Exposure to multiple hazards among Australian workers

Safe Work Australia | February 2015

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Preface

The Australian Safety and Compensation Council (ASCC) (now Safe Work Australia) requested the development of the National Hazard Exposure Worker Surveillance (NHEWS) survey to examine the nature and extent of Australian workers' exposure to selected occupational disease-causing hazards. The survey also collected information from workers about the controls that were provided in workplaces to eliminate or reduce these hazards. The results of the NHEWS survey are intended to be used to identify where workplace exposures exist that may contribute to the onset of one or more of the eight priority occupational diseases identified by the National Occupational Health and Safety Commission (NOHSC) in 2004. These diseases are: occupational cancer, respiratory diseases, noise-induced hearing loss, musculoskeletal disorders, mental disorders, cardiovascular disease, infectious and parasitic diseases and contact dermatitis.

The NHEWS survey was developed by the ASCC in collaboration with Australian WHS regulators and a panel of experts. These included Dr Tim Driscoll, Associate Professor Anthony LaMontagne, Associate Professor Wendy Macdonald, Dr Rosemary Nixon, Professor Malcolm Sim and Dr Warwick Williams. The NHEWS survey was the first national survey on exposure to workplace hazards in Australia.

In 2008, Sweeney Research was commissioned to conduct the NHEWS survey using computer assisted telephone interviews (CATI). The data, collected from 4500 workers, forms a national data set of occupational exposures across all Australian industries. The survey was conducted in two stages. The first stage (n=1900) focussed on the five national priority industries as determined by NOHSC in 2003 and 2005. These industries were selected to focus the work under the National Strategy 2002-2012 relating to reducing high incidence and high severity risks. The priority industries are Manufacturing, Transport & storage, Construction, Health & community services and Agriculture, forestry & fishing. The second stage (n = 2600) placed no restrictions on industry.

This report focuses on Australian workers' self-reported exposure to multiple hazards in the workplace. It examines the prevalence of exposure to multiple hazards, examines different types of multiple exposures such as co-exposure to noise and vibration. The report identifies patterns of exposure to multiple hazards in terms of demographic, employment and workplace characteristics.

This research report has been written to inform the development of work health and safety policies to reduce exposure to hazards in Australian workplaces. The views and conclusions expressed in this report do not necessarily represent the views of Safe Work Australia members.

Contents

Key Messages

- It is generally well known that workers can be exposed to disease-causing hazards in their workplaces. However, specific hazards and their controls are usually examined on an individual basis or in isolation. This means the contribution of multiple and often concurrent exposures to disease-causing hazards to work health and safety risks is much less well understood.
- The findings in this report specifically deal with multiple hazard exposures and examine factors such as particular types of workers, occupations and industries with high exposures and few or no controls.
- Workplaces and regulators should focus on the following issues to reduce hazard exposures before disease occurs:
    - 62% of workers reported exposure to multiple types of hazards; one in five reported exposure to at least five hazards.
    - A significant proportion of workers reported that they had incomplete or no access to control measures for the multiple hazards that they reported being exposed to.
    - The most common self-reported exposure was to high job demands, followed by exposure to airborne hazards and exposure to chemicals.
    - Working longer hours, being young, working as Labourers or Technicians and trades workers and working in Agriculture, forestry and fishing were associated with exposure to multiple hazards.
- This report highlights the need for duty holders to ensure exposures to hazards are controlled as far as is reasonably practicable in line with the work health and safety laws. Workers should be encouraged to use controls provided and work health and safety regulators need to encourage appropriate control of hazards in the workplace. It is recommended that workplaces follow the hierarchy of control measures when addressing occupational hazards and apply higher order control measures if reasonably practicable.
- Duty holders must take action to increase awareness and knowledge of health and safety hazards and risk control measures among young workers.
- Comprehensive risk assessment and risk management activities are essential in workplaces instead of focusing on a single hazard at a time. Controls measures should be implemented according to the hierarchy of controls.
- Help can be found on the websites of Safe Work Australia and the WHS regulator in each state or territory in the form of codes of practice or guidance material relating to most workplace hazards.

Executive Summary

Background and aim

The 2008 National Hazard Exposure Worker Surveillance (NHEWS) Survey was conducted to obtain information about the prevalence of exposures to hazards associated with occupational diseases. A total of 4500 workers participated in this survey. Eight reports from the NHEWS survey on individual hazards have been published. These were reports on noise, vibration, biological materials, biomechanical demands, wet work, skin contact with chemicals, airborne hazards and sun exposure. The current report examines self-reported exposure to multiple hazards among participants of the NHEWS survey.

This research report has been written to inform the development of work health and safety policies to reduce exposure to hazards in Australian workplaces. The views and conclusions expressed in this report do not necessarily reflect the views of Safe Work Australia members.

Main findings

Among the nine hazards examined in this report, the most common self-reported exposure was to high job demands, followed by exposure to airborne hazards and exposure to chemicals. Over 60% of workers reported that they were exposed to more than one hazard in the workplace. One in five workers reported exposure to at least five hazards.

Average number of hazards

On average, workers reported that they were exposed to 2.6 (out of nine examined) hazards.

There were differences in the average number of hazards workers were exposed to by: gender, age, working hours and night work. Males reported exposure to an average of 3 hazards whereas females reported exposure to an average of 2.1 hazards. The average number of hazards declined with age and increased with working hours. Night workers reported exposure to more hazards on average than workers who worked during the day.

Workers in certain industries and occupations were more likely to report exposure to multiple hazards. Those in the Agriculture, forestry & fishing industry had the highest average self-reported exposure to hazards (3.7 hazards), followed by Construction (3.5 hazards) and Mining (3.5 hazards). Technicians and trades workers (3.8 hazards) and Labourers (3.6 hazards) were occupations with the highest average self-reported exposure to hazards.

The risk of self-reported exposure to hazards

Workers 15-24 years old reported exposure to 30% more hazards than workers who were 55 years and older, taking into account other characteristics such as occupation and education. Workers who worked more than 45 hours per week reported exposure to 60% more hazards compared to those who worked 19 hours or fewer per week. Workers employed as a permanent employee reported exposure to 25% more hazards than workers in fixed term employment. However, this may be because contract (or casual) workers may not have adequate training

and knowledge to identify or understand hazards in their workplace and therefore they may not be aware of exposure to certain hazards. Workers in the Health & community services industry reported exposure to 18% more hazards and those in the Agriculture, forestry & fishing industry reported exposure to 12% more hazards than workers in the Transport & storage industry. Labourers and Technicians & trades workers reported exposure to almost twice as many hazards as Managers. Night workers reported exposure to 16% more hazards than day workers. There were no significant differences by gender.

Co-exposure to six or more hazards

One in ten workers reported exposure to six or more hazards. However, about 30% of males reported exposure to six or more hazards compared to 5% among females. Similarly, 31% workers who worked more than 45 hours per week reported exposure to six or more hazards compared to 6% among those who worked 19 hours or fewer per week. About one in five workers in Agriculture, forestry & fishing and Construction reported exposure to six or more hazards. Over one in five Technicians & trades workers also reported this extent of exposure to disease-causing hazards.

These demographic and employment factors were included in a regression model to determine the odds of the likelihood of exposure to six or more hazards for each factor, taking into account other factors. Younger workers had significantly higher odds of reporting exposure to six or more hazards compared to workers 55 years and older. The odds of reporting high levels of exposure declined with decreasing hours of work. Compared to those who did not complete Year 12, workers with a postgraduate level education had significantly lower odds of reporting high levels of exposure. In terms of industry, compared to the Transport & storage industry, those working in the Agriculture, forestry & fishing and the Health & community services industry were 2.2 times more likely to report exposure to six or more hazards. Compared to Managers, Technicians & trades workers were 2.9 times more likely to report exposure to six or more hazards. There were no significant differences by gender.

Co-exposure to noise and vibration

About one in five workers reported exposure to both noise and vibration. Male, younger workers and those working longer hours were more likely to report exposure compared to females, older workers and those working fewer hours. Almost 30% of workers with a trade certificate reported co-exposure to noise and vibration compared to 5% among workers with a postgraduate level of education. About half (53%) of workers in Mining reported co-exposure to noise and vibration and the proportion was 40% among Construction workers. Almost half (45%) of Technicians & trades workers reported co-exposure to noise and vibration.

When these factors were considered together, males were 2.5 times more likely than females to report co-exposure to noise and vibration. The odds of reporting co-exposure to noise and vibration generally declined with age with the highest odds of reporting exposure observed among the youngest workers. Compared to workers in the Health & community services industry, workers in the Agriculture, forestry & fishing industry were 3.2 times more likely to report co-exposure to noise and vibration. Workers from Manufacturing, Transport & storage, and Construction industries also had significantly higher odds of co-exposure to noise and vibration than workers from the Health & community services industry. Labourers and Technicians

& trades workers were 2.8 times and 2.7 times more likely to report co-exposure to noise and vibration than Managers. The odds of reporting co-exposure to noise and vibration also increased with increasing work hours.

Co-exposure to airborne hazards and chemicals

Almost one in four workers reported exposure to both airborne hazards and dermal contact with chemicals. About 30% of males reported co-exposure to airborne hazards and chemicals and the proportion among females was 14%. Over a third (35%) of workers aged 15–24 years reported co-exposure compared to 20% among workers aged 55 years or older. The proportion of workers reporting co-exposure to airborne hazards and chemicals also declined with workplace size. About 39% of Construction workers reported this co-exposure and the proportion of workers in the Agriculture, forestry & fishing industry who reported co-exposure was 36%. Almost half (45%) of Technicians & trades workers and 39% of Labourers reported co-exposure to airborne hazards and chemicals.

When demographic and employment factors were considered together, males were significantly more likely to report co-exposure to airborne hazards and chemicals compared to females. The odds of reporting co-exposure to airborne hazards and chemicals generally decreased with age, with workers in the 15-24 years age group having the highest odds of exposure compared to those who were 55 years and older. Compared to those working 19 hours or less, those working more than 45 hours were 1.9 times more likely to report co-exposure to airborne hazards and chemicals. Workers in the Accommodation, cafes and services industry and workers in the Agriculture, forestry and fishing were 2.4 times more likely to report co-exposure to airborne and chemical hazards than workers in the Property & business services industry. Workers in the Agriculture, forestry & fishing, Construction and Health & community services industries also had significantly higher odds of reporting co-exposure to airborne hazards and chemicals than workers in the Property & business services industry. Compared to Managers (reference group), Technicians & trades workers were 3.2 times more likely to report co-exposure to airborne hazards and chemicals. Those who worked at night were 1.5 times more likely to report co-exposure to airborne hazards and chemicals compared to those who worked during the day. Those working in micro workplaces and small workplaces had significantly higher odds of reporting co-exposure to airborne hazards and chemicals compared to those working in large workplaces.

Control measures

About one in four workers with co-exposure to noise and vibration reported that they were not provided with any control measures or they had control measure for only one of the two hazards. Similar findings were observed for co-exposure to airborne hazards and chemicals.

Conclusions

The findings of this report suggest that co-exposures to multiple hazards were common among NHEWS participants. This highlights the need for duty holders to ensure exposures to hazards are controlled as far as is reasonably practicable, to encourage workers to use controls provided and for work health and safety regulators to encourage appropriate control of hazards. It is recommended that workplaces follow the hierarchy of control measures when addressing occupational hazards and apply higher order

control measures if reasonably practicable. Particular types of workers were especially at risk—young workers, those working in Agriculture, forestry & fishing, those working as Technicians & trades workers or Labourers and those working at night.

Given that young workers were more likely to report exposure to multiple hazards, it is important to ensure that they are protected at work. Young workers are particularly vulnerable because of their inexperience and lack of knowledge about hazards at work. A good place to start is work health and safety training while young people are still at school. However, South Australian research indicates that there are no minimum standards for what should be covered in this training (Pisaniello et al., 2013). Moreover, this study also found that a proportion of teachers who are teaching work health and safety at schools have no formal work health and safety training and are often just using what they have read online. A one-stop shop of resources for young people and their teachers on work health and safety might be useful.

The other issue that has not been examined much to date is whether young workers alter their safety practices (either positively or negatively) after their health and training at school or at vocational education institutions to be consistent with the safety practices of the workplace. This is suggested as a future area of research. A profile on young worker health and safety based on existing data sources, including comparisons of their attitudes and perceptions of safety to older workers and examination of specific industries and occupations with a high proportion of young workers is recommended as a next step.

Females are usually considered to undertake less hazardous work compared to men as they are not usually employed in occupations with high risk of injuries or fatalities. This report found that in terms of the number of hazards workers reported exposure to there were no significant differences by gender. However, males had higher odds of reporting exposure to certain types of multiple exposures compared to females. This suggests that exposure to multiple hazards among females should not be discounted even if females are less likely to be exposed to specific types of hazards such as vibration and noise. Gender segregation of occupations and tasks is still prevalent and much occupational research and attention is still focused on hazards that exist in male dominated industries and occupations. This report highlights the need to also concentrate on hazards that are prevalent in female dominated occupations and industries.

Although this report examines individual characteristics such as age, gender and education, ultimately it is the exposure to hazards that is an important predictor of work-related illness. Individual and employment differences only serve to help identify priorities and strategies for intervention. The findings presented here demonstrate that the majority of workers are exposed to multiple hazards in the workplace. This stresses the importance of continuing research into the health effects of multiple hazard exposures in the workplace. It also highlights the need to consider the whole range of potential hazards in the workplace when conducting risk assessment and risk management activities.

The findings also suggest the need for better access to control measures in the workplace, particularly for airborne hazards and vibration. However, there may have been engineering or administrative controls in place that workers were not aware of and therefore were not captured in this self-report survey.

