there sufficient information about the model to interpret the results?**

    Yes
    No
    Unclear
    Not applicable – Regression not used

    - Did they discuss/justify the method of entering predictors into the model?
    - Did they describe which predictors were dummy coded and what the referent group was?
    - Did they clearly state whether coefficient or odds ratios were adjusted for or unadjusted for?

35. **Were the interpretations of the findings accurate?**
    - The interpretations must be accurate in relation to the statistic we want to extract.

    Yes
    No
    Unclear
    - If there is an explanation of the findings, or the authors offered a hypothesis to explain their findings = Yes
    - If the findings are misinterpreted or the explanation isn't reasonable = No
    - If the authors only describe the findings without interpreting them = Unclear

36. Were any limitations stated?

Yes
No
Unclear

37. What is your overall quality appraisal of the research analysis?

High
Moderate
Low
Very low

SUMMARY

38. What would be your overall appraisal of this study?

High
Moderate
Low
Very low

39. Should this reference proceed to DE? Why?

Yes, please comment
No, please comment

Appendix D: Background Tables

Survey Data - Occupational Disease									
Respiratory Conditions									
Author	**Time period** **Juris-diction**	**N/Age** **Data Source**	**Risk factor evaluated** **Unit of Measure**	**Information provided regarding the reliability/ validity/ standard categorize-ation of risk factors/ confounders**	**Outcome definition**	**Information provided regarding the reliability/ validity of outcomes**	**Recruitment method** **Follow-up rate**	**Risk factors adjusted for** **Method of assessing the association of risk factors with outcomes**	**Findings/ Interpret-tations regarding the risk factors examined**
Arbak 2004	September - December 2002 Northwest Turkey	N (furniture decoration students) = 64 Male = 57 Female = 7 Mean age = 20.9 +/- 3.7 years N (controls) = 62 Male = 54 Female = 8 Mean age = 20.5 +/- 2 years Source: Furniture	Occupational training program (furniture decorating students vs. students from other departments) Unit of measure: Number of students	Students workspace was 0.02 students per meter cubed, twice a week for 4 hours. 4 main activities undertaken: Sawing wood, grinding wood, using alkyd and nitro-cellulose based paints, gluing	Work-related respiratory complaints: Cough, shortness of breath, chest tightness, wheezing. Other complaints: Rhinitis, conjunctivitis urticaria. Pulmonary function tests (measured using spirometer):	Multiple measures for PEF. Assessment by professional staff (physician and technician) requiring three technically acceptable measure-ments. For self-report	Recruitment method: Not reported Follow-up rate: Not reported	RFs adjusted: None Method of association: Student's t test for numeric variables and chi square or Fisher exact tests for categoric variables. Interaction between smoking and wood dust exposure was	Comparing furniture decorating students (FDS) with controls, for FDS's: Reported cough and shortness of breath was significantly higher; Had higher (but not significant) rate of conjunct-ivitis, urticaria, and

		decoration department of a high school in Duzec, Turkey		furniture with formaldehyde - based glue.	Forced vital capacity (FVC), forced expiratory volumes in one second (FEV), forced mid-expiratory flow between 25-75% of FVC (FEF 25-75%), peak expiratory flow (PEF).	measures, reliability/ validity not reported.		determined by log-linear analysis. A p value of <0.05 was considered significant.	rhinitis; Had significantly lower baseline PEF values; Had higher FVC values after the study; Had higher diurnal variability in PEF at work was, although diurnal variability in PEF on weekends showed no differences between groups. **Baseline measures were done one month into program**

De Zotti 2000 (De Zotti 1995)	November 1992 - 1993 Northern Italy	N (trainee bakers) = 125 57% Male 43% Female Mean age (SD) = 15.5 (1.6) years Source: Vocational school for bakers, Northern Italy	Atopy Drug treatment for allergic disease Exposure to wheat outside school History of allergic disease Length of time in baker's course Skin sensitization to wheat or alpha-amylase Unit of measure: Number of workers	Atopy - Prick test Drug treatment - Not reported Exposure to wheat outside school - Self report, reliability/ validity not reported History of allergic disease - Not reported Skin sensitization to wheat - Prick test	Work-related respiratory symptoms: Attacks of rhinitis, coughing, wheezing, and dyspnoea when working with flours.	Not reported	Recruitment method: Recruited students in bakers training in vocational school in Northern Italy - sub sample from earlier cross-sectional study (De Zotti 1995) followed prospectively. Follow-up rate: 73% available at 6 months 58% at 18 months 38% at 30 months	RFs adjusted: History of allergic disease, skin sensitization to wheat or alpha amylase, exposure to wheat outside school, drug treatment for allergic disease, atopy. Method of association: Odds ratios were used to measure the effect of covariates on binary responses with multivariate marginal logistic regression models. 95% CIs for Ors were derived from robust variance estimates.	Work-related respiratory symptoms over time were significantly related to personal history of allergic disease and skin sensitization to wheat flour, but not to atopy based on a skin prick test. Increased ORs were found for drug treatment for respiratory disease and exposure to wheat flour outside school.

