safe work australia

NATIONAL HAZARD EXPOSURE WORKER SURVEILLANCE:

EXPOSURE TO BIOLOGICAL HAZARDS AND THE PROVISION OF CONTROLS AGAINST BIOLOGICAL HAZARDS IN AUSTRALIAN WORKPLACES

MARCH 2011

National Hazard Exposure Worker Surveillance – Exposure to biological hazards and the provision of controls against biological hazards in Australian workplaces

Acknowledgement

This report was commissioned and developed by the Australian Safety and Compensation Council (ASCC), which is now known as Safe Work Australia. The survey was administered and data collected by Sweeney Research. The data analyses were undertaken and the report written by Dr Fleur de Crespigny, Safe Work Australia.

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Foreword

The Australian Safety and Compensation Council (ASCC), now Safe Work Australia, requested the development and fielding of the National Hazard Exposure Worker Surveillance (NHEWS) survey to determine the current 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 will 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 work health and safety 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 and storage, Construction, Health and community services and Agriculture, forestry and fishing. The second stage (n = 2600) placed no restrictions on industry.

An initial report on the results of the NHEWS survey can be found on the Safe Work Australia website[1]. It contains a descriptive overview of the prevalence of exposure to the nine studied occupational hazards within industries and the provision of the various hazard control measures.

This report focuses on the exposure of Australian workers to biological hazards and the control measures that are provided in workplaces that eliminate, reduce or control worker exposure to biological hazards. The aims of this report are threefold:

1. to describe the percentage of Australian workers who are exposed to biological hazards and the employment and demographic factors that distinguish workers exposed to biological hazards
2. to provide a description of the types of biological hazards that workers are typically exposed to, and
3. to describe the employment, demographic and exposure factors that affect the provision of controls against biological hazards in Australian workplaces.

Based on these findings, the report will make policy recommendations and recommendations for future research in this field.

[1] http://www.safeworkaustralia.gov.au/swa/AboutUs/Publications/2008ResearchReports.htm

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Glossary

ANZSCO	Australian and New Zealand Standard Classification of Occupations
ASCC	Australian Safety and Compensation Council
CATI	Computer assisted telephone interviews
EU	European Union
EWCS	European Working Conditions Survey
Exposure	Workers who reported there were biological materials in their workplace were considered exposed to biological hazards, irrespective of the efficacy of any control measures for biological hazards provided in the workplace. The NHEWS survey was unable to determine whether or not workers were adequately protected from biological hazards.
HIV - AIDs	Human Immunodeficiency Virus – Acquired Immunodeficiency Syndrome
NDS	National Data Set for Workers' Compensation Based Statistics
NHEWS	National Hazard Exposure Worker Surveillance
NOHSC	National Occupational Health and Safety Commission
WHO	World Health Organisation

Summary

Biological hazards are organic substances that pose a threat to the health of humans and other living organisms. Biological hazards include pathogenic micro-organisms, viruses, toxins (from biological sources), spores, fungi and bio-active substances. Biological hazards can also be considered to include biological vectors or transmitters of disease. Worldwide, it is estimated that around 320 000 workers die each year from communicable diseases caused by work-related exposures to biological hazards (Driscoll *et al.* 2005; OSHA 2007).

Biological hazards pose risks for many workers in a wide variety of ways. For example, workers in health care professions are exposed to biological hazards via contact with human bodily matter, such as blood, tissues, saliva, mucous, urine and faeces, because these substances have a high risk of containing viral or bacterial diseases. Likewise, people who work with live animals or animal products (blood, tissue, milk, eggs) are exposed to animal diseases and infections, some of which (zoonoses) have the potential to infect humans (e.g. Q-fever, avian flu or Hendra virus) or cause serious allergy via sensitisation. Exposure to biological hazards in the work environment can also occur when people are in contact with laboratory cell cultures, soil, clay and plant materials, organic dusts, food, and rubbish, wastewater and sewerage. Exposure to moulds and yeasts is common in some industrial processes, in workplaces with air conditioning systems and high humidity, and in the Construction industry. Exposure to biological hazards is therefore widespread and the risk of exposure is not always obvious.

Australian workers' compensation statistics indicate that around 1300 workers are compensated annually for diseases attributed to animal, human or biological factors. However, it is not clear how accurate this estimate is because, amongst other things, many workers in the Agriculture forestry and fishing industry are not covered by workers' compensation schemes. Another way to evaluate the risk posed to workers by biological hazards is to determine how many workers are exposed and to what biological hazards. The National Hazard Exposure Worker Surveillance (NHEWS) survey was developed and undertaken in 2008 with this aim in mind. The findings of this study are presented in this report. The report describes the percentage of workers who reported they were exposed to biological hazards in the workplace and defines exposed workers by demographic and employment characteristics. It also explores factors affecting the provision of controls against biological hazards and makes recommendations for future research in this field and the development of policy interventions.

Summary of the main findings of the report

- 19% of workers surveyed reported they worked in places where there were biological materials. These workers were considered exposed to biological hazards.
- 75% of exposed workers were exposed to human bodily matter.
- 30% of exposed workers were exposed to live animals or animal products.
- Between two and four percent of exposed workers were exposed to laboratory cultures and biohazard waste, sewerage or rubbish.
- Workers in the Health and community services and the Agriculture, forestry and fishing industries were most likely to report exposure to biological hazards.
- Biological hazard control provision was high for workers exposed to human bodily matter, laboratory cultures and biohazard waste, sewerage and rubbish but relatively low for workers exposed to animals and animal products.
- Future surveillance studies should endeavour to collect more information on the poorly reported biological hazards – moulds, bacteria, algae, plants and wastes – this is supported by recent European research, in which these and the general lack of information on biological risks, are cited as major emerging biological risks for workers.
- Effort should be made to raise the level of knowledge about biological hazards. This may be partially achieved by considering the need for policy interventions on biological hazards and their identification and control in the workplace.

Detailed findings

Exposure to biological hazards

Just over 19% of the workers participating in the NHEWS survey reported they worked in places where there were biological materials. For the purposes of this research, these workers were considered exposed, at least to some extent, to biological hazards. Throughout the report these workers are referred to as having reported exposure to biological hazards. The main types of biological materials at the workplaces were:

- human bodily matter (blood, tissues, vomit, urine, faeces, saliva and breast milk etc.) - 75% of exposed workers
- animal products (meat, offal, skins, bones, blood, milk and eggs) - 18% of exposed workers
- live animals (mammals, birds, fish, invertebrates and their urine or faeces) - 12% of exposed workers
- biohazard waste, sewerage and rubbish - 3.4% of exposed workers, and
- laboratory cultures - 2.8% of exposed workers.

Exposure to biological hazards was most common in the Health and community services industry (57% of workers reported exposure) and the Agriculture, forestry and fishing industry (33% of workers reported exposure).

Exposure to biological hazards was most common in the following broad occupations; Community and personal service workers (56% reported exposure), Professionals (31% reported exposure) and Labourers (20% reported exposure). At a finer occupational scale:

- more than 70% of Health professionals and Carers and aides reported exposure to biological hazards, and
- 43% of Farmers and farm managers reported exposure to biological hazards.

Workers in the Agriculture, forestry and fishing industry reported longer durations of exposure to biological hazards than workers in the Health and community services industry.

Demographic and employment characteristics of workers exposed to biological hazards in the Health and community services and Agriculture, forestry and fishing industries

Sex

Overall, 63% of workers who reported exposure to biological hazards were female. However, while 79% of exposed workers in the Health and community services industry were female, females accounted for only 23% of exposed workers in the Agriculture, forestry and fishing industry.

Education level

Workers who reported exposure to biological hazards typically had a TAFE or trade qualification (43%) or a Bachelor degree (29%). The pattern for Health and community services was similar but a large proportion (27%) of Agriculture, forestry and fishing workers who reported exposure to biological hazards had not completed Year 12 at school.

Workplace size

Most workers in the Health and community services industry who reported exposure to biological hazards worked in large workplaces (≥20 workers) while most exposed workers in the Agriculture, forestry and fishing industry worked in small workplaces with less than five workers.

Control measures against biological hazards provided in workplaces

The control measures surveyed in the NHEWS study were grouped into three categories of biological hazard control: protective clothing; engineering, warnings and waste disposal; and, training on safe handling of biological materials. Overall, workers exposed to biological hazards were most likely to be provided with protective clothing and least likely to be provided with training.

There were marked differences in biological hazard control provision based on the type of biological hazard workers reported exposure to:

- Workers exposed to living animals were least likely to be provided with any of the control measures, with fewer than 75% of exposed workers provided with protective clothing and 45% or fewer provided with engineering, warnings or waste disposal or training.
- Larger percentages of workers exposed to animal products reported the provision of the three control types but the best protected workers were exposed to human bodily matter, laboratory cultures or biohazard waste, sewerage or rubbish.
- More than 20% of workers exposed to live animals were provided with none of the biohazard controls surveyed. This compares to 9% of workers exposed to animal products and 4% or fewer workers exposed to the other types of biological hazard.
- The differences in control provision, based on the type of biological hazard workers reported exposure to, were reflected in the industry of employment. The Health and community services industry had a higher level of control provision than the Agriculture forestry and fishing industry. However, it is important to note that this study cannot evaluate how suitable or appropriate the biological hazard controls were for given exposures and these findings cannot be used as an indicator of compliance with work health and safety regulations.

