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Chronic health problems and risk of accidental injury in the workplace: A systematic literature review

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Abstract

Objectives—To investigate whether common important health conditions and their treatments increase risks of occupational injury.

Methods—A systematic search was conducted of Medline, Embase and PsycINFO databases from inception to November 2006 employing terms for occupational injury, medications, and a broad range of diseases and impairments. Papers related solely to driving, alcohol, or substance abuse were excluded, as were studies that did not allow analysis of injury risk. For each paper that was retrieved we abstracted standard information on the population, design, exposure(s), outcome(s), response rates, confounders and effect estimates; and rated the quality of information provided.

Results—We found 38 relevant papers (33 study populations): 16 studies were of cross-sectional design, 13 were case-control and four were prospective. The overall quality was rated as excellent for only two studies. Most commonly investigated were problems of hearing (15 studies), mental health (11 studies) and vision (10 studies).

For impaired hearing, neurotic illness, diabetes, epilepsy and use of sedating medication there were moderate positive associations with occupational injury (ORs 1.5–2.0), but there were major gaps in the evidence base. Studies on vision did not present risks by category of eye disease; no evidence was found on psychotic illness; for diabetes, epilepsy and cardiovascular disease there were remarkably few papers; studies seldom distinguished risks by sub-category of external cause or anatomical site and nature of injury; and exposures and outcomes were mostly ascertained by self-report at a single time point, with a lack of clarity about exposure timings.

Conclusion—Improved research is needed to define the risks of occupational injury arising from common health complaints and treatments. Such research should delineate exposures and outcomes in more detail, and ensure by design that the former precede the latter.

Introduction

The populations of many developed countries are ageing. In future, therefore, the prevalence of common age-related illness and infirmity during employment is likely to rise. However, there is an economic need to retain skilled and experienced older workers, other

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considerations allowing. Thus, strategic plans to maximise employment have been announced by the governments of several countries.[1]

One possible deterrent to full employment at older ages is the potentially greater risk of accidental injury in people taking medication and in those who are limited by sensory, neurological, locomotor, cardiovascular, metabolic, psychiatric or other health impairments. For some kinds of work involving public and third party risk (e.g. drivers and pilots) and some health complaints (e.g. epilepsy), restrictions on employment are legally prescribed.[2]

The evidence underpinning such restrictions has evolved mostly in relation to driving and the risk of road traffic accidents (RTAs), there being evidence, for example, that defects of peripheral vision,[3,4,5] glaucoma,[4] and use of benzodiazepines[6] raise crash and injury rates in drivers. The strength of evidence in other employment situations is less clear but important to establish, as employers need to avoid unjustified restriction of work opportunity while at the same time observing health and safety obligations.

In this paper we report a systematic literature review of chronic health conditions and accident risk that takes as its focus accidents and accidental injuries in the workplace, rather than on the highway or in the home. We have chosen for study a selection of health problems that are both common (or likely to become common in an ageing workforce), and could plausibly carry a higher risk of accidents and accidental injury.

Methods

Search strategy

Systematic searches were conducted of the bibliographic electronic databases MEDLINE (1966 to week 1, Nov 2006), EMBASE (1980 to week 1, Nov 2006) and PsycINFO (1985 to week 1, Nov 2006). The following search terms (medical subject headings and key words) were used:

1. For work accidents (the outcome): workplace accident$, occupation$ accident$, work-related accident$, accident$ at work, work accident$, accidents occupational, industrial accident$, industrial injur$.
2. For disease and medication categories (exposures of interest):
    - neurological: epilepsy, epileptic, seizure disorder, stroke (cerebrovascular disorder, cerebrovascular disease, cerebrovascular accident (CVA)), transient ischaemic attack, cerebral infarction), Parkinson's disease, multiple sclerosis, vestibular disease, vestibular disorder, vertigo, labyrinthitis, labyrinth diseases sensory: visual impairment, vision disorder, cataract, visual acuity, near/far vision defect$, reduced field of view, binocular/monocular vision, blindness, partial$ sight$, contrast sensitivity, glaucoma, macular degeneration, diabetic retinopathy, eye disease$, hearing impairment$, deafness, hearing disorder$, hearing loss, sensory impairment$
    - metabolic: diabetes, diabetes mellitus, hypoglycaemia, hypothyroidism, hyperthyroidism, thyrotoxicosis
    - cardiovascular: dysrhythmia$ (arrhythmia, heart block), ischaemic heart disease (myocardial infarction, myocardial ischaemia, coronary disease, heart attack, angina pectoris), heart disease, hypertension, syncope
    - locomotor: arthritis, cervical spondylosis, spondylolisthesis, spinal osteophytosis, vertebrobasilar insufficiency

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- psychiatric: mental disease, mental illness, mental disorders (including: mania, schizophrenia, anxiety, depression, bipolar disorder)
- medication$, prescribed drug$, prescribed medication$, pharmaceutical preparations, therapeutic uses (including: anticonvulsants, neuroleptics, antipsychotics, antidepressants, psychotropics, sedatives, tranquillisers, benzodiazepines), antihistamines, insulin.

Inclusion and exclusion criteria

We limited findings to publications with an abstract in English, and excluded papers that related solely to vocational driving, those for which the health outcome was a consequence of rather than a risk factor for injury; those concerned only with alcohol or drug abuse, and those that did not conduct an analysis of accident or injury risks (or provide enough data to derive estimates of risk), including case-only series and studies solely of impaired performance.

Data abstraction and quality assessment

All of the procedures were replicated independently by two of us (KTP and ECH), and differences were resolved by consensus. Abstracts were examined, duplicates and irrelevant hits were eliminated, and paper copies then obtained of all primary research papers and reviews. We checked the reference lists of retrieved papers for supplementary relevant material.

For each primary research paper that was finally retrieved, we abstracted details of the study populations, setting, design, exposure comparisons, strategies for assessment of exposure(s) and outcome(s), response rates, confounders considered, and estimates of effect. Some papers featured numerous risk estimates for the same subcategories of injury and exposure: in these circumstances we selected the risk estimates that were the most fully adjusted for confounding. Where papers provided frequencies but not estimates of relative risk we calculated odds ratios (ORs) with exact 95% confidence intervals (95%CIs) using STATA software.

We also formed a subjective judgement on the quality of information in each paper (‘quality rating’) taking into account limitations of design, potential for bias or confounding, and power to detect important associations. Studies were ranked higher if they were well-powered, employed a representative sampling frame, achieved a high response rate, were prospective, controlled adequately for confounding, and had assessed exposures and outcome independently and by objective means. We rated each of these qualities individually; some of the components of our decision-making are summarised below. We also formulated an overall assessment on a four-point scale. (This did not reflect a simple sum of each individual score but a judgement informed by them.)

Confounding and effect modification—The potential for important confounding depends on the relative risk associated with a confounder, its prevalence and the likelihood that it might vary importantly between groups with contrasting exposures. Additionally, some factors may act as effect modifiers. Based on our understanding of risk factors for occupational accidents and occupational injury, the factors that should be allowed for in assessing confounding/effect modification are: (1) age, (2) sex, (3) location, (4) time period, (5) occupational demands/job activities, (6) job experience (years in the work), (7) weekly working hours and (8) alcohol consumption. We rated control of confounding as ‘excellent’ (+++) if analysis and/or design allowed for seven or eight of these items, as ‘good’ (++) if it covered five or six, as ‘moderate’ (+) if it controlled for four of them and as ‘poor’ if it covered three or fewer of these items (−).

Bias—Two categories of bias need to be distinguished – "inflationary" bias (bias that could cause important overestimation of relative risks) and bias that could cause elevated relative risks to be underestimated (bias to the null or negative bias).

Inflationary bias may arise from non-independent assessment of exposures and outcomes or from measurement error. Thus, concern arises where blinding is insufficient, or when exposure and outcome are self-reported together and in retrospect (a common design feature of the cross-sectional studies we found). Inflationary bias from measurement error is a concern when the timing of exposure relative to injury is unclear and the exposure is liable to change as a consequence of occupational injury (e.g. tranquilliser use, low mood), or perhaps be brought to attention through injury (e.g. poor vision).