1. Context

Background

Prevention of occupational diseases has been a national priority for work health and safety in Australia since 2002 with the launch of the National Occupational Health and Safety Strategy 2002-12. In 2004, the National Occupational Health and Safety Commission (NOHSC) considered eight occupational diseases as priority occupational diseases for prevention. Prevention of occupational diseases is also reflected in the outcomes of the new Australian Work Health and Safety Strategy (2012-2022) with the identification of five priority occupational diseases (musculoskeletal disorders, mental disorders, cancers, contact dermatitis and noise induced hearing loss) for the first five years of the Strategy.

In order to inform prevention strategies for occupational diseases, information on worker exposure to occupational disease-causing hazards is needed. This is because compensation and other occupational disease data (when available) are inadequate for diseases of long latency. This is because they can only provide indications of past exposures and not current exposures. In response to this need the National Hazard Exposure Worker Surveillance (NHEWS) Survey was conducted in 2008. The survey aimed to estimate the prevalence of exposure to occupational disease causing hazards in Australian workers. The hazards covered in the NHEWS survey were noise, vibration, airborne hazards, wet work, biological materials, sun exposure, biomechanical demands, job demands and skin contact with chemicals.

Although the NHEWS sample is not nationally representative, the NHEWS dataset provides information on workplace exposures in Australia for a wide number of hazards across all industries and occupations. This is a strength of the NHEWS survey as many studies tend to be limited in coverage in terms of hazards, industries and occupations (Checkoway, Pearce, & Kriebel, 2004). Using the NHEWS dataset, eight research reports on individual hazards have already been published.

The need to look at multiple exposures

It is well recognised that workers are typically exposed to a number of occupational hazards at the same time (e.g. Hagberg et al., 2001; Quinn et al., 2007) and the need for better research into multiple exposures in the workplace has been identified as a priority for work health and safety research (Smith, 2010). A first step in this area is to better understand the prevalence of multiple or concurrent exposures in the workplace and the characteristics of workers with exposure to multiple occupational hazards.

This examination of the prevalence of exposure to multiple hazards is particularly important as most occupational studies focus on exposure to a single hazard rather than multiple hazards (Quinn et al., 2007). When the issue of multiple exposures to hazards has been examined it has predominantly been in relation to multiple exposures to different chemicals

(Apostoli et al., 1998; Laitinen et al., 2012; Murti, 1987). Other than chemicals, a limited number of studies have examined multiple exposures to hazards that could cause the same health outcome as part of attempts to establish the exposure-outcome relationship (e.g. cancer) (Sliwinska-Kowalska et al., 2004). The nature of such studies means that much of the available information on multiple exposures is limited to studies on particular groups of workers or industry (Attarchi, et al., 2013; Neitzel et al., 2013; Rosenberg et al., 2002). Therefore information on the prevalence of exposures to multiple hazards among a wide range of workers is needed.

Some information for Australian workers on the prevalence of exposure to multiple hazards is available (LaMontagne & Vallance, 2008). A study of Victorian workers examined self-reported exposure to ten hazards and found that exposure to multiple hazards varied by occupational skill level and workplace size. Hazards measured in this study included dangerous work methods, dangerous chemicals, air pollution, excessive noise, infectious diseases, dangerous machinery or tools, environmental tobacco smoke and unwanted sexual advances.

Aim and structure of the report

The wide coverage of the NHEWS survey in terms of different occupational hazards and inclusion of workers across all states and territories provides a unique opportunity to examine the prevalence of self-reported worker exposure to multiple hazards.

This report will provide the first look at the prevalence of exposure to multiple types of hazards among workers across Australia for the nine hazards covered in the NHEWS survey. Specifically, this report will examine:

- average number of self-reported hazard exposures by socio-demographic and employment characteristics of workers
- factors associated with different types of self-reported multiple exposures including:
    - exposure to six or more hazards (high reported hazard exposure)
    - co-exposure to noise and vibration, and
    - co-exposure to airborne hazards and chemicals (skin contact)
- control measures for workers with co-exposure to noise and vibration, and
- control measures for workers with co-exposure to airborne hazards and chemicals.

In this report we examine exposure to different ranges of hazards like exposure to noise and chemicals. For certain types of hazards for example, chemicals, a worker can be exposed to a number of different chemicals. This report does not focus on such multiple exposures, rather on multiple exposures to different broad categories of hazards. For ease of reading exposure to multiple categories of hazards are referred to in this report as exposure to multiple hazards.

The following section describes the exposure variables used in this report with more details of the survey and data analysis provided in Appendix A and Appendix B. Section 3 summarises the main findings and Section 4 is a discussion of these findings. Appendices C and D contain supplementary tables and figures to support the main findings presented in this report.

2. Approach

The detailed methodology of the NHEWS survey and the survey instrument are provided in Appendix A.

Exposure was defined in one of two ways in this report (Table 1). For noise, vibration, biological hazards, chemical hazards and airborne hazards, a person was considered exposed based on any self-reported exposure to a particular hazard regardless of frequency, intensity or duration of exposure. This simple classification has to be used because there was no way of determining what might be considered high or hazardous exposure based on the information obtained in the NHEWS survey. However, for four hazards, a more rigorous definition of exposure (i.e. high exposure) could be defined based on methods covered in previous NHEWS reports (wet work, biomechanical demands and sun) and/or the literature (job demands).

For further details on how exposure was defined for each hazard and the links to relevant reports on individual hazards from the NHEWS survey, please see Appendix B.

Table 1. Definition of exposure for hazards covered in this report

Hazard	Definition of exposed worker
Sun	Self-reported exposure to sun for 4 or more hours a day during the week preceding the survey
Wet work	Self-reported exposure to hand washing 20 or more times a day and/or hands immersed in liquids for more than two hours per day during the week preceding the survey
High biomechanical demands	Self-reported exposure to eight measures of biomechanical demands whose combined exposure score was at the upper 25th percentile
High job demands	Self-reported exposure to eight measures of psychological job demands whose average score was at the median for the sample or above
Noise	Self-reported exposure to loud noise* the week preceding the survey
Vibration	Self-reported exposure to hand/arm and/or whole body vibration the week preceding the survey
Biological hazards	Self-reported exposure to biological materials the week preceding the survey
Chemical hazards (dermal)	Self-reported exposure to working with chemicals in the week preceding the survey
Airborne hazards	Self-reported exposure to dusts and/ or gases, vapours or fumes the week preceding the survey
Note: * defined as noise so loud that you would have to raise your voice to be heard to speak to people who are at one arm's length away from you. This has been reported to be roughly equivalent to 85 dB(A).	

3. Main Findings

Description of the survey sample

About 56% of the workers who participated in the NHEWS survey were male. Less than 6% of the sample were workers aged 15 to 24 years old. The majority (93%) of the sample understood English very well. About 6% were night workers and 38% worked between 20 and 38 hours per week. About one in five worked in workplaces with less than five employees.

Noting that the NHEWS study oversampled within the priority industries, the most common industry of employment was the Health & community services industry (21%), followed by Manufacturing (16%) and Construction (15%). This oversampling of priority industries had an effect on the distribution of occupations in the NHEWS sample. About one in four workers in the NHEWS survey were Professionals and 19% were Technicians & trades workers.

Further details on the socio-demographic and employment characteristics of the NHEWS sample are provided in Table C.1 and Table C.2 in Appendix C. Characteristics of the employed Australian population from Census 2006 are also provided for comparison in Table C.1.

Summary of exposures

62% of workers reported exposure to more than one type of hazard and almost 20% reported exposure to 5 or more hazards

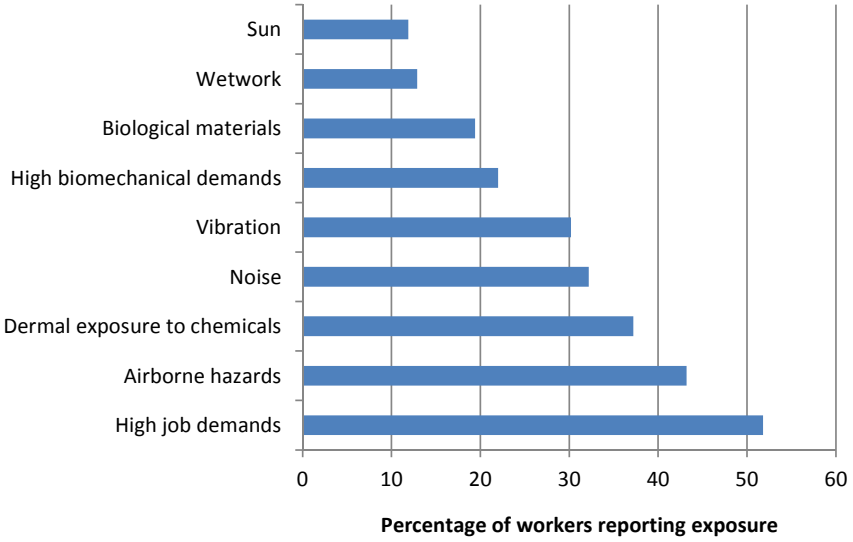
A total of 3760 (86%) workers who participated in the NHEWS survey reported exposure to at least one of the nine occupational hazards (see Table 2). Approximately 20% of workers reported exposure to at least five hazards. Only five workers reported exposure to all nine hazards covered in this report.

Table 2. Prevalence of exposure to multiple hazards in the NHEWS survey

Number of hazards	N	%
None	637	14.5
One hazard	1033	23.5
Two hazards	666	15.1
Three hazards	645	14.7
Four hazards	553	12.6
Five hazards	438	10.0
Six hazards	271	6.2
Seven hazards	112	2.5
Eight hazards	37	0.8
Nine hazards	5	0.1
Total	4397	100.0
Note: excludes workers with missing data for any of the nine hazards (n=103)		

When looking at individual hazards, 13% of workers reported exposure to wet work and 19% to biological materials (Figure 1). About 22% reported exposure to high biomechanical demands and 43% of workers reported exposure to airborne hazards. Over half of workers reported exposure to high job demands.

Figure 1. Percentage of workers reporting exposure by type of hazard



Average number of hazards workers reported exposure to by worker demographic and employment characteristics

Individual factors

Males, night workers, those with low English competency, long working hours, small workplaces and those with a trade qualification were exposed to more hazards on average.

Workers reported that they were exposed to an average of 2.6 hazards in their workplace. When stratified by gender, males reported that they were exposed to an average of 3.0 hazards in their workplace whereas females reported that they were exposed to 2.1 hazards on average (Figure 2). The average number of hazards workers reported exposure to declined with increasing age, from 3.2 hazards among workers who were 15–24 years old to 2.3 hazards among workers who were 55 years or older.

On average, night workers reported exposure to significantly more hazards than day workers. In addition, workers with a lower level of English competency reported exposure to more hazards on average than workers who understood English very well.

There were also differences observed by working hours and workplace size. The average number of hazards workers reported exposure to increased with longer working hours. Workers who worked 19 hours or less per week had an average self-reported exposure to 1.9 hazards. In contrast, workers with the longest working hours (> 45 hours per week) reported exposure to 3.3 hazards on average. The average number of hazards workers reported exposure to also significantly differed by workplace size. Workers in small workplaces reported exposure to a higher number of hazards on average than workers in larger workplaces.

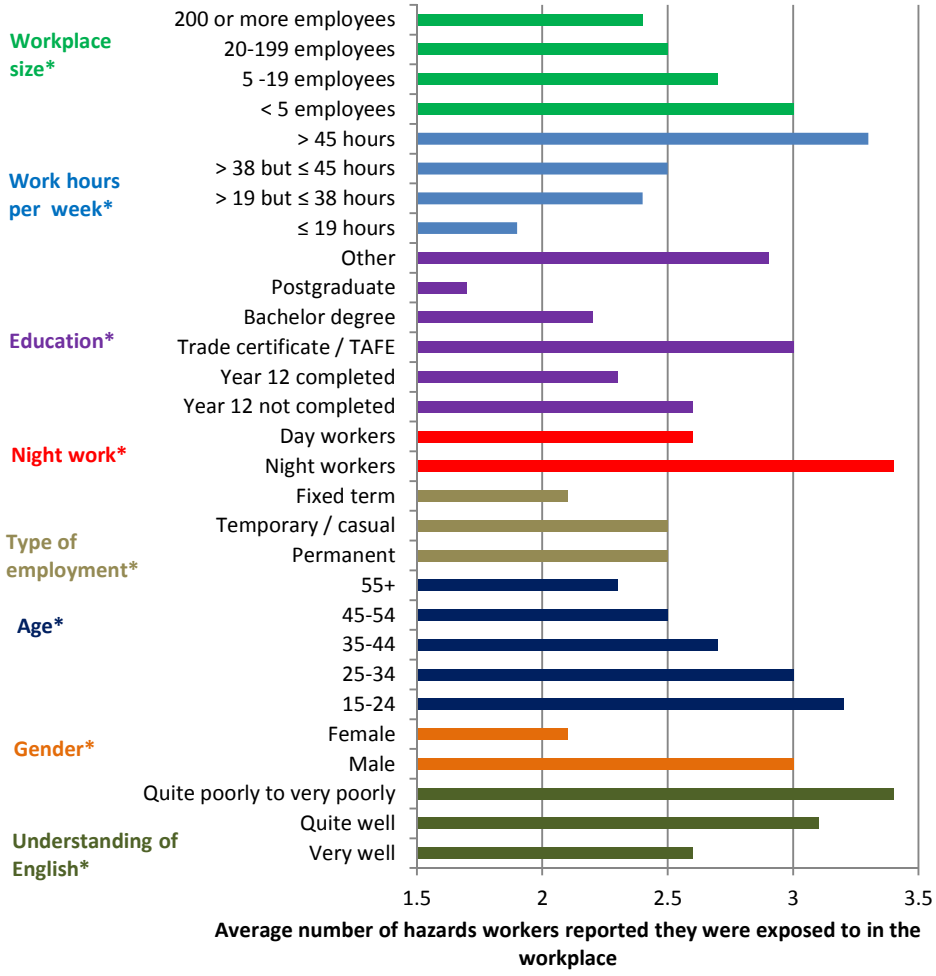
Workers with a trade certificate or TAFE qualification reported that they were exposed to three hazards on average. This was the highest average among different education categories. This was followed by those with ‘other’ level of education. This particular educational group primarily consists of vocational or task specific training (e.g. forklifting, scaffolding certificate or hospital based nurse training) and license for a particular occupation (e.g. pilot license).