Policy implications and recommendations

- More surveillance should be undertaken in which representative industry samples are obtained, survey biases are removed and information is collected on subtle biological hazards, such as moulds, bacteria and waste exposures.
- Policy development should focus on workers in the Agriculture, forestry and fishing industry and Health and community service industry because these industries have the highest likelihoods of exposure to biological hazards.
- Policy development needs to be sensitive to major differences in the demographic and employment characteristics of workers in the Agriculture, forestry and fishing and Health and community services industry.
- The adequacy of biological hazard control provision for workers in contact with animals or animal products and those in the Agriculture, forestry and fishing industry requires further investigation.
- The levels of training in the safe handling of biological hazards need improvement, particularly where workers are exposed to animals or animal products.
- Australian authorities should consider developing policy interventions similar to those in the European Union for safe work with biological hazards. This may improve the current state of knowledge about biological hazards, improve risk assessments for biological hazards in the workplace and ultimately reduce work-related disease resulting from exposure to biological hazards.

Introduction

Biological hazards, also known as biohazards, are organic substances that pose a threat to the health of humans and other living organisms. Generally speaking, biological hazards include pathogenic micro-organisms, viruses, toxins (from biological sources), spores, fungi and bio-active substances. Biological hazards can also be considered to include biological vectors or transmitters of disease. Outside the health arena, biological hazards include substances that cause social and economic disruption, property damage and environmental degradation, such as insect plagues or infestations. Worldwide, it is estimated that around 320 000 workers die each year from communicable diseases caused by work-related exposures to biological hazards (Driscoll *et al.* 2005; OSHA 2007).

Humans are exposed to biological hazards in the work environment in a variety of ways. For example, workers in health care professions are exposed via contact with human bodily matter, such as blood, tissues, saliva, mucous, urine and faeces, because these substances have a high risk of containing viral or bacterial diseases. Likewise, people who work with live animals or animal products (blood, tissue, milk, eggs) are exposed to animal diseases and infections, some of which (zoonoses) have the potential to infect humans (e.g. Q-fever, avian flu or Hendra virus) or cause serious allergy via sensitisation. For instance, it is estimated that up to one third of people exposed to laboratory animals develop allergies (Harrison 2001) that can sometimes result in anaphylactic shock and death. Similarly, in a study of zoo veterinarians, 32% reported an allergy to the animals they treated and many report allergies to cats, pigs and poultry (Jeyaretnam and Jones 2000). Exposure to biological hazards in the work environment can also occur when people are in contact with laboratory cell cultures, soil, clay and plant materials, organic dusts, food, and rubbish, wastewater and sewerage (OSHA 2003). Exposure to moulds and yeasts is common in some industrial processes involving metal and wood, in museums and libraries, in workplaces with air conditioning systems and high humidity, and in the Construction industry (OSHA 2003). Exposure to biological hazards is therefore widespread and the risk of exposure is not always obvious.

Although Safe Work Australia (or its predecessors) has published a specific Code of Practice for the management of exposure to the blood borne viruses hepatitis and HIV (NOHSC 2003) and an information guide about diseases acquired from animals (NOHSC 1989), currently Australia has no official regulations or Codes of Practice relating to work-related exposures to biological hazards generally. Australian Standards has developed a standard for Safety in Laboratories (AS2243.3) microbiological aspects and containment facilities. There are also numerous other relevant standards for work undertaken in the health care industry e.g. AS/NZS 3816 (1998) Management of Clinical and Related Wastes. The Australian Department of Health and Aging has published Infection Control Guidelines[2]. This document outlines the principles involved in and the procedures necessary for the prevention of the transmission of infectious diseases in the health care setting. Included in the appendices of this document is a list of Australian standards relevant to the health care setting.

The European Union (EU) has a directive on 'biological agents' (EEC 1990), which are defined as 'microorganisms, including those that have been genetically modified, cell cultures and human endoparasites, which may be able to provoke any infection, allergy or toxicity'. These biological agents are classified into four risk groups according to their level of risk of infection. Group One agents are unlikely to cause human disease. A Group Two agent can cause human disease and might be a hazard to workers, but is unlikely to spread to the community and usually has effective prophylaxis or treatment available. Group Three agents can cause severe human disease and present a serious hazard to workers. They may present a risk of spreading to the community but there is usually effective prophylaxis or treatment available. Group Four biological agents cause severe human disease and are a serious hazard to workers. They may

[2] http://www.health.gov.au/internet/main/publishing.nsf/Content/icg-guidelines-index.htm

present a high risk of spreading to the community and there is usually no effective prophylaxis or treatment available. These risk group classifications have been adopted in a reworded but essentially unchanged format in the Australian Standards (AS2243.3) Safety in Laboratories: microbiological aspects and containment facilities. Both the EU and Australian and New Zealand risk groups are modified from the World Health Organisation (WHO) risk groups.

It is difficult to estimate how many Australian workers suffer ill health as a result of their exposure to biological hazards in workplaces annually. One estimate can be obtained by using Australian workers' compensation data[3] but this is complicated owing to the wide variety of resulting diseases and the range of vectors of exposure / transmission of disease. By restricting the data to claims attributed to animal, human and biological agencies for specific types of diseases, it can be estimated that, each year, there are around 1320 successful workers' compensation claims for diseases attributable to 'biological hazards'. The industries with the highest rates of such workers' compensation claims are Agriculture forestry and fishing and Health and community services, which both averaged 40 claims per 100 000 workers over the nine year period 2000-01 to 2008-09. Labourers and related workers, with an average of 30 claims per 100 000 workers is the occupation with the highest rate of claims for diseases attributed to animal, human or biological factors. Professionals, Associate professionals and Tradespersons and related workers averaged 20 claims per 100 000 workers over the same nine year period.

Figure 1 shows the average number of workers' compensation claims over a nine year period that were attributed to animal, human or biological agencies for major disease groups. Only infectious or parasitic diseases, respiratory and dermal diseases are presented because these encompass the main deleterious disease health outcomes following exposure to biological hazards – infectious disease, allergy and sensitisation. However, it should be noted that biological hazards can also result in poisoning or have toxic effects. These health outcomes are classified as injuries in the workers' compensation data. There are approximately 1100 successful workers' compensation claims per year for poisoning or toxic effects of substances that are attributed to animal or biological agencies. These are in addition to the annual estimate of 1320 claims per year described in the previous paragraph.

As is shown in Figure 1, *Other diseases of the respiratory system*, which include upper respiratory tract infections, influenza and the common cold, were the most commonly compensated respiratory disease. For infectious and parasitic diseases there were three groups of diseases that averaged more than 100 claims per year. These were *Viral diseases* (excluding hepatitis, sexually transmitted diseases and HIV – AIDs)[4], *Intestinal infectious diseases*[5] and *Other infectious and parasitic diseases*[6]. *Other diseases of the skin and subcutaneous tissue* was the most commonly reported group of diseases attributed to animal, human or biological agencies, with more than 250 claims on average per year. This group includes, amongst other things, the following conditions: corns and callosities, ingrown toenails, infections from cuts, ingrown toenails, skin ulcers and abscesses, cellulitis, pilonidal sinus or cyst and keratosis. It does not include tinea, which would be coded with other fungal conditions under mycoses.

It is not clear how accurately the workers' compensation data set counts the number of Australian workers who contract diseases as a result of their work-related exposure to biological hazards. In practice, biological hazards are not defined by a single code in workers' compensation data and this affects the resolution of any estimate. Furthermore, workers'

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[3] Australian workers' compensation data (NDS) can be accessed through the Safe Work Australia website at http://nosi.ascc.gov.au/

[4] *Viral diseases* include rubella, cowpox, orf, mumps, foot & mouth disease and Ross River disease

[5] *Intestinal infectious diseases* include cholera, typhoid, salmonella, dysentery and gastroenteritis

[6] *Other infectious and parasitic diseases* include scabies and head lice

compensation data may tend to underestimate the true number of cases because workers' compensation claims depend on conditions being attributed to workplace exposures. This can be especially difficult for disease, particularly long latency diseases such as asthma or allergies or diseases that could also be contracted outside of the workplace, such as some infectious diseases. Finally, workers' compensation schemes do not cover all Australian workers, typically excluding the self-employed. This means that the work-related illnesses of large numbers of workers in the Agriculture, forestry and fishing and Construction industries for example, are not captured in the workers' compensation data set. This has important implications for disease estimates based on compensation data for workers in Agriculture, forestry and fishing because these workers are known to have high exposure to biological hazards via contact with animals.