Bias towards the null is of more concern where there is simple non-differential misclassification of exposure or outcome – as might arise, for example, when health limitations are assessed in vague non-objective terms. Negative bias can arise from the 'healthy worker' effect and the migration of workers with health limitations to less hazardous jobs; we rated this of lower concern when analyses were stratified by or otherwise controlled for occupational activity.

We rated the potential for inflationary bias as 'high', 'possible' or 'low', and that of bias leading to an underestimate of increased relative risks as 'possible' or 'low'.

Sampling—We assessed whether the sampling frame and procedures were clearly stated, whether inclusion and exclusion criteria were explicit, and whether we could track and account for all of the subjects from the description given. Findings were graded on a three-point scale.

Exposure assessment—Some studies employed objective quantitative measures of exposure (e.g. measured level of hearing loss). We rated these more highly, especially where they provided exposure-response information.

Response rates—We calculated effective response rates for the analyses of interest (focussing for the cohort studies on response at follow-up), and we rated response rates of ≥85% as 'excellent' (+++), of 75-84% as 'satisfactory' (++), of 50-74% as 'fair' (+), and of <50% as 'poor' (−).

Completeness of reporting—Incomplete reporting sometimes impaired our capacity to assess overall quality. In reaching the final rating, we assumed that missing items did not meet the criteria we proposed.

Meta-analysis

We considered the scope for meta-analysis for studies with sufficiently similar definitions of exposure (illness) and outcome (accident event), but in practice found these too limited to warrant a pooling of risk estimates.

Results

Following elimination of duplicates and non-English publications we identified 760 potentially relevant abstracts. Assessment of these 760 abstracts allowed us to exclude 515 published papers that did not permit an analysis of accident risks (including 155 case-only series), 114 papers in which the health condition followed rather than preceded injury, and 70 with a sole focus on alcohol or substance misuse. We retrieved 61 papers and added to these 16 other candidate papers, identified from a perusal of reference lists. However,

among the 77 papers read in full, four were reviews, 10 defined the injury outcome and/or health exposure inadequately, and on closer scrutiny 25 did not allow RRs of occupational injury to be derived in relation to the study exposures. Thus, finally, 38 research papers (33 independent studies) satisfied our selection criteria of which 15 papers (11 studies) were set in agricultural communities.

The main design features and our quality assessment of the final selection are presented in Table 1. Altogether, 16 independent studies (18 published papers) were of cross-sectional design, 13 were case-control studies (16 papers) and four were prospective cohort studies. One paper[24] duplicated information from earlier studies,[21,22] and does not appear in later tables or calculations.

Several eligible papers considered more than one health problem, and as a result we identified 19[8,10,15,16,20-23,25,26,31,35-39,41,43,44] papers on hearing problems, 14 papers on visual problems,[8,16,21-23,25,31,35-38,40,43,44] 15 papers related to mental health, [11,13,14,17,21,22,28,33,35-38,40,43,44] 15 papers related to other health problems (musculoskeletal, cardiovascular, epilepsy, diabetes and allergy and asthma),[8,9,12,15,16,20,23,29,30,35-38,40,42] and 12 papers related to medication.[7,9,18,19,25,27,29,30,31,32,34,40]

Most investigations took as their outcome accidental injury in the past 12 months, although outcome definitions were heterogeneous, varying for example in the extent of injury, the residual limitation and the involvement or otherwise of medical aid; in four studies[10,11,12,18] the outcome was defined as an accident rather than as an accidental injury or accident requiring medical attention.

Several studies employed an independent assessment of exposure[10,13,25,39,42] or outcome[18,28,30,31] or both,[12,29,40] but for the most part, exposures and outcome were ascertained by self-report at a single time point. Few of the cross-sectional and retrospective studies established by design that exposure preceded outcome, and we rated the potential for inflationary bias as ‘high’ for at least some comparisons in 14 of the studies.[7,11,14,15,17,19-22,25,28,33,35-38] Confounding was addressed in various ways (restriction, matching, stratification, regression modelling), but 15 of the studies[9,13,15,16,18,21-24,27,29,30,32,33,34,42,44] failed to control for five or more of the eight factors suggested by us as relevant.

We rated the overall quality of information as excellent (++++) in two studies,[29,40] as useful but with some important limitations in seven studies (+++),[10,23,25,31,35-37,43,44] as moderately informative (++ or +(+)) in ten studies[8,11,16,20,21,22,26,28,30,39,41] and as limited in 14 studies (+).[7,9,12-15,17-19,27,32,33,34,42]

The main findings are presented in Tables 2 to 5. Each table is organised first by exposure category and study design and then alphabetically by first author.

Impairments of hearing

The relation between risks of accidental injury and hearing problems was considered in 15 studies, including three of cohort design (Table 2). Exposure assessment was mostly based on self-report, although three studies made use of the judgement of an assessor[10,23,25] and in three studies, pure tone audiometry was measured.[31,39,41]

None of the various studies on hearing impairment were classed as having a high potential for inflationary bias. In most comparisons, moderately positive associations were reported (OR ≥ 1.5) with RRs sometimes exceeding 2.0;[10,16,23,31,35-39] and most of the studies of

higher quality were compatible with a rough doubling of risks.[23,31,35-38] In the largest one, based on over 76,000 subjects from the cross-sectional National Health Interview Survey,[23] odds were raised over two-fold among those considered deaf by the interviewer and 1.6-fold in those with self-reported hearing impairment; a measured hearing loss of 25 dBHL in the better ear was associated with an OR of 1.6 in a cohort study,[41] and a 20 dBHL was associated with an OR of 1.9 in one case-control study.[31] In another case-control study the odds of accidental injury were more than doubled for a binaural hearing loss of 20% - 54%, although findings were not significant at the 5% level.[39] There were some indications in this last investigation that hearing loss in a noisy work environment raised risks even further. In a cross-sectional study of physician-assessed hearing disorder significantly increased ORs were found in relation to injuries requiring hospitalisation or prolonged sick leave, although there was little evidence that risk varied by type of incident causing injury;[10] the nature of the hearing disorder and the criteria employed in diagnosis were unstated.

In only two of the studies was there an attempt to distinguish risks by sub-category of external cause[10,35-37] and none reported outcomes by anatomical site or nature of injury.

On balance we assess the evidence as favouring a moderately higher risk of accidental injury in those with hearing impairment; a few studies included objective measurement of hearing loss, and these tend to support this interpretation.

Impairments of vision

We identified 10 studies on problems of vision (Table 2), including two studies of cohort design.[43,44] Three of the papers made use of an assessor's judgement ('blind', physician-determined poorly corrected vision disorder, medically diagnosed eye disorder),[23,25,40] but most took as their exposure definition self-report of visual difficulty or wearing glasses.

There were few positive findings of note, although Zwerling *et al* reported associations with poor self-rated vision in one cross-sectional survey (OR 1.5 in non-farmers, 3.1 in farmers),[21,22] and with an interviewer's opinion that the participant was blind in another (OR 3.2).[23] In one cohort study, also by Zwerling *et al*,[44] the OR for accidental injury was 1.45 (P>0.05) in those with self-reported poor sight; in a much smaller study by the same group,[43] no injuries were reported in the group with a "vision problem". A case-control study that took medically diagnosed eye disorder as its risk factor reported an OR of 1.2 (P>0.05) but provided no breakdown by diagnostic subcategory.[40] In several analyses, ORs were less than 1.0 (although none were significantly so at the 5% level).

In summary, we found little evidence that impairments of vision increase risks of occupational injury, but also few investigations with a focus on well-defined eye pathology.