Workers in Agriculture, forestry & fishing, Construction and Mining reported exposure to the highest average number of disease-causing hazards

There were significant differences in the average number of hazards that workers reported being exposed to by industry of employment and occupation. Workers from the Finance & insurance industry reported the least exposure to occupational hazards with an industry average of 0.7 (See Figure D.1 at Appendix D). In contrast, workers in the Agriculture, forestry & fishing industry had the highest average self-reported exposure to multiple hazards (3.7 hazards) with the most common exposures being sun, vibration and airborne hazards. Other industries with a high average number of self-reported hazard exposures include Construction (3.5 hazards) and Mining (3.5 hazards). Again, these results should be interpreted noting that the majority of the hazards examined in the NHEWS Survey were hazards that are common in blue collar industries. There was also differential exposure to multiple hazards by occupation. Technicians & trades workers reported the highest average exposure to multiple hazards (3.8 hazards), followed by Labourers (3.6) and Machinery operators & drivers (3.4) (Figure D.2, Appendix D).

Statistical details of these analyses are provided in Table C.3, Appendix C.

Figure 2. The average number of hazards workers reported that they were exposed to by demographic and employment characteristics (* indicates p < 0.05)



The risk of exposure to hazards

The number of hazards each worker reported exposure to (a number from 0 to 9) can be used as an outcome variable to determine the incidence rate ratio. The incidence rate ratio (IRR) is the probability of exposure to hazards for a given characteristic (e.g. male) compared to the probability of exposure to hazards for those not having a given characteristic (e.g. female).

When holding other factors constant in a Poisson regression model (regression model for counts), the following characteristics were associated with self-reported exposure to more hazards (Table 3):

- age
- working hours
- employment type
- industry of employment
- occupation, and
- night work.

Workers who were 15–24 years old reported exposure to 30% more hazards compared to workers who were 55 years when other factors were taken into account

Workers aged 15–24 years old reported exposure to 30% more hazards than workers who were 55 years and older when the remaining factors were held constant. Workers who worked more than 45 hours per week reported exposure to 61% more hazards than those who worked 19 hours or less per week. Those who were employed as a permanent employee reported exposure to 25% more hazards than those in fixed term employment. However, this may be because contract (or casual) workers may not have adequate training and knowledge to identify or understand hazards in their workplace and therefore they may not be aware of exposure to certain hazards.

Labourers and Technicians & trades workers reported exposure to 96% and 90% more hazards than Managers

Workers in the Health & community services industry reported exposure to 18% more hazards and those in the Agriculture, forestry & fishing industry reported exposure to 12% more hazards compared to workers in the Transport & storage industry. Labourers reported exposure to 96% more hazards than Managers. Similarly, Technicians & trades workers reported exposure to 90% more hazards than Managers. Night workers reported exposure to 16% more hazards than day workers.

Once other factors were taken into account, there were no significant differences in the number of hazards males and females workers reported exposure to.

Table 3. Model factors for Poisson regression model predicting the number of hazards workers reported exposure to (n=3326)

Characteristics	IRR	95% CI
Age groups		
15–24 vs. 55+	1.30	1.19–1.43
25–34 vs. 55+	1.33	1.24–1.43
35–44 vs. 55+	1.19	1.11–1.27
45–54 vs. 55+	1.10	1.03–1.17
Hours worked per week		
> 19 but ≤ 38 hours vs. ≤ 19 hours	1.29	1.17–1.42
> 38 but ≤ 45 hours vs. ≤ 19 hours	1.37	1.23–1.52
> 45 hours vs. ≤ 19 hours	1.61	1.44–1.78
Highest educational qualification		
Year 12 completed vs. Year 12 not completed	0.97	0.88–1.06
Trade certificate / TAFE vs. Year 12 not completed	1.07	1.00–1.14
Bachelor degree vs. Year 12 not completed	0.97	0.88–1.06
Postgraduate vs. Year 12 not completed	0.87	0.77–0.99
Other vs. Year 12 not completed	1.13	0.99–1.28
Industry		
Construction vs. Transport & storage	1.01	0.93–1.11
Manufacturing vs. Transport & storage	0.95	0.88–1.04
Health & community services vs. Transport & storage	1.18	1.07–1.30
Wholesale & retail trade vs. Transport & storage	0.89	0.78–1.02
Accommodation, cafes & restaurants vs. Transport & storage	0.98	0.84–1.15
Finance & insurance vs. Transport & storage	0.42	0.33–0.55
Property & business services vs. Transport & storage	0.59	0.51–0.69
Government administration & defence vs. Transport & storage	0.69	0.60–0.79
Education vs. Transport & storage	0.85	0.75–0.97
Cultural, recreational & personal services vs. Transport & storage	0.92	0.76–1.12
Agriculture, forestry & fishing vs. Transport & storage	1.12	1.00–1.26
Occupation		
Professionals vs. Managers	1.26	1.14–1.39
Technicians & trades workers vs. Managers	1.90	1.72–2.10
Community & personal service workers vs. Managers	1.55	1.38–1.75
Clerical & administrative workers vs. Managers	0.70	0.62–0.79
Sales workers vs. Managers	1.18	1.01–1.36
Machinery operators & drivers vs. Managers	1.72	1.54–1.93
Labourers vs. Managers	1.96	1.76–2.18
Worked at night in the reference week?		
Night workers vs. Day workers	1.16	1.08–1.26
Employment type		
Permanent vs. Fixed term	1.25	1.08–1.37
Temporary/casual vs. Fixed term	1.20	1.05–1.37

Note. IRR = incidence rate ratio; CI = confidence interval; English competency was not included in the final reduced model because it was not a significant predictor after accounting for all the other factors in the full model. Gender was also not a significant predictor but it was left in the model as gender was a variable of interest.

Co-exposure to six or more hazards (high exposure to multiple hazards)

Approximately 10% (n=425) of workers reported that they were exposed to six or more hazards (out of 9 covered in this report). For the purposes of this report, this is considered to be high self-reported exposure to disease-causing hazards.

Individual factors

As shown in Figure 3, a higher proportion of males (13%) reported exposure to six or more hazards compared to females (5%). Almost one in five (17%) workers who worked more than 45 hours a week reported exposure to six or more hazards compared to 7% among those who worked 20 to 38 hours a week. More night workers reported exposure to six or more hazards than day workers.

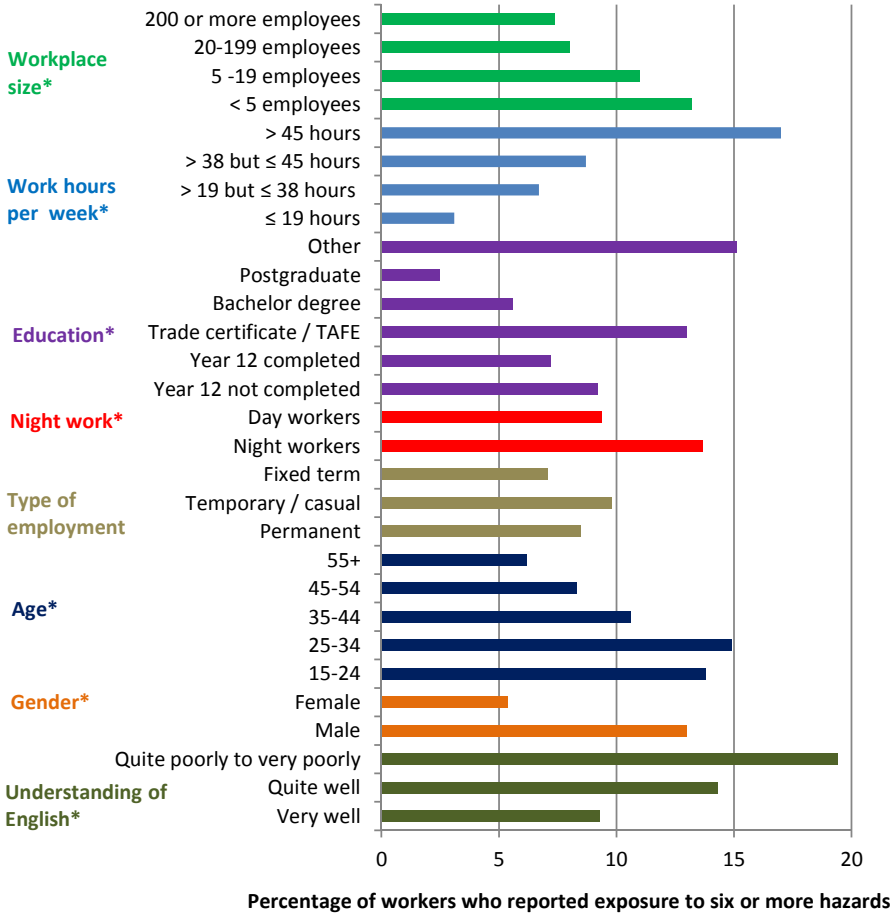
A higher proportion of workers with poorer English speaking skills and younger workers reported exposure to six or more hazards than those with better English and older workers. A higher proportion of workers with a trade certificate/TAFE and workers with 'other' level of education reported exposure to six or more hazards compared to workers with other levels of education. As mentioned earlier, the 'other' education category included vocational specific training. These differences were all statistically significant (Table C.3, Appendix C).

There were no statistically significant differences by type of employment.

High self-reported exposure to disease-causing hazards most commonly reported by workers in Agriculture, forestry & fishing (20%) and Construction (19%). No workers from Communication services and Finance & insurance industries reported co-exposure to six or more hazards (Figure D.3, Appendix D).

Approximately 21% of Technicians & trades workers and 16% of Labourers reported co-exposure to six or more hazards (Figure D.4, Appendix D). In contrast, only approximately 1% of Clerical & administrative workers reported co-exposure to six or more hazards.

Figure 3. Co-exposure to six or more hazards by demographic and employment characteristics (* indicates p < 0.05)



Characteristics associated with exposure to six or more hazards

The following characteristics were associated with exposure to six or more hazards when the above mentioned factors were accounted for in a logistic regression model:

- age
- working hours
- education
- industry of employment, and
- occupation.

Compared to workers who were 55 years and older, younger workers had significantly higher odds of reporting exposure to six or more hazards (Table 4). The odds of reporting exposure to six or more hazards also declined with decreasing hours of work. Compared to those who did not complete Year 12, workers with a postgraduate level education had significantly lower odds of reporting exposure to six or more hazards. In contrast, those with the 'other' level of education (e.g. forklift training) had increased odds of self-reported exposure to six or more hazards compared to the reference group (those who did not complete Year 12).

Workers in Agriculture, forestry & fishing were 2.2 times more likely to report exposure to six or more hazards than workers in Transport & storage

Technicians and trades workers had almost 3 times the odds of reporting exposure to 6 or more hazards compared to Managers

Compared to the reference industry, Transport & storage, those working in the Agriculture, forestry & fishing and the Health & community services industry had 2.2 times the odds of self-reported exposure to six or more hazards. Compared to Managers, Technicians & trades workers had 2.9 times the odds of reporting exposure to six or more hazards.

Table 4. Model factors for the logistic regression model predicting co-exposure to six or more hazards (n=4051)

Characteristics	OR	95% CI
Age groups		
15–24 vs. 55+	2.38	1.45–3.91
25–34 vs. 55+	2.75	1.88–4.02
35–44 vs. 55+	1.92	1.35–2.73
45–54 vs. 55+	1.46	1.03–2.07
Hours worked per week		
> 19 but ≤ 38 hours vs. ≤ 19 hours	2.45	1.28–4.70
> 38 but ≤ 45 hours vs. ≤ 19 hours	2.81	1.44–5.46
> 45 hours per week vs. ≤ 19 hours	5.59	2.89–10.81
Highest educational qualification		
Year 12 completed vs. Year 12 not completed	0.78	0.47–1.28
Trade certificate / TAFE vs. Year 12 not completed	1.15	0.82–1.60
Bachelor degree vs. Year 12 not completed	0.79	0.49–1.29
Postgraduate vs. Year 12 not completed	0.40	0.18–0.92
Other vs. Year 12 not completed	2.01	1.13–3.59
Industry		
Construction vs. Transport & storage	1.20	0.78–1.85
Manufacturing vs. Transport & storage	0.66	0.42–1.05
Health & community services vs. Transport & storage	2.17	1.25–3.77
Wholesale & retail trade vs. Transport & storage	0.50	0.21–1.17
Accommodation, cafes & restaurants vs. Transport & storage	1.01	0.43–2.41
Property & business services vs. Transport & storage	0.51	0.22–1.16
Government administration & defence vs. Transport & storage	0.57	0.23–1.45
Education vs. Transport & storage	0.79	0.34–1.81
Cultural, recreational& personal services vs. Transport & storage	1.14	0.48–2.73
Agriculture forestry & fishing vs. Transport & storage	2.20	1.34–3.61
Occupation		
Professionals vs. Managers	0.74	0.44–1.23
Technicians & trades workers vs. Managers	2.85	1.92–4.24
Community & personal service workers vs. Managers	1.14	0.64–2.03
Clerical & administrative workers vs. Managers	0.13	0.05–0.38
Sales workers vs. Managers	0.75	0.30–1.91
Machinery operators & drivers vs. Managers	1.52	0.93–2.49
Labourers vs. Managers	2.49	1.60–3.88

Note. OR = odds ratio; CI = confidence interval; model is also adjusted for gender. Workplace size, night work and English language competency were excluded from this final reduced model because they were not significant predictors in the full model accounting for other factors in the model. Model details: Chi-square=418.102, p <.001, Nagelkerke R square=.203.