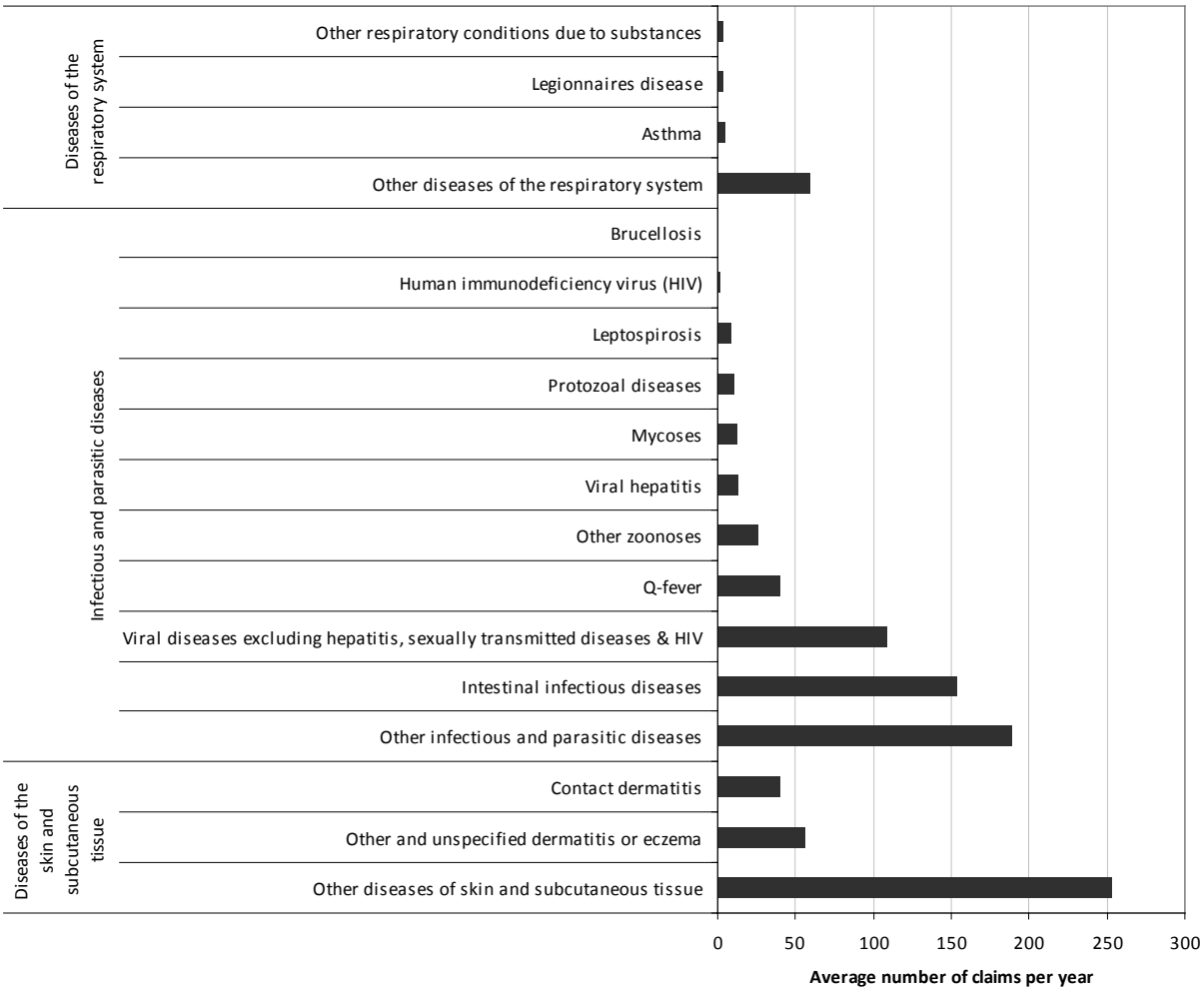

Figure 1 The average number of workers' compensation claims per year for diseases attributed to animal, human or biological agencies. Not all conditions for which animal, human or biological agencies were attributed are presented in this graph.

Another way to evaluate the risk of biological hazards to workers' health is to determine which workers are exposed to biological hazards and the types of biological hazards these workers are exposed to. However, there is very little information available on worker exposure to biological hazards both within Australia and worldwide. An exception to this is a recent French study which estimated that 15% of the French workforce were employed in occupations where they could by exposed to biological agents (Guignon and Sandret 2006). Of the potentially exposed workers 54% were in contact with biological agents of human origin, 8% were in contact with animals and 23% worked in waste disposal or were involved with handling wastes / food stuffs. More than half of the potentially exposed workers belonged to the health care sector, in which 66% of workers were exposed. The study concluded that one in three workers

exposed to animals and one in four workers in the waste disposal sector were badly protected from biological hazards, while workers in the health care environment were the best protected. The 2005 European Working Conditions Survey (EWCS) asked workers whether or not they were exposed to infectious materials (such as waste, bodily fluids and laboratory materials) in their workplace. Nearly one in 10 workers reported being exposed to infectious materials at least one quarter of the time and more women than men reported high levels of exposure (all or nearly all of the time) (Parent-Thirion et al. 2007). Furthermore, the health and social work sector, in which 23% of workers reported themselves exposed all or nearly all of the time, was the most exposed employment sector.

In 2007, the European Risk Observatory undertook a study that sought to identify emerging biological risks that affect workers in the EU (OSHA 2007) by surveying European experts in work health and safety. The most important emerging biological risks identified by the experts included occupational risks related to global epidemics, difficult assessment of biological risks, worker exposure to drug resistant micro-organisms, lack of information on biological risks, poor maintenance of air-conditioning / water systems and biohazards in waste treatment plants. The report identified farmers, healthcare workers and people in 'evolving' industries such as waste treatment as being most at risk of exposure from biological hazards. The report also concludes that, despite existing European law, knowledge about biological hazards is limited and risks are often poorly assessed or controlled. Furthermore, there appears to be inadequate provision of work health and safety training regarding biological hazards.

These studies highlight the importance of developing an understanding of the exposure of Australian workers to biological hazards and the provision of controls that regulate exposure. In 2008 the National Hazard Exposure Worker Surveillance (NHEWS) survey was undertaken in an effort to obtain such information about Australian workers' exposures to a variety of workplace hazards, including biological hazards. The information collected in the survey enables the preliminary identification of workers with potentially dangerous exposures to biological hazards, based on exposure and control provision, by key employment and demographic characteristics. By understanding 'who' is exposed to biological hazards and to what types of biological hazards, policy interventions for biological hazards can be developed efficiently and targeted towards workers currently at risk. It is hoped that this research will ultimately reduce the exposure of workers to biological hazards and therefore the incidence of deleterious consequences for worker health.

Overview of NHEWS survey methodology

The NHEWS survey collected data on workers' exposure to biological hazards from 4500 Australian workers using computer assisted telephone interviews (CATI). Survey participants were asked to estimate the duration (hours per day or hours per week) they worked in places where there were biological materials. For the purposes of this report, workers who reported they worked where there were biological materials were considered to have been exposed to biological hazards, irrespective of the efficacy of controls to prevent the transmission of disease or other deleterious health effects or whether or not workers were actually physically in contact with biological materials (this was not explicitly surveyed). Consequently, throughout the report these workers are referred to as having reported exposure to biological hazards.

Workers who reported that they were exposed to biological materials were then asked what the main types of biological materials at their workplace were. Workers who reported exposure were also asked whether they / their employer (depending on whether or not they were self employed) do any of the following to prevent health problems caused by exposure to biological materials: provide gloves; provide masks; provide labelling and warning signs; provide protective clothing; provide safety goggles; provide safety cabinets; provide training on safe handling of biological materials; and, provide ventilation systems.

This report presents detailed descriptive statistics on demographic and employment factors that were associated with exposure to biological hazards and the provision of controls against these

substances. Due to small sample size and splits within the data set, formal logistic modelling was not feasible.

The data presented in this report are unweighted and are therefore only representative of the survey sample.

Full details of the survey design, fielding methodology and the data analysis methodology can be found in Appendix A of this report.

Results

Exposure to biological hazards

Although the NHEWS survey was designed to identify workplace exposure to biological hazards, which are by definition microorganisms, cell cultures and human endoparasites, in practice workers were asked about their exposure to biological materials. These may be considered as the vectors of biological hazards (i.e. the transmitters of biological hazards) or substances containing biological hazards.

The types of biological hazards that workers reported were in their workplaces were categorised into five broad groups reflecting the source of potential transmission of biological hazards:

- ***Human bodily matter*** including blood, tissues, vomit, urine, faeces, saliva and breast milk etc., that may contain viral or bacterial diseases
- ***Living animals*** including cattle, sheep, poultry, fish and invertebrates, and their urine and faeces
- ***Animal products*** including raw and cooked meat, offal, skins, blood, milk and eggs
- ***Laboratory cultures*** including animal and human tissue cultures, bacterial and cell cultures, and
- ***Biohazard waste, sewerage and rubbish***.

This classification scheme did not include a categorisation of exposure to plants, algae, moulds or fungi because these were cited as exposures by fewer than 10 survey participants and as the sole exposure in only two cases. These latter two cases were included with the 23 cases where people listed their exposure as ‘nothing’ or ‘don’t know’ and have been excluded from the analyses. However, it is important to bear in mind that plants, algae, moulds and fungi are important groups of biological hazards in workplaces. These may have been over looked by survey participants because they are not necessarily obvious in the working environment or because they are not considered to be biological hazards.

As can be seen in Table 1, just over 19% of the workers surveyed reported they were exposed to biological materials. Most (75%) of these workers reported they were exposed to human bodily matter. In terms of the whole survey sample, exposure to this group of biological materials occurred to almost 15% of workers. Exposures to live animals or animal products were reported by approximately 30% of workers exposed to biological materials but were reported by less than 6% of the survey sample.

The vast majority (89%) of workers who reported they were exposed to biological materials were exposed to one broad type of biological hazard. The remainder (11%) were exposed to two types. Only one person reported exposure to three types of biological hazard.

Table 1 Exposure to biological hazards: the number and percentage of workers who reported exposure to each category of biological material (multiple exposures allowed)

Biological material worker reported exposure to	Number of workers	Percentage of workers surveyed	Percentage of exposed workers
Human bodily matter	653	14.5%	74.9%
Animal products	160	3.6%	18.3%
Living animals	104	2.3%	11.9%
Biohazard waste, sewerage & rubbish	30	0.7%	3.4%
Laboratory cultures	24	0.5%	2.8%
Nothing[1] / don't know / plants only	25	-	-
Total exposed to biological hazards	872	19.4%	

1. These participants provided an estimate of the hours they were exposed to biological hazards but then said they were exposed to 'nothing' or that they 'didn't know' what they were exposed to. These cases have not been included in the statistical analyses and are not included in the sum of workers exposed to biological materials

Industry

Exposure to biological materials / hazards was most common in the Health and community services industry, where 57% of the workers surveyed reported exposure. Not surprisingly, 55% of workers in this industry reported exposure to human bodily matter. Exposures to the other types of biological hazard were each reported by 1-2% of workers in this industry.

The Agriculture, forestry and fishing industry recorded the second highest percentage of workers who reported exposure to biological hazards / materials. In this industry, 33% of workers reported exposure, with 22% reporting exposure to live animals and 12% reporting exposure to animal products. Exposure to human bodily matter was reported by 6% of workers and laboratory cultures by 1% of workers in the Agriculture, forestry and fishing industry[7].

