

## Original Paper

# A silent hazard—noise in the veterinary sector: a scoping review

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**Background:** Veterinarians work with various species of animals, in many different work environments and have the potential to be exposed to sources of noise at levels that may be of concern.

**Aims:** To undertake a scoping review to compile existing evidence and determine the extent of knowledge that exists on the topic of occupational noise in the veterinary setting, including the sources, exposure levels, health impacts and hazard controls that exist.

**Methods:** A systematic search of five electronic databases (PubMed, SCOPUS, Web of Science, Embase and CINAHL) as well as grey literature was undertaken to identify articles in accordance with the methodology developed by the Joanna Briggs Institute and using the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist.

**Results:** A total of 19 articles met the inclusion criteria. Various sources of noise were identified, including animals as well as equipment used. Personal noise exposures were found to exceed the commonly applied Occupational Exposure Limit (OEL)/upper exposure action value of  $LA_{eq,8h}$  85 dB(A) for some workers, and audiometric testing found that some workers had hearing loss. Various noise controls were discussed that could be applied more widely to the veterinary sector.

**Conclusions:** Noise is a hazard of importance in the veterinary sector, and further research is needed to ensure that veterinary workers are aware of the risks associated with occupational noise exposure, including what strategies can be implemented to reduce noise exposures.

## INTRODUCTION

Globally, the veterinary sector employs at least 600 000 veterinarians [1] and a much larger number of veterinary nurses, technicians, animal care workers, kennel hands, groomers, veterinary and nursing students and support staff. Individuals work in a variety of environments (including farms, veterinary clinics, zoological gardens, wildlife centres, animal shelters and research facilities) and are exposed to a wide range of hazards including chemicals, animal bites and scratches, zoonotic diseases [2] and noise.

Despite routine exposure to high noise levels from animals, equipment and clinical environments, noise is commonly only mentioned in passing as a hazard of concern, and very little research has been undertaken on the topic. In comparison, other industries such as construction [3–5] and mining [3, 6] have clearly recognized this hazard, and recently this recognition has arisen in less ‘noisy’ settings such as healthcare (including in human hospitals [7], human intensive care units (ICU) [8] and within the dental profession [9, 10]).

The well-known impacts of noise exposure are hearing loss and tinnitus, as well as an increased risk of cardiovascular disease and hypertension [11, 12]. Hearing loss can lead to reduced employability, social isolation, depression, difficulty forming and maintaining relationships and reduced quality of life [11]. Exposure to loud noise has also been linked with negative psychological effects, including anxiety, depression, fatigue and sleep disruption [11, 12] and it has been suggested recently that noise exposure may negatively influence older-age cognitive function and potentially increase the risk of dementia [13]. Occupationally, noise exposure can contribute to psychological stress, reduced productivity, interfere with communication and concentration and create a psychosocial hazard at levels lower than those that could damage hearing [14, 15].

Therefore, this scoping review was carried out to compile existing evidence and determine the extent of knowledge on occupational noise in the veterinary setting, including the sources of noise, exposure levels occurring, the health impacts that may be experienced and any potential noise control solutions which should be utilized, and thereby determine what further research is needed on the topic.

### Key learning points

#### What is already known about this subject:

- Occupationally induced hearing loss is a health impact of concern for many workers
- Veterinary workers work in a wide variety of work environments and with many different types of animals and equipment, which have the potential to be sources of nuisance or hazardous noise

#### What this study adds:

- Veterinary sector noise is not a well-researched topic and there is limited information about the sources of noise, levels of noise occurring, health impacts or potential noise controls which can be utilized
- Veterinary sector workers have the potential to be exposed to episodes of noise at a level of concern for increased risk of ONIHL, and other health impacts
- Some noise control methods have been documented but they have not been assessed for their effectiveness

#### What impact this may have on practice or policy:

- Further identification and quantitation of sources of noise exposure, with comparison to known occupational exposure limits is needed
- A determination of what personal exposure levels are being experienced by the wider veterinary sector, as well as the levels of ONIHL present (via audiometry), and the other impacts that noise is having on workers, both physical and psychological, is required.
- Further assessment into which hazard controls should be utilized in the veterinary setting, such as practical engineering controls that could be implemented, and recommendations of when hearing protection is required.

## METHODS

This scoping review looked at the topic of noise in the veterinary sector. A scoping review was chosen for this research focus to determine what literature is available on the subject, and to allow the authors to assess what knowledge gaps are present in order to determine what future studies are required to further the knowledge of the subject of noise in the veterinary sector.