Gautrin 2000 (Gautrin 1997)	September 1993 - December 1995 Quebec, Canada	N (animal health apprentices) = 417 Male = 57 Female = 360 Mean age = 19.6 +/-3.2 years N (dental hygiene apprentices) = 122 Male = 2 Female = 120 Mean age = 21.3 +/-5.2 years Source: 7 specialized schools	Occupational training program Unit of measure: Person year	Not necessary	"New case": subject developed sensitization to at least one work-related allergen and if the proportion of sensitized subjects to this allergen, at the end of the study period, was significantly greater in his or her program than in the other programs.	Self-assessed questionnaire derived from the standardized questionnaire of the International Union Against Tuberculosis and Lung Disease. Skin prick tests - Positive reaction defined as a wheal >3mm in the absence of relation to the diluent and in the presence of a positive reaction to histamine phosphate. Atopy - Defined as at least two positive reactions to the common inhalants.	Recruitment method: All students starting a career program in the selected institutions were invited to an information session presented by two of the authors. They were given an information letter and asked to participate. (Gautrin 1997) Follow-up rate: (Present at least one follow-up) Animal Health - 394 Dental Hygiene - 110	RFs adjusted: None Method of association: CIs	The greatest number of incident cases of sensitization were in animal health apprentices, compared to dental apprentices. A non-negligible number of new cases of sensitization to non-work related occupational antigens was found in both programs, although there was a higher proportion of sensitization to agents related to the programs.

Gautrin 2001	1993-1999 Canada	N (animal health apprentices) =417 Male = 57 Female = 360 Mean age (SD) = 19.6 (3.2) years Source: 5 specialized schools	Years in training program Unit of measure: Number of workers	Not necessary	Rhinocon-junctivitis (RC) - Defined as subjects who developed a specific immuno-logical sensitization to at least one work-related allergen and nasal and/or conjunctival symptoms after baseline visit. Occupational Asthma (OA) - Defined as subjects who developed a specific immuno-logical sensitization to at least one work-related allergen and a 3.2-fold decrease in PC20 methacholine after baseline visit.	Self-assessed questionnaire derived from the standardized questionnaire of the International Union Against Tuberculosis and Lung Disease. Skin reactivity - Skin prick tests OA - Methacholine inhalation tests Reliability/ validity for skin reactivity, RC and respiratory symptoms not reported	Recruitment method: See Gautrin 2000 Follow-up rate: Of the total 417 apprentices (3 and 4 year programs): Follow-up at 20 months = 345 (82.7%) Follow-up at 32 months = 355 (85.1%) Of the 110 apprentices in the 4-year program: Follow-up at 44 months = 98 (89%)	RFs adjusted: None Method of association: Descriptive only	Work-related RC is at its peak 3 years after entering the programme. The number of cases of OA is comparable throughout the first 3 years.

Li 1995	1990 - 1991 Shijia-zhuang, China	N (cotton workers) = 110 Male = 34 Female = 76 Age = 17 to 21 years (one 16-year old and one 27-year old) Source: Two cotton mills in Shijia-zhuan, China	Atopic vs. non-atopic Gender Smoking Time spent on job Unit of measure: Number of workers	Atopic vs. non-atopic - Skin tests to determine presence or absence of atopy Smoking - Not reported	Severity of injury measured by: Pulmonary function (baseline spirometry), airway responsive-ness (average decrease in FEV1 after 1.25 mg metacholine), and symptoms (dry cough, cough phlegm, chest tightness, nasal irritation, tiredness).	Two previously used questionnaires, one based on the suggested standard questionnaire for organic dusts. Pulmonary function - Hi-298 microspiro-meter, procedure based on the American Thoracic Society standard recommendations. Metacholine provocation test - According to the method of Yan et al (1).	Recruitment method: Selected from newly recruited workers at two cotton mills in Shijiazhuang, China. Follow-up rate: Workers from one of the mills did not participate for practical reasons. Of the mill that could be followed-up, 85% follow-up rate (110 out of 129).	RFs adjusted: Atopy status Method of association: None reported	Subjects with a skin reaction to a crude extract of cotton dust were at risk of developing symptoms after prolonged exposure. Pulmonary function changes were more pronounced at 10 weeks after the start of the work than at one year, regardless of the group of workers. The most pronounced decreases over the shift were found in atopic workers. A slightly larger decrease in FEV1