Together, the Health and community services and Agriculture, forestry and fishing industry accounted for 74% of all the workers who reported exposure to biological hazards. While it is not surprising that exposure to biological hazards is concentrated in these industries, this finding is also partially a result of the bias in the survey towards these two national priority industries. A consequence of this bias is a high level of uncertainty associated with the estimates of exposure in the less well surveyed industries. Therefore, although the percentage of workers who reported exposure to biological hazards was also high in the Accommodation, cafes and restaurants (30% reported exposure) and Cultural, recreational and personal services (19% reported exposure) industries, these findings need to be treated with caution. In these two industries, the most common types of exposures were animal products and human bodily matter for the Accommodation, cafes and restaurants and Cultural, recreational and personal services industries respectively.

Occupation

Exposures to biological hazards were most common amongst Community and personal service workers (56% reported exposure), Professionals (31% reported exposure) and Labourers (20% reported exposure). Community and personal service workers and Professionals together accounted for more than 60% of all the workers who reported exposure to biological hazards. As discussed for industry of main employment, this concentration of exposures may be partially a result of survey bias towards the national priority industries, in which Health and community services and Agriculture, forestry and fishing are included.

[7] Note that these percentages do not sum to the percentage of workers exposed within the Agriculture, forestry and fishing industry owing to multiple exposures.

Figure 2 shows the percentage of the total number of workers who reported exposure by occupation at finer resolution (ANZSCO 2nd digit level). Health professionals and Carers and aides accounted for the majority of workers exposed to biological hazards within the whole survey sample (Figure 2). In excess of 70% of the workers in each of these occupations reported exposure to biological hazards. Farmers and farm managers accounted for the third largest number of workers who reported exposure to biological hazards. However only 43% of the workers in this occupation reported they were exposed to biological hazards. This may highlight differences in understanding and / or reporting of biological hazards between groups of workers. For instance, not all farmers who were in contact with animals reported exposure to biological materials in this survey. Once again, care should be taken in future research on this matter to ensure that survey participants understand what is considered a biological material or hazard. Lack of a consensus understanding of the definition of biological materials will lead to major bias in any data collected on this subject. This may be particularly important for workers in industries where biological hazards are less obvious than they are in the Health industry.

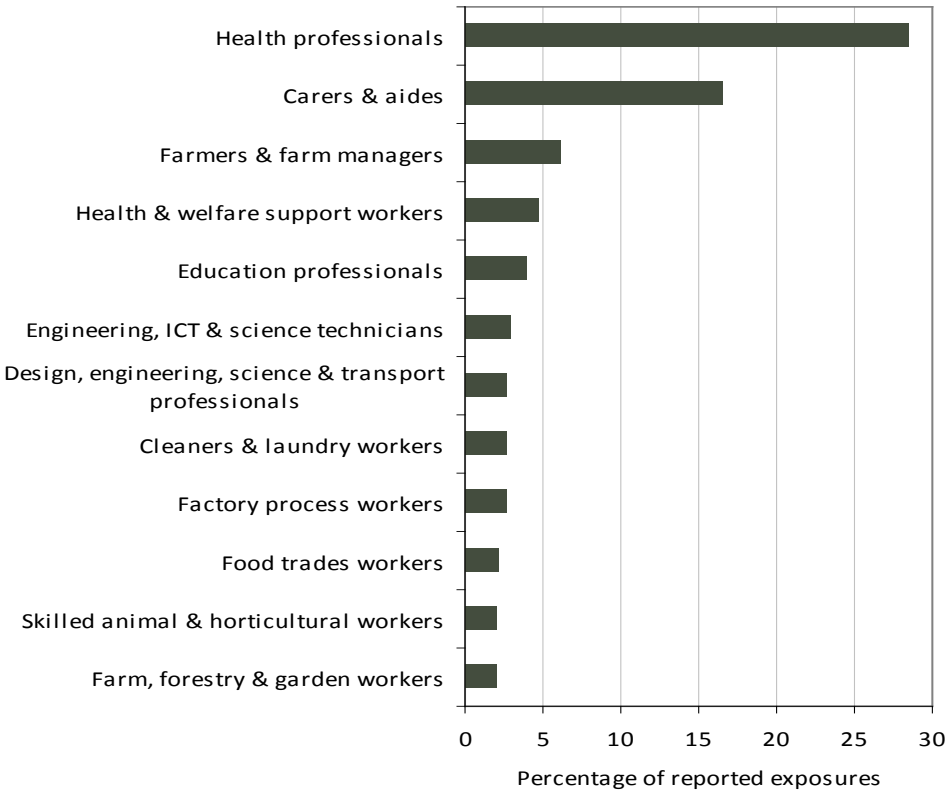

Figure 2 The percentage of the total reported exposures to biological hazards by occupation. Only occupations that accounted for more than 2% of the workers who reported exposure to biological hazards are presented.

With potential response biases in mind, occupation was examined within the two main industries where exposures to biological materials were reported. Figure 3 shows the four occupations within each industry that accounted for the greatest percentages of workers who reported exposure to biological hazards within each industry. Farmers and farm managers accounted for over 50% of the workers who reported exposure to biological materials within the Agriculture, forestry and fishing industry. Farm, forestry and garden workers, Skilled animal and horticultural workers and Mobile plant operators were the other three occupations within Agriculture, forestry and fishing that were most commonly exposed to biological hazards. Health professionals and Carers and aides again accounted for the majority of workers exposed to biological hazards within the Health and community services industry. The next two most important occupations in terms of reporting exposure to biological materials were Health and welfare support workers and Engineering, ICT and science technicians.

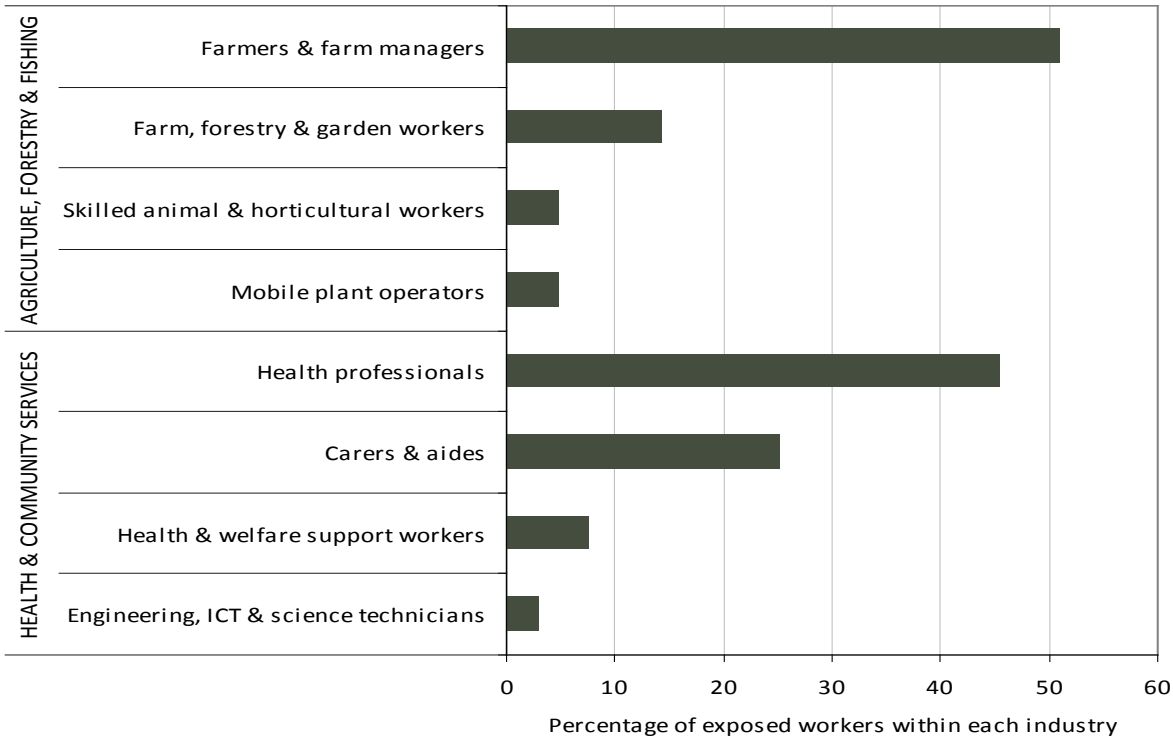

Figure 3 The percentages of the exposed workers within each industry that are accounted for by each occupation. Only the top four occupations are shown for each industry.

Demographic characteristics of workers who reported exposure to biological materials / hazards

Sex

Overall, 63% of workers who reported exposure to biological materials / hazards were female. However, this varied dramatically by industry of employment. Within the Health and community services industry, 79% of exposed workers were female. This compares to 23% in the Agriculture, forestry and fishing industry and 44% overall in the remaining industries.

Age

There were no dramatic differences in exposure to biological materials / hazards by worker age. Older workers (45-54 years) tended to account for the largest proportions of the exposed workers in both the Health and community services industry, the Agriculture, forestry and fishing industry and overall. However, this finding could be affected by bias within the survey towards participants of a certain age. When the percentage of workers who reported exposure to biological hazards was examined within age groups, young workers (15-34 years) in the Health and community services industry recorded higher percentages exposed (63%-64%) than the older age groups (53%-59%). Within the Agriculture, forestry and fishing industry, 35-44 year old workers were most likely to report exposure to biological hazards.

Education

Workers who reported exposure to biological hazards typically had a TAFE or trade qualification (43%) or a Bachelor degree (29%). Similar patterns were found in the Health and community services industry albeit with a slightly higher percentage of workers with a Bachelor degree (35%). Workers in the Agriculture, forestry and fishing industry who were exposed to biological hazards had a different educational background. While 38% had a TAFE or trade qualification,

the next greatest cohort of workers (27%) had not completed year 12 at school. Only 15% had a Bachelor degree.