Co-exposure to noise and vibration

About 1 in 5 workers reported exposure to both noise and vibration

Just over half of all workers surveyed did not report exposure to either noise or vibration (Table 5). About one in four workers reported exposure to either noise or vibration and one in five reported exposure to both noise and vibration.

Table 5. Self-reported exposure to noise and vibration

Self-reported exposure	Per cent (n=4494)
Not exposed to any	56.9
Exposed to noise or vibration	23.8
Exposed to both noise and vibration	19.3
Note. Six workers had missing data on at least one of the hazards so they were excluded from this analysis.	

Individual factors

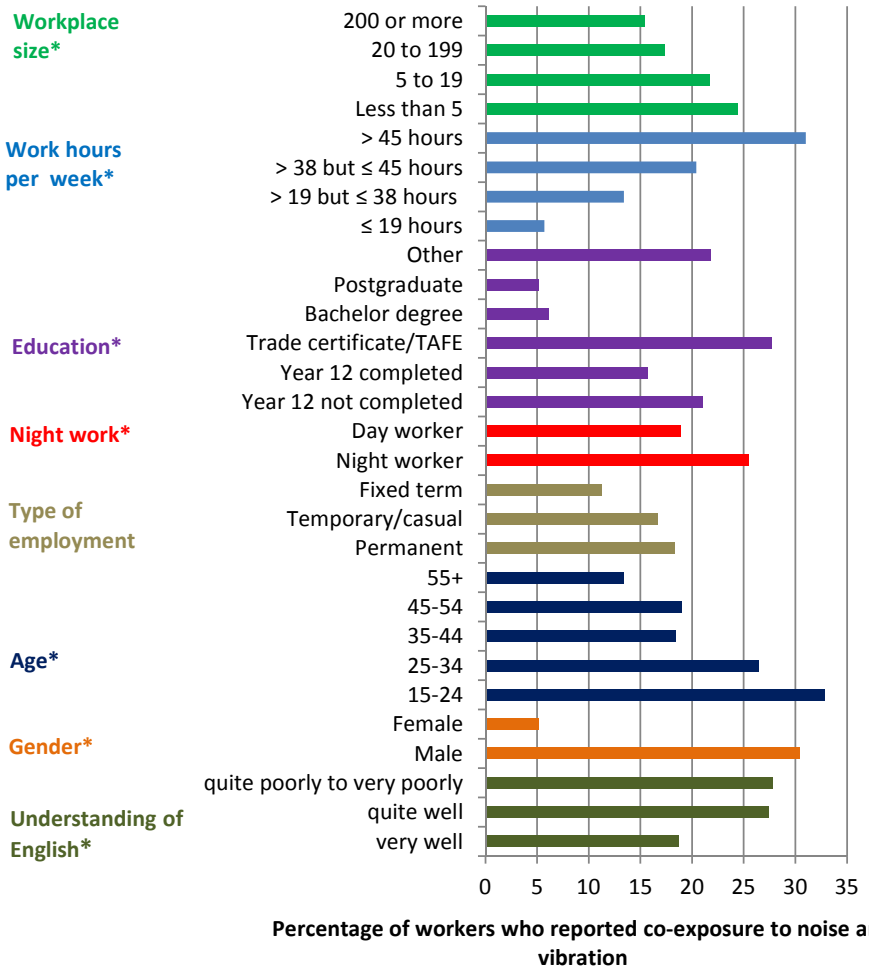
The proportion of workers who reported co-exposure to noise and vibration varied significantly within the following factors: gender, age, education, hours worked and workplace size (Figure 4). Almost a third of male workers reported co-exposure to noise and vibration compared to 5% among females. A third of young workers (15-24 years) reported exposure compared to 13% among workers 55 years and older. Those working longer hours were more likely to report exposure to both noise and vibration. About 28% of workers with a trade certificate and 21% of workers who did not complete Year 12 reported co-exposure to noise and vibration compared to 5% of workers with a postgraduate level of education.

There were no significant differences in the proportion of workers who reported co-exposure to noise and vibration by type of employment.

Analyses also showed that there were significant differences in the proportion of workers who reported co-exposure to noise and vibration by industry and occupation. Industries with the highest proportion of workers who reported exposure to noise and vibration were Mining (53%) and Construction (40%). In contrast, none of the workers in Finance & insurance reported co-exposure to noise and vibration (Figure D.5, Appendix D). Approximately 45% of Technicians & trades workers and 40% of Machinery operators & drivers reported co-exposure to noise and vibration (Figure D.6, Appendix D).

Statistical details of these analyses are provided in Table C.3, Appendix C.

Figure 4. Co-exposure to noise and vibration by demographic and employment characteristics (* indicates p < 0.05)



Characteristics associated with exposure to noise and vibration

All the demographic and employment factors mentioned above were examined in a logistic regression model to determine which factors predicted co-exposure to noise and vibration. The following six factors were associated with self-reported co-exposure to noise and vibration (Table 6):

- gender
- age
- industry of employment
- occupation
- working hours, and
- education.

Table 6. Model factors for the logistic regression model predicting co-exposure to noise and vibration (n=4187)

Characteristics	OR	95% CI
Gender		
Male vs. female	2.46	1.87–3.24
Age groups		
15–24 vs. 55+	3.53	2.34–5.32
25–34 vs. 55+	2.60	1.90–3.56
35–44 vs. 55+	1.42	1.08–1.88
45–54 vs. 55+	1.58	1.21–2.06
Hours worked per week		
> 19 but ≤ 38 hours vs. ≤ 19 hours	2.22	1.33–3.70
> 38 but ≤ 45 hours vs. ≤ 19 hours	2.32	1.39–3.90
> 45 hours per week vs. ≤ 19 hours	3.58	2.14–5.98
Highest educational qualification		
Year 12 completed vs. Year 12 not completed	0.78	0.53–1.15
Trade certificate / TAFE vs. Year 12 not completed	1.28	0.99–1.67
Bachelor degree vs. Year 12 not completed	0.69	0.46–1.05
Postgraduate vs. Year 12 not completed	0.73	0.38–1.33
Other vs. Year 12 not completed	1.22	0.73–2.04
Industry		
Manufacturing vs. Health & community services	2.62	1.68–4.08
Transport & storage vs. Health & community services	2.10	1.28–3.44
Construction vs. Health & community services	2.36	1.50–3.73
Agriculture, forestry & fishing vs. Health & community services	3.20	1.96–5.23
Wholesale & retail trade vs. Health & community services	0.80	0.40–1.61
Accommodation, cafes & restaurants vs. Health & community services	0.40	0.14–1.09
Communication services vs. Health & community services	0.20	0.03–1.58
Property & business services vs. Health & community services	0.62	0.31–1.24
Government administration & defence vs. Health & community services	1.23	0.66–2.31
Education vs. Health & community services	0.61	0.27–1.35
Cultural, recreational & personal services vs. Health & community services	1.16	0.53–2.56
Occupation		
Professionals vs. Managers	0.53	0.35–0.83
Technicians & trades workers vs. Managers	2.71	1.99–3.69
Community & personal service workers vs. Managers	0.88	0.48–1.59
Clerical & administrative workers vs. Managers	0.40	0.23–0.69
Sales workers vs. Managers	0.34	0.15–0.79
Machinery operators & drivers vs. Managers	2.02	1.41–2.90
Labourers vs. Managers	2.84	2.00–4.02

Note: OR = odds ratio; CI = confidence interval; English competency, workplace size, night work and employment type were excluded from the final reduced model as they were non-significant predictors in the full model. Model details: Chi-square= 1174.919, p <.001, Nagelkerke R square=.389.

Males were more than twice as likely to report co-exposure to noise and vibration as females

Males were 2.5 times more likely to report exposure to both noise and vibration than females, accounting for all the factors in the model. The odds of reporting co-exposure to noise and vibration generally declined with age, with the highest odds of exposure observed among the youngest workers. However, those aged 45–54 years and those aged 35–44 years had similar odds ratios.

Compared to workers in the Health & community services industry, workers in the Agriculture, forestry & fishing industry were 3.20 times more likely to report co-exposure to noise and vibration. Workers in other priority industries such as Manufacturing, Transport & storage, Construction also had significantly higher odds of co-exposure to noise and vibration than workers in the Health & community services industry. Labourers and Technicians & trades workers were 2.8 times and 2.7 times more likely to report co-exposure to noise and vibration than Managers.

The odds of reporting co-exposure to noise and vibration also increased with increasing work hours. Education was a significant factor in the model but there were no significant differences in the odds of reporting exposure between those who did not complete Year 12 and the other levels of education.

Provision of controls for exposure to vibration and noise

About 8% of workers with self-reported co-exposure to noise and vibration reported that they were not provided with control measures for either hazard

The types of controls provided to workers who reported co-exposure to noise and vibration were examined by looking at the control measures provided for each hazard and then in combination.

Of the 868 workers who reported co-exposure to noise and vibration, 8% (n=67) reported they were not provided with controls for either noise or vibration (Table 7). A further 16% were provided with control measures for either noise or vibration but not both. About 76% were provided with control measures for both hazards.

Table 7. Provision of control measures for workers who reported co-exposure to noise and vibration (n=868)

Type of control measure	Per cent provided with control measure
Noise	
No control measure	11.3
PPE only	19.0
No PPE but provided other types of controls	6.2
Both PPE and other types of controls	63.5
Vibration	
No control measure	20.3
PPE only	24.5
No PPE but provided other types of controls	9.3
Both PPE and other types of controls	45.9
For both noise and vibration	
No control for both hazards	7.7
Control measure for both hazards	76.2
Control measure for only one of the two hazards	16.1

Of the 67 workers who did not have access to any control measure for these two hazards, two thirds were males. Over one in five (22%) were working in the Construction industry and 18% each were working in the Transport & storage and the Health & community services industries. About a third of these workers were Technicians & trades workers and 20% were Professionals.

Co-exposure to airborne hazards and chemicals

Workers were asked about whether they were exposed to dusts, vapours, gases and fumes in their workplace. If they reported exposure, they were classified as being exposed to airborne hazards. Low toxicity dust was the most common airborne hazard reported by workers. Types of low toxicity dust included substances such as environmental dust, dirt/road dust, chalk dust, fibreglass dust and steam. Combustion products (carbon monoxide, diesel/ non-diesel exhaust fumes, smoke) were the second most frequently reported airborne hazard by workers (Safe Work Australia, 2010b).

Workers were also asked about whether they worked with chemicals and this question primarily captured skin contact with chemical substances. While some workers reported a specific chemical (e.g. nitric acid), the majority of types of chemicals reported were those relating to their function, for example, cleaning agents (MacFarlane, Benke, & Keegel, 2012). These responses were then classified into broad chemical categories according to Types of Occurrence Classification System 2.1. The most common types of chemicals reported were detergents (34%), organic solvents (28%), disinfectants (21%), bases and alkalis (12%) and paint (11%), varnishes and inks (11%), and cement and lime.

Almost 25% of workers reported exposure to both airborne hazards and chemicals

A total of 1032 workers (23%) reported co-exposure to chemical and airborne hazards (Table 8). In contrast, over 40% of workers in the NHEWS survey did not report exposure to either chemical or airborne hazards. About one in five workers reported being exposed to only airborne hazards.

Table 8. Self-reported exposure to airborne hazards and chemicals

Self-reported exposure	Per cent (n=4493)
Not exposed to any	42.5
Only exposed to chemicals	14.3
Only exposed to airborne hazards	20.3
Exposed to both airborne hazards and chemicals	23.0

Individual factors

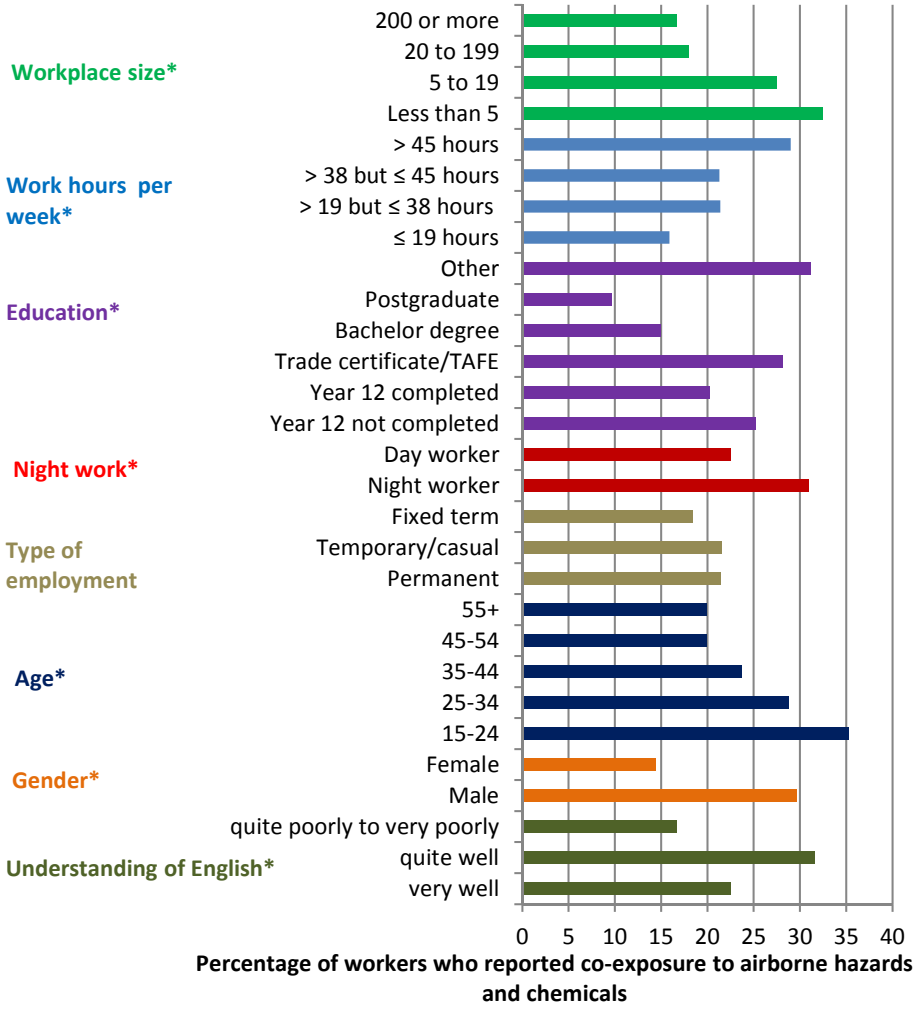
About twice as many males reported co-exposure to chemical and airborne hazards compared to females

There were distinct patterns for co-exposure to airborne and chemical hazards within demographic and employment characteristics. As seen in Figure 5, about twice as many males reported co-exposure to chemical and airborne hazards as females (30% vs. 14%). Over a third of workers aged 15–24 years reported co-exposure to chemical and airborne hazards whereas 20% of workers in the oldest age group (55 years and over) reported exposure these hazards.

