Occupational hazards reported by swine veterinarians in the United States

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Summary

Objective—*To evaluate and document the health and safety hazards specifically associated with the swine confinement facilities to which the swine veterinarian is routinely exposed, and to heighten the awareness of swine veterinarians to everyday work hazards and so reduce the risk of harm.*

Design and procedure—*We mailed a seven-page questionnaire to the 1435 members of the American Association of Swine Practitioners (AASP) and achieved a response rate of 65%.*

Results—*Ninety-three percent of respondents reported symptoms related to dust and gases in swine confinement buildings. The five highest reported physical injuries were: 1) needlestick injuries (73%), 2) pain from repetitious motions (51%), 3) injuries from handling swine postmortem (36%), 4) back problems associated with lifting or moving swine (31%), and 5) hot or cold weather-related problems (30%). Twenty-eight percent of swine practitioners had been involved in a vehicular accident while working. Twenty-two percent have a diagnosed hearing impairment. Zoonotic infections occurred in 13% of respondents. In all, we assessed a total of 20 different types of health problems related to swine veterinary work.*

Implications—*Practitioners should take the appropriate measures for their practice type and alert others (e.g., farm workers) with similar potential exposures to the hazards associated with swine confinement work.*

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Veterinarians are exposed to many hazardous situations in their daily practice. Those who work with swine face unique hazards associated with these animals and their environment. Contact with hogs in high densities and at close quarters, the air quality of confinement facilities, and the elevated noise levels inside these facilities are all potentially harmful. Although other studies have investigated the occupational health of veterinarians, there has been a lack of information about the prevalence of injuries and illnesses specific to swine practitioners. We report here the results of a national survey to:

- identify the hazards to which swine practitioners are subject,
- heighten practitioner awareness of these hazards, and
- offer suggestions for mitigating these hazards.

Materials and methods

The study was restricted to members of the American Association of Swine Practitioners (AASP) with a United States address, who were mailed a seven-page questionnaire (available from the authors). A second mailing, similar to the first, was sent to all nonrespondents 2 months later.

The survey design and procedures were similar to the methods described by Dillman.[1] Questions were categorized as:

- physical injuries,
- allergic or irritant reactions,
- chemical exposures, and
- infections.