Workplace size

Exposure to biological hazards occurred across the range of workplace sizes. Overall, smaller workplaces (< 20 workers) accounted for approximately 40% of exposures. Workplace size varies dramatically with industry of employment and this was borne out in terms of exposure to biological hazards within industries. For instance, over 70% of exposures to biological hazards in the Agriculture, forestry and fishing industry occurred in workplaces with fewer than five workers and a further 20% of exposures occurred in workplaces with five to 19 workers. In contrast, 39% of exposures to biological hazards in the Health and community services industry occurred in workplaces with 200 or more workers and a further 32% occurred in workplaces with 20 – 199 workers.

Duration of exposure to biological materials / hazards

Workers reported they were exposed to biological hazards for an average of 17 hours per week. However, the data were not normally distributed and the median number of hours of exposure per week (11) was substantially lower than the average. Figure 4 shows the mean and median duration of exposure to each type of biological hazard. Workers reported the longest exposures to animal products and living animals and the shortest to human bodily matter. It should be noted that the data on some types of biological hazard, in particular laboratory cultures and biohazard wastes, sewerage and rubbish, have wide confidence intervals as a result of small sample sizes and they should therefore be interpreted with caution.

Figure 5 shows the duration of exposure to biological materials / hazards in relation to industry and occupation of employment. Workers in the Agriculture, forestry and fishing industry reported longer exposures to biological materials than workers in the Health and community services industry and the remaining industries grouped together. Skilled animal and horticultural workers and Farm, forestry and garden workers together recorded the longest average exposure to biological hazards of the occupations studied. However, the 95% confidence intervals for this occupation group were wide due to small sample size and the median duration of exposure was less than the median exposure duration of Health professionals, which had the second greatest average exposure duration. Health professionals were exposed to biological hazards for an average of just over 20 hours per week. This was followed by Farmers and farm managers (18h/week), all other occupations (16h/week) and Carers and aides (14h/week).

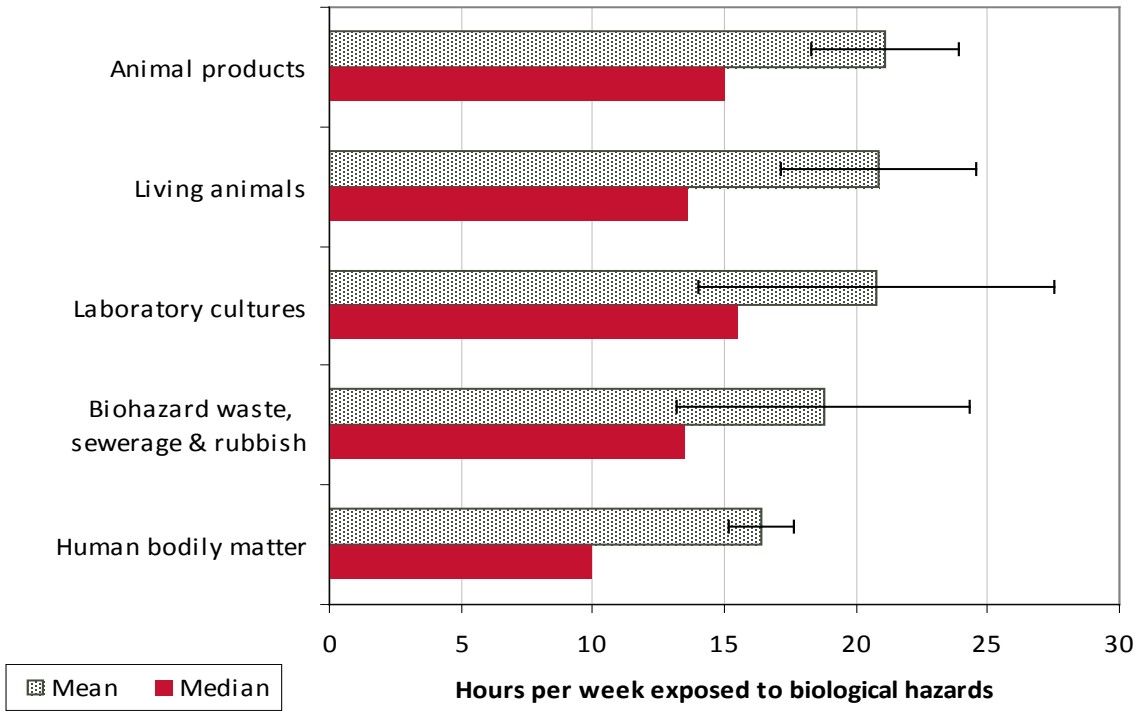

Figure 4 The mean (±95% confidence interval) and median hours of exposure to biological hazards per week by type of biological material

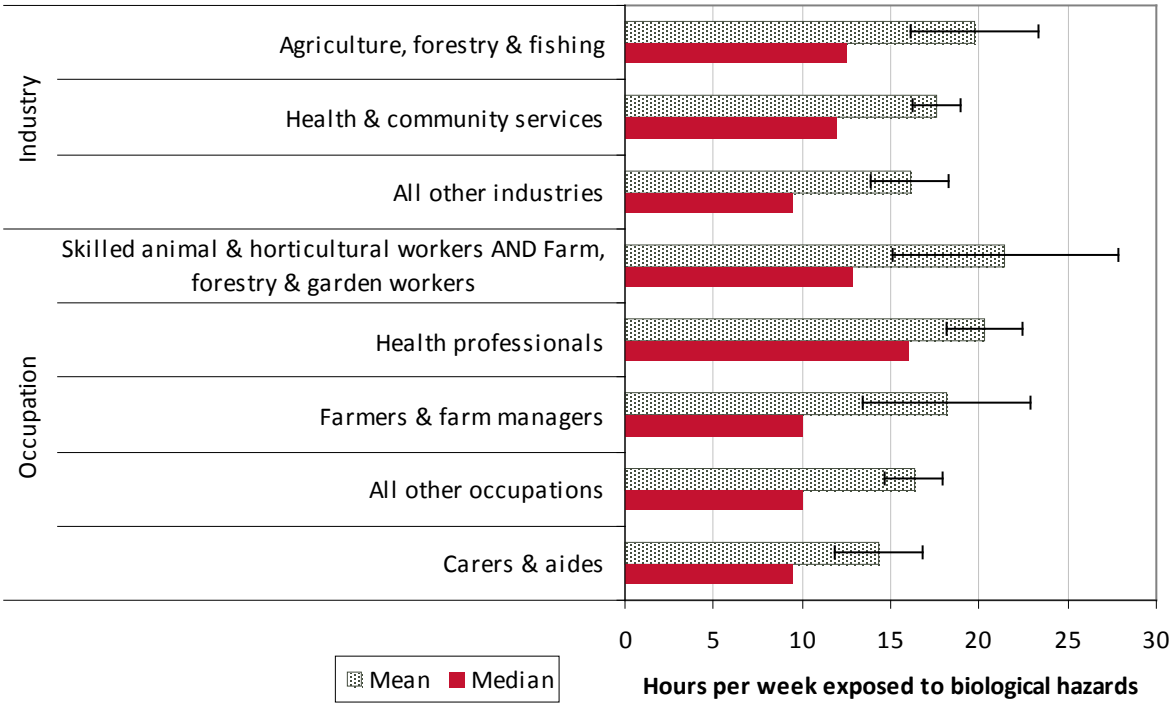

Figure 5 The mean (±95% confidence interval) and median hours of exposure to biological hazards per week by industry and occupation of employment

Control measures against biological hazards in workplaces

Participants in the NHEWS survey who reported they were exposed to biological materials / hazards were asked about the types of controls against biological hazards that were provided in their workplace. Specifically, they were asked whether or not each of the following control measures individually were provided; gloves, masks, labelling and warning signs, protective clothing, safety goggles, safety cabinets, training on safe handling of biological materials, and ventilation systems. The responses to these questions were grouped into three categories of biological hazard control: Protective clothing (gloves, masks, protective clothing, and safety goggles); Engineering, warnings and waste disposal (labelling and warning signs, safety cabinets, and ventilation systems); and, Training. In addition, some participants volunteered information about additional types of biological hazard control. These included the provision of sharps containers, biohazard bags and area isolation. These responses were categorised under Engineering, warnings and waste disposal because they were considered to match or be a variant of the formally surveyed items. For example, biohazard bags and sharps containers could be considered a form of labelling or warning sign since part of their function is to alert workers to their contents.

Overall, workers who reported exposure to biological hazards were most likely to be provided with Protective clothing and least likely to be provided with Training on safe handling of biological materials. However, there were marked differences in control provision based on biological hazard exposure. Figure 6 shows the provision of the three broad types of biohazard controls with respect to the type of biological hazard workers reported exposure to. Fewer than 75% of workers exposed to living animals were provided with Protective clothing and 45% or fewer were provided with Engineering, warnings and waste disposal or training. The percentages of workers provided with these controls were higher when workers were exposed to the other types of biological hazard. This difference is likely to be due, in part, to the appropriateness or feasibility of using these controls when handling live animals. Future research on biological hazards should endeavour to ensure that questions on biohazard control measures encompass control measures used when handling animals.