A protocol was developed by the authors which followed the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist [16] and the Joanna Briggs method [17, 18]. This methodological framework starts with the development of a research question, then the development of a search strategy (including inclusion and exclusion criteria), the finding of suitable sources, the development of a data extraction system prototype, testing of the prototype, using the developed data extraction system to extract the data from the sources to then collate, summarize and analyse it. Each author participated in each of the steps via weekly meetings.

The search strategy was developed using the PCC (Population, Concept, Context) framework. The population was individuals in the veterinary sector (veterinarians, veterinary nurses or technicians, kennel, shelter or animal care attendants, veterinary and veterinary nursing students, groomers). The concept was purposely kept broad and was 'noise'. The context was also purposely broad and was workplaces where these individuals worked, worldwide. No time limit for the year of publication was imposed.

All authors along with assistance from a health sciences librarian, developed the PCC framework and literature search strategy. The search was undertaken in April and May 2025. Five scientific databases were searched (PubMed, SCOPUS, Web of Science, Embase and CINAHL) along with a search of grey literature, using the search terms 'veterinary' and 'noise' on the websites of national health and safety regulators or educators including Safe Work Australia (SWA), Centres for Disease Control (CDC), World Health Organisation (WHO), United Kingdom Health and Safety Executive (UKHSE), International Labour Organization (ILO), Canadian Centre for Occupational Health and Safety (CCOHS), Occupational Safety and Health Administration (OSHA, USA) and National Institute for Occupational Safety and Health (NIOSH, USA) (File 1, available as Supplementary data at *Occupational Medicine Online*).

Citations identified by the searches as being potentially relevant were imported to Covidence, an online software for reviews (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia; available at [www.covidence.org](http://www.covidence.org)). Articles met the inclusion criteria if they made reference to noise in the veterinary sector. All countries of origin and languages were included; non-English articles were translated into English. Articles were included if they were original research, research analysing secondary data or an opinion article, but were excluded if they were a blog article, were focused on the wrong population (for example, they looked at the impact of noise on an animal population), or the wrong outcomes (for example, they looked at occupational hazards but did not include noise), or both the wrong population and outcome.

Screening occurred in two phases. During the first phase, all articles underwent title and abstract screening, which was undertaken by a minimum of two authors independently to assess their relevance. Each author tagged the article with a 'yes' or 'no'. Conflicts on whether an article should be included or excluded were resolved through discussion with all three authors to achieve consensus. Articles that appeared to meet the inclusion criteria went on to the next stage, which was full-text review. This was undertaken by a minimum of two authors who independently tagged each article with a 'yes' or 'no' with the reason for the exclusion stated by the author. Any conflicts were resolved by discussion with all three authors to reach consensus. Additional articles were manually identified by hand searching the references and citations of the included articles and underwent the same process.

A data extraction spreadsheet was developed using the Joanna Briggs methodology [17, 18]. All three authors piloted the data extraction spreadsheet prototype on four of the articles, independently as per the method [17, 18], and the spreadsheet was further refined by all three authors before the remaining articles underwent data extraction.

Key article characteristics such as author, title, year of publication and article type were extracted from the selected articles along with details of the methods that had been used to evaluate the topic (which were personal dosimetry, environmental area monitoring, cross-sectional questionnaire, interviews, audiometry, incident data analysis or 'none of these' if they were an opinion article) (File 2, available as Supplementary data at *Occupational Medicine Online*).

Four main themes relating to the topic of noise in the veterinary setting emerged which were noise sources, noise levels (or exposure levels), health impacts of noise on the workers and the hazard controls that could reduce noise exposures, and these themes were also included in the data extraction spreadsheet (File 2, available as Supplementary data at *Occupational Medicine Online*).

For the articles that represented original research or undertook secondary data analysis, information about the study population (if applicable), sample size (if applicable), data processes used (if applicable) and outcomes or key findings were also assessed.

## RESULTS

A total of 3894 articles were found, 5 of which were grey literature. After 1787 duplicates were removed automatically by Covidence, the remaining 2107 underwent title and abstract screening. A total of 2047 articles were removed at this stage as they did not meet the study design or inclusion criteria. Fifty-nine articles underwent full-text screening, and 40 were rejected with reasons. This process is represented schematically in Figure 1. A total of 19 articles met the inclusion criteria and underwent the data extraction process.