Poor mental health

Findings in relation to mental health were considered in 11 studies and results were mixed (Table 3). In many studies lower confidence limits exceeded one and several studies indicated ORs ≥1.5, or even higher in certain subgroups. However, we classed more studies as prone to inflationary bias in this than for other categories of health problem.[11,14,17,21,22,28,33,35-38]

Approaches to exposure definition varied. The CES-D scale for depression was a popular instrument,[14,17,21,22,35-38,43,44] although with differing cut-points chosen to define high exposure; in addition, three other screening instruments for minor psychiatric disorder and emotional instability were employed,[11,28,33] as well as a physician's diagnosis of depression[35-38] or neurotic disorder.[40] One small study of limited quality was found on schizophrenia.[13]

Among studies that used the CES-D depression scale, the three largest suggested only modest RRs (OR <1.5 for accidental injuries overall, all with P<0.05).[17,21,44] In the three studies of highest quality, ORs ranged from 1.37 to 3.22,[35-38,43,44] the extremes representing the two investigations which had a prospective design. Self-report of doctor-diagnosed depression carried an OR of 1.82 (P<0.05) for all injuries in a case-control study of farmers by Sprince *et al*,[36] and an OR of 2.37 (P<0.05) for fall-related injuries in the same study group;[38] but an OR of 1.07 was found in a second case-control study that linked records of hospital attendance for injury and prescribed medication for ICD-defined neurotic disorder.[40]

On balance, we assessed the evidence as favouring a higher risk of injury in those with emotional problems, while not firmly establishing this to be so.

Other long-term health conditions

Table 4 summarises our findings in relation to five other categories of long-term health problem. Musculoskeletal symptoms were assessed in six studies, largely based on self-report of regional pain or 'arthritis'.[8,15,20,24,35-38,40] ORs were generally ≤1.5, and in a single high quality paper based on physician's diagnosis of osteoarthritis the estimated OR was close to unity.[40] However, in one study it was significantly raised for self-report of joint discomfort (OR 2.56),[15] while Sprince et al found risks of occupational injury in those with self-reported arthritis or rheumatism to be elevated two to three-fold in sub-analyses related to specific types of injury (falls and injury with livestock).[37-38]

For cardiovascular disease (self-report of heart disease,[20,35-38] self-report of high blood pressure,[20] or doctor diagnosis of these disorders[40]) the evidence base was sparse but did not point to elevated risks.

We found four studies on epilepsy.[12,16,23,42] ORs were raised 1.5 to 2.5-fold, although findings were not significant at the 5% level in three of the four studies, including a very large cross-sectional study by Zwerling et al.[23] Two of the remaining studies, rated of lower quality, failed to account for a matched design in their analysis.[12,42]

We identified three studies concerning diabetes or prescribed diabetic medication.[23,29,40] The largest study found a moderate elevation of risk (OR 1.47),[23] as did a well-conducted case-control study linking recent hypoglycaemic prescription with medically recorded injuries (OR 1.3 - 1.4).[29] Risk of accidental injury was also somewhat higher for physician diagnosis of diabetes in another record linkage study by Voaklander *et al*.[40]

Finally, we identified four studies on allergy, hay fever and asthma.[9,20,30,35-38] In a cross-sectional study by Bunn et al[9] there was a trend of increasing injury risk with increasing severity of doctor-diagnosed allergy, although numbers in the analysis were unclear. In a small study of self-reported allergy there was no such increase in risk of injury.[20] In a large case-control study, self-reported doctor-diagnosed asthma showed a moderate association with injury risk overall (OR 1.6),[36] with a higher risk in a sub-analysis related to injuries from livestock (OR 2.46, P<0.05);[37] and in a sub-analysis confined to fall-related injuries (OR 2.27);[38] while in a second large case-control study, there was little association between acute traumatic injury and physician-diagnosed nasal allergy.[30]

The papers on epilepsy and diabetes, although consistent with a small increase in risk of accidental injury, provide a limited evidence base on which to draw conclusions. Those on allergy were few and inconsistent.

Medication

We found several papers on medication - related to use of anxiolytics, hypnotics and sedatives,[18,19,25,29,31,32,34,40] antidepressants,[19,29,34] antipsychotics,[29] or otherwise psychoactive medicines,[6,18] and other drugs with sedative potential (narcotics[29,40] and antihistamines[9,27,29,30]) (Table 5).

Voaklander *et al*[40] found that prescription of anxiolytics, sedatives or hypnotics in the preceding 30 days was associated with a three-fold increase in odds of hospital attendance with work-related injury, whereas in a study of similar design Gilmore *et al*[29] ORs were much lower (0.8 in men and 1.5 in women). Two other studies favoured a more than doubling of risk,[19,25] although both had the potential for inflationary bias through reverse causation - in Wadsworth *et al*,[19] for example, the taking of sleeping pills related to the 14 days prior to questioning, whereas injuries might have occurred up to a year beforehand.

The study by Gilmore *et al*[29] found little evidence of elevated risks in those taking antidepressants, antipsychotics or narcotics; and two other studies of lower quality found limited (OR 1.5)[7] or no effect[18] from psychoactive medication in general.

Hanrahan *et al*[30] reported that antihistamines in the prior two weeks raised the odds of accidental injury almost three-fold in an adjusted analysis that included a term for interaction between use of antihistamine and age. However, there were no important differences between injury cases and referents in the crude prevalence of sedative antihistamine use (9% vs. 8% respectively). Bunn *et al*[9] found a cross-sectional relation between self-report of injury and sedative antihistamine use in the past 12 months (prevalence ratio 1.6, $P<0.05$); but the prevalence of injury was similar in those using non-sedative antihistamines, pointing if anything to an effect from hay fever rather than its treatment.

Finally, Voaklander *et al*[40] found moderately positive associations with prior use of non-steroidal anti-inflammatory drugs.

In summary, most of the data we found on medication and injury risk related to drugs with sedative potential. Findings were compatible with a moderate increase in risks, although not wholly consistent.

Discussion

Our review suggests that some chronic health conditions and their treatments, including impaired hearing, neurotic illness, diabetes, epilepsy and use of sedating medication may raise the risks of occupational injury to a moderate degree, the evidence base being most complete in relation to hearing (15 studies). However, the most notable finding is an apparent shortage of good quality evidence. Thus, for example, studies of hearing impairment seldom employed objective measures of hearing loss; those on vision did not present risks by specific categories of eye disease and did not employ a quantitative measure of impairment; we found no evidence on major categories of psychiatric illness such as bipolar disorder and mania; for some common important health outcomes including diabetes, epilepsy and cardiovascular disease, the evidence base was remarkably thin; and first injury was seldom distinguished from recurrent injury risk. Moreover, few studies attempted to distinguish risks by category of external cause (e.g. fall, injury from machinery) or by anatomical site or nature of injury (e.g. a fractured femur, burn to the hand). The studies that we did identify tended to have important limitations, including potential for confounding and inflationary bias, and a frequent lack of clarity regarding the timing of illness relative to injury; there were few prospective investigations. Finally, health-

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related selection into and out of jobs may have led to residual confounding by work activity, insofar as studies tended to control for this factor only crudely, at the level of occupational title. Apparently protective effects of some health problems in some studies may have arisen from such selection. Thus, for example, the finding of an association with impaired hearing but not impaired vision could reflect an earlier withdrawal from certain hazardous work in those with overt problems of seeing than in those with insidious loss of hearing.

Our search had limitations too and may not have been fully comprehensive. We did not assess the grey literature or consult experts in accident research or review the research abstracts of conferences. However, the search encompassed the three major biomedical bibliographic databases, we were thorough in the search terms we employed, and we checked other reviews and their bibliographies for relevant material. It seems unlikely, therefore, that a major volume of high quality research has been overlooked.

The relative shortage of information on occupational risks can be contrasted with a more extensive literature on health impairments and road traffic accidents (RTAs) (including some studies of vocational drivers). In a previous review of this topic[45] we identified several studies employing specific measurements of visual performance (visual acuity, field of vision, binocularity, contrast sensitivity), and covering several specific eye diseases (cataracts, glaucoma, macular degeneration); reduced field of vision was consistently associated with risk of accidental injury, with estimated RRs ranging from 1.9 to 22.0 for a >40% reduction.[3,4,5] We also identified some 14 primary research studies on epilepsy and RTAs, including seven papers of cohort design; in general these suggested that the excess risk, if any, was modest, and that patients who experienced reliable auras or complied with anti-epileptic treatment or had their last seizure some time ago did not have an increased risk of RTA;[46,47] in one cohort study an increased risk of RTAs existed for patients with generalised and complex seizures but not for patients with simple seizures.[48] The present review failed to identify any papers relating to occupational injuries that covered common health problems in comparable depth.