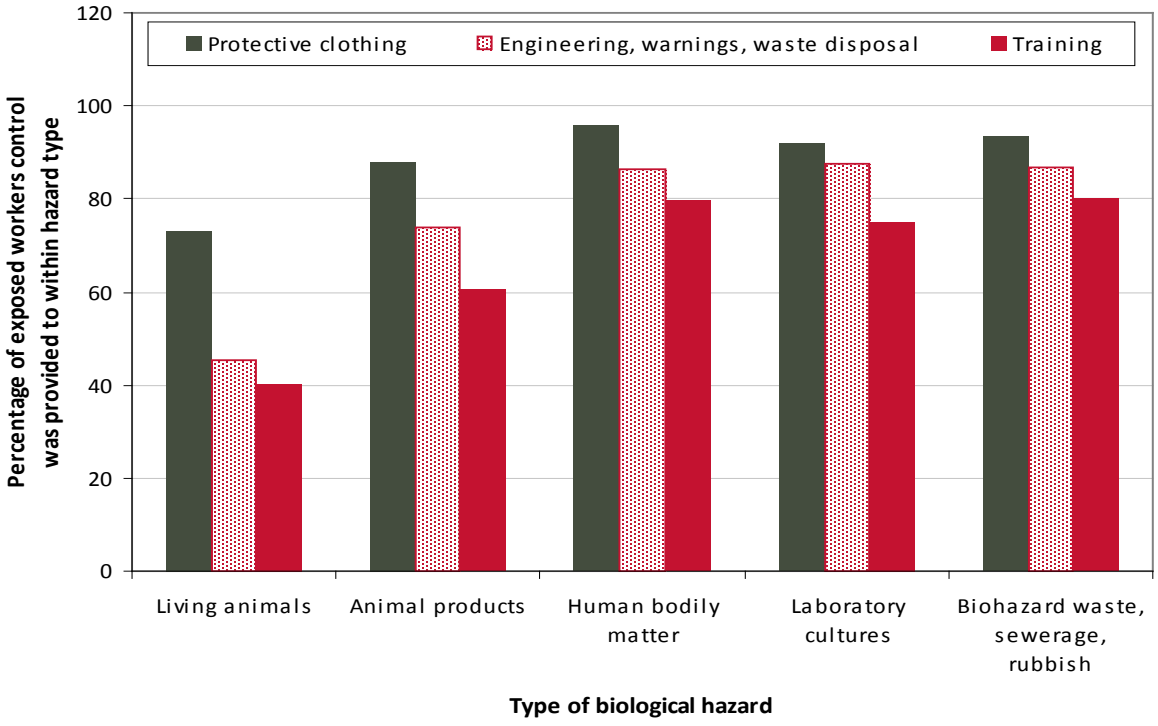

Figure 6 The percentage of exposed workers that were provided with each type of control within each type of biological hazard exposure

In addition to the difference between living animals and the other types of biological hazards, there were differences in control provision to workers exposed to animal products (blood, meat – cooked and uncooked, offal, milk and eggs) compared with those workers exposed to human bodily matter, laboratory cultures or biohazard waste, sewerage and rubbish. In particular, the percentages of workers provided with Engineering, warning and waste disposal controls and Training were lower when workers were exposed to animal products.

The control measure types discussed above were also examined in terms of how many (zero, one-two, or three) controls were provided to workers exposed to biological hazards. In general, workers were more likely to be provided with all three control types than just one or two and they were least likely to be provided with no biohazard control. However, type of biohazard exposure had a considerable influence on the percentage of workers who were provided with each number of biological hazard controls. As can be seen in Figure 7, more than 20% of workers who were exposed to living animals were not provided with any control measures. These workers were also most likely to report they were provided with one or two controls only and the least likely to report that three types of biohazard control were provided in the workplace. Workers exposed to human bodily matter, laboratory cultures or biohazard waste, sewerage or rubbish had similar patterns of control provision, with at least 70% of workers exposed to these biological materials being provided with all three types of control and 4% or fewer being provided with no controls. In contrast, 54% of workers exposed to animal products were provided with three controls and 9% were provided with no controls.

Together, these findings suggest that the provision of biohazard controls to people who work with live animals or animal products is less comprehensive than for workers who are exposed to human bodily matter, laboratory cultures or biohazard wastes, sewerage or garbage. To a certain extent this may reflect the degree of risk associated with these exposures. Exposure to human bodily matter, for example, is high risk due to the high probability of transfer of diseases and hospitals and health care centres have stringent policies in place to prevent cross contamination. However, cross-species transfer of disease also poses a significant risk to humans e.g. Q-fever, bird flu and the Hendra virus in horses that recently killed a veterinarian in Queensland. Indeed, more than three quarters of human diseases are zoonoses (OSHA 2007).The risks of contracting these diseases could be substantially reduced by implementing similarly stringent control measures against exposures to animals or animal products.

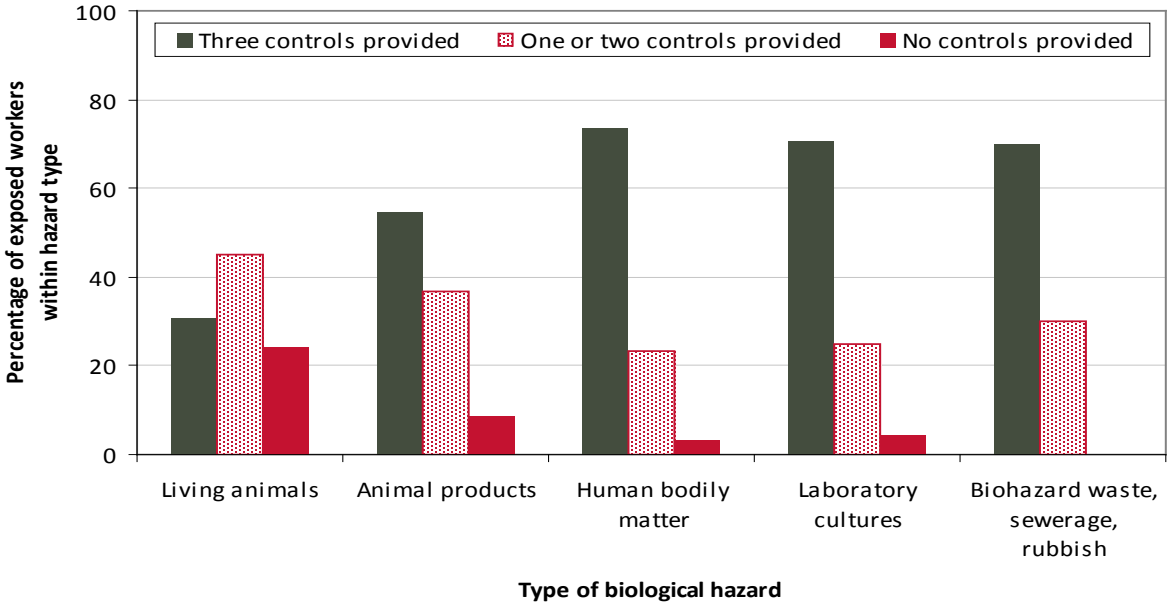

Figure 7 The percentage of exposed workers that were provided with each number of biological hazard controls within each type of biological hazard exposure

Similar patterns in the provision of biological hazard controls were observed when the data were examined by industry and occupation of employment (Figure 8 and Figure 9). In general, larger percentages of workers who reported exposure to biological hazards were provided with each type of biological hazard control in the Health and community services industry compared to the Agriculture, forestry and fishing industry and to all the other industries together. Workers in the Agriculture, forestry and fishing industry, who were most likely to be exposed to live animals and animal products, were least likely to be provided with controls.

Within the Health and community services industry, Health professionals were most likely to be provided with each of the biological hazard controls. All exposed Health professionals surveyed were provided with protective clothing, while 96% were provided with Engineering, warnings and waste disposal controls and 90% were provided with Training (Figure 8). There was a six percentage point difference between Health professionals and Carers and aides in the provision of protective clothing and 11 percentage point differences between these two occupations in the provision of the remaining controls. Health professionals also differed from Carers and aides in that all Health professional were provided with some form of biological hazard controls whereas 3.5% of Carers and aides were provided with no controls. Furthermore, 87% of Health professionals were provided with all three controls compared to just 70% of Carers and aides (Figure 9).