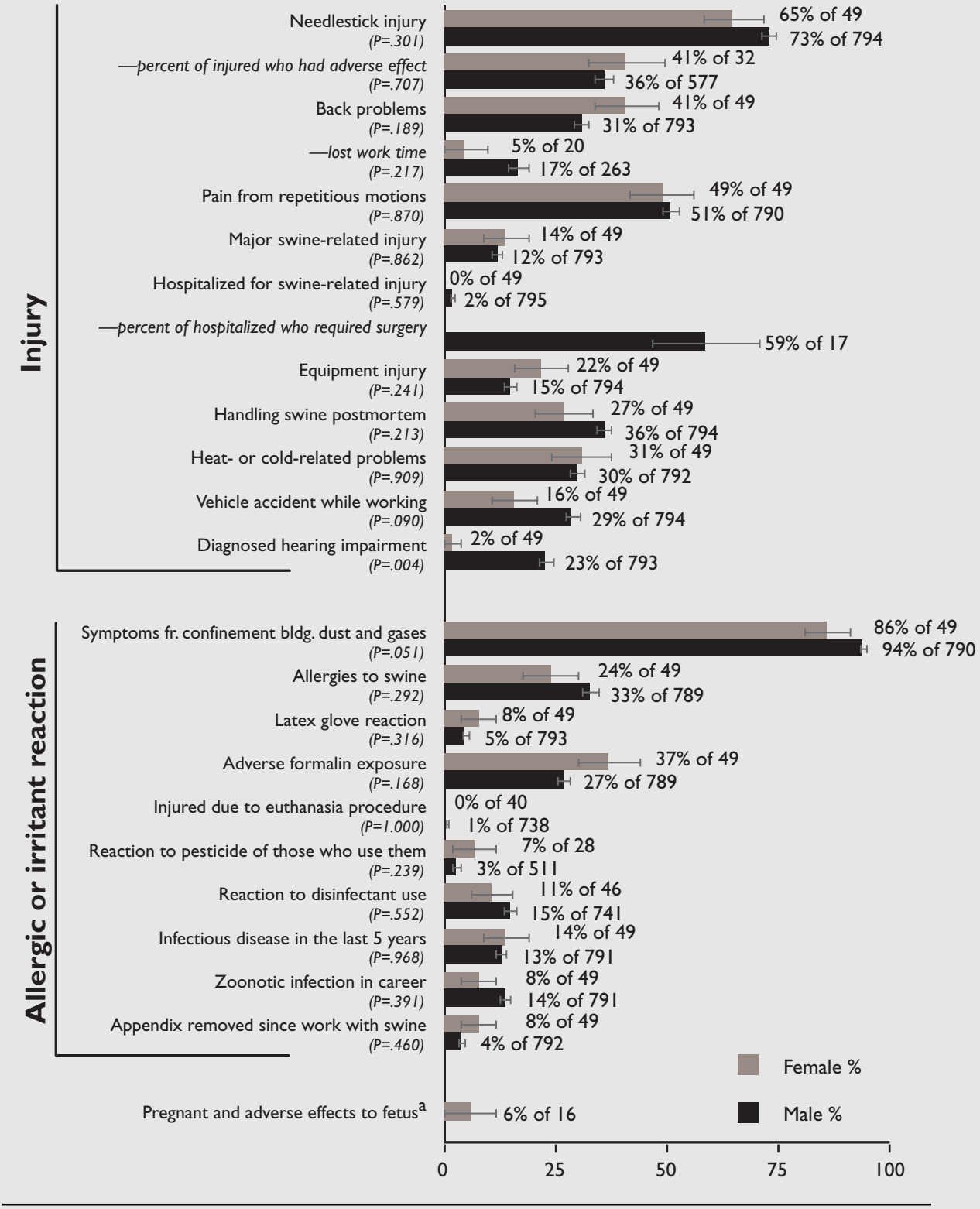
A separate category, 'preventive measures,' was included to assess hygiene practices and the use of personal protective equipment. Demographic information was also obtained. The opportunity for comments was provided on the last page.

The questionnaires were coded for confidentiality. The survey was pretested on eleven AASP members in North Carolina. Their responses were included in the results.

Statistical analysis

The responses received were entered using Epi Info Version 6 (Centers for Disease Control and Prevention, Atlanta, Georgia), designed specifically for epidemiological analysis.[2] Simple frequency calculations were performed on responses to approximately 20 health and safety hazards questions and 15 hygiene practices questions. Calculations for measures of association between health hazards and employment types, and between health hazards and sex, were performed

Figure 1



Sex distribution of injuries

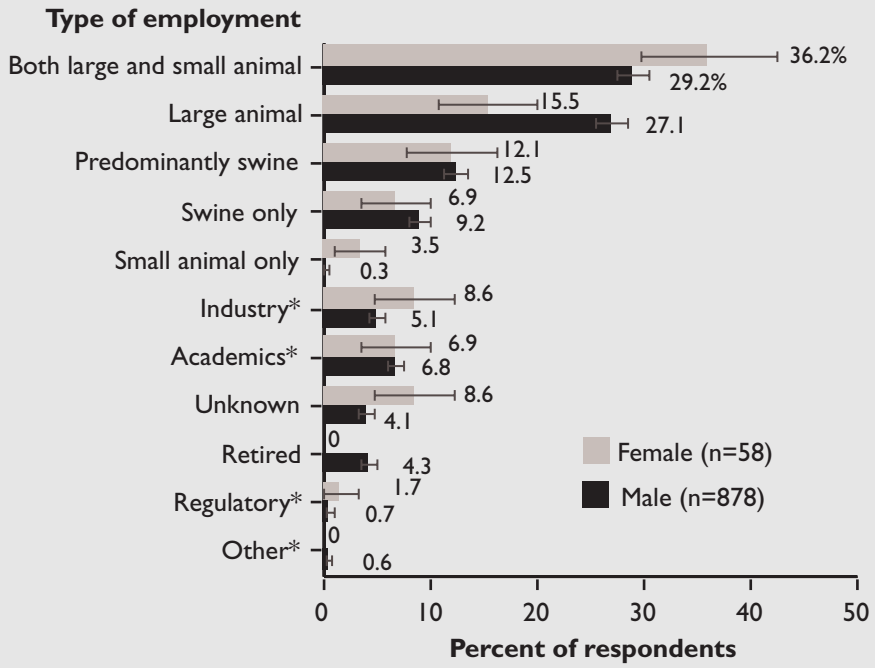
Notes:

Percentages rounded to nearest whole number; number responding to question is given for each category.

Fisher exact test 2-tailed *P* values given.

a = One female reported having two babies with adverse health effects but was unsure if the condition was occupationally related

Figure 2



Employment types of total respondents by gender
* Infered from address or other information

using contingency tables. *P* values with one degree of freedom are given for the Yates-corrected Chi-square formula for small sample sizes, except where stated otherwise. Stratified Mantel-Haenszel analysis was applied in some cases to examine confounding by years in practice and age.

Results

A total of 936 responses were received from 1435 surveys mailed (a response rate of 65.2%). Of these, 82 respondents (8.8%) did not complete the survey because they felt the questions were not relevant to their employment situation. These respondents were included in only the overall statistics of sex and employment type but were excluded from the majority of the analyses. Therefore, a total of 854 (59.5%) respondents answered most or all of the questions in the survey and analysis was based on these data. They reported having suffered various injuries, allergic or irritant reactions, and infections (Figure 1).

Of the 936 respondents, 878 (93.8%) were male and 58 (6.2%) were female. The average age of females was 34.8 (±6.2) years and the median age was 34.5. The average age of males was 45.3 (±11.1) years and the median age was 43. Average years in employment was 8.6 (±6.5) years for females with a median of 6 years. No female was in practice longer than 23 years. Average years in employment for males was 18.9 (±11.1) years with a median of 17 years.

Seventy-one (8.5% ±11.0) respondents smoked, one (2.0% ±11.9) female and 70 (8.8% ±11.0) males. The smoking group is further categorized as those who considered themselves regular smokers (6.2% ±10.8) and those who considered themselves ex-smokers for less than 1 year (2.3% ±10.5).

Respondents were asked to choose the employment type that best describes their current type of animal practice from among six practice categories (Figure 2):

- small animal only,
- both large and small animal,
- large animal only,
- predominantly swine,
- swine only, and
- retired.

No category was provided on the questionnaire for employment types other than the ones listed.

During data collection, five more employment categories were added based on information volunteered by respondents and deduced from mailing addresses. These were industry, academics, regulatory, other, and unknown. Only seven of the 41 respondents who did not list an employment type completed the survey.

Facility type was divided into five categories:

- mostly confinement facilities,
- mostly outdoor facilities,
- confinement facilities only,
- outdoor facilities only, and
- 50% outdoor facilities and 50% confinement facilities.

The fifth category was not a choice offered on the survey but was volunteered by some respondents. Five hundred forty-one (69.5% 11.7) males and twenty-seven (57.4% ±17.2) females visit 'mostly

confinement' facilities, followed in frequency of response by 'mostly outdoor' facilities (M=20.4% ±1.4, F=27.7% ±6.5), 'confinement facilities only' (M=8.1% ±1.0, F=12.8% ±4.9), '50% outdoor and 50% confinement facilities' (M=1.8% ±0.5, F=2.1% ±2.1), and 'outdoor facilities only' (M=0.1% ±0.1) respectively.