The information gap is both surprising and urgent to fill. There is a pressing need, particularly in the context of an ageing workforce, for more and better targeted research to ensure that health-related decisions on job placement are evidence-based. Future research should define exposures and outcomes in greater detail, while ensuring by design that the former precede the latter.

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Main messages

- Impaired hearing, neurotic illness, diabetes, epilepsy and use of sedating medication may raise the risks of occupational injury to a moderate degree
- Research evidence on the occupational injury risks arising from many common health problems and/or their treatments is surprisingly limited
- Gaps in the evidence base encompass the nature and extent of injury (e.g. fractured hip), the category of external cause (e.g. fall), and often the specific diagnostic entity examined as a risk factor (e.g. type of eye problem)

Policy implications

- The potentially greater risk of accidental injury in people taking medication or limited by chronic health conditions is a deterrent to full employment
- Better research is urgently needed to define such risks, and to provide an evidence base to underpin fitness for work decisions

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Table 1

Features of the studies included in the review

First author, (year) location	Study populations	Sources of information on exposure and outcome	Outcome	Exposure(s)		Potential for inflationary bias		Control of confounding	Sampling methods	Response rate	Quality rating
			Definition	Categories	Timing vs. accident	Reverse causation	Bias in exp or outcome assessment				
Cross-sectional studies											
Bhattacherjee A, (2003)[7] France	Subjects aged ≥15 years from randomly selected households with telephones in a defined region	E: Self-completed questionnaire O: Same	Damage to the body resulting from an accident at work, with sick leave of ≥1 day and with compensation in the 2 years before survey	Medication	Unclear	H	P	++	++	−	+
Browning SR, (1998)[8] USA	Male farmers aged ≥55 years from a 2-stage cluster sample of farms in Kentucky	E: Self-report at telephone interview O: Same	Injury doing farm work or chores in past 12 months	1 Hearing	1 Before?	L	P	+++	+++	+	++
				2 Vision	2 Before?	L					
				3 MSD	3 Unclear	P					
Bunn WB, (2003)[9] USA	Employees at 6 auto manufacturing sites	E: Self-completed questionnaire O: Same	≥1 reported injury in past 12 months	1 Allergy 2 Medication	Unclear	L	P	−	−	?	+
Chau N, (2004)[10] France	Men who worked for ≥5 years in the construction industry and had ≥1 occupational injury with sick leave & had seen an occupational physician	E: Physicians' examination (criteria unstated) O: Yearly medical examination or return to work interview. Physician completed questionnaire.	Falls, struck by moving object, handling/carrying accidents, accident with hand tool, machinery accident	Hearing	Probably before	L	P	++	+++	+++	+++
da Silva MC, (2006)[11] Brazil	Rag pickers, identified by key informants in poor neighbourhoods; non-rag pickers living in adjacent households	E: Self-report at interview O: Same	Any work accident in past 12 months	Mental health	After	H	P	++	−	++	+(+)
Dasgupta AK, (1982)[12] England	45 epileptic workers and 38 partially matched controls from a steel company	E: Medical records O: Company accident records	Accident at work over a 1-year period	Epilepsy	Unclear	P	P	++	−	++ (e) ? (ne)	+
Edlund MJ, (1989)[13] USA	All recently diagnosed schizophrenic outpatients aged 21 - 64 from a hospital	E: Clinician's psychiatric (DSM-III R) diagnosis	Accident at work requiring professional medical attention in	Mental health	Probably before	L	P	−	++ (e) − (ne)	++ (e) ? (ne)	+

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First author, (year) location	Study populations	Sources of information on exposure and outcome	Outcome	Exposure(s)		Potential for inflationary bias		Control of confounding	Sampling methods	Response rate	Quality rating
			Definition	Categories	Timing vs. accident	Reverse causation	Bias in exp or outcome assessment				
	clinic; volunteer staff from a medical centre with no psychiatric history	O: Interview administered questionnaire	the past 12 months								
Frone MR, (1998)[14] USA	16-19 year old student volunteers with part-time jobs, recruited through advertising at colleges and high schools	E: Self-completed questionnaire O: Same	Number of work injuries in 7 categories in the past 9 months (average score)	Mental health	After	H	P	++	−	?	+
Hwang SA, (2001)[15] USA	Adult farmers and farm residents on 552 farms in New York state	E: Self-report at telephone interview O: Same	≥1 severe farm injury (sought medical care or died or missed >0.5 work days) in past 6-12 months	1 Hearing	1 Before?	L	P	+	++	−	+
				2 MSD	2 Unclear	H	P				
Lewis MQ, (1998)[16] USA	Principal farm operators, chosen from an agricultural database in Iowa	E: Self-completed questionnaire O: Same	Injury for which medical attention or treatment received from a doctor/medical assistant; or which led to reduced activities for ≥0.5 days, or loss of consciousness in past 12 months	1 Epilepsy 2 Hearing 3 Vision	Unclear, but probably before	L	P	+	++	−	+(+)
Nakata A, (2006)[17] Japan	Workers from randomly selected small + medium scale manufacturing factories listed in a commercial directory	E: Self-completed questionnaire O: Same	Injury at work (including minor scratches and cuts) in previous 1 year	Mental health	After	H	P	++	++	++	+
Proctor RC, (1981)[18] USA	Employees of 3 large furniture producing companies	E: Self-completed questionnaire O: Works records	On the job accidents in past 6 months	Medication	Unclear	H	P	−	++	−	+
Wadsworth EJK, (2003)[19] England	General population sample, chosen from electoral registers	E: Self-completed postal questionnaire O: Same	Accident at work requiring medical attention in past 12 months; minor injury not requiring attention	Medication	After	H	P	++	++	+	+
Xiang H, (1999)[20] USA	Male farmers aged ≥ 60	E: Telephone interview	Any farm work-related injury in	1 Allergy		L	P	++	++	+	++

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First author, (year) location	Study populations	Sources of information on exposure and outcome	Outcome	Exposure(s)		Potential for inflationary bias		Control of confounding	Sampling methods	Response rate	Quality rating
			Definition	Categories	Timing vs. accident	Reverse causation	Bias in exp or outcome assessment				
	years from Colorado, drawn from an agricultural statistics database	O: Same	past 12 months requiring medical treatment other than first aid, being unable to do usual work activities, having lost consciousness or needing transfer to another job.	2 CVD		L					
				3 Hearing		L					
				4 MSD		P					
Zwerling C, (1995),[21] (1996),[22] (1998)[24] USA	Multi-stage area probability sample of 51-61 year olds from the general population (Health & Retirement Study). Separate papers for agricultural workers and other occupations	E: Self-report at interview O: Same	Injury at work requiring medical attention or treatment or interfering with work activities, past 12 months	1 Hearing	1 Before?	L	P	–	++	++	++
				2 Mental health	2 After	H					
				3 Vision	3 Before?	L					
Zwerling C, (1997)[23] USA	1 in 6 sample of 18-65 year old workers (other than farmers) participating in the National Health Interview Survey (a nationwide Census Bureau multi-stage probability survey of US households)	E: Self-report at interview O: Same	Injury in the past year that caused a residual limitation at time of interview	1 Diabetes 2 Epilepsy 3 Hearing 4 MSD 5 Vision	Before	L	P	–	++	+++	+++
Case-control studies											
Chau N,[25] (2004) France	Male workers employed ≥5 years in the construction industry. Cases: as defined in ref 10. Controls: men who had not had ≥1 occupational injury with sick leave, matched on occupation	E: Mainly by physician's examination (criteria unstated); O: Yearly medical examination or return to work interview. Physician completed questionnaire.	Occupational injury with sick leave and consultation with an occupational physician (routinely or in relation to the injury)	1 Hearing	Unclear	L	P	++	+++	+++	+++
				2 Vision	Unclear	L					
				3 Medication	Unclear	H					
Crawford MJ,[26] (1998) USA	Cash-grain farmers (principal operators) from a	E: Self-completed questionnaire O: Same	Agricultural injury which led to	Hearing	Probably before	L	P	+++	++	–	++