									induced by methacholine at 10 weeks and one year than before work. Smokers had slightly larger decreases than non-smokers on all test occasions. Small difference between workers with a positive skin test and those with a negative one, which was significant at one year. Among the workers with a positive skin test, the decrease in FEV1 induced by methacholine at one year was larger than at 10 weeks.

									Proportion of workers reporting dry cough, cough with phlegm, chest tightness, nasal irritation, and tiredness at work increased significantly at 10 weeks compared with before work.

Rao 1992	Time period not reported India	N (slate pencil industry) = 62 Male = 58 Female = 4 N (wool carpet industry) = 92 Male = 76 Female = 16 N (diamond cutting and polishing industry) = 45 100% Male Age = 15-18 years Source: Not reported	Gender Industry Smoking Unit of measure: Number of workers	Smoking - Not reported	Restrictive and Obstructive impairment - Not defined	Not Reported	Recruitment method: Not reported Follow-up rate: Not reported	RFs adjusted: Industry Smoking Method of association: Significance levels	Irrespective of smoking habits, a reduction of lung volume and obstruction in smaller airways in diamond workers, and impairment in smaller airways of silica dust exposed workers (slate pencil workers) was demonstrated.
Walusiak 2004	Time period not reported Poland (three counties)	N (apprentice bakers) = 287 73.9% Male 26.1% Female Mean age (SD) = 16.19 (0.47) years	History of skin symptoms Positive SPT to at least one common/ occupational allergen	History of skin symptoms: Not reported Positive SPT to at least one common allergen: Skin prick tests (SPTs)	Hypersens-itivity to occupational allergens Diagnosis of occupational allergic rhinitis Occupational asthma/cough -variant	Questionnaire adapted from the International Union Against Tuberculosis and Lung Disease instrument.	Recruitment method: Apprentice bakers in the first month of their vocational training.	RFs adjusted: History of skin symptoms, Positive SPT to at least one common/ occupational allergen	History of skin symptoms and positive SPT to common allergens at the baseline were significant risk factor of

		Source: Vocational training program	Unit of measure: Number of workers	performed on the volar part of the forearm with a standard battery of common allergens and bakery series.	asthma	Hypersen-sitivity to occupational allergens - Defined as at least one positive result of SPT to occupational allergens or positivity of specific serum IgE assay. Diagnosis of occupational allergic rhinitis - Based on questionnaire data and positive nasal response to provocation test and a significant increase in the proportion of eosinophils and in the permeability index. Occupational asthma/cough	Follow-up rate: 62% - Initial cohort consisted of 461 trainees; 174 subjects did not continue the training.	Method of association: Stepwise logistic regression	hypersensitivity to occupational allergens at stage III. Positive SPT to common allergens was also found to be a significant risk factor of occupational allergic rhinitis and bronchial asthma. Positive SPT to occupational allergens before the vocational training reached the significance level in the stepwise analysis for risk factors of asthma development.

						-variant asthma - Subjects reporting work-related chest symptoms, for whom a specific challenge test induced significant bronchial response (at least a 20% decrease in FEV1) - early or dual asthmatic reaction, or a threefold increase in nonspecific bronchial hyper-reactivity.			