Injuries

A major swine-related injury was sustained by 12.5% (±1.1) of 842 respondents (Table 1). Major swine-related injury implies an illness or injury requiring medical treatment, either by a physician or self-administered, excluding those requiring only topical antibiotics. Years in practice was not significantly associated with injury (P=.118). The variety of treatments included self-administered antibiotics, wound dressing, stitches, time, and bed rest.

Of the 17 males hospitalized for a swine-related injury, 10 (58.8% ±11.9) required surgery. Surgery types listed were two knee surgeries, one bilateral carpal tunnel surgery, one hand surgery, three laminectomies, one cervical decompression, and one wound debridement.

Needlestick injuries

Seventy-three percent of respondents (±1.5) experienced at least one needlestick injury during their career. In the past 2 years, females reported an average of 4.3 (±5.2) and median 2.5 needlesticks while males reported an average of 2.8 (±5.7) and median 2 needlesticks (Kruskal-Wallis H test for two groups: $P \leq .013$).

Of the 586 respondents reporting a needlestick injury in the past 2 years, vaccines were the most common exposures (40% ±2), followed by swine blood (37% ±2), antibiotics (35% ±2), and prostaglandins (1% ±0.4). Ivermectin and clean or empty needles constituted most of the remaining 8% (±1) of needlestick exposures reported.

Adverse effects from needlestick injuries included pain, local swelling, hematoma, infection, superficial abscess, and cellulitis. The erysipelas vaccine was the most commonly cited agent for causing an adverse effect, followed by LA 200® (Liquamycin™, LA-200. Pfizer Inc. Animal Health Division. 235 East 42nd St., New York, New York 10017) and APP Bacterin® (Salsbury™ APP Bacterin. Solvay Animal Health, Inc. 1201 Northland Dr., Mendota Heights, Minnesota 55120-1139).

Back injuries

Thirty-one percent (±1.6) of 842 respondents experienced back problems as a result of lifting or moving swine. Pain was mild in 45.4% (±3.1), moderate in 37.8% (±3), and severe in 16.8% (±2.3) of the 262 respondents. No data were collected concerning the number of back injuries these percentages represented.

Other injuries

Fifty-one percent (±1.7) of 839 respondents reported pain from occupationally related repetitious motions. The two most reported activities were bleeding swine and performing frequent injections. Kneeling, bending over, or squatting caused the pain associated with bleeding swine. Sore wrists, elbows, and blistered fingers resulted from performing frequent injections using a pistol-grip syringe.

Table 1

Percentage of respondents who reported a major swine-related injury

Injury reported	% (n=842)
Other than listed injury*	6.4 ±0.8
Bite	3.2 ±0.6
Stepped on	2.0 ±0.5
Crush	1.8 ±0.5
Gore from boar tusks	0.8 ±0.3
No injuries	87.5 ±1.1

* Includes injuries occurring as a result of pigs running into and/or knocking over the respondent, knife injuries, lacerations, back strains, and knee injuries associated with trying to restrain a pig.
More than one injury may be reported per respondent therefore percentages do not sum to 100.

Table 2

Percentage of respondents who received injuries while handling swine postmortem

Injury reported	% (n=843)
Knife wound	33.7 ±1.6
Infection	4.7 ±0.7
Back injury	2.0 ±0.2
Chemical exposure	0.8 ±0.3
Other than listed injury*	0.7 ±0.3
Burn	0.2 ±0.1
No injuries	64.2 ±1.6

* Includes chemical exposures, burns, one *Salmonella* exposure, one rabies exposure, one *Klebsiella* pneumoniae exposure, and one band saw laceration.
More than one injury may be reported per respondent therefore percentages do not sum to 100.

Arthritis, tendonitis, bursitis, past knee injuries, and being "out-of-shape" were pre-existing conditions reported that contributed to the pain involved in these activities. The years in practice (0–49 years) did not significantly affect response (P=.152).

One hundred thirty-one (15.5% ±1.2) respondents reported being injured by equipment while handling swine or working in swine houses. The types of injuries can be grouped into four main categories, listed in order of decreasing occurrence:

- injuries from gates and sow chutes,
- injuries from hog snares,
- injuries from overhanging objects, and
- electrical shock injuries.