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First author, (year) location	Study populations	Sources of information on exposure and outcome	Outcome	Exposure(s)		Potential for inflationary bias		Control of confounding	Sampling methods	Response rate	Quality rating
			Definition	Categories	Timing vs. accident	Reverse causation	Bias in exp or outcome assessment				
	roster held by an agricultural statistics service, Ohio		consultation with a doctor or medical assistant, or cut down usual activities for ≥0.5 days in past 12 months								
Dunn EV,[27] (1979) Canada	Packaging workers. Cases: workers attending a company health centre with work-related injury; controls: next employee of same sex listed alphabetically in the centre records	E: Nurse's interview O: Clinic attendance records	Work-related injury (major or minor)	Medication	Before	L	H	−	++	+++	+
Ghosh AK,[28] (2004) India	Male miners from 3 underground coalmines. Cases: randomly chosen from those suffering a work injury during 1996-2000. Controls: individually matched to cases by job and mine from among those with no career injury	E: Interviewer-administered questionnaire O: Safety department injury register	Injury to body from an accident at work with ≥1 day lost work and with compensation in the previous 1-5 years	Mental health	After	H	P	++	++	+++	++
Gilmore TM,[29] (1996) USA	Members of the Group Health Co-operative of Puget Sound, Washington State. Cases: aged ≥18 years seen in a hospital department in 1992-3 for work-related injury. Controls: 2 subjects/ case, randomly chosen from members free of injury in prior 90 days (matched on age, sex and industry)	E: GHC Pharmacy Database O: Hospital billing records Both automated	Hospital attendance for a work-related injury (acute traumatic injury with costs billed to an employer)	Diabetes Medication	Before	L	L	+	+++	+++	++++
Hanrahan LP,[30] (2003) USA	Worker compensation claimants with certain categories of injury (cases -	E: self report at telephone interview	Compensation claims for acute injuries arising from falls or slip	1 Allergy 2 Medication	Before	L	P	+	++	−	+(+)

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First author, (year) location	Study populations	Sources of information on exposure and outcome	Outcome	Exposure(s)		Potential for inflationary bias		Control of confounding	Sampling methods	Response rate	Quality rating
			Definition	Categories	Timing vs. accident	Reverse causation	Bias in exp or outcome assessment				
	see outcome definition); controls - claims for materials handling related back injury	O: Compensation claims database	injury, struck or 'struck by objects' and 'caught in or between objects or machines'								
Moll van Charante AW,[31] (1990) Netherlands	Male manual shipyard workers. Cases: workers injured in 1984-6. Controls: matched by age and sex, and chosen from the 1988 payroll	E: Self-completed questionnaire O: Accident records	Injury recorded in the company's accident register	Hearing	Before?	L	P	++/ +++	+++	+++	+++
				Medication	After?	H					
				Vision	Before?	L					
Montastruc JL,[32] (1992) France	Service industry workers attending clinics of 15 occupational physicians in 1989-90. Cases: having an industrial injury; controls: next 2 willing clinic attendees	E: Administered questionnaire O: Physician records	Industrial injury (other than road traffic accident) causing sick leave of >1 week and <3 months	Medication	Before	L	P	−	+	?	+
Peele PB,[33] (2005) USA	Individuals attending two general occupational health clinics. Cases: workers presenting with a work-related injury in past 72 hours. Controls: other attendees free from injury in the past 12 months	E: Self-report O: Self-completed questionnaire	Self-reported work-related injury in past 72 hours	Mental health	After	H	P	+/−	−	−	+
Pickett W,[34] (1996) Canada	Farm operators followed from an earlier cross-sectional survey. Cases: farm injury, controls: no injury.	E: Self-completed questionnaire O: Self-completed questionnaire	At least 1 unintentional farm injury serious enough to limit normal activity for > 4 hours in 12 months prior to cross-sectional survey	Medication	Before	L	P	−	+	++	+
Sprince NL, (2002),[35] (2003)[36,37,38] USA	Random sample from a private pesticide applicators'	E: Interviewer-administered questionnaire O: Same	Farmer injured seriously enough to get medical advice or	1 Allergy 2 CVD 3 Hearing 4 Mental	After	L	P	++/ +++	+++	++	+++
						L					

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First author, (year) location	Study populations	Sources of information on exposure and outcome	Outcome	Exposure(s)		Potential for inflationary bias		Control of confounding	Sampling methods	Response rate	Quality rating
			Definition	Categories	Timing vs. accident	Reverse causation	Bias in exp or outcome assessment				
	register		treatment in past 12 months (all injuries, fall-related injuries, injuries related to machinery or large livestock)	health 5 MSD 6 Vision		H P L					
Viljoen DA, (2006)[39] Australia	Male underground miners employed throughout 1994- 2004 and who had had PTA. Cases - sustained an injury; Controls - did not.	E: PTA in routine medical assessment closest in date to the accident O: Not stated	Injury caused by moving or falling objects	Hearing	Before	L	L	++	+	?	++
Voaklander DC, (2006)[40] Canada	Male farmers aged ≥66 years from Alberta. Cases: attending a hospital over a 3-year period. Controls: a random selection of farmers receiving fuel tax rebates in 1998-9	E: Register of prescriptions O: Hospital billing records	Hospital attendance for an injury related to agricultural activity	1 CVD 2 Diabetes 3 Mental health 4 MSD 5 Vision 6 Medication	Before	L	L	++	+++	+++	++++
Cohort studies											
Choi SW,[41] (2005) USA	Principal farm operators from Iowa, identified from a random sample of rural residents. Analysis based on farmers receiving injury prevention interventions	E: Regular telephone interviews and diary records O: Same	Sudden unexpected unintentional incident related to farm work with an external cause leading to tissue damage, poisoning, loss of consciousness or other bodily injury (within prior 6-12 months)	Hearing	Before	L	L	++	−	?	++
Cornaggia CM, (2006)[42] 8 European countries	Epileptics ≥18 years, in employment (identified from clinic attendance); non- epileptics, matched by age, sex, residency and social	E: Physician's hospital diagnosis O: Self-recorded in a follow-up diary	Event at work arising from sudden unexpected cause (not a disease), leading to physical damage, requiring medical	Epilepsy	Before	L	P	+	++	?	+

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First author, (year) location	Study populations	Sources of information on exposure and outcome	Outcome	Exposure(s)		Potential for inflationary bias		Control of confounding	Sampling methods	Response rate	Quality rating
			Definition	Categories	Timing vs. accident	Reverse causation	Bias in exp or outcome assessment				
	class, volunteered by cases from relatives, friends, or workmates		attention, or resulting in financial loss								
Park H,[43] (2001) USA	Principal farm operators from ref 16 who agreed to be mailed a follow-up questionnaire	E: Self-report at baseline O: Self-completed postal questionnaire	Injury for which medical attention or treatment received from a doctor or medical assessor, or which led to reduced usual activities for >0.5 days or loss of consciousness in past 12 months	1 Hearing 2 Mental health 3 Vision	Before	L	P	+/ ++	+++	++	+++
Zwerling C,[44] (1998) USA	Multi-stage area probability sample of employed Americans, aged 51-61 years (excluding farmers), followed up in 1992-4 (Health & Retirement Study)	E: Self-report at baseline O: Self-report at follow-up interview	Injury at work that required special medical attention or treatment or interfered with work activities (between baseline and follow-up interviews)	1 Hearing 2 Mental health 3 Vision	Before	L	L	−	++	++	+++

MSD = musculoskeletal disorder; PTA = pure tone audiometry; E: Exposure; O: Outcome; CVD = cardiovascular disease; (e) = exposed; (ne) = not exposed; H = high; P = possible; L = low. (The criteria underlying the plus/minus notation are described in the methods section.)