Skin Conditions									
Bauer 2001 (Bauer 1998)	August 1996 - July 1999 East Thuringia region, Germany	N (food profession apprentices) = 63 Female = 36 Male = 27 Mean age = 19.5 +/-0.99 years (38 or 60.3% of apprentices were in training for the baking profession) Source: Occupa-tional school of Gera, East Thuringia	House building as a leisure activity Skin atopy Previous and present flexural dermatitis Previous hand dermatitis Wet work and hand washing Unit of measure: Number of workers	Skin atopy - Erlagen atopy score (>10), Diepgen et al (2) Wet work and hand washing - Self report - reliability/ validity of measure not reported. House building as a leisure activity - Self report - reliability/ validity of measure not reported.	Presence of hand dermatitis (HD) - Defined as mild when erythema and scaling on the dorsal aspects and/or interdigital folds (ID) of the hands. Moderate - Infiltration and papules seen and affected area enlarged Severe - Vesicles and fissures appeared	Not reported	Recruitment method: All bakers', confection-ners' and bakery-shop assistants' apprentices in the occupational school were included in the study. Follow-up rate: Initial exam = 91 apprentices 6-month follow-up = 79/91, 87% 1-year follow-up = 63/91, 69% End of training follow-up = 69/91, 76% (Included in the data analysis were only those who had been present at	RFs adjusted: None Method of association: Logistic regression analysis	Food industry apprentices with proven skin atopy showed an elevated risk of developing HD. Respiratory atopy, metal sensitization, or gender were associated with an increased risk for HD. Previous HD in childhood and adolescence as well as present and previous flexural dermatitis is associated with an increased risk for the development of HD.

							every examination time point (n=63)).		There was little evidence that work-related exogenous factors play a crucial role in the develop-ment of HD in bakers', confectioners' and shop assistants' apprentices. Only the combination of wet work and hand washing > 20 times daily showed a weak but significant risk increase. Only those apprentices involved in house build-ing or rebuil-ding regularly (daily or weekly) showed an elevated risk of developing HD.

Berndt 1999	Autumn 1994 - Spring 1997 Switzerland	N (trainee metal workers) = 205 100% Male Age = 15 - 25 years Source: 24 metal-working factories in Switzerland	History of flexural eczema Metal reactivity Unit of analysis: N/A, uses bivariate regression and calculates ORs	Atopy Score - A score of 10 and above, according to Diepgen et al (2), was considered to have an atopic skin diathesis.	A case of eczema - Considered as the presence of at least one of the following skin conditions: erythema and scaling, papules, excoriation, vesicles or exudation.	Skin examinations - Reliability/ validity information not reported	Recruitment method: Metal working trainees from 24 factories who were starting their apprentice-ship Follow-up rate: 201 of 205	RFs adjusted for: None Method of association: Bivariate regression	Metal reactivity increases the likelihood of the develop-ment of hand eczema in trainee metal workers, especially during the first months of the appren-ticeship. The overall incidence of hand eczema seems to be related to a history of flexural eczema. A history of flexural eczema and reported metal reac-tivity appeared to be inde-pendent factors as no individual showed both at the same time.

Funke 2001	1990 - 1998 Germany	N = 2078 Male = 1524 Female = 368 Metalworker apprentices: Male = 992 Female = 118 Blue-collar apprentices: Male = 503 Female = 118 White-collar apprentices: Male = 29 Female = 145 Median age: Male = 15.7 years Female = 16.0 years Source: Auto manufac-turer Audi AG in Ingol-stadt and Neckarsulm, Germany	Apprentice-ship Gender Occupational group	Not reported	Hand eczema - Defined as skin problems on the hands and/or forearms reported during the apprentice-ship. Not included as cases of HE were: reported dry skin without any other symptoms, minimal skin symptoms like redness or scaling, dyshidrosis lemellosa sicca with no hints of worsening, and (definitively diagnosed) mycosis. Definition developed in accordance with dermatolo-gists.	Initial examination done by specially-trained occupational physicians at the job application stage. 2nd and 3rd examinations were performed by dermatolo-gists who also recorded the outcome variable hand eczema.	Recruitment method: All apprentices in two AUDI AG locations were recruited at the start of their apprentice-ships. Follow-up rate: 98.3% (8.1% of drop-outs were followed by drop-out tracing questionnaire (but did not undergo examination).	RFs adjusted for: None Method of association: CIs	In occupations such as cooks, tool mechanics, milling cutters and varnishers, the prevalence of HE was significantly increased. The incidence was not uniformly distributed over the 3-year period. Within the first 6 months, a particularly high incidence rate of HE occurred, which then declined and remained steady at a lower rate of the 2nd and 3rd years.