Injuries from gates and sow chutes were mostly minor bruises and pinched fingers, but respondents also reported more severe lacerations and crushed fingers and hands. Hog snare injuries were mainly head injuries. Injuries from overhanging objects included equipment such as augers, fans, ventilation systems, feed delivery equipment, and

heat exchangers. Six injuries were reported as a result of electrical shock from either wires, heat lamps, or heaters.

Postmortem swine-related injuries

While 802 (95.1% ±0.7) respondents euthanize swine, only seven males (0.9% ±0.3) and no females reported being injured as a result of a euthanasia procedure. One male bruised his shin in the process of delivering a blow to the head of a pig. Three stuck their own hands when using an injectable solution such as barbiturates, one experienced an adverse reaction to phenobarbital when the bottle broke, and one reported mental stress as a result of being reported for animal cruelty.

Thirty-six percent (±1.6) of respondents reported being injured from handling swine postmortem (Table 2). Approximately two-fifths of the knife wounds and three-quarters of infections required some form of medical treatment. More than half of the other exposures listed also required medical treatment. Only two of the 17 back injuries required medical treatment. Fifty-two percent (±2.6) of the 355 injuries reportedly did not require medical treatment.

Heat- and cold-related problems

Of 841 respondents, 13.7% (±1.2) reported problems related to the cold, 5.6% (±0.8) reported problems related to heat, and 10.9% (±1.1) reported problems related to both the cold and heat. Cold-related problems consisted mostly of cold or numb extremities but approximately one-quarter of the cold-related problems were frostbite of the fingers and ears. Frequent colds and flu were also reported. High temperatures caused heat exhaustion in approximately one-third of those who reported heat-related problems. Other problems included fatigue, dehydration, overheating, dizziness, and one heat stroke.

Vehicle accidents

Respondents drove an average of 463 (±264) miles per week while working, with a median of 500 miles per week. Twenty-eight percent (±1.5) of 843 respondents were ever involved in an occupationally related vehicle accident. Those accidents reported by respondents may include ones in which the respondent was not the driver. The years in practice (Figure 3) were significantly associated with a vehicle accident (P=.008).

Hearing impairments

Twenty-two percent (±1.4) of 842 respondents have a hearing impairment (Figure 4). This may be an underestimation of hearing impairment because only 46% (±1.7) have had their hearing tested during their careers. Additionally, one female and 20 males think they may have a hearing impairment, although they have never had a hearing test. The years in practice (0-49 years) were significantly associated with having a diagnosed hearing impairment (P<.001).

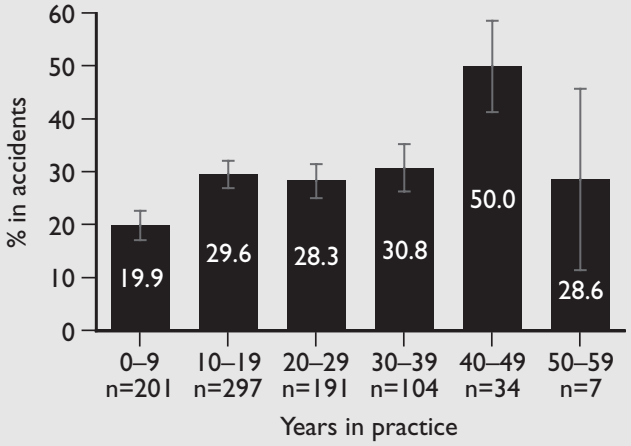
Respondents were evaluated for their use of earplugs and because there was misinterpretation of the question (see Discussion), attention is focused on those 25% who reported never wearing earplugs. There was no increased risk of a hearing impairment associated with males who never wear earplugs (Crude RR=1.0, age-standardized RR=0.8).

Allergic or irritant reactions

Five percent (±0.7) of respondents have developed a skin reaction from using latex gloves. It is not known whether the skin reaction was an allergic or irritant response.