The publication period of the articles ranged from 1970 to 2024; no articles were retrieved from the 1980s. Most articles (68%) were 20 years old or less, with 21% published in the past 5 years, suggesting that the volume of information available on the topic is increasing. Fifteen of the 19 articles originated from the United States of America, and one each from Canada, England, Germany and South Africa. The articles were published in a variety of publications. The four grey literature articles were health hazard evaluation reports published by NIOSH. Of the 15 articles that were not grey literature, 12 were published in veterinary journals, two in an occupational health and safety focussed journal, and one in a human medical journal.

Populations assessed included animal groomers [19], animal shelter workers [20–22] and veterinary clinic workers [23–32]. Settings studied included veterinary intensive care units [26, 28], veterinary operating room [25], animal shelters [20–22, 29] and veterinary hospitals [23, 24].

Six of the articles were opinion pieces, which qualitatively discussed the general topic of workplace hazards in the veterinary sector and included some discussion on the topic of noise [19, 33–37]. The remaining articles studied quantitative aspects of noise in the veterinary sector and utilized a variety of methods of data collection (Figure 2).

Of the four studies that undertook quantitative personal noise dosimetry, the methodology was very similar, as they were all undertaken by the Department of Health and Human Services of the CDC, as part of NIOSH. These utilized a personal noise dosimeter, calibrated prior to use and worn during work shifts, with the microphone located at the midpoint between the outside of the

shoulder and the ear. Workers were required to undertake their regular work activities, and the results are summarized (Table 1).

For the seven studies that involved environmental area measurements, a sound level meter was used and located within the work area; for example, in the corner of the operating room [25], suspended from the ceiling [28] or on top of patient cages [26], at varying distances from the noise sources. The results are summarized (Table 2).

Sources of noise which were discussed but not quantitated included cats meowing [33], animals (such as chimpanzees) banging on metal cages in enclosed areas [19, 31], phones ringing [20], door chimes dingling [33], doors opening [19, 33], cages shutting [33], buzzers or alarms going off, such as those on anaesthetic monitoring equipment [25, 28, 33], grooming clippers [34], clothes dryer [19, 34], high-pressure cleaning equipment [37], tractors [37], ultrasonicators used to clean instruments [31], conversations [25, 28, 33] and music playing [25].

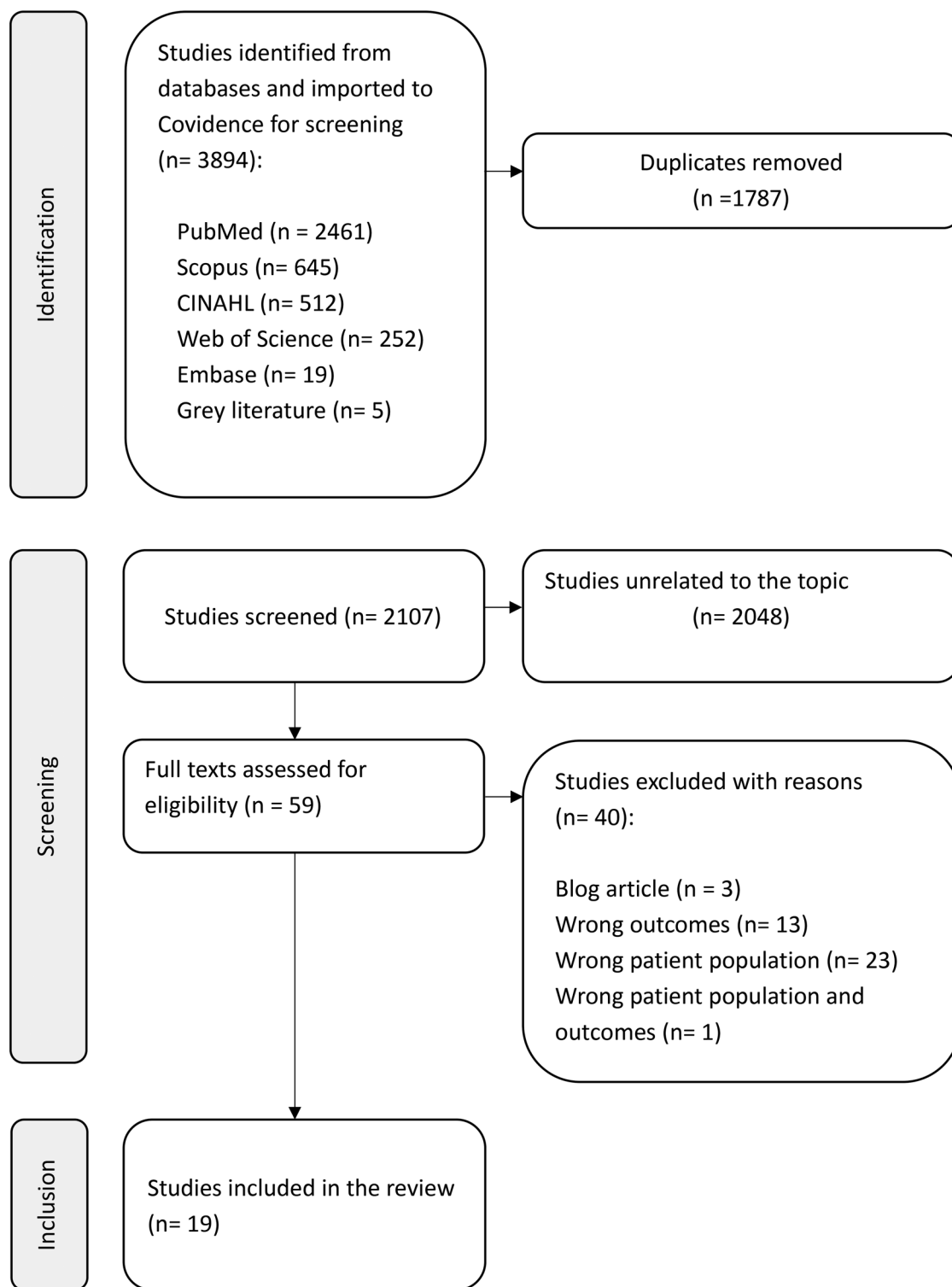
Where audiometry was undertaken, this occurred on site in a hearing booth, in a noise-controlled area of the building. Cross-sectional studies were utilized in three of the studies and included questions about opinions and attitudes on the topic of occupational noise [29], or experience of workplace incidents, including the self or professional diagnosis of a hearing impairment [30, 31]. Interviews were conducted in three of the studies and asked participants about self-reported hearing loss [24], perceptions regarding loud noises as a workplace hazard [27] and the management of problem barking noises (according to interviewees who were acoustic design engineers, animal regulatory officers and government officials) [29].