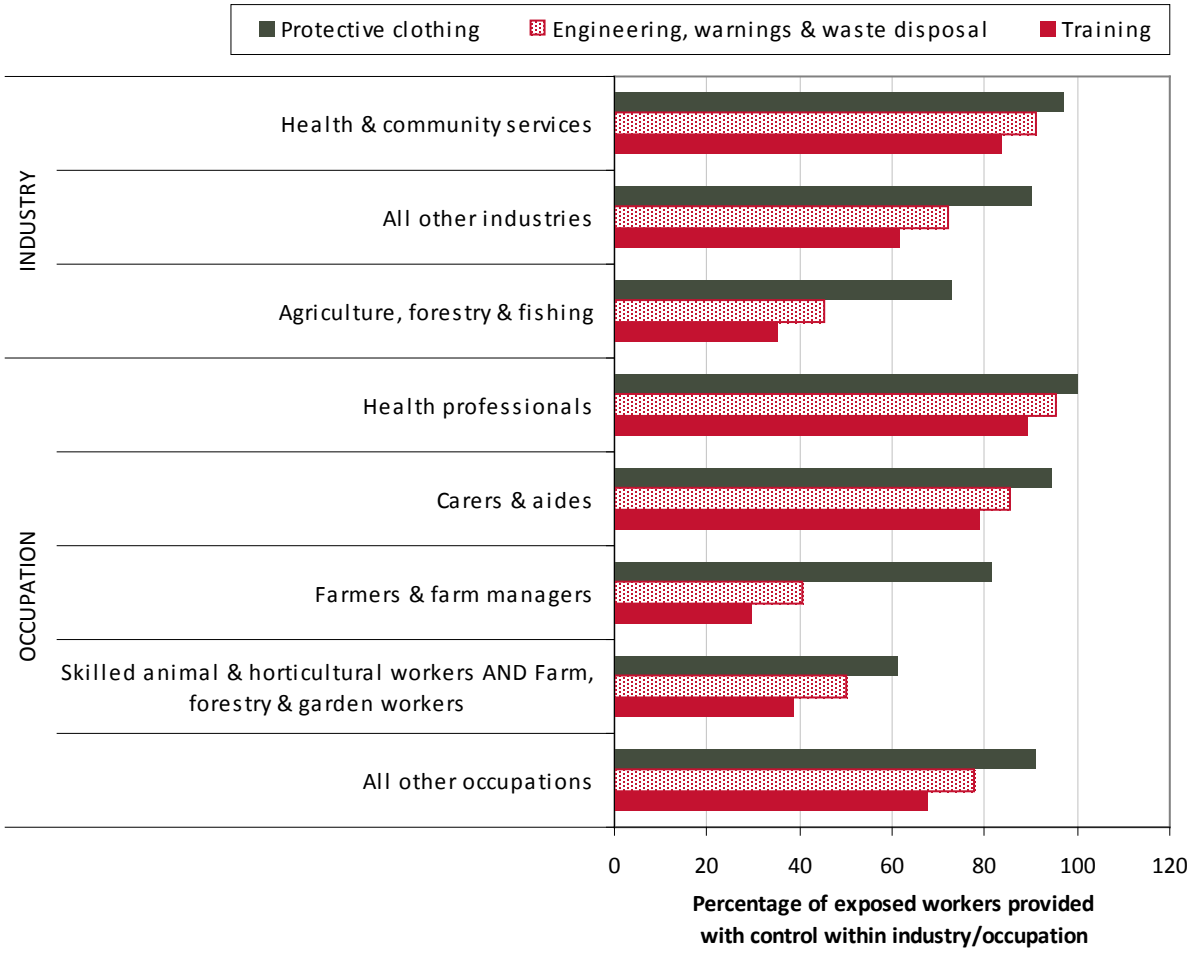

Figure 8 The percentage of exposed workers that were provided with each type of control within each industry and occupation of employment

More than 80% of Farmers and farm managers reported that protective clothing was provided in their workplaces. However only 61% of Skilled animal and horticultural workers and Farm, forestry and garden workers reported that they were provided with protective clothing. Interestingly, these two occupations recorded similar percentages of workers who reported the

other two controls were provided. Farmers and Skilled animal and horticultural workers and Farm, forestry and garden workers also differed in how many controls were provided (Figure 9). More than 61% of Farmers and farm managers were provided with one or two controls only and around 20% were provided with all three groups of biological hazard controls. In contrast, one third of Skilled animal and horticultural workers and Farm, forestry and garden workers were provided with no controls, one third with one or two controls and one third with three controls.

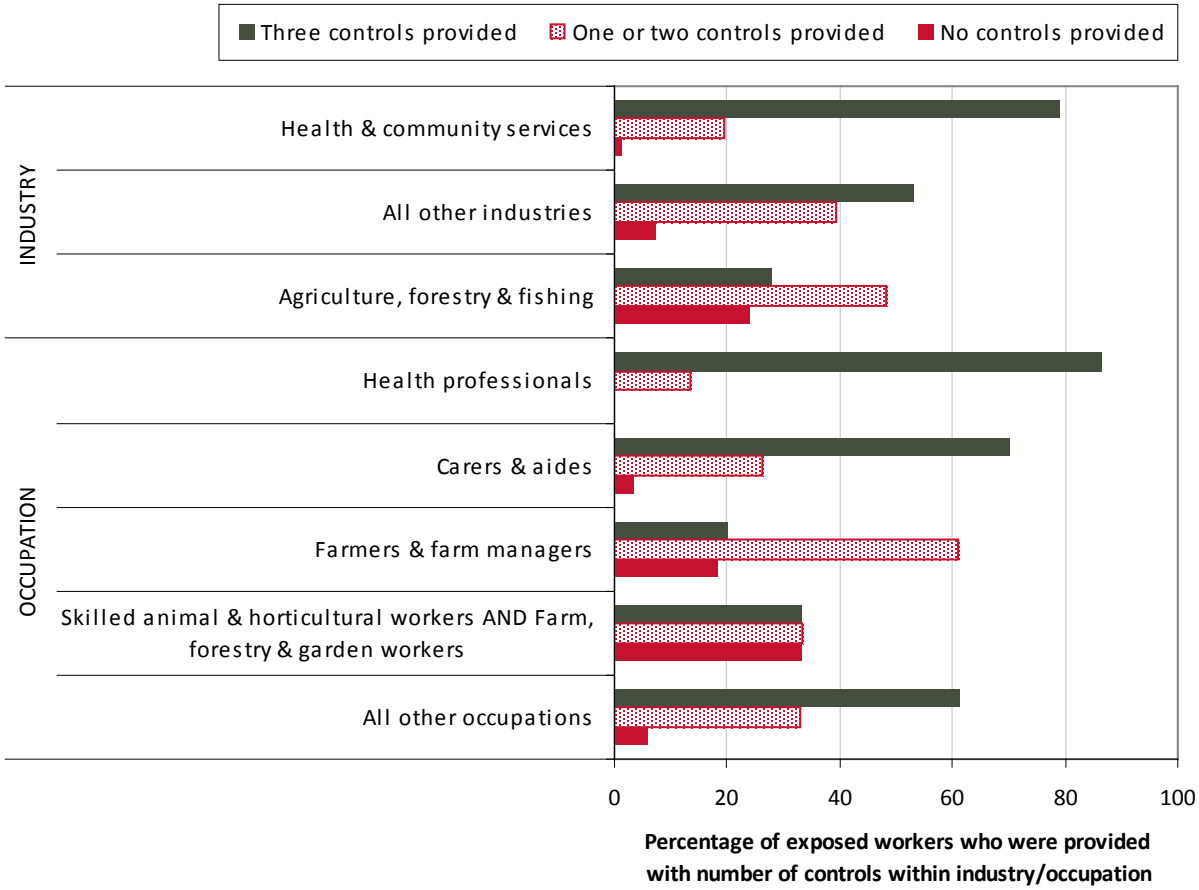

Figure 9 The percentage of exposed workers who were provided with each number of controls within each industry and occupation of employment

Policy implications and recommendations

Estimates of exposure to biological hazards

This study found that just over 19% of workers surveyed reported exposure to biological materials. This is not a weighted estimate so it only reflects the survey sample, which was biased towards the national priority industries. It could therefore be an overestimate of the true national incidence of exposure to biological hazards. For comparison, 15% of French workers were estimated to be exposed to biological hazards (Guignon and Sandret 2006).

Similar to the French study, most exposed Australian workers were in contact with biological materials of human origin. However, the percentages of workers in contact with human bodily matter were considerably greater in Australia than France (75% versus 54%). Furthermore, in Australia around 30% of exposed workers were in contact with biological materials of animal origin compared to 8% of French workers. An additional noticeable difference between France and Australia was the percentages of workers exposed via contact with biohazard waste, sewerage and rubbish. Approximately 3% of exposed Australian workers reported contact with these materials compared to 23% of French workers.

Some of these differences between France and Australia can be attributed to differences in the employment profiles of France and Australia, study methodologies and classification of biological materials. However, it is important to recognise the possibility that the NHEWS survey may not have accurately captured information on exposures to biological hazards in wastes and sewerage in particular. These were not specifically mentioned within the survey question wording, whereas blood, urine, animal flesh and meat were, and this may have generated a response bias in the data. Future surveillance must ensure that any response bias is eradicated and that the surveillance captures information on all types of biological hazard.

The NHEWS study found that there were two main industries in which workers reported exposure to biological hazards. These were the Health and community services industry, where 57% of workers reported exposure, and the Agriculture, forestry and fishing industry, in which 33% of workers reported exposure. Other industries in which there were large percentages of workers who reported exposure to biological hazards include Accommodation, cafes and restaurants and Cultural, recreational and personal services. These findings are supported by patterns of workers' compensation claims in Australian workers' compensation statistics and are similar to the findings of the French study (Guignon & Sandret 2006). Furthermore, workers in these industries were identified as being at risk of exposure to biological hazards by European work health and safety experts (OSHA 2007). Policy development should focus on the exposures of workers in these industries in order to most efficiently combat biological hazards. However, that said more hazard surveillance research is required within all industries in order to identify the more cryptic biological hazards e.g. exposures to moulds, bacteria in air-conditioning or wastes. This may result in a change in the profile by industry of worker exposure to biological hazards or identification of new groups of 'at risk' workers.

Workers who were exposed to biological hazards in the Health and community services and Agriculture, forestry and fishing industries differed in terms of the predominant gender of their exposed workers, education level and workplace size in addition to the duration of their exposures to biological hazards. This has clear implications for policy development in the sense that a *one size fits all* approach may not be effective at raising the profile of biological hazards and reducing worker exposure across these industries.

The provision of control measures (in terms of types and number) against biological hazards varied with the type of biological hazard workers were exposed to and with industry and occupation of employment. Workers whose biological hazard exposure was of human origin, laboratory culture or biohazard waste, sewerage or rubbish were generally well provided with the surveyed controls. Workers who were exposed to biological hazards through contact with live animals were the worst protected. Thus, workers in the Health and community services

industry typically had high levels of control provision while workers in the Agriculture, forestry and fishing industry had lower levels of control provision. The other industries were intermediate. It is important to note that the control measures surveyed in the NHEWS survey were often impractical for use in the Agricultural sector. Other forms of control, not explicitly surveyed in this study, may be used by workers in this sector. Furthermore, the risks associated with exposure to biological hazards in the Agriculture, forestry and fishing industry are lower than in the Health and community services industry. One could therefore expect lower levels of control provision in the Agriculture, forestry and fishing industry. However, it is important to keep in mind that these data can in no way determine whether or not control provision was appropriate or adequate for the biological hazard exposures concerned.