John 2000*	1992 - 1995 Osnabrück, Germany	N (apprentice hairdressers) = 66 3% Male 97% Female Median age = 17.1 years Source: Osnabrück vocational training school	Capacitance (RSM=rela-tive skin moisture) Previous history of eczema Training year Transepi-dermal water loss (TEWL) Unit of measure: 100 person-years	Previous history of eczema - Measured by physicians in specialist training for occupational dermatology, or dermato-logists. Dermatolo-gical history was taken using a questionnaire - Reliability/ validity not reported. TEWL - Measured in a perspex incubator using the ServoMed gold-plated protection cover (steel grid) and a rubber stopper as an insulating probe holder. Capacitance -	Skin changes of the hands - Operational definition based on 11 morphology/ spread and 6 site/severity categories with a 4-point ordinal scale. (See Uter 1998b) Hand dermatitis - Defined as "moderate" or severe" skin changes according to a case definition modeled on a 3-point ordinal scale ("no", "minimal", "moderate or severe" skin changes).	Not reported	Recruitment method: A cohort of all 92 hairdresser apprentices from the Osnabrück vocational training school were followed for a full educational cycle (3 years), after obtaining informed consent. Follow-up rate: 72% (6 had dermatitis on 1st examination, 20 dropped out or had started work longer than 48 days prior to investigation)	RFs adjusted: Past flexural eczema Past hand eczema TEWL forearm R TEWL dorsum hand R RSM dorsum hand R Method of association: Multiple logistic regression	Incidence rate increases in 1st year of training compared to overall rate. This is most likely due to extreme wet-work exposure such as shampooing up to 50x daily. A past history of flexural eczema contributes significantly to the risk of developing dermatitis. Past hand dermatitis did not.

				Measured in triplicate, with the median taken as the RSM value.					
Majoie 1996	1984 - 1990 Amsterdam, the Netherlands	N (apprentice hairdressers) = 86 Male = 12 Mean age = 20 years, Range = 16-29 years Female = 74 Mean age = 18 years, Range = 15-30 years Source: School for hairdressers, Amsterdam	Nickel sensitivity Time after start of apprentice-ship Type of skin Working activities Unit of measure: Number of workers	Not reported	Hand Eczema - Classified according to questionnaire responses 1) Selection of "Vesicles on hands or fingers" in the past 12 months, OR 2) Selection of any three of the following: "red and swollen hands or fingers", "red hands or	Self-reported outcomes - Reliability/ validity not reported	Recruitment method: Not reported Follow-up rate: 86 junior hairdressers in initial study; 69 after two years of study; After 6 years, 58 could be assessed, and 51/69 (74%) question-naires could be evaluated.	RFs adjusted: None Method of association: None reported	The prevalence of hand eczema was high after 8 years, both in practicing and in non-practicing hairdressers. There is no decrease in the frequency of hand eczema in those who stopped working. No

					fingers and fissures", "scaling hands or fingers with fissures", "itching hands or fingers with fissures" in the past 12 months.				correlation was found between nickel sensitivity at the onset of apprentice-ship and the development of hand eczema. There was no correlation between washing/ dyeing hair or setting a perm and the development of hand eczema.
Smit 1994	September 1990 - July 1992 Jurisdiction not reported	N (apprentice hairdressers) = 74 Male = 17 Mean age = 18.8 years Female = 57 Mean age = 17.6 years N (apprentice nurses) = 111	Atopic mucosal symptoms Childhood eczema Gender Patch test Prick test Skin type Transepi-dermal water loss (TEWL) Unit of measure:	Childhood eczema - Self reported Skin type - examination by physician Patch Test - Read by a dermatologist Prick Test - Read by an experienced dermatologist TEWL - Measured	Dermatitis diagnosed if one or more combinations of symptoms, as reported in the questionnaire, had occurred during the previous follow-up period, if the symptoms were	"Set of validated questions"	Recruitment method: Hairdressers recruited at the beginning of their training, Nurses recruited in the third year of their training Follow-up rate:	RFs adjusted: Gender Childhood eczema Atopic mucosal symptoms Skin type Prick test Patch test TEWL Method of association: Cox	The incidence rate of hand dermatitis was higher for the apprentice hairdressers than for the nurses. The presence of dry skin and a positive history of atopic