There were also significant differences in the proportion of workers who reported co-exposure to airborne hazards and chemicals by workplace size. A third (33%) of workers from micro workplaces (<5 employees) reported co-exposure. In contrast, 17% of workers from large workplaces (200 or more employees) reported co-exposure to these hazards.

Night workers and those working longer hours were more likely to report co-exposure to airborne and chemical hazards than those who worked during the day or those who had shorter working hours.

Figure 5. Co-exposure to airborne hazards and chemicals by demographic and employment characteristics (* indicates p < 0.05)



There were also significant differences in the proportion of workers who reported co-exposure to airborne hazards and chemicals by industry and occupation. Workers in the Construction industry were most likely to report exposure (39%), followed by workers in the Agriculture, forestry & fishing industry (36%). No worker in Finance & insurance or Communication services industries reported co-exposure to airborne hazards and chemicals (Figure D.7, Appendix D). Almost half (45%) of Technicians & trades workers reported co-exposure to airborne hazards and chemicals. Clerical & administrative workers were least likely to report this co-exposure with only 6% reporting co-exposure (Figure D.8, Appendix D).

Statistical details of these analyses are provided in Table C.3, Appendix C.

Characteristics associated with co-exposure to airborne hazards and chemicals

When demographic and employment factors were considered together in a logistic regression model, education and type of employment were not significant predictors of self-reported co-exposure to airborne hazards and chemicals. They were therefore not included in the final model presented in Table 9.

As shown in Table 9, the following factors were significantly associated with self-reported co-exposure to airborne hazards and chemicals when other factors were accounted for in the model:

- gender
- age
- working hours
- industry of employment
- occupation
- working at night, and
- workplace size.

Young workers were significantly more likely to report co-exposure to airborne hazards and chemicals than older workers

Males were 1.3 times more likely to report co-exposure to airborne hazards and chemicals than females. The odds of reporting co-exposure to these hazards generally decreased with increasing age, with workers in the 15–24 years age group having the highest odds of self-reported co-exposure to airborne hazards and chemicals than workers who were 55 years and older.

Working hours was a significant predictor of self-reported co-exposure to airborne hazards and chemicals. Compared to those working 19 hours or less, those working more than 45 hours had 1.9 times the odds of reporting this type of exposure. Those working 20 to 38 hours a week also had significantly higher odds of reporting co-exposure compared to the reference group. However, those working between 39 to 45 hours a week did not have significantly different odds of self-reported co-exposure to airborne hazards and chemicals compared to the reference group.

Workers in the Accommodation, cafes were significantly more likely to report exposure to airborne hazards and chemicals than workers in the Property & business services industry

Workers in the Accommodation, cafes and services industry were 2.4 times more likely to report co-exposure to airborne and chemical hazards than workers in the Property & business services industry. Workers in the Agriculture, forestry & fishing, Manufacturing, Construction and Health & community services industries also had significantly higher odds of reporting co-exposure to airborne hazards and chemicals than workers in the Property & business services industry. Compared to Managers (reference group), Technicians & trades workers were 3.2 times, labourers were 2.7 times and Machinery operators & drivers were 1.8 times more likely to report co-exposure to airborne hazards and chemicals.

Those who worked at night had 1.5 times the odds of reporting co-exposure to airborne hazards and chemicals than those who worked during the day

Those who worked at night were 1.5 times more likely to report co-exposure to airborne hazards and chemicals than those who worked during the day.

After accounting for other factors, those working in micro workplaces and small workplaces had significantly higher odds of reporting co-exposure to airborne hazards and chemicals compared to those working in large workplaces.

Table 9. Model factors for the logistic regression model predicting co-exposure to airborne hazards and chemicals (n=4114)

Characteristics	OR	95% CI
Gender		
Male vs. female	1.32	1.07–1.63
Age groups		
15–24 vs. 55+	1.73	1.22–2.44
25–34 vs. 55+	1.67	1.28–2.17
35–44 vs. 55+	1.29	1.03–1.63
45–54 vs. 55+	1.01	0.81–1.26
Hours worked per week		
> 19 but ≤ 38 hours vs. ≤ 19 hours	1.69	1.21–2.37
> 38 but ≤ 45 hours vs. ≤ 19 hours	1.35	0.94–1.93
> 45 hours per week vs. ≤ 19 hours	1.86	1.30–2.65
Industry		
Transport & storage vs. Property & business services	1.50	0.92–2.44
Construction vs. Property & business services	1.83	1.18–2.85
Agriculture, forestry & fishing vs. Property & business services	2.23	1.39–3.57
Health & community services vs. Property & business services	1.88	1.19–2.97
Wholesale & retail trade vs. Property & business services	1.51	0.88–2.59
Accommodation, cafes & restaurants vs. Property & business services	2.39	1.29–4.44
Manufacturing vs. Property & business services	1.84	1.19–2.86
Government administration & defence vs. Property & business services	0.90	0.47–1.72
Education vs. Property & business services	1.53	0.89–2.64
Cultural, recreational & personal services vs. Property & business services	1.56	0.81–3.02
Occupation		
Professionals vs. Managers	0.72	0.51–1.00
Technicians & trades workers vs. Managers	3.17	2.40–4.20
Community & personal service workers vs. Managers	1.16	0.77–1.74
Clerical & administrative workers vs. Managers	0.37	0.24–0.58
Sales workers vs. Managers	1.07	0.66–1.73
Machinery operators & drivers vs. Managers	1.82	1.29–2.57
Labourers vs. Managers	2.71	1.99–3.71
Worked at night in the reference week?		
Night workers vs. day workers	1.53	1.12–2.09
Workplace size		
< 5 employees vs. 200 or more employees	1.85	1.43–2.40
5 –19 employees vs. 200 or more employees	1.62	1.26–2.09
20–199 employees vs. 200 or more employees	1.01	0.80–1.28

Note. OR = odds ratio; CI = confidence interval; Model also adjusted for English language competency. Education and type of employment were excluded from this final reduced model because they were not significant predictors in the full model. Model details: Chi-square =610.163, p <.001, Nagelkerke R square=.206.

Provision of controls for airborne hazards and chemicals

Among workers who reported that they were exposed to both airborne hazards and chemicals, about 20% reported that they were not provided with any control measure for airborne hazards

Of the 1032 workers who reported co-exposure to airborne hazards and chemicals, 22% reported that they were not provided with any control measure for airborne hazards (Table 10). The proportion of workers with no control measure for chemicals was much lower at 7%.

Three out of four workers (75%, n=775) were provided with at least some control measures for both airborne hazards and chemicals. Of these workers, 65% were provided with both engineering/administrative controls and PPE for airborne hazards. One in five had only PPE as a control measure for airborne hazards. For skin contact with chemicals, 90% were provided with both PPE and other types of control measure for chemicals.

Only 4.4% (n=45) of workers with co-exposure to airborne hazards and chemicals did not have access to any control measure for either hazard. Of those, just over a third was working in the Construction industry (36%) and a further 20% were working in the Manufacturing industry. The majority of these workers were working in workplaces with less than 20 employees (76%). In terms of occupation, 31% were Technicians & trades workers and another 31% were Labourers.

Table 10. Provision of control measures for workers who reported co-exposure to airborne hazards and chemicals (n=1032)

Type of control measure	Per cent provided with control measure
Airborne hazards	
No control measure	21.9
PPE only	16.7
No PPE but provided administrative/engineering controls	11.8
Both PPE and administrative/engineering controls	49.6
Chemicals (dermal exposure)	
No control measure	7.4
PPE only	4.6
No PPE but provided other types of controls	9.1
Both PPE and other types of controls	79.0
Combined control measures	
No control for both hazards	4.4
Control measure for both hazards	75.1
Control measure for only one of the two hazards	20.5

4. Discussion

This report provides the first estimates of prevalences of exposure to multiple disease-causing hazards among workers across all states and territories in Australia. It is noted that many of the nine hazards covered in this report are hazards that are predominantly found in male dominated, blue collar jobs (e.g. vibration and noise). The hazards examined in the report also reflect the hazards found in the five priority industries for Australia at the time of the NHEWS survey (Agriculture, forestry & fishing, Construction, Manufacturing, Transport & storage and Health & community services). The main findings summarised below should be read with these in mind.

Factors associated with exposure to multiple hazards

Age

There was a distinct pattern of self-reported exposure to multiple hazards by age with the odds of exposure generally decreasing with increasing age. Workers who were 25–34 years old had the highest odds of exposure to most multiple exposures examined in this report. However, those who were 15–24 years old had the highest odds of exposure to vibration and noise. As these findings included adjustment for characteristics such as education, occupation and industry of employment, they indicate that the higher odds of exposure observed in younger workers were not limited to those working in lower skilled jobs. It also suggests that when both younger and older workers are employed in similar jobs, younger workers are assigned different tasks to older workers.

The finding of age-related differences in exposures is supported by other studies although the definition of young workers varies between studies. For example, young workers in Europe are also reported to be more exposed to dangerous substances, heat and cold, vibration and noise (Verjans, Broeck, & Eeckelaert, 2007). A number of studies in the US have also reported that young workers are exposed to multiple hazards in the workplace (Runyan et al., 2007; Simoyi, Frederick, & Niezen, 2001).

Exposure to multiple hazards in young workers is a particular concern because they may not have the experience and knowledge needed to avoid hazardous exposures. An Australian study of apprentices showed that young workers had high job rotations exposing them to hazards without sufficient knowledge of hazards associated with each workplace (Underhill, 2003). This Australian study also found that young workers were more likely to be employed in smaller businesses where health and safety knowledge and risk management was lower.

Moreover, there may be age differences in risk perception and attitudes towards health and safety that could make young workers more vulnerable to work-related injury and illness. A study of attitudes and perceptions of health and safety in Australian workers found that young workers were less likely to discuss health and safety concerns with managers, supervisors or co-workers and were less likely to report that they make work practices safe (Safe Work Australia, 2010a). In addition, young workers were more likely

to think that sometimes it was necessary to depart from health and safety requirements and were more likely to report that they got so involved in their work that they sometimes forgot about safety. A prospective study on young workers also found that those with strong work risk taking orientation were more likely to report work injuries compared to young workers with weak risk taking orientation (Westaby & Lowe, 2005). In addition, this study found that young workers' risk taking behaviour was strongly influenced by co-worker risk behaviour.

Industry and occupation

Certain industries of employment were associated with self-reported exposure to multiple hazards. The Agriculture, forestry & fishing industry stood out as the industry with the highest odds of reporting exposure to multiple hazards after considering other demographic and employment factors. The Health & community services industry also had higher odds of reporting exposure to six or more hazards. These findings could not be compared to other studies due to the lack of similar studies comparing hazard exposures across all industries.

Like industry, occupations were also associated with self-reported exposure to multiple hazards. Labourers and Technicians & trades workers were more likely to report exposure to multiple hazards than workers in other occupations. Direct comparisons cannot be made between this study and other studies due to large differences in occupational coding between countries. However, previous studies showed that manual labourers or trades workers have the highest exposures. In a US study assessing national prevalence of exposures, construction workers and machine operators had high exposure to airborne hazards, chemicals and outdoor work (Calvert, Luckhaupt, Sussell, Dahlhamer, & Ward, 2012). A Finnish study that examined multiple exposures to a number of physical and psychosocial hazards found that manual workers had the highest odds of exposure to multiple hazards (Kausto et al., 2011). Similarly, in a New Zealand survey of workplace exposures, trades workers and plant and machine operators and assemblers reported the highest prevalence of exposure to dust; smoke/fume/gas; lifting and loud noise (Eng et al., 2010).

A final note regarding occupation concerns young workers being employed in high risk occupations. A recent Safe Work Australia report using the data from the 2009–10 Work-related Injuries Survey found that young workers were over represented in two of the most high risk occupations for multiple exposures (Technicians & trades workers and Labourers) (Safe Work Australia, 2013). A third of all injuries in young workers occurred among those working as Technicians & trades workers.

Workplace size

The size of the workplace was generally not a predictor of multiple exposures to occupational disease-causing hazards once other socio-demographic and employment factors were considered. The exception to this finding was co-exposure to airborne hazards and chemicals. For this particular co-exposure, workers in workplaces with less than 5 employees and 5 to 19 employees had significantly increased odds of reporting exposure compared to workers in workplaces with 200 or more employees. The NHEWS research report on chemicals, which looked at the odds of exposure to broad groups of chemicals, found that smaller workplaces had higher odds of exposure to cement and lime and paints, varnishes and inks (MacFarlane et al., 2012).