Although the adequacy of control provision and use for biological hazards was not assessed in the NHEWS study, this has been investigated in smaller, occupation specific studies. For instance, in confirmation of the NHEWS study conclusion that workers exposed to animals have lower levels of control provision, an American study of veterinarians concluded that most veterinarians are not aware of appropriate personal protective equipment and do not engage in practices that may help reduce zoonotic disease transmission (Wright et al. 2008). In a study of injuries in Australian veterinarians it was concluded that safety measures were underutilised and often ineffective (Lucas et al. 2009). Furthermore, although these data require updating, in the past it has been shown that large percentages of Australian veterinarians and veterinary nurses have contracted zoonotic infections such as Q-fever, toxoplasmosis and brucellosis, with 23% showing exposure to two or more infections (Jeyaretnam and Jones 2000). In this same study, infection was most commonly observed among veterinarians undertaking meat inspection, which reinforces the need for adequate control provision amongst workers handling animal products.

Training on the safe handling of biological materials was consistently the least commonly provided form of 'control' to workers exposed to biological materials. Only about 40% of workers exposed to live animals received training and only about 60% of workers exposed to animal products received training. Close to 80% of workers exposed to human bodily matter, laboratory cultures and biohazard waste, sewerage and rubbish received training. While all exposed workers should receive training in the safe handling of biological hazards, efforts clearly need to be made in the Agriculture, forestry and fishing industry in particular to increase levels of training. This view is supported by European Agency for Safety and Health at Work's forecast on emerging biological risks related to occupational safety and health where inadequate provision of training to workers was reported (OSHA 2007).

Recommendations

- More surveillance should be undertaken in which representative industry samples are obtained, survey biases are removed and information is collected on subtle biological hazards, such as moulds, bacteria and waste exposures.
- Policy development should focus on workers in the Agriculture, forestry and fishing industry and Health and community service industry because these industries have the highest likelihoods of exposure to biological hazards.
- Policy development needs to be sensitive to major differences in the demographic and employment characteristics of workers in the Agriculture, forestry and fishing and Health and community services industry.
- The adequacy of biological hazard control provision for workers in contact with animals or animal products and those in the Agriculture, forestry and fishing industry requires further investigation.
- The levels of training in the safe handling of biological hazards need improvement, particularly where workers are exposed to animals or animal products.

Definition of biological hazards

One of the barriers to undertaking research on biological hazard exposure in workplaces is the relatively poor understanding of biological hazards in the general public (OSHA 2007). This survey combated this problem by asking workers about their exposure to biological materials, which are not strictly speaking biological hazards but rather the vectors or transmitters of biological hazards. The data collected in the NHEWS survey were heavily biased towards human and animal associated exposures and deficient in terms of the less obvious sorts of biological hazards, such as moulds, algae, bacteria in air-conditioning and wastes. As mentioned previously, this may partially be a consequence of the phrasing of the question but it is also likely that the general understanding of what constitutes a biological hazard is poor or different to how it is defined in science, standards and regulations.

Poor understanding of biological hazards leads to poor risk assessments in workplaces. This was considered the second most important of the emerging issues identified in the European Risk Observatory Report, and of particular importance in the office workplace and agricultural sector (OSHA 2007). In Australia, this understanding could be improved by defining biological hazards appropriately, explaining the risks and providing clear information about where workers might encounter them. This could be publicised and made generally available by the national authorities and jurisdictional regulators in their policy interventions. Together with this information, advice could be provided on how to control biological hazards in workplaces.

Policy interventions for biological hazards

Apart from specific hazards such as blood borne diseases, Australia currently has no official policy interventions relating to work-related exposures to biological hazards generally. It is recommended that policy makers consider developing policy interventions similar to the EU (EEC 1990), which follow the WHO position and are already incorporated into the various Australian and New Zealand standards. The EU regulations define the biological hazards by the risk they pose to human health and prescribe control measures suitable for the risk concerned. Having national work health and safety policy interventions on biological hazards provides the opportunity to protect all Australian workers better from consequences of biological hazard exposure.

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Appendix A. Detailed methodology

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 (e.g. sex, age, educational qualifications) and employment information (occupation, industry, employment conditions, size of workplace) in addition to worker exposure to a variety of different occupational hazards and information about the hazard controls provided in the workplace.

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. For example, these included the European Working Condition Survey, the National Exposures at Work Survey (NIOSH, USA), the Swedish Workplace and Environment Survey and the Victorian WorkCover Authority Worker Survey amongst others.

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 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. Of particular relevance to the noise data was the recommendation that noise exposure be collected on two different scales (hours per day and hours per week) since many workers had difficulty describing a typical day at work.

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.

More information, including the full survey instrument for all occupational hazards and their controls, can be found in the National Hazard Exposure Worker Surveillance (NHEWS): Survey Handbook and the National Hazard Exposure Worker Surveillance (NHEWS) Survey: 2008 Results, which are published on the Safe Work Australia website[8].

[8] http://www.safeworkaustralia.gov.au/swa/AboutUs/Publications/2008ResearchReports.htm

Biological hazard exposure and biological hazard exposure control questions

The specific questions relating to exposure to biological hazards and the provision of controls for these substances were as follows:

Exposure to biological hazards

1. On a typical day at work last week, how long (hours per day / hours per week) did you work in places where there were biological materials, such as blood, urine, animal flesh, meat or laboratory cultures?

   Workers who indicated they worked in places where there were biological materials were considered to be exposed to biological hazards in their workplace. Throughout the report these workers are referred to as having reported exposure to biological hazards.

2. What were the main types of biological materials at your workplace last week? Anything else?

Biological hazard controls

1. Does your employer (or, in the case of self employed / contractors etc. *do you*) do any of the following to prevent health problems caused by exposure to biological materials?
   a. Provide gloves
   b. Provide masks
   c. Provide labelling and warning signs
   d. Provide protective clothing
   e. Provide safety goggles
   f. Provide safety cabinets
   g. Provide training on safe handling of biological materials
   h. Provide ventilation systems

Survey administration

The NHEWS survey was conducted by Sweeney Research Pty Ltd using CATI. The survey obtained an Australia-wide sample of 4500 workers across all seventeen Australian industries. Households were randomly selected using the desk top marketing systems (DTMS) database, which collects its information from directories such as the White / Yellow pages. To be eligible for the research, respondents were required to have worked in the last week and to have earned money from the work. Where more than one individual was eligible for the research, the person whose birthday came next was selected. Overall, the survey achieved a 42.3% response rate.

The sampling scheme for the NHEWS can be considered as two stages with three waves of data collection. The first wave resulted in 1900 completed interviews which met quotas by sex within industry (five national priority industries: Manufacturing, Transport and storage, Construction, Health and community services and Agriculture, forestry and fishing) within state (1300 interviews), plus an additional sample coming from state contributions (600 interviews).

The second and third waves of the survey (n_{total} = 2600) placed no restrictions on industry and differed only in that some additional questions were asked. The second wave involved recontacting those households that had not been interviewed in the first wave due to being out of scope (e.g. had no persons working in the priority industries) or quotas already being met, and had given permission to be recontacted for further studies. This wave resulted in 485

completed interviews. The third wave (n=2115) resulted in the balance of the 4500 interviews, meeting sex within state quotas.

For reporting purposes the following industries were collapsed into two integrated industries: 1) Wholesale and Retail trade and 2) Cultural and recreational services and Personal and other services.

Data analyses

The data were analysed using SPSS 16.0. All data were inspected prior to formal analysis for missing cases or unusual values. Due to small sample sizes and concentration of exposures to biological hazards within two industries, formal statistical analyses in the form of logistic regressions were unfeasible. Detailed descriptive statistics are presented instead. The descriptive statistics were focussed on the data from workers in the Agriculture, forestry and fishing and Health and community services industries and certain key occupations as a result of wide confidence intervals on the remaining data.

Duration of exposure to biological hazards

Survey participants were asked how long they worked in a place where there were biological materials. Participants could respond in one of two scales: hours per day and hours per week. The resulting duration of exposure data therefore required conversion to a common scale. For the purposes of these analyses, hours per week was chosen as the common scale because the hours per day exposure data were considered more reliable and therefore more robust for conversion. The data were converted to hours per week as follows:

The total number of hours each survey participant worked was divided by eight to give the number of standard eight hour days worked per week. This number was multiplied by the number of hours per day workers reported they were exposed to biological hazards to convert hours per day exposure to biological materials to hours per week. The two data sets on hours per week exposed were merged into one variable. This variable was divided by the total hours worked to check that the duration of exposure to biological hazards per week did not exceed the number of hours a worker reported they worked per week. Those cases where duration of exposure exceeded hours worked were capped at total hours worked. Only a small number of cases were capped and this generally occurred when workers reported a typical daily exposure that was in excess of a standard eight hour working day.

Classification of biological hazards

The types of biological hazards that workers reported exposure to were categorised into five broad groups:

- ***Human bodily matter*** including blood, tissues, vomit, urine, faeces, saliva and breast milk etc., that may contain viral or bacterial diseases
- ***Living animals*** including cattle, sheep, poultry, fish and invertebrates, and their urine and faeces
- ***Animal products*** including raw and cooked meat, offal, skins, blood, milk and eggs
- ***Laboratory cultures*** including animal and human tissue cultures, bacterial and cell cultures, and
- ***Biohazard waste, sewerage and rubbish***.

This classification scheme did not include a categorisation of exposure to plants, algae, moulds or fungi. However, these were cited as exposures by fewer than 10 survey participants and as the sole exposure in only two cases. These latter two cases were included with the 23 cases where people listed their exposure as ‘nothing’ or ‘don’t know’ and have been excluded from the analyses. It should be noted that communicable diseases are rarely transmitted from plants to humans. Most deleterious exposures to plants, algae or fungi result in poisoning or allergic responses.