		Male = 7 Mean age = 23 years Female = 104 Mean age = 21.9 years Source: Not reported	Incidence rate per 100 person-years	using the evaporimeter EPIC (ServoMed AB, Kinna, Sweden)	recurrent or had lasted for at least three weeks (definition used in validation study,) and if this information was supported by the skin findings recorded during the examination of the hands: "A signs" - grouped papules, grouped pustules, grouped vesicles and exudation "B signs" - erythema, scaling, edema, fissures, and lichenifi-cation.		Hairdressers: 4 of 74 hairdressers were lost to follow-up. Nurses: 6 of the 111 nurses were lost to follow-up.	proportional hazard model (Relative risk)	mucosal symptoms were associated with the risk of hand dermatitis.
Uter 1995	Summer 1992 & 1993	N (apprentice hairdressers) = 859	Atopy score Gender Flexural eczema	Atopy score - from Diepgen et al (2) For other	Examiner looked for the following morphology:	Not reported Analyses did control for	Recruitment method: Recruited through	RFs adjusted: Gender, atopy score, previous hand	Previous hand eczema and smoking were

	Northern Germany	92.7% Female Mean age = 17.1 year, Median = 17 years, SD = 2.5 years Source: 14 vocational training schools	Observer Previous hand eczema Smoker Training duration Unprotected wet work (hours) Unit of measure: Number of students	self-report measures, reliability/ validity not provided	erythema, scaling, vesicles, papules, infiltration, erosion excretion, lichenifi-cation, hyperkera-tosis, and changes in fingernails. Minor and severe forms of irritative hand problems were counted in the subsequent analyses.	observer effects	vocational schools Participation Rate: 93%	eczema, flexural eczema, training duration, observer, unprotected wet work (hours), smoker. Method of association: Logistic regression	individual factors increased the likelihood of current irritating hand problems. 2+ hours of wet work, and being in the 9th to 12th week of the program were also associated with hand problems.
Uter 1998a*	1992 - 1997 North West Germany (15 cities)	N (apprentice hairdressers) =2352 Source: 15 vocational training schools in north-west Germany	Time (Length of training) Unit of measure: Number of students Incidence per 100 persons/year	Exam 2 = end of first year Exam 3 = end of third year	Skin changes - The occurrence of at least 1 category of morphology or site/severity which was at least "mildly" affected was taken as the quantifiable feature.	Self-administered questionnaire - Reliability/ validity not reported. Operational definitions for skin changes of the hands are employed for standard-ization.	Recruitment method: Vocational training schools where hairdressing apprentices had been examined soon after the start of their training. Follow-up	RFs adjusted: None Method of association: 95% CIs	Point prevalence slowly increased from initial examination to follow-up examinations, whereas incidence, the rate of new cases, decreased. This illustrates that

					Hand eczema - At least 1 morphology or site had to have been registered as "moderate" or "severe" to qualify. (See Uter 1998b for operational definitions)		rate: Initial recruitment = 2352 of 2529 Intermediate follow-up = 1717 Final follow-up = 1134		the 1st year, particularly the first few months of training is a period of particularly high risk.
Uter 1998b	1994 - 1997 Osnabruck, Germany	N (apprentice office workers) = 111 23.4% Male Mean age (SD) = 20.5 years (4.6), Median age = 19 years Source: Vocational school in Osnabruck, Germany	Length of time on job Unit of measure: Number of workers	Not Necessary	Skin changes - defined as the occurrence of at least 1 category of morphology or site/severity which was at least "mildly" affected. Hand eczema - Defined as at least 1 morphology or site registered as "moderate" or "severe" to qualify **See table 1	Self-administered questionnaire, checked by trained observers (dermato-logists) - Information regarding validity/relia-bility not reported.	Recruitment method: All office apprentices attending vocational training schools in Osnabruck were recruited. After a short introductory lecture on objectives and course of the study a self-administered questionnaire was distributed. Follow-up	RFs adjusted for: None Method of association: CIs	Higher incidences of skin changes and eczema were found at the second examination in comparison to baseline and third examination (Reviewer's interpre-tation) A change in morbidity between examinations was not uncommon. Few showed skin changes

					and 2 in Uter 1998b for full operational definitions of skin changes**		rate: Initial recruitment - 111 of 193 apprentices (57.5% response rate). 1st follow-up: 40 of 58 persons from the group of 58 on 3-year training. Final follow-up: 68 of 111 (61.3%) of persons initially recruited (37 of 52 students in 2-year program and 25 of 58 students in 3-year program).		on all examinations.