Table 2
Sensory impairment and risks of occupational injury

Design First Author	Definition of exposure(s)	Sub-category of injury	Nos. in analysis	Effect measure	Point estimate (95% CI)	Confounders considered
HEARING **Cross-sectional studies**						
Browning SR, 1998[8]	Self-reported hearing difficulty (other than deafness)	All	998	OR	1.59 (0.95 - 2.67)	a,s,l,t,o,y,w
Chau N, 2004[10]	Physician-determined hearing disorder (criteria unstated)	Fall, same level	880	OR	1.18 (0.65 -2.15)	a,s,l,t,o,y
		Fall, lower level	880	OR	1.43 (0.89 - 2.27)	
		Injury from handling	880	OR	0.66 (0.41 - 1.06)	
		Injury from hand tool	880	OR	0.56 (0.22 - 1.46)	
		Injury from machinery	880	OR	1.10 (0.60 - 1.99)	
		Injury from moving object	880	OR	2.02 (1.08 - 3.75)	
		Injury requiring hospitalisation	880	OR	1.69 (1.12 - 2.55)	
		Injury with sick leave >60 days	880	OR	1.65 (1.10 - 2.49)	
Hwang SA, 2001[15]	At least 'a little trouble hearing in either or both ears	All	1523	OR	1.86 (1.22 - 2.83)	a,l,t,w
Lewis MQ, 1998[16]	Self-reported hearing problem (no details)	All	390	OR	2.04 (0.90 – 4.65) *	s,l,t,o
Xiang H, 1999[20]	Self-reported hearing loss	All	113	OR	1.88 (0.55 - 6.41) *	a,s,l,t,o,al
Zwerling C, 1995[21], 1996[22]	Self-reported poor or fair hearing with hearing aid vs. others	Injuries in non-farmers	6370	OR	1.60 (1.11 - 2.30)	a,s,t,o
		Injuries in agricultural workers	237	OR	0.29 (0.01 - 2.22)	
Zwerling C, 1997[23]	Deaf, as assessed by interviewer	All	~76,600	OR	2.19 (1.17 - 4.12)	a,s,t,o
	Self-reported hearing impairment	All	~76,600	OR	1.55 (1.29 - 1.87)	
Case-control studies						
Chau N, 2004[25]	Physician-determined hearing disorder (criteria unstated)	All	1760	OR	1.30 (0.94 - 1.80)	a,s,l,t,o,y
Crawford MJ, 1998[26]	Self-reported hearing in right ear 'not good'	All	1565	OR	1.90 (0.82 - 4.40)	a,s,l,t,o,w,al
					(95% CI)	
Moll van Charante AW, 1990[31]	Hearing loss on PTA (vs. ≤20 dBHL and noise <82.5 dBA): ≤20 dBHL, noise >82.5 dBA	All	512	OR	1.83 (1.17 - 2.88)	a,s,l,t,o,w,al
	>20 dBHL, noise <82.5 dBA				4.25 (2.14 - 8.47)	
	>20 dBHL, noise >82.5 dBA				1.80 (0.56 - 5.83)	
	>20 dBHL overall				1.90 (1.64 - 2.21)	a,s,l,t,o,w
Sprince NL, 2002,[35] 2003[36-38]	Wearing hearing aid	All injuries	904	OR	2.36 (1.07 - 5.20)	a,s,l,t,o,w
		Injury from machinery	678	OR	4.37 (1.55 - 12.25)	a,s,l,t,o,w,y,al
		Injury from livestock	458	OR	5.35 (1.59 - 18.0)	a,s,l,t,o
		Fall-related injury	552	OR	3.16 (1.11 - 9.00)	
	Self-reported hearing poor/fair vs. better	All injuries	902	OR	1.05 (0.76 - 1.46)	
		Injury from machinery	676	OR	1.04 (0.69 - 1.58)	
		Injury from livestock	457	OR	1.32 (0.80 - 2.20)	
		Fall-related injury	552	OR	1.29 (0.74 - 2.26)	
	Difficulty hearing normal conversation with hearing aid	All injuries	902	OR	1.42 (1.05 - 1.92)	

Design First Author	Definition of exposure(s)	Sub-category of injury	Nos. in analysis	Effect measure	Point estimate (95% CI)	Confounders considered
		Injury from machinery	676	OR	1.40 (0.96 - 2.04)	
		Injury from livestock	457	OR	1.79 (1.13 - 2.83)	
		Fall-related injury	552	OR	1.82 (1.07 - 3.08)	
Viljoen DA, 2006[39]	aural high tone hearing loss on PTA (vs. none): <10%	All	1080	OR	1.50 (0.85 - 2.64)	a,s,l,t,o,y,w
	10 - 19%				0.82 (0.32 - 2.12)	
	20 - 54%				2.28 (0.84 - 6.22)	
Cohort studies						
Choi SW, 2005[41]	PTA:					a,s,l,t,o,w
	>25 dBHL, both ears	All	150	RR	1.44 (0.94 - 2.23)	
	>25 dBHL, worse ear				1.35 (0.87 - 2.10)	
	>25 dBHL, better ear				1.62 (1.03 - 2.55)	
	>5 dBHL hearing difference, worse vs. better ear				1.67 (1.14 - 2.44)	
	Self-reported hearing fair/poor vs. good	All	150	RR	1.96 (1.26 -3.05)	
Park H, 2001[43]	Self-reported hearing problem (no further details)	All	290	OR	1.21 (0.55 - 2.65) *	s,l,t,o
Zwerling C, 1998[44]	Self-reported poor hearing	All	4883	OR	1.35 (0.95 - 1.93)	a,s,t,o
VISION **Cross-sectional studies**						
Browning SR, 1998[8]	Self-reported vision difficulty	All	998	OR	1.42 (0.76 - 2.63)	a,s,l,t,o,y,w
Lewis MQ, 1998[16]	Self-reported problem of vision (no details)	All	390	OR	0.63 (0.10 - 4.06) *	s,l,t,o
Zwerling C, 1995,[21] 1996[22]	Self-reported poor or fair vision with glasses vs. others	Injuries in non-farmers	6370	OR	1.53 (1.11 - 2.09)	a,s,t,o
		Injuries in agricultural workers	237		3.08 (0.41 - 19.19)	
Zwerling C, 1997[23]	Blind, as assessed by interviewer	All	~76,600	OR	3.21 (1.32 - 7.85)	a,s,t,o
	Self-reported visual impairment	All	~76,600	OR	1.37 (0.87 - 2.17)	
Case-control studies						
Chau N, 2004[25]	Physician-determined poorly corrected vision disorder (criteria unstated)	All	1760	OR	0.9 (0.7 - 1.2)	s,l,t,o
Moll van Charante AW, 1990[31]	Wearing glasses	All	512	OR	0.8 (0.6 - 1.2)	a,s,l,t
Sprince NL, 2002,[35] 2003[36-38]	Wearing glasses	All	904	OR	0.88 (0.66 - 1.18)	a,s,l,t,o
		Injuries from machinery	678	OR	0.72 (0.50 - 1.02)	
		Injury from livestock	458	OR	1.62 (0.97 - 2.73)	
		Fall-related injury	552	OR	1.00 (0.58 - 1.72)	
	Self-reported vision poor/fair vs. better	All	904	OR	0.67 (0.37 - 1.21)	
		Injuries from machinery	678	OR	0.47 (0.20 - 1.10)	
		Injuries from livestock	458	OR	0.49 (0.17 - 1.41)	
		Fall-related injury	552	OR	0.39 (0.10 - 1.56)	
Voaklander DC, 2006[40]	Medically diagnosed eye disorder (ICD 360-379)	All	1692	OR	1.23 (0.83 - 1.83)	a,s,l,t,o
Cohort studies						
Park H, 2001[43]	Vision problem	All	290	OR	0 (0 - 1.56)	s,l,t,o

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Design First Author	Definition of exposure(s)	Sub-category of injury	Nos. in analysis	Effect measure	Point estimate (95% CI)	Confounders considered
Zwerling C, 1998[44]	Self-reported poor sight	All	4883	OR	1.45 (0.94 - 2.22)	a,s,t,o

a - age; s - sex; l - location; t - time period; o - occupation/job demands; y - years of experience in job; w - weekly working hours; al - alcohol consumption; PTA - Pure tone audiometry; dBHL - decibels hearing loss