The impacts of noise exposure were discussed or assessed in nine of the articles. The health impact that was mentioned most frequently was impaired hearing [19, 22, 29, 36, 37]. Hearing loss was investigated via audiometry in three articles, with hearing loss impairments reported in between 10 and 40% of workers in the NIOSH reports [20, 21, 23]. Additionally, some workers with normal hearing were found to have 'notches' on their audiograms (occurring between 3000 and 6000 Hz), which may be indicative of early hearing loss, at a rate of 36 [23], 50 [20] and 64% [21] at three different workplaces.

Self-reported hearing loss was assessed in two of the studies, with 17% of veterinary clinic workers [24] and 22% of pig veterinarians [30] reporting hearing loss, with the percentage of pig veterinarians with hearing loss increasing for years of practice from 25% of workers with 0–9 years of practice, to 73% of veterinarians with 40–49 years in practice [30]. In the German study looking at 2058 veterinary worker injury claims, 'hearing loss' claims represented 0.4% of all veterinary 'occupational disease' claims [32].

The rate at which audiometry assessments were undertaken was assessed in two of the studies, with 28% of zoo veterinarians reporting that they had had an audiometry assessment at some stage of their career (and 2% did this annually) [31], and in another study of pig veterinarians, 46% ( $\pm 2\%$ ) had had their hearing tested at least once during their career [30]. Tinnitus that lasted 5 minutes or more was reported in 8% of workers undertaking dental procedures [24].

Non-auditory health impacts discussed (but not quantitatively assessed) in the articles included both physical and psychological changes such as arterial vasoconstriction, increase in heart rate,