There is limited peer-reviewed research comparing the prevalence of workplace exposures by business size. Most work health and safety research examining business size focuses on injury rates or the performance of organisations with respect to health and safety management rather than prevalence of exposure to hazards. The few studies that have examined the prevalence of hazardous exposures by business or workplace size are summarised below.

In a study of Danish workplaces using data linkage between the Danish Work Environment Cohort Study and Surveillance of Health and Safety Activities in Enterprises Study, smaller enterprises had higher risk of chemical, ergonomic and physical risks (Sorensen, Hasle, & Bach, 2007). The definition of small enterprises was obtained from employers and the study compared exposures by business size and did not include other socio-demographic and employment variables in significance testing. In contrast, in the NHEWS study workplace size was obtained from the worker and can only indicate the size of a particular workplace rather than business size. In many cases, workplace size and business size are expected to be the same. The exception will be for businesses with many worksites. In addition, if other factors were not taken into account, workers in smaller workplaces reported higher exposure to multiple hazards.

In a study of self-reported exposures among Victorian workers, workers in small workplaces were more likely to report exposure to multiple hazards (LaMontagne & Vallance, 2008). Specifically, small workplaces had higher odds of exposure to most of the hazards examined such as dangerous work methods, dangerous tools, dangerous chemicals, air pollution, dust and fumes and a summary hazard score. This study used a similar question to NHEWS for workplace size and therefore, measured workplace size instead of business size. The inconsistent finding may be partly because workplace size was analysed as a dichotomous measure (less than 20 employees and 20 or more employees) as opposed to a four category variable in this report. While the Victorian study controlled for a number of factors it did not include industry, education and hours of work in the analyses.

Overall, the evidence suggests that business size may not be a determinant of exposure to disease-causing hazards but rather an indication of other demographic and employment factors. However, even if the prevalence of hazards does not significantly differ by workplace size or business size, there is strong evidence for lower capacity of smaller workplaces to manage these hazards due to limited time and resources (Eakin, 1992;

Legg et al., 2010; Maceachen et al., 2010; Mayhew, 1997). This means that small business should still be the focus for provision of assistance and guidance materials that are tailored to them to enable them to address existing hazards and their control in their workplace.

Gender

Gender differences in exposure to hazards depended on the type of the exposure variable examined. For example, Poisson regression analysis with the response variable a count of hazards workers reported exposure to, found that men were not exposed to more hazards than women. The same was true for co-exposure to six or more hazards. However, further analysis in the report shows that for co-exposure to noise and vibration and co-exposure to airborne hazards and chemicals, men had significantly higher odds of reporting exposure compared to women.

The observed gender differences in this report should be considered in light of the focus on priority industries of which all except Health & community services are male dominated. In addition, many of the hazards covered in this report were primarily hazards associated with male blue collar workers (e.g. vibration, noise). Gender differences in the distribution of exposures have been reported in other population based studies of exposure to occupational hazards (Eng et al., 2011; Parent-Thirion, Macias, Hurley, & Vermeylen, 2007). These gender differences may be due to gender segregation of jobs with some occupations and industries that are predominantly males and some that are predominantly females.

It has also been shown that even when males and females have the same job title, there may be differences in tasks or type of employment that could influence exposures (Hooftman, van der Beek, Bongers, & van Mechelen, 2005). Messing and colleagues (1994) found in their study of gardeners that female gardeners were more likely to do weeding and pruning whereas male gardeners were more likely to be involved in heavier tasks and using equipment. In a more recent study of hospital workers, more females than males were exposed to cleaning agents according to all three methods of exposure assessment: self-report, expert assessment and job exposure matrix (Dumas et al., 2012). The majority of people who were exposed were working in the same occupation: institutional based personal care workers. However, the New Zealand study that examined self-reported exposures among matched occupations between men and women found that men still reported more exposure to airborne hazards and solvents compared to women (Eng et al., 2011).

Provision of control measures

Among workers with co-exposure to noise and vibration or co-exposure to airborne hazards and chemicals, approximately three out of four workers reported that they were provided with control measures for all hazards that they reported exposure to. The rest were provided with control measures for only one of the two hazards or none at all.

Even among workers who were provided with some or all control measures for the hazards that they reported exposure to, hazardous exposure was still likely especially if control measures provided were limited to PPE. This is because compliance or appropriate use of PPE in this study is unknown. The New Zealand Occupational Exposure Survey reported that in general,

the prevalence of self-reported PPE use was only 48% (Eng et al., 2010). Among workers exposed to airborne hazards (smoke/fume and gas), only 24% reported wearing simple dust masks and only 11% reported wearing filter cartridge respirators. Among those exposed to loud noise, only 40% reported wearing protection. Relative PPE use in Finland and the UK was even lower compared to New Zealand according to the European Working Conditions Survey (Parent-Thirion et al., 2007). This means that if PPE is the primary control measure provided, there needs to be supplementary actions to ensure such measures are used by workers at all times when there is potential exposure and that they are appropriately fitted.

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Appendix A. NHEWS survey methodology and analysis

The NHEWS survey was part of a National Occupational Health and Safety Commission (NOHSC) approved strategy on occupational disease to address the gap in data on occupational diseases and occupational disease causing hazards (at NOHSC 67 and NOHSC 71). The Australian Safety and Compensation Council (ASCC) (now Safe Work Australia) then requested the development and fielding of the National Hazard Exposure Worker Surveillance (NHEWS) survey in 2008. Australian work health and safety regulators contributed to the development of the NHEWS survey and also contributed to the cost of the telephone interviews.

NHEWS survey methodology and analysis

Survey design

The purpose of the NHEWS survey was to gather information to guide decision makers in developing prevention initiatives that ultimately lead to a reduction in occupational disease. Therefore, the survey was designed to collect demographic (for example gender, age, education level) and employment information (occupation, industry, employment conditions, size of workplace), exposure to a variety of different occupational hazards and information about the hazard controls provided in the workplace.

The NHEWS survey focused on hazard exposures that are associated with one or more of the eight priority occupational diseases identified by the National Occupational Health and Safety Commission in 2004. These diseases are occupational cancer, respiratory diseases, noise-induced hearing loss, musculoskeletal disorders, mental disorders, cardiovascular disease, infectious and parasitic diseases and contact dermatitis.

The design and wording of the survey was undertaken by the ASCC in consultation with Australian work health and safety regulators and a panel of experts. It was based on existing Australian and international hazard exposure survey instruments. These included the:

- European Working Condition Survey,
- National Exposures at Work Survey (NIOSH, USA),
- Swedish Workplace and Environment Survey,
- Victorian WorkCover Authority Worker Survey,
- Danish Work Environment Cohort Study Survey, and
- Working Life in New Zealand Study Survey

A draft of the survey was reviewed by Dr Rebbecca Lilley, Preventative and Social Medicine, Injury Prevention and Research Unit, University of Otago, New Zealand who is an expert on occupational hazard exposure. Comments and feedback from her review were incorporated into the survey instrument.

Skirmish testing (undertaken on ASCC staff) and cognitive testing on eleven workers, who were of a low literacy or non-English speaking background, and worked in several industries, was undertaken in face to face interviews.

The survey was piloted by the Victorian WorkCover Authority on 160 workers using the Computer Assisted Telephone Interview (CATI) technique. This assisted in revising the survey length and correcting CATI programming issues. Feedback from the cognitive and pilot testing was incorporated into the final survey instrument.

The NHEWS research design and survey instrument were submitted to the University of Sydney Human Research Ethics Committee. The approval reference number is: 02-2008/10506. The research design and instrument met the National Statistical Clearing House guidelines. The research design and instrument were also in accordance with the Australian Market and Social Research Society (AMSRS) guidelines and the research company that undertook the CATI is a member of the AMRSRS and met all privacy and other guidelines.

For full details regarding the NHEWS survey and its methodology, please refer to the survey handbook at this link.

For more details on the sample and individual hazards, please consult relevant reports at Safe Work Australia website.

Statistical analysis

This report used unweighted data from the NHEWS survey.

Poisson regression was conducted to examine the association between demographic and employment factors and the number of hazards a worker reported exposure to. Over dispersion was checked using two test statistics: the ratio of deviance value to degrees of freedom and the ratio of Pearson Chi-square statistic and the degree of freedom (Allison, 1999; McCullagh & Nelder, 1989). Both test statistics were close to 1; therefore, Poisson regression was conducted instead of negative binomial regression. In addition the Akaike Information Criterion (AIC) for Poisson regression was lower than the AIC for the negative binomial regression indicating that the Poisson model was the better fitting model. One limitation is noted: although the questions for eight of the nine hazards asked about exposures during the week before the survey and the question for the ninth hazard (job demands) asked about exposures generally, no offset variable was used as it was not possible to create an offset variable that includes the time period ‘generally’.

For the remaining analyses, logistic regression was conducted as the response variables were binary. The use of logistic regression also meant that the analyses in this report were generally comparable to the analyses presented in the NHEWS reports on individual hazards which also used logistic regression.

For all regression models, three industries were consistently excluded due to their small sample size ($n \leq 50$). They were Communication services, Mining and Electricity, gas and water supply. Industries where there were no workers reporting a particular exposure were also excluded. For co-exposure to airborne hazards and chemicals, Communication services and Finance and insurance industries were excluded as none of the workers from these industries reported this particular co-exposure. For co-exposure to noise and vibration, the Finance and insurance industry was excluded due to no workers reporting this particular type of co-exposure. For the occupation variable, the category ‘don’t know’ (n=108) was assigned as

missing and excluded from regression analysis. All models presented in this report had acceptable fit.

Limitations

Exposures in the NHEWS survey are self-reported. We note that casual and contract workers may not be aware of hazards and controls in the workplace compared to permanent workers. However, self-reported exposures are commonly used as a way of obtaining information on exposures in large population based surveys as measurement of specific exposures is not feasible for large studies (Burr, Bjorner, Kristensen, Tüchsen, & Bach, 2003; Eng et al., 2010; LaMontagne & Vallance, 2008; Park & Lee, 2009). However, the self-report nature of exposures in the NHEWS survey means that these exposures are perceived or potential exposures. There could be bias in self-reported exposures. Self-reports may be affected by socio-demographic characteristics, risk perception, job experience and health status (Sembajwe et al., 2010). For example, a UK study reported that inexperienced miners and trainers were more likely to rate jobs as hazardous compared to supervisors or experienced miners (Behrens & Brackbill, 1993; Rushworth et al., 1986). Another study compared accident reports in chain saw operators to ranking of risk of injury by body part by the workers (Dunn, 1972). It found that risk rating among chain saw operators was similar but did not correlate with accident reports. In a recent UK study of construction dumper drivers, there were differences in level of risk reported by drivers compared to observed accident data (Bohm & Harris, 2010). Thus, accuracy of self-reported data could be affected by a number of factors including risk perception.

Self-reported exposures for some hazards appear more reliable than others (Anveden, Lidén, Alderling, & Meding, 2006) (Ahlborg Jr, 1990). There is a general consensus that self-reported exposures to chemicals are underestimates when compared to expert assessment or measured exposures (Benke et al., 2001; Delclos, Gimeno, Arif, Benavides, & Zock, 2009; Donnay et al., 2011). This is the case even for common chemicals such as cleaning agents. The accuracy was dependent on employees' awareness of chemicals that they worked with and their familiarity with specific chemical or chemical compound names as opposed to conventional names. For example, when comparing self-reported and measured exposure to tetrachloroethylene in dry cleaners, the researchers found that only 20% of dry cleaners perceived exposure during tasks that involved significant exposure to this chemical (Bosco, Figà-Talamanca, & Salerno, 1987). In contrast, self-reported exposures to noise and vibration are considered more reliable (Ahmed, Dennis, & Ballal, 2004; R. Neitzel, Daniell, Sheppard, Davies, & Seixas, 2009; Palmer, Haward, Griffin, Bendall, & Coggon, 2000; Schlaefer, Schlehofer, & Schüz, 2009). Self-reported exposures to airborne hazards (vapours, gas, dust and fumes) have also been reported to have moderate agreement with expert based assessments such as job exposure matrix (Blanc et al., 2005; Quinlan et al., 2009).

Another limitation of the NHEWS survey is that it is not nationally representative and information obtained is more robust for some industries than others. This is due to its focus on the five national priority industries. However, data from the five priority industries are considered robust. In

contrast, while the Mining industry was found to be one of the top industries for multiple hazard exposures, it had to be excluded from multivariate analysis due to the small sample of workers from this industry.

It is also noted that questions relating to control measures in the NHEWS survey were on provision of controls rather than the use or effectiveness of control measures. Therefore, no judgement of adequacy of control measures could be made. However, it has been reported that workers were more likely to use PPE and safe practice measures if they were provided with PPE by their employer (Mathews et al., 2008; Strong, Thompson, Koepsell, & Meischke, 2008) and some workers may be reluctant to request PPE measures for fear of losing their job (Levesque, Arif, & Shen, 2012). Thus, questions on provisions of control measures still provide some indication of control measures available in the workplace.

Appendix B. Details of data variables used in this report

How exposure is defined

In addition to the brief descriptions of exposure provide in Table 1, further details for how exposure was defined for each hazard are described below.

Sun exposure

Exposure to sun generally refers to people who work outside in direct sunlight. However, the definition used in the NHEWS survey also included transport workers and office workers if the sun shone directly on them even though they were indoors or were inside a vehicle. Exposure to direct sunlight was assessed by the NHEWS survey using the following question:

"On a typical day at work last week, how long (hours per day or hours per week) did you work in direct sunlight, with or without protective lotions or clothing?"

In this report, if a worker reported four or more hours of exposure to sunlight per day, they were classified having sun exposure.

For further details, please see the report on sun exposure from the NHEWS survey at this link.