* original 90% CI recalculated as 95% CI

Table 3
Mental ill-health and risks of occupational injury

Design First Author	Definition of exposure(s)	Sub-category of injury	Nos. in analysis	Effect measure	Point estimate (95% CI)		Confounders considered
Cross-sectional studies							
da Silva MC, 2006[11]	Minor psychiatric disorder on SRQ-20 screening instrument (≥6 for men, ≥8 for women)	All	879	PR	1.4	(1.2 - 1.7)	a,s,l,t,al
Edlund MJ, 1989[13]	Schizophrenia (DSM-III-R) for ≥1 year on consensus of two psychiatrists	All	93	OR	0.8	(0.1 - 4.7)	l,t
Frone MR, 1998[14]	CES-D 20 depression score	All	319	r with CES-D score = 0.20, adjusted r = 0.00			a,s,l,t,w,y
Nakata A, 2006[17]	CES-D scale for depression (>15)	Accidents across all jobs	1489 (M)	OR	1.31	(1.01 - 1.71)	a,s,l,t,o,y
			721 (F)	OR	1.07	(0.69 - 1.66)	
		Accidents in manufacturing/production	767 (M)	OR	1.55	(1.08 - 2.21)	
			241 (F)	OR	1.29	(0.61 - 2.73)	
Zwerling C, 1995,[21] 1996[22]	Worst 30% on CES-D scale for depression	Injuries in non-farmers	6370	OR	1.47	(1.17 - 1.85)	a,s,t,o
		Injuries in agricultural workers	237	OR	3.05	(1.03 - 9.55)	
Case-control studies							
Ghosh AK, 2004[28]	'Emotional instability' (worse 10%)	All	404	OR	2.33	(1.04 - 5.22)	a,s,l,t,o,w
Peele PB, 2005[33]	PHQ-9 depression score: Depression present (Yes vs No)	All	79 (F)	OR	3.36	(1.03 - 10.98)	a,s,l,t
			182 (M)	OR	1.42	(0.69 - 2.92)	s,l,t
Sprince NL, 2002,[35] 2003[36-38]	Doctor-diagnosed depression	All	898	OR	1.82	(1.06 - 3.13)	a,s,l,t,o
		Injury from machinery	674	OR	1.79	(0.93 - 3.43)	
		Injury from livestock	454	OR	1.41	(0.63 - 3.16)	
		Fall-related injury	552	OR	2.37	(1.04 - 5.41)	
	High depression score on 11 item CES-D (top 10%)	All	892	OR	1.65	(1.06 - 2.56)	
		Injury from farming	670	OR	1.52	(0.88 - 2.63)	
		Injury from livestock	453	OR	1.87	(0.97 - 3.62)	
		Fall-related injury	552	OR	2.71	(1.43 - 5.13)	
Voaklander DC, 2006[40]	Physician-diagnosed neurotic disorder (ICD 300-309)	All	1692	OR	1.07	(0.59 - 1.91)	a,s,l,t,o
Cohort studies							
Park H, 2001[43]	CES-D score 16	All	290	OR	3.22	(1.04 - 9.99)	s,l,t,o
Zwerling C, 1998[44]	Worse 30% on CES-D depression score	All	4883	OR	1.37	(1.05 - 1.77)	a,s,t,o

a - age; s - sex; l - location; t - time period; o - occupation/job demands; y - years of experience in job; w - weekly working hours; al - alcohol consumption; OR = odds ratio; PR = prevalence ratio; r = Pearson correlation coefficient; M = male; F = female

Table 4
Other long-term illnesses and risks of occupational injury

Design First Author	Definition of exposure(s)	Sub-category of injury	Nos. in analysis	Effect measure	Point estimate (95% CI)		Confounders considered
MUSCULOSKELETAL DISORDERS **Cross-sectional studies**							
Browning SR, 1998[8]	Self-reported arthritis	All	998	OR	1.34	(0.83 - 2.17)	a,s,l,t
Hwang SA, 2001[15]	Self-reported joint trouble (ache, pain, discomfort in past year in upper or lower limbs or low back)	All	1523	OR	2.56	(1.52 - 4.32)	a,s,l,t
Xiang H, 1999[20]	Self-reported arthritis	All	113	OR	0.47	(0.15 - 1.49)	a,s,l,t,o,al
	Self-reported back pain	All	113	OR	3.35	(0.97 - 11.6)	
Zwerling C, 1997[24]	Self-reported: Back impairment	All	~76,600	OR	1.10	(0.91 - 1.33)	a,s,t,o
	Upper extremity impairment	All	~76,600	OR	1.46	(1.05 - 2.05)	
	Lower extremity impairment	All	~76,600	OR	1.20	(0.94 - 1.53)	
	Arthritis	All	~76,600	OR	1.34	(1.07 - 1.68)	
Case-control studies							
Sprince NL, 2002,[35] 2003[36-38]	Self-reported doctor-diagnosed arthritis or rheumatism	All	898	OR	1.50	(1.06 - 2.13)	a,s,l,t,o
		Injury from machinery	674	OR	1.23	(0.78 - 1.93)	
		Injury from livestock	454	OR	3.00	(1.71 - 5.24)	a,s,l,t,o,w
		Fall-related injury	552	OR	2.05	(1.11 - 3.79)	a,s,l,t,o
Voaklander DC, 2006[40]	Physician-diagnosed osteoarthritis (ICD 715-6)	All	1692	OR	1.16	(0.78 - 1.71)	a,s,l,t,o
CARDIOVASCULAR DISORDERS **Cross-sectional studies**							
Xiang H, 1999[20]	Self-reported heart disease	All	113	OR	0.47	(0.15 - 1.49)	a,s,l,t,o,al
	Self-report, high blood pressure	All	113	OR	0.20	(0.06 - 0.69)	
Case-control studies							
Sprince NL, 2002,[35] 2003[36-38]	Self-reported doctor-diagnosed heart disease	All	903	OR	0.84	(0.53 - 1.34)	a,s,l,t,o
		Injuries from machinery	677	OR	0.78	(0.42 - 1.44)	
		Injuries from livestock	457	OR	1.80	(0.90 - 3.59)	
		Fall-related injury	552	OR	1.76	(0.88 - 3.53)	
Voaklander DC, 2006[40]	Physician-diagnosed cardiovascular disorder (ICD 410-4, 420-9)	All	1692	OR	0.98	(0.63 - 1.53)	a,s,l,t,o
	Hypertension (ICD 401-5)	All	1692	OR	0.67	(0.44 - 1.02)	
EPILEPSY **Cross-sectional studies**							
Dasgupta AK, 1982[12]	Medical record of epilepsy	All	83	OR	2.0	(0.6 - 6.7)	a,s,l,t,o
Lewis MQ, 1998[16]	Self-report, ‘ever had seizures’	All	390	OR	1.61	(0.12 - 21.82) *	s,l,t,o
Zwerling C, 1997[23]	Self-reported epilepsy	All	~76,600	OR	1.56	(0.50 - 4.89)	a,s,t,o
Cohort studies							
Cornaggia CM, 2006[42]	Physician-diagnosed: ≥2 unprovoked seizures of known epileptic origin, >24 hrs apart	All	684	OR	2.5	(1.1 - 6.4)	a,s,l,t
DIABETES MELLITUS							