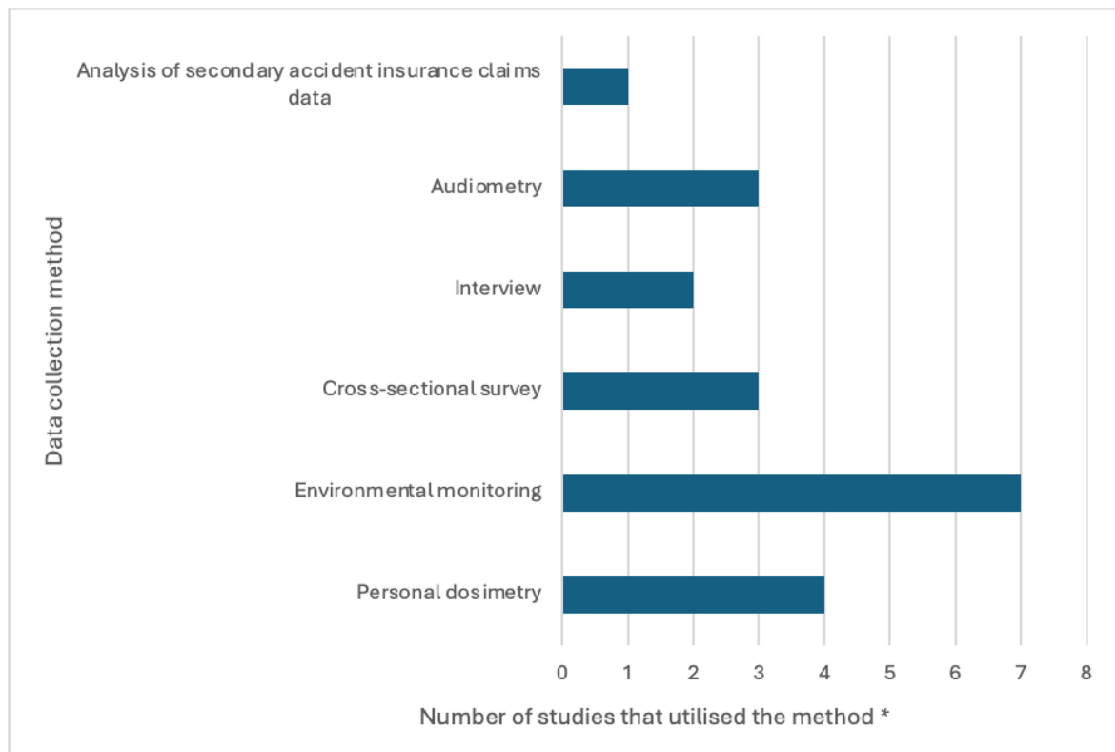


**Figure 1.** Flowchart of article selection process. Some studies utilized more than one method. Personal dosimetry [20, 21, 23, 24], environmental monitoring [22–26, 28, 29], a cross-sectional self-administered questionnaire [29–31], interviews [24, 27], audiometry assessments [20, 21, 23] or analysis of secondary accident insurance claims data [32].

drying of the mouth, contracture of the abdominal musculature, dilation of pupils, inhibition of gastric juice flow and excessive production of epinephrine [29], increased cortisol levels [26], a source of distraction or an impact on the ability to concentrate [19, 35, 37], worker stress [19, 25], increased fatigue [37],

difficulty understanding speech [29, 37] and noise contributing to a poor worker state of mind [22].

A range of noise hazard controls were identified in the articles and could be broadly categorized into worker factors, equipment factors, facility factors and animal factors (Table 3).



\* Some studies utilised more than one method. Personal dosimetry (23, 24, 26, 27), environmental monitoring (25-29, 31, 32), a cross-sectional self-administered questionnaire (32-34), interviews (27, 30), audiometry assessments (23, 24, 26), or analysis of secondary accident insurance claims data (35).

**Figure 2.** Methods of data collection utilized.

**Table 1.** Summary of the findings from the studies that undertook personal dosimetry assessments

Title of study	Noise metric assessed	Summary of findings
Health hazard evaluation report 2006-0196-3036 Liberty Veterinary Hospital, Liberty Township, Ohio [23]	TWA ( $LA_{eq}$ )	Kennel workers: 91–95 dB(A); Hospital workers: 70–84 dB(A)
Health hazard evaluation report 2018-0165-3374: evaluation of employee noise exposures and ergonomic risks during dental procedures at a veterinary hospital [24]	TWA ( $LA_{eq}$ )	Veterinarians: 77.8–81.5 dB(A); Veterinary technicians, nurses or technical assistants: 61.9–77.1 dB(A)
Health hazard evaluation report 2007-0068-3042 Louisiana Society for the Prevention of Cruelty to Animals, Algiers, Louisiana. Noise exposures and hearing loss assessments among animal shelter workers [21]	$LA_{eq,8h}$	16 of the 21 valid personal dosimeter results exceeded the 100% daily allowance. <sup>a,b</sup> $LA_{eq,8h}$ of 82.2–91.0 dB(A)
Health hazard evaluation report 2006-0212-3035 Kenton County Animal Shelter, Covington Kentucky [20]	$LA_{eq,8h}$	6 of 18 personal dosimeter results exceeded the 100% daily allowance. <sup>a,b</sup> $LA_{eq,8h}$ of 79–87 dB(A)

<sup>a</sup>Individual results were not provided in the report.