Wet work

Exposure to wet work was assessed by two items in the NHEWS survey:

1. On a typical day at work last week, how many times did you wash your hands with water, including when using the bathroom?
2. On a typical day at work last week, excluding time spent hand-washing, how long (hours per day or hours per week) did you have your hands immersed in or covered by any liquid (including water) with or without gloves?

Those who reported that they washed their hands more than 20 times a day and/or those who reported that they had their hands immersed or covered by any liquid for more than two hours a day were classified as having exposure to wet work in this study.

For further details, please see the report on wet work exposure from the NHEWS survey at this link.

High biomechanical demands

Worker exposure to individual biomechanical demands was measured in the NHEWS survey by asking respondents about the specific biomechanical demands involved in their work. Responses were on a five point frequency scale (1= Never, 2= Rarely, 3= Sometimes, 4= Often, 5= All the time). Respondents were asked about nine biomechanical demands. These were:

- lifting or carrying heavy loads
- making the same hand or arm movements over and over again

(repetitive hand movements)

- work with the body bent forward
- work in a twisted or awkward posture
- work with the hands raised above the head
- work while sitting down
- squatting or kneeling while working
- pushing or pulling using some force, and
- work while standing in one place.

A composite measure reflecting both the intensity and the number of concurrent biomechanical demand exposures was constructed for this report.

This composite measure provides a way of identifying workers with the greatest exposure to a combination of different types of biomechanical demands. The composite exposure score, which was based on a similar analysis conducted for the EU Working Conditions Survey, was created in two steps:

1) The raw composite score for each respondent was calculated by taking the mean of the responses to the nine biomechanical demands. As all the nine biomechanical demand items in the NHEWS survey were measured using the same five point scale (from 5 'all of the time' to 1 'never'), the average exposure on a scale of 1–5 is calculated for a composite variable representing combined exposure. The greater the exposure to multiple biomechanical demands and the more intense the exposure, the higher an individual's composite score would be.

2) For easier interpretation, a standardised score (z-score) was then calculated across the distribution: 0 represents median exposure, a positive score is greater than median exposure and a negative score is less than median exposure, measured in standard deviation units. A positive score indicates higher exposure and can be considered a negative from a worker health and safety perspective. The formula for calculation of z-score is (Gravetter and Wallnau 2009):

$$z = \frac{(x - \mu)}{\sigma}$$

The variables in the z-score formula are:

z= z score

x= raw score

μ= mean of the population

σ = standard deviation of the population.

Although it was originally intended to include all nine biomechanical demand items in this composite measure, reliability analysis showed that the Cronbach's alpha for the 9-item scale was less than ideal (0.653). Generally, an alpha of 0.7 or more is considered acceptable. It was found that removing the item, 'working while sitting down', increased the

Cronbach's alpha to 0.809. Therefore, a decision was made to exclude 'work while sitting down' from the composite exposure scale. The final composite score, therefore contained eight items and excludes 'sitting down', a measure of sedentary behaviour.

It should be noted that this methodology assumes that all biomechanical demands contribute equally to biomechanical hazards and the likelihood of injury. This may not be the case in reality. Furthermore, the presence of multiple biomechanical demands may have a multiplicative effect on injury risk, rather than a summative effect as calculated (by taking the mean) here. Therefore, in terms of the latter assumption, the z score may confer an underestimate of the biomechanical demand exposure health risks of workers.

Workers whose composite z score was in the upper 25th percentile were classified as having exposure to high biomechanical demands.

For further details, please see the report on exposure to biomechanical demands from the NHEWS survey at this link.

High job demands

Worker exposure to job demands was measured in the NHEWS survey by asking respondents about the specific job demands involved in their work. Responses were on a five point frequency scale (1= Never, 2= Rarely, 3= Sometimes, 4= Often, 5= All the time). Respondents were asked about eight aspects of job demands. These were:

- I am pressured to work long hours
- I have unachievable deadlines
- I have to work very fast
- I am unable to take enough breaks
- I have to neglect some tasks because I have too much to do
- It's hard for me to juggle work requests from different people
- I have to keep track of more than one thing at a time, and
- My work needs my undivided attention.

The job demands score for each respondent was calculated by taking the mean of the responses to the eight items listed above. These items form a job demands scale which had good reliability (Cronbach's alpha= 0.77). Those with the job demands score at the median or higher were classified as having exposure to high job demands.

Noise

Noise exposure was assessed using the following question:

"On a typical day at work last week, how long did you work in loud noise?"

Loud noise was defined as noise so loud that a person would have to raise their voice to be heard when speaking to people who are at one arm's length away from them. Research suggests that this definition corresponds roughly to an A-weighted background noise level of 85 dB(A) (Ahmed et al. 2004; Neitzel et al. 2009).

In this report, workers who reported exposure to loud noise, regardless of

the duration of exposure, were classified as being exposed to noise.

For further details, please see the report on noise exposure from the NHEWS survey at this link.

Vibration

Exposure to vibration was assessed using the following question:

"On a typical day at work last week, how long did you work with tools, equipment or in vehicles that vibrate?"

Vibration was not defined in the survey. Workers who reported exposure to vibration, regardless of the duration of exposure were classified as being exposed to vibration.

For further details, please see the report on vibration exposure from the NHEWS survey at this link.

Biological hazards

Exposure to biological hazards was assessed using the following question:

"On a typical day at work last week, how long did you work in places where there were biological materials, such as blood, urine, animal flesh, meat or laboratory cultures?"

Workers who reported that they worked in in places where there were biological materials were considered to be exposed to biological hazards in their workplace.

For further details, please see the report on exposure to biological materials from the NHEWS survey at this link.

Chemical hazards

Exposure to chemicals was assessed using the following question:

"On a typical day at work last week, how long did you work with chemicals such as cement, cleaning products, disinfectants, solvents, resins, paints, pesticides or other chemical substances?"

Workers who reported working work chemicals regardless of the duration of exposure were classified as being exposed to chemical hazards.

For further details, please see the report on chemical exposures from the NHEWS survey at this link.

Airborne hazards

The specific questions relating to exposure airborne hazards were as follows:

- On a typical day at work last week, how long (hours per day / hours per week) did you work in a place where your work or other people's work created dust or made the air dusty?
- On a typical day at work last week, how long (hours per day / hours per week) did you work in a place where there were gases, vapours, smoke or fumes?

Workers who reported exposure to either dust or gases, vapours, smoke

or fumes, regardless of the duration of exposure, were classified as being exposed to airborne hazards.

For further details, please see the report on airborne hazards from the NHEWS survey at this link.

Table B.1. Demographic and employment variables

Variable	Description
English language competency	The interviewers silently ranked how well participants understood English. The lowest level, Understands English very poorly, was assigned to just four respondents, so these were incorporated into a third category, Understands English quite poorly.
Workplace size	Participants were asked about the number of employees at their workplace. This may differ from business size in terms of number of employees if a business has more than one workplace or site.
Industry	Contains ANZSIC first level industry groupings. Wholesale trade and retail trade (into Wholesale and retail trade) and Cultural and recreational services and personal other services (into Cultural, recreational and personal services) were combined due to small numbers.
Occupation	Contains eight ANZSCO first level occupational groups. This is coded from job title and main tasks in participant's job. There were 109 workers in the NHEWS survey who could not be coded to an ANZSCO occupation category because their responses did not contain adequate information. People in this category included public servants, consultants, supervisors, team leaders. They were assigned to the 'other' category and excluded from analyses.
Night work	Participants were asked whether they worked most of the time at night the week prior to the survey (between 10pm and 6am).Those who worked between 10pm and 6am were coded as doing night work.
Education	This was based on two questions on education: The highest year of primary or secondary school completed and the level of the highest qualification completed.
Working hours	This was obtained by asking participants about how many hours they worked in all their jobs the week before the survey.
Age	Age was categorised into five groups from a continuous age variable.
Gender	Male or Female, recorded by the interviewer.
Employment type	Those who worked for an employer were asked about the type of employment in terms of whether it was fixed term, temporary/casual or permanent employment.

Table B.2. Exposure variables

Variable	Description
Count of nine hazards	A count of the number of self-reported and concurrent exposure to occupational hazards including job demands (n=4397, missing=103).
High exposure to multiple hazards	A dichotomous variable (either exposed to six or more hazards or not) based on the count of nine hazards variable.
Co-exposure to noise and vibration	A dichotomous variable where those with self-reported exposure to both noise and vibration hazards were coded as exposed and others were coded as unexposed.
Co-exposure to chemicals and airborne hazards	A dichotomous variable where those who reported as exposed to both chemicals (skin contact) and airborne hazards were coded as exposed and others were coded as unexposed.

Table B.3. Control measures

Controls for	Description
Noise	A four category variable (0=no controls provided, 1=PPE only, 2=no PPE but provided other types of controls, 3=both PPE and other types of controls provided). PPE measures for noise were provision of ear muffs or ear plugs. Other control measures for noise were training on how to prevent hearing damage, rotating jobs, placing noisy equipment in an isolated room, purchasing quieter machinery whenever possible and signage.
Vibration	A four category variable (0=no controls provided, 1=PPE only, 2=no PPE but provided other types of controls, 3=both PPE and other types of controls provided). The PPE measure for vibration was provision of gloves. Other control measures for vibration were provision of vibration dampeners, vibration absorbing seats, purchasing products with less vibration and training.
Noise and vibration	A three category variable based on two variables described above (control measures for noise and vibration). The categories were no control for both hazards, provided with some type of control measure for both hazards and provided with control measures for one hazard.
Airborne hazards	A four category variable (0=no controls provided, 1=PPE only, 2=no PPE but provided administrative/engineering controls, 3=provided PPE and administrative/engineering controls). PPE measures for airborne hazards were provision of masks and respirators. Administrative/engineering control measures for airborne hazards were providing ventilation systems and reducing time spent in places with airborne hazards.
Chemicals	A four category variable (0=no controls provided, 1=PPE only, 2=no PPE but other control measures, 3=both PPE and other control measures provided). PPE measures for chemicals were provision of gloves and protective clothing. Other control measures for chemicals were labelling and warning signs, washing facilities, training on safe handling of chemicals.
Airborne hazards and chemicals	A four category variable based on two variables described above (control measures for airborne hazards and control measures for chemicals). The categories were no control provided for both hazards, provided with control measures for both hazards and provided with control measures for only one of the two hazards.

Appendix C. Supplementary tables

Table C.1. Characteristics of the Australian employed population from 2006 census and the NHEWS sample

Characteristic	% in 2006 census	% in NHEWS
Age		
15–24	16.7	5.6
25–34	21.4	14.0
35–44	24.0	25.7
45–54	22.8	32.8
55+	15.1	21.9
Gender		
Male	53.9	55.9
Female	46.1	44.1
Education†		
Postgraduate (degree/diploma)	5.8	7.3
Certificate/Diploma	30.5	44.4
Bachelor	16.2	20.6
Year 12 completed	19.0	9.8
Year 12 not completed	28.5	14.7
Occupation		
Managers	13.3	13.2
Professionals	20.0	23.9
Technicians & trades workers	14.5	19.0
Community & personal service workers	8.9	8.4
Clerical & administrative workers	15.1	13.3
Sales workers	9.9	4.6
Machinery operators & drivers	6.7	8.3
Labourers	10.5	9.4
Industry		
Mining	1.2	0.8
Agriculture, forestry & fishing	3.2	7.0
Manufacturing	11.1	15.9
Electricity, gas & water supply	0.8	0.8
Construction	7.9	14.6
Wholesale trade	4.8	5.3*
Retail trade	14.5	
Accommodation, cafes & restaurants	4.8	2.0
Transport & storage	4.5	8.7
Communication services	1.5	1.1
Finance & insurance	3.9	2.1
Property & business services	10.9	5.8
Government administration & defence	5.5	5.4
Education	7.6	7.1
Health & community services	10.9	21.2
Cultural & recreational services	2.2	2.1*
Personal & other services	3.6	

Note: † excludes 3.2% without adequate information on education; * categories combined due to small numbers

Table C.2. Additional characteristics of the NHEWS sample (n=4500)

Characteristic	Per cent
Competency at English	
Understands English very well	93.3
Understands English quite well	5.9
Understands English quite poorly to very poorly	0.8
Type of employment*	
Permanent	81.6
Temporary / casual	14.6
Fixed term	3.9
Worked at night in the reference week?	
Night workers	5.8
Day workers	94.2
Hours worked per week	
≤ 19 hours per week	8.3
> 19 but ≤ 38 hours per week	38.2
> 38 but ≤ 45 hours per week	27.1
> 45 hours per week	26.4
Workplace size	
< 5 employees	21.8
5 –19 employees	21.4
20–199 employees	33.8
200 or more employees	23.0
Note. *This data is for people who worked for an employer only (N=3627).	