Design First Author	Definition of exposure(s)	Sub-category of injury	Nos. in analysis	Effect measure	Point estimate	(95% CI)	Confounders considered
Cross-sectional studies							
Zwerling C, 1997[23]	Self-reported diabetes	All	~76,600	OR	1.47	(0.90 - 2.40)	a,s,t,o
Case-control studies							
Gilmore TM, 1996[29]	Hypoglycaemic medication dispensed in prior 30 days	All	5931 (M)	OR	1.4	(0.8 - 2.2)	a,s,l,t
		All	4251 (F)	OR	1.3	(0.7 - 2.5)	
Voaklander DC, 2006[40]	Physician-diagnosed diabetes	All	1692	OR	1.63	(0.77 - 3.43)	a,s,l,t,o
	Prescribed diabetes medication prior to injury: 0 - 30 days	All	1692	OR	0.70	(0.26 - 1.87)	
	31 - 90 days				0.45	(0.12 - 1.68)	
	91 - 180 days				0.92	(0.09 - 9.34)	
	≥180 days				5.06	(0.24 - 105.60)	
ALLERGY AND ASTHMA **Cross-sectional studies**							
Bunn WB, 2003[9]	Doctor-diagnosed allergy (vs. none): Low severity		Unclear		(vs. 10.7%) 11.3%		a,s,t
	Mild severity				13.7%		
	Moderate severity				14.0%		
	High severity				30.8% (p<0.05)		
Xiang H, 1999[20]	Self-reported allergy		113	OR	0.45	(0.11-1.78)	a,s,l,t,o,al
Case-control studies							
Hanrahan LP, 2003[30]	Physician-diagnosed nasal allergy or hayfever		~2425	OR	1.1	(0.9 - 1.4)	a,s,t,o
Sprince NL, 2002,[35] 2003[36-38]	Self-reported doctor-diagnosed asthma	All injuries	903	OR	1.63	(0.90 - 2.96)	a,s,l,t,o
		Injuries from machinery	677	OR	1.45	(0.70 - 3.04)	
		Injuries from livestock	457	OR	2.46	(1.15 - 5.25)	
		Fall-related injury	552	OR	2.27	(0.95 - 5.45)	

a - age; s - sex; l - location; t - time period; o - occupation/job demands; y - years of experience in job; w - weekly working hours; al - alcohol consumption

* original 90% CI recalculated as 95% CI; M = Male; F = Female.

Table 5
Medication and risks of occupational injury

Design First Author	Definition of exposure(s)	Sub-category of injury	Nos. in analysis	Effect measure	Point estimate (95% CI)	Confounders considered
ANXIOLYTICS, HYPNOTICS, SEDATIVES **Cross-sectional studies**						
Proctor RC, 1981[18]	Diazepam in prior 6 months vs. none	All	620	Mean no. of accidents (SD) 0.12 (0.40) vs 0.11 (0.34), P>0.05		l,t
Wadsworth EJK, 2003[19]	Sleeping pills in last 14 days	Injuries requiring medical attention	1535	OR	2.82 (0.84 - 9.44)	a,s,l,t,al
		Injuries not requiring medical attention	1541	OR	2.18 (0.79 - 6.02)	
Case-control studies						
Chau N, 2004[25]	Regular consumption of sleeping pills	All	1760	OR	4.7 (2.0 - 12.7)	s,l,t,o
Gilmore TM, 1996[29]	Sedative hypnotics in prior 30 days	All	5931 (M)	OR	0.8 (0.4 - 1.5)	a,s,l,t
		All	4251 (F)	OR	1.5 (0.9 - 2.3)	
Moll van Charante AW, 1990[31]	Self-reported use of tranquillisers	All	512	OR	1.4 (0.4 - 4.4)	a,s,l,t
Montastruc JL, 1992[32]	Benzodiazepines in prior 7 days	All	662 (M)	OR	0.7 (0.3 - 1.4)	s,l,t
		All	328 (F)	OR	1.1 (0.6 - 2.2)	
Pickett W, 1996[34]	Tranquilizers/sleeping pills in prior 30 days	All	675	OR	0.4 (0.0 - 1.9)	t,w
Voaklander DC, 2006[40]	Anxiolytics, sedatives, or hypnotics in prior: 0 - 30 days	All	1692	OR	3.01 (1.39 - 6.52)	a,s,l,t,o
	31 - 90 days				0.83 (0.31 - 2.20)	
	91 - 180 days				0.49 (0.14 - 1.75)	
	>180 days				0.34 (0.10 - 1.16)	
ANTIDEPRESSANTS **Cross-sectional studies**						
Wadsworth EJK 2003[19]	Antidepressants in last 14 days	Injuries requiring medical attention	1535	OR	1.91 (0.71 - 5.11)	a,s,l,t,al
		Injuries not requiring medical attention	1541	OR	1.16 (0.47 - 2.87)	
Case-control studies						
Gilmore TM, 1996[29]	Antidepressants in prior 30 days	All	5931 (M)	OR	1.2 (0.7 - 2.1)	a,s,l,t
		All	4251 (F)	OR	1.2 (0.9 - 1.7)	
Pickett W, 1996[34]	Antidepressants in prior 30 days	All	675	OR	0 (0.0 - 1.3)	t,w
ANTIPSYCHOTICS **Case-control studies**						
Gilmore TM, 1996[29]	Antipsychotics in prior 30 days	All	5931 (M)	OR	0.4 (0.1 - 1.8)	a,s,l,t
		All	4251 (F)	OR	0.6 (0.3 - 1.4)	
PSYCHOTROPIC DRUGS (UNSPECIFIED) **Cross-sectional studies**						
Bhattacherjee A, 2003[7]	Regular psychotropic drug use	All	2562	OR	1.54 (1.16 - 2.05)	a,s,l,t,o
Proctor RC, 1981[18]	Psychoactive medication, past 6 months (vs. none)	All	648	Mean no of accidents (SD) 0.16 (0.41) vs 0.11 (0.34), P>0.05		l,t

Design First Author	Definition of exposure(s)	Sub-category of injury	Nos. in analysis	Effect measure	Point estimate (95% CI)		Confounders considered
NARCOTICS **Case-control studies**							
Gilmore TM, 1996[29]	Narcotics in prior 30 days	All	5931 (M)	OR	1.0	(0.7 - 1.4)	a,s,l,t
		All	4251 (F)	OR	0.8	(0.5 - 1.1)	
Voaklander DC, 2006[40]	Narcotic pain killers in prior: 0 - 30 days	All	1692	OR	0.68	(0.28 - 1.63)	a,s,l,t,o
	31 - 90 days				9.37	(4.95 - 17.72)	
	91 - 180 days				1.03	(0.44 - 2.38)	
	>180 days				0.63	(0.32 - 1.24)	
ANTIHISTAMINES **Cross-sectional studies**							
Bunn WB, 2003[9]	Self-report in past 12 months of antihistamine use (vs. none): Sedating	All	Unclear		(vs. 10.1%) 15.9%	(P<0.05)	a,s,t
	Non-sedating				14.2%		
	Both sedating and non-sedating				13.5%		
Case-control studies							
Dunn EV, 1979[27]	Antihistamines in previous 24 hours	All	230	OR	0.5	(0.2 - 2.0)	s,l,t
Gilmore TM, 1996[29]	Antihistamines in prior 30 days	All	5931 (M)	OR	1.4	(1.0 - 2.1)	a,s,l,t
		All	4251 (F)	OR	1.5	(1.1 - 2.1)	
Hanrahan LP, 2003[30]	Sedating antihistamines in prior 2 weeks	All	~2425	OR	2.93	(2.83 - 3.04)†	a,s,t,o
OTHER DRUGS **Case-control studies**							
Gilmore TM, 1996[29]	Non-narcotic analgesics in prior 30 days	All	5931 (M)	OR	1.4	(1.1 - 1.8)	a,s,l,t
		All	4251 (F)	OR	0.9	(0.7 - 1.1)	
	Antibiotics in prior 30 days	All	5931 (M)	OR	1.3	(1.0 - 1.7)	
		All	4251 (F)	OR	1.2	(0.9 - 1.5)	
Pickett W, 1996[34]	Heart or circulatory drugs in prior 30 days	All	675	OR	1.1	(0.5 - 2.1)	t,w
Voaklander DC, 2006[40]	Nonsteroidal anti-inflammatory drugs in prior: 0 - 30 days	All	1692	OR	1.56	(0.80 - 3.03)	a,s,l,t,o
	31 - 90 days				2.40	(1.43 - 4.03)	
	91 - 180 days				0.95	(0.51 - 1.84)	
	>180 days				1.67	(1.00 - 2.81)	

a - age; s - sex; l - location; t - time period; o - occupation/job demands; y - years of experience in job; w - weekly working hours; al - alcohol consumption

†Main effect (the model included an interaction term with age, pointing to slightly lower risks at older ages); M = male; F = female; OR = odds ratio; SD = standard deviation