<sup>b</sup>When compared to the NIOSH recommended exposure level which uses a 3 dB exchange rate and  $LA_{eq,8h}$  of 85 dB(A).

Only one study looked at the rate at which staff wore hearing protection and found that 53% wore hearing protection whilst undertaking dental procedures in a small animal setting [24].

## DISCUSSION

To the authors' knowledge, this is the first scoping review exploring the topic of noise in the veterinary sector. This review determined that there is a very small broadly focused group of articles on the topic of noise in the veterinary sector.

Sources of noise in the veterinary sector were from both animal and non-animal sources. The locations that were identified as being the loudest included kennel rooms [22, 23, 29] and the rooms adjacent to kennel rooms, such as the kennel kitchen [23]. This was followed by veterinary ICU [26], grooming [23] and operating rooms [25] (especially when neurological surgeries were undertaken or music was playing).

Kennel workers were exposed to the highest levels of noise in the studies that collected personal dosimetry measurements ( $LA_{eq}$  91–94 dB(A)) [23]. This is likely due to the increased exposure

**Table 2.** Summary of findings from the studies that undertook environmental area noise assessments

Study	Noise metrics	Reported noise levels
Barking dogs as an environmental problem [29]	Peak <sup>a</sup>	Beagle: 108 dB(A) <sup>b</sup> ; Shetland Sheepdog: 104 dB(A) <sup>b</sup> ; Corridor in which dogs were confined: 106 dB(A); Adjoining areas: 70–85 dB(A)
Noise in the animal shelter environment: building design and the effects of daily noise exposure [22]	LA <sub>max</sub>	LA <sub>max</sub> > 118.9 dB(A); 30–38% time > 100 dB(A) in large-dog areas
Noise levels in an academic veterinary intensive care unit [26]	LA <sub>eq</sub> , LA <sub>max</sub>	Mean LA <sub>eq</sub> : 76.97 dB(A); LA <sub>max</sub> : 86.54 dB(A)
Noise levels in veterinary operating rooms and factors that contribute to their variations [25]	LA <sub>eq</sub> , LA <sub>max</sub>	Mean LA <sub>eq</sub> : 71.7 dB(A); LA <sub>max</sub> : 90.3 dB(A)
Sound pressure levels in 2 veterinary intensive care units [28]	LA <sub>eq</sub> , LA <sub>max</sub> , LA <sub>90</sub>	ICU1: LA <sub>eq</sub> : 62.7 ± 2.9 dB(A) LA <sub>max</sub> : 78.3 ± 3.3 dB(A) LA <sub>90</sub> : 49.2 ± 1.5 dB(A) ICU2: LA <sub>eq</sub> : 59.4 ± 1.5 dB(A) LA <sub>max</sub> : 74.9 ± 1.7 dB(A) LA <sub>90</sub> : 47.0 ± 1.1 dB(A) Spikes over 80 dB(A) were frequent. ICU1 had up to 162 spikes/day
Health hazard evaluation report 2006-0196-3036 Liberty Veterinary Hospital, Liberty Township, Ohio [23]	LA <sub>max</sub>	Spot area up to 112 dB(A) in the large dog kennel (in the afternoon); 105.4 dB(A) in the small animal kennel in the morning; 70 dB(A) laboratory; 90.9 dB(A) in grooming (wet vacuum in tub); 67.5 dB(A) ultrasonic dental; 81.4 dB(A) kennel kitchen (door closed); kennel kitchen 91.0 dB(A) (door open)
Health hazard evaluation report 2018-0165-3374: evaluation of employee noise exposures and ergonomic risks during dental procedures at a veterinary hospital [24]	LA <sub>max</sub>	LA <sub>max</sub> : Dental scaler 78 dB(A), polisher 73 dB(A), drills 80 dB(A)

<sup>a</sup>Assumed to be LA<sub>max</sub>, not stipulated in the study.

<sup>b</sup>Measured at 1.2–2.4 m from the dog.