Table C.3. Statistical details of bivariate analyses presented in this report

Demographic or employment characteristic	Statistical details
Average number of hazards	
Gender	t(4333)= 15.624; $p < .001$
Age	F(4,4360)= 20.035; $p < .001$
Type of employment	F(2, 3547)= 2.810; $p = .060$
Worked at night in the reference week?	t(4391)= 6.808; $p < .001$
Competency at English	F(2,4394)= 11.743; $p < .001$
Education	F(5,4385)= 42.252; $p < .001$
Hours worked per week	F(3,4386)= 72.840; $p < .001$
Workplace size	F(3,4371)= 18.242; $p < .001$
Industry	F(14,4382)= 52.786; $p < .001$
Occupation	F(7,4282)= 164.046; $p < .001$
Exposure to six or more hazards	
Gender	Chi-square= 71.771; $p < .001$
Age	Chi-square= 40.927; $p < .001$
Type of employment	Chi-square= 1.304; $p = .521$
Worked at night in the reference week?	Chi-square= 5.221; $p < .05$
Competency at English	Chi-square= 10.226; $p < .01$
Highest educational qualification	Chi-square= 69.571; $p < .001$
Hours worked per week	Chi-square= 106.308; $p < .001$
Workplace size	Chi-square= 26.439; $p < .001$
Industry	Chi-square= 175.353; $p < .001$
Occupation	Chi-square= 232.721; $p < .001$
Co-exposure to noise and vibration	
Gender	Chi-square= 450.837; $p < .001$
Age	Chi-square= 72.812; $p < .001$
Type of employment	Chi-square= 4.986; $p = .083$
Worked at night in the reference week?	Chi-square= 6.872; $p < .05$
Competency at English	Chi-square= 13.865; $p = .001$
Highest educational qualification	Chi-square= 242.932; $p < .001$
Hours worked per week	Chi-square= 186.749; $p < .001$
Workplace size	Chi-square= 33.114; $p < .001$
Industry	Chi-square=702.324; $p < .001$
Occupation	Chi-square=835.398; $p < .001$
Co-exposure to airborne hazards and chemicals	
Gender	Chi-square= 145.776; $p < .001$
Age	Chi-square= 46.908; $p < .001$
Type of employment	Chi-square= 0.740; $p = .691$
Worked at night in the reference week?	Chi-square= 10.193; $p = .001$
Competency at English	Chi-square= 12.527; $p = .002$
Highest educational qualification	Chi-square= 104.681; $p < .001$
Hours worked per week	Chi-square= 39.401; $p < .001$
Workplace size	Chi-square= 105.265; $p < .001$
Industry	Chi-square= 287.119; $p < .001$
Occupation	Chi-square= 492.719; $p <.001$

Appendix D. Supplementary figures

Figure D.1. The average number of types of hazards workers reported exposure to by industry

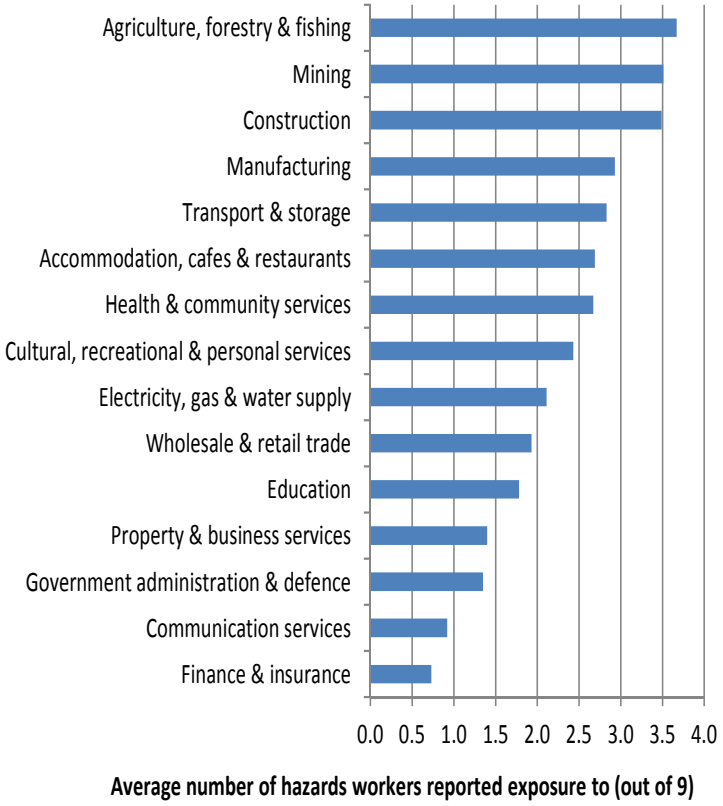


Figure D.2. The average number of types of hazards workers reported exposure to by occupation

Figure D.3. The proportion of workers reporting co-exposure to six or more hazards by industry

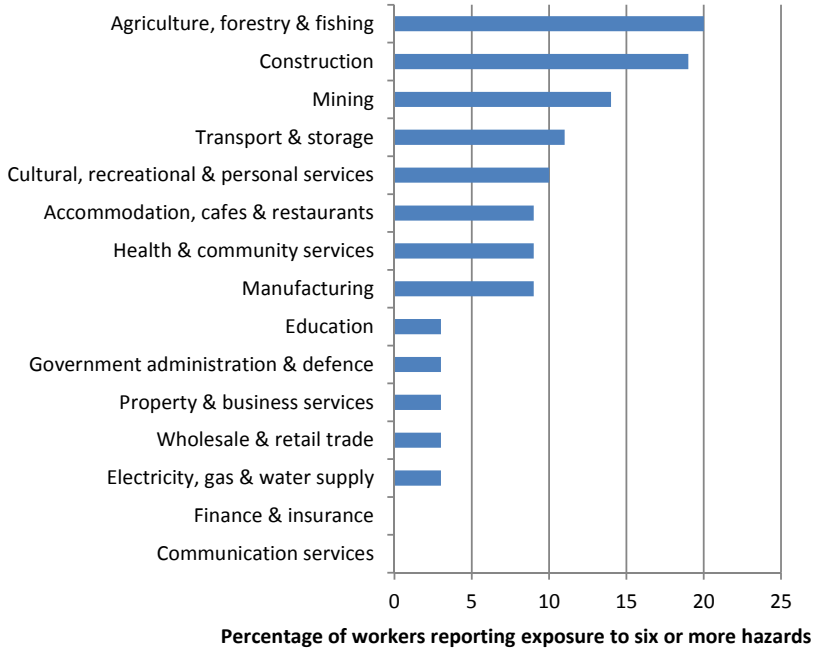


Figure D.4. The proportion of workers reporting co-exposure to six or more hazards by occupation

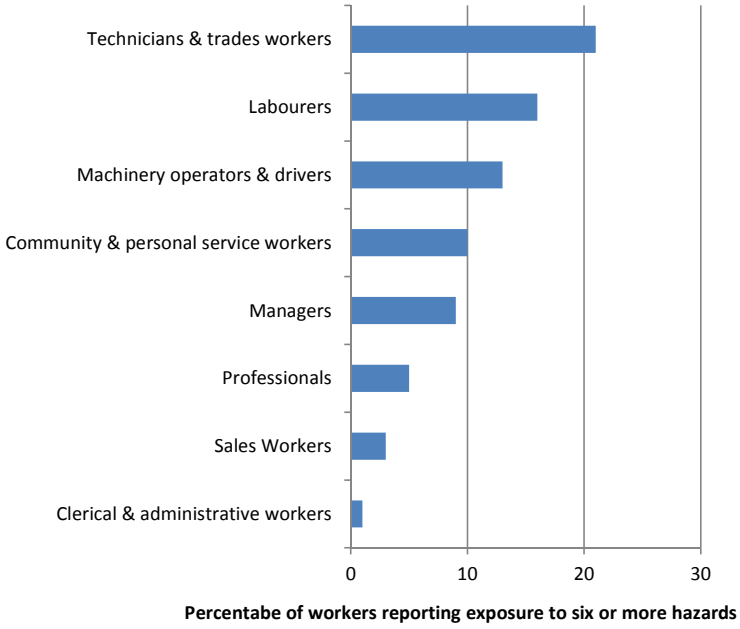


Figure D.5. The proportion of workers reporting co-exposure to noise and vibration by industry

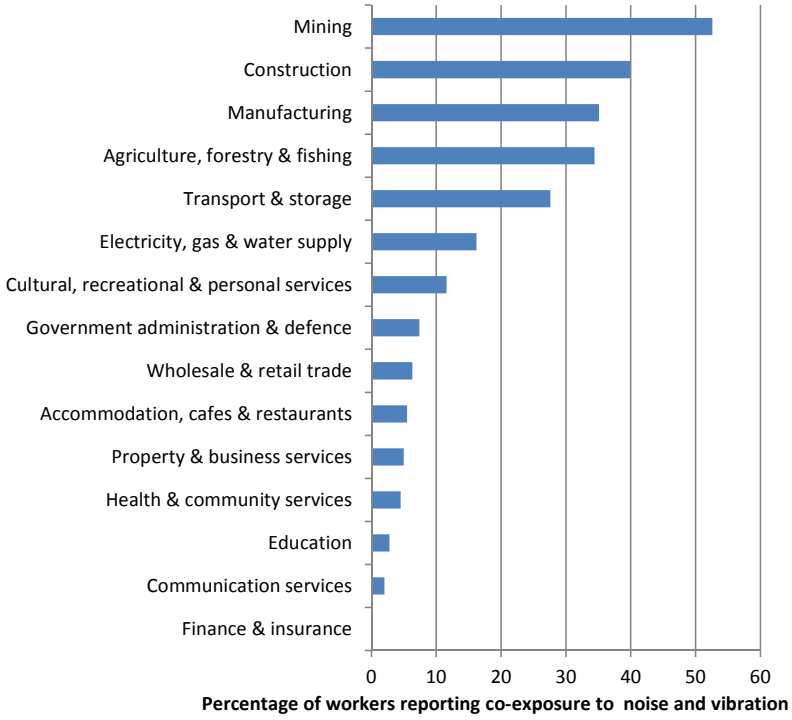


Figure D.6. The proportion of workers reporting co-exposure to noise and vibration by occupation

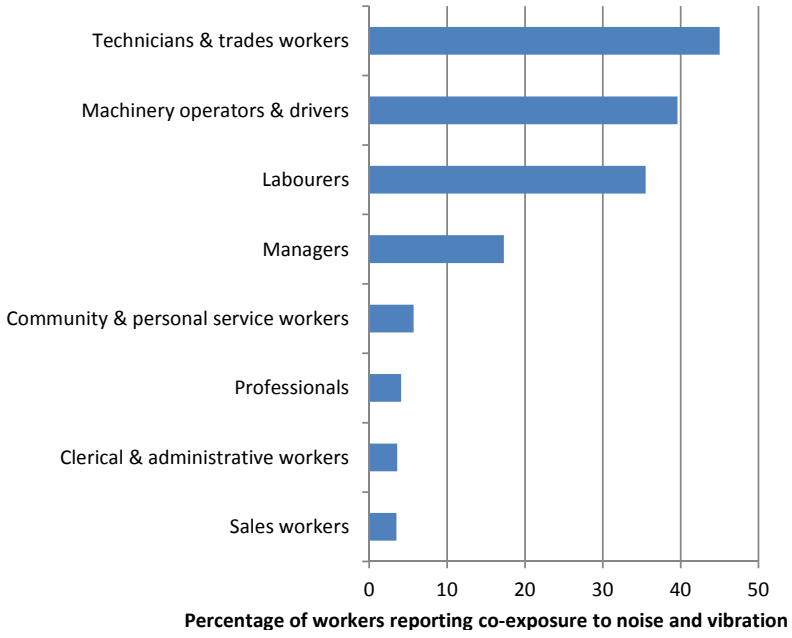


Figure D.7. The proportion of workers reporting co-exposure to airborne hazards and chemicals by industry

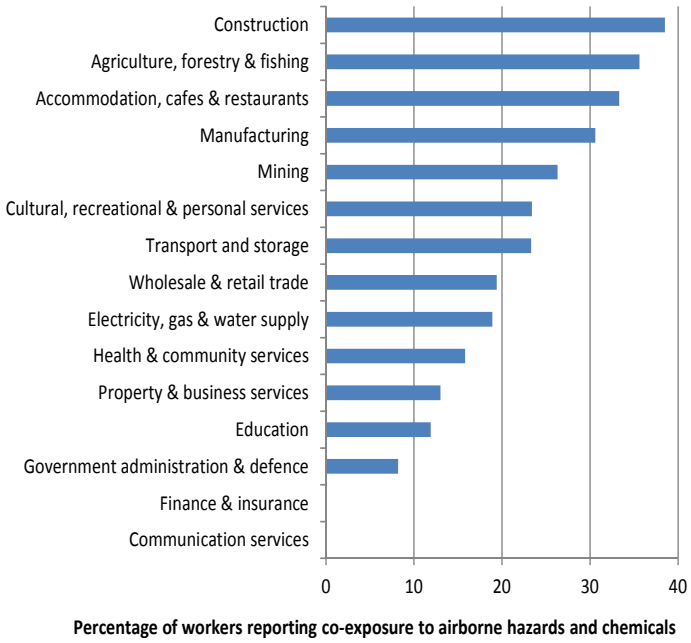
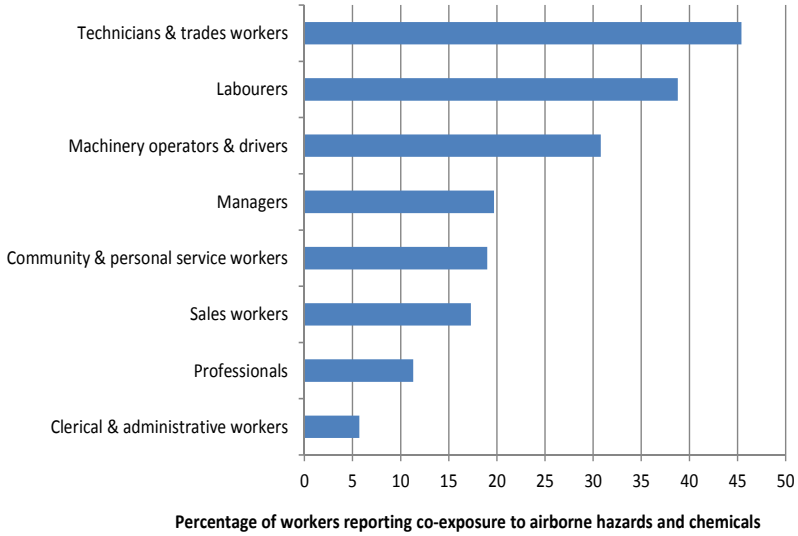


Figure D.8. The proportion of workers reporting co-exposure to airborne hazards and chemicals by occupation



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