Uter 1999a (Uter 1998c) (Uter 1999b)	1992 - 1997 West Germany (15 cities)	N (apprentice hairdressers) =2352 6.1% Male Age </=16 years = 27.3% Age 17 years = 34.5% Age 18 years = 17.9% Age 19+years = 20.3% Source: Vocational schools in 15 cities in West Germany.	Atopy score Gender Hand washing Humidity Previous hand eczema Previous flexural eczema Use of emollient in salon Wet work & use of gloves Unit of analysis: Number of workers	Atopy score - Diepgen et al (3) Absolute Humidity - German Meteoro-logical Society	Skin changes - Defined as the occurrence of at least 1 category of morphology or site/severity which was at least "mildly" affected. Hand eczema - At least 1 morphology or site registered as "moderate" or "severe" to qualify. (See Uter 1998b for operational definitions)	Self-administered questionnaire and dermatolo-gical findings reported on a standardized measure - Information regarding reliability/ validity not reported.	Method of recruitment: Not reported Follow-up rate: Initial response = 91.5% at the recruitment stage. Final examination = 1134 of 2352 (48.2%) of apprentices were examined.	RFs adjusted: Atopy score Gender Hand-washing Humidity Previous hand eczema Previous flexural eczema Wet work & use of gloves Use of emol-lient in salon Method of association: Multiple logistic regression	A significant decline in risk for skin changes is noted with increasing age. Low absolute humidity and unprotected wet work of more than 2 hours duration is shown to be a significant risk factor. An elevated atopy score has been found to be a significant risk, although the highest score category showed a striking decline in risk. Previous flexural or hand dermatitis is

									not associated with an increased risk. However, the rare combination of both factors shows a tendency to being a risk factor.

* Same cohort as Uter 1999a, but different outcome measures

References in brackets represent supporting articles

(1) Yan K, Salome C, Woolcock AJ (1983) Rapid method for measurements of bronchial responsiveness. Thorax 38:760-765.

(2) Diepgen TL, Farasch M, Hornstein OP (1991) Kriterien zur Beurteilung der atopischen Hautdiathese. Dermatosen 39:79-83.

(3) Diepgen TL, Sauerbrei W, Fartasch M (1996) Development and validation of diagnostic scores for atopic dermatitis incorporating criteria of data quality and practical usefulness. J Clin Epidemiol 49:1031-1038.

Health Records Data - Occupational Disease							
Toxic Effects							
Author	**Time Period** **Jurisdiction**	**N/Age** **Data Source**	**Unit of Measure**	**Risk Factors Evaluated**	**Outcome Definition**	**Definition of Work Relatedness**	**Findings/interpretations regarding the risk factors examined**
Brevard 2003	1993-1998 USA	N (6-17 year olds) = 307 Male 161 (52%) Female 146 (48%) N (15-17 year olds) = 275 Source: Toxic Exposure Surveillance System (TESS) and California Department of Pesticide Regulation (CDPR)	Disinfectant related illness - Number of cases per billion hours worked	Industry Season	Identification of cases based on the judgment of the Poison Control Centres' specialist managing the specific case (consistent with dose toxicology and timing of disinfectant exposure).	TESS and CDPR records include whether the illness occurred as a result of workplace exposure.	Average annual incidence rate for acute occupational disinfectant-related illness in the US (all industries) was 16.8/billion hours worked (BHW). The average annual incidence rates for California was 55.9/BHW in all industries, 88.6/BHW in eating and drinking places, and 98.2/BHW in miscellaneous entertainment and recreation services. The rate of illness was roughly the same for the summer months as for the rest of the year.

Calvert 2003	1988-1999 USA (Except Maine, Mississippi, South Carolina and Vermont)	N = 531 Median age 16 years Male 68% Source: Toxic Exposure Surveillance System (TESS), California Department of Pesticide Regulation (CDPR) and State health departments	Pesticide related illness - Number of cases per billion hours worked	Gender Industry	Cases where health effects were developed subsequent to pesticide contact and effects were evaluated by poison control or state surveillance professionals as consistent with the known toxicology of the pesticide product.	TESS and State agency records include whether the illness occurred as a result of workplace exposure.	Incidence rate was higher among those employed in agriculture than among those not so employed. The rate was higher among male than female youths.