**Table 3.** Hazard controls identified in the extracted articles

Hazard control category	Suggested noise control strategies
Worker factors	Adjust voice to quieter tone [33] Wear hearing protection [20, 21, 23, 24, 30, 34, 36, 37] Reduce exposure time in noisy situations [37] Have a hearing conservation program, involving regular audiometry assessments [20, 21, 23, 31, 34, 37]
Equipment factors	Adjust the level of rings on phone and equipment alarms down [33]
Facility factors	Design quieter kennels such as those created as separate 'rooms' [22], or located outside rather than inside, so that noise can dissipate more [34] Select surface textures that provide noise dampening such as acoustic panels [20–23, 26, 29, 35], acoustic flooring [35] or the use of rubber mats that reduce noise by preventing food bowls clanging on hard floors [20, 23, 33] Build noise-controlling walls or barriers between noisier kennel areas and other work areas [29], and ensure there are 'quiet zones' in animal care workplaces [35] Install signage near areas where loud noises occur, so that hearing protection usage is encouraged [34]
Animal factors	Aim to have pets calmer and therefore quieter by utilizing 'fear free' handling [33], along with other stress-reducing methods such as sedation tablets, compression jackets, stress-reducing pheromones [29, 33] or muzzles [29] Implement waiting room management techniques that reduce noise levels [33] such as moving pets out of waiting rooms and into the examination room as soon as possible Encourage exercise and play for kennelled dogs, in a play area [29], to contribute to quieter behaviour (as a dog that is mentally and physically exercised is usually quieter)

they have to barking dogs and other sounds generated by dogs in kennel areas (such as the banging of food bowls). Personal dosimetry measurements were found to exceed the commonly used OEL/upper exposure action value of LA<sub>eq,8h</sub> 85 dB(A) (with a 3 dB(A) exchange rate) [38–40] in the NIOSH studies that

undertook personal dosimetry [38–40] in 33–76% of workers in the two studies that assessed this [20, 21]. For those measurements that were found to be under this commonly applied OEL/upper exposure action value for noise, they were still potentially too high, given that comfort and cognitive performance are

disrupted if occupational noise levels exceed 55 dB(A) [41], and noise can create psychological stress, reduce productivity, interfere with communication and concentration [14], and create a psychosocial hazard [15] at levels lower than those that could damage hearing. The non-auditory impacts of noise exposure were not quantitatively investigated in the articles included in this scoping review and represents an area for future study.

Hearing loss was assessed via surveys asking for self-reported hearing loss and via audiometry. Self-reported hearing loss varied from 2 to 23% of the study population [30, 31]. This self-reporting is problematic as it may over- or under-represent the true levels and cannot be considered representative of results using audiometry [42]. In the studies that undertook audiometry, the percentage of workers with hearing loss ranged from 10 to 40%, which suggests that occupational noise induced hearing loss (ONIHL) may be occurring at a rate higher than that of the general working public, which is around 16% in the United States [3]. Concerningly, between 36 and 64% of workers with normal hearing investigated in the articles were found to have 'notches' suggestive of early ONIHL [20, 21, 23], indicating that many workers may already be on the way to developing ONIHL, and the rate of workers with confirmed ONIHL may be just the tip of the iceberg. Detailed guidance on the interpretation of audiograms in the diagnosis of ONIHL is provided by The Society of Occupational Medicine Noise Special Interest Group document 'Supplementary Guidance on Interpreting an Audiogram for Indications of Occupational Noise-Induced Hearing Loss (NIHL)' [43], and a UK HSE research team paper which discusses the current practices in noise health surveillance [44].

It was found that between 28 [31] and 46% ( $\pm 2\%$ ) [30] of veterinary workers had had their hearing tested during their career indicating that hearing loss is not routinely or regularly monitored in the sector, despite hearing conservation programmes being recommended in many of the articles, [20, 21, 23, 31, 34, 37], and audiometry being a key component to these. Hearing conservation programmes should be developed and implemented in workplaces where exposures are exceeding the commonly used OEL/upper exposure action value of  $LA_{eq,8h}$  85 dB(A) [38–40], and are a requirement stipulated globally by safety regulators and administrators such as the UK HSE, SWA, Australia, ILO, CCOHS, Canada and OSHA, USA, as well as professional organizations, such as the Society of Occupational Medicine (UK). The essential elements of a hearing conservation programme are to identify the noise source(s), assess them (such as the frequency or level of noise occurring), control the noise (ideally at the source), use hearing protection for residual protection, monitor the impact of the controls (on both the noise levels and the worker health effect(s) using audiometry) and document each of these components, via detailed record keeping. Given that the studies confirmed that veterinary sector worker exposures are exceeding the commonly used OEL/upper exposure action value of  $LA_{eq,8h}$  85 dB(A) [38–40], audiometric testing should be being implemented as part of a hearing conservation programme, for veterinary sector workers.

One of the most common noise control methods mentioned in the articles was hearing protection; however, while it was found to be used in a small animal clinic undertaking dental procedures [27], the true rate of hearing protection use in the veterinary

sector was not investigated and is unknown. In the study that observed employees using hearing protection [24], it was found that they were using protection that reduced noise more than needed, which is problematic as it can lead to issues with poor compliance or issues with communication between workers as well as reduced awareness of workplace alarms and equipment sounds [15]. Further review of hazard controls needs to be explored to determine what other methods can be utilized, including the substitution of noisy equipment for quieter equipment and the isolation of noisy equipment from workers [15], as well as a more comprehensive risk assessment of when hearing protection should be used [15] and the best hearing protection for different situations. In the same study that observed workers wearing hearing protection, it was also found that some of the workers did not have the hearing protection (ear plugs) properly inserted into the ear canal [24], which is concerning given that the correct selection and fit of hearing protection are critical for effectiveness [45, 46].

Various other hazard control methods for noise were discussed in the studies; unfortunately, testing of these to determine their effectiveness was not undertaken for any, including hearing protection. A commonly made recommendation was for the implementation of noise-dampening strategies such as acoustic panels or rubber mats in kennel areas [20, 21, 23, 29, 35]. A challenge relating to the use of acoustic panels in the veterinary setting exists, as they are usually made of an absorbent and porous material with a fabric covering, and therefore, they are not ideal because high levels of cleanliness need to be maintained for infection and vector control (such as ticks and fleas). Additionally, acoustic panels only protect the worker from direct noise if they are located between the worker and the source of noise [47]. A more effective noise-reduction method may be to reduce animal-derived noise at the source via evidence-based stress-reduction interventions [48–50].

There were limitations to this scoping review and the articles included in it. Despite the broad search criteria, due to the disparate and varied nature of the articles included (including grey literature and opinion pieces), the findings can only be applied to a limited degree to the wider veterinary setting. The studies themselves also had limitations such as the commonly identified challenges of cross-sectional questionnaires (recall and selection bias). The noise metrics assessed in the studies were not consistent, with  $LA_{max}$ ,  $LA_{eq}$  and  $LA_{eq,8h}$  varyingly measured, making comparisons difficult between results. The articles included in this study that undertook qualitative noise assessments, were also of varying levels of quality. The studies of the highest data quality had detailed methodologies with clear study designs, stipulated what noise metrics they were collecting and collected multiple data points [23–25, 28]. The studies that were of lower quality provided less methodological detail [22, 29], provided a summary of personal dosimetry results but not individual results [20, 21], or used a fixed-location sound level meter when personal dosimetry may have been more informative [26].

Many sources of noise that exist in veterinary settings were not explored, including those from other types of animals such as birds, wildlife, horses and goats. Noise levels generated from other known 'noisy' types of veterinary equipment were also not fully explored, such as firearms, farm vehicles, pallet lifters, horse treadmills, horse dental floats and air compressors. Further studies to

identify additional animals, equipment and work tasks that create noise would be advantageous to assist workers to better understand the sources of noise that contribute to their exposures.

The aim of this scoping review was to provide an overview of research undertaken to date on the topic of noise in the veterinary sector; specifically, the sources of noise, the levels of noise occurring, the health impacts of these on workers and potential controls that may assist in reducing noise levels in a veterinary workplace. This scoping review found that multiple sources of noise are occurring at a concerning level that exceeds the commonly applied OEL/upper exposure action value of  $LA_{eq}$  85 dB(A) [38–40]. Further research is needed to investigate the presence of additional sources of noise in the veterinary setting and determine the levels of hazardous noise exposures occurring for comparison with occupational exposure standards. But it is also important to identify noise that is occurring below the OEL/upper exposure action value, as this is known to impact worker cognition and wellbeing. It would be beneficial to further explore the health impacts of noise exposures in this sector, particularly the level of ONIHL occurring, as well as potential practical hazard controls that can be used to reduce noise exposure and therefore the risk and impact of ONIHL.

## ACKNOWLEDGEMENTS

The authors thank Marcos Riba, a health services librarian at The University of Queensland, for assistance with the development of the PCC terms and literature search strategy.

## SUPPLEMENTARY DATA

Supplementary data are available at *Occupational Medicine* online.

## FUNDING

This study is supported by an Australian Government Research Training Program (RTP) Scholarship.

## COMPETING INTERESTS

None declared.

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