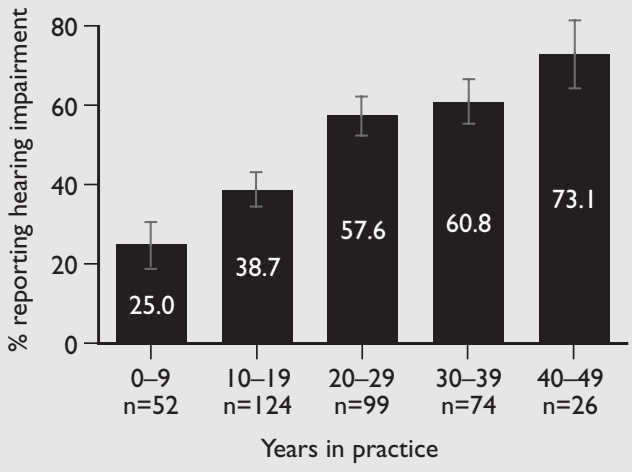
Thirty-two percent (±1.6) of respondents reported allergies to swine (Table 3). Responses are assumed to include both diagnosed and pre-

Figure 3



Percentage of respondents ever involved in vehicle accidents by years in practice
n is respondents in each age group
Groups 20–29 through 50–59 included only male respondents.

Figure 4



Percentage of respondents with a hearing impairment by years in practice.
n is total number of respondents in this year group who had a hearing test.
Groups 20–29 through 40–49 included only male respondents.

Table 3

Percentage of respondents with symptoms related to swine allergies

Symptom reported	% (n=838)
No symptoms	67.7 ±1.6
Cough	25.8 ±1.5
Wheezing	14.7 ±1.2
Sneezing spells	13.5 ±1.2
Itchy, watery eyes	11.7 ±1.1
Other symptoms*	3.5 ±0.6
Dermatitis	2.0 ±0.5

* Includes headaches, sinusitis, and flu-like symptoms. More than one symptom may be reported per respondent; therefore, percentages do not sum to 100.

sumed allergies because no definition of allergy was provided in the question.

The symptoms reported as swine allergies can be caused by factors other than swine antigens and therefore, respondents may also report them as symptoms related to swine confinement barn dust. Respondents who reported allergies were 5.4 times more likely to report symptoms related to dust exposure than those who did not report allergies. (95% CI: 2.10–14.1, P=.001). Those in the smoking group did not report a higher risk for experiencing these symptoms than those in the nonsmoking group. Ninety-three percent (±0.9) of respondents were affected by swine confinement barn dust and gases (Table 4).

Chemical exposures

Twenty percent (±1.4) of 838 respondents experienced eye irritation, 13.2% (±1.2) experienced respiratory irritation, and 5.5% (±0.8) experienced dermatitis as a result of exposure to formalin. Other (1.1%, ±0.4) reactions experienced were burning or stinging in open skin wounds, dry skin, and dryness of oral and nasal membranes.

Eighteen respondents (3.3% ±0.8) experienced adverse reactions to pesticide use. Adverse reactions to pesticides included eye, nose, and throat irritation, headaches, dermatitis, and choking or bronchiospasms. Retired males were 7.3 times more likely to report (95% CI:2.66–20.3, P=.003) an adverse pesticide reaction as compared with other employment groups, even though for males, the years in practice were not associated with an adverse pesticide reaction (P>.1).

Fifteen percent of respondents (±1.3) experienced adverse reactions from using disinfectants. Chlorhexidine caused dry skin and rash on eleven people. Use of iodine resulted in dry, cracked, and irritated hands, watering eyes, and respiratory irritation from the spray, and dermatitis on the hands in seventeen people. Quaternary ammonium compounds caused a rash and skin irritation in four people. Phenolics caused dry skin and skin peeling, chlorine caused skin and nasal

Table 4

Percentage of respondents with symptoms related to dust and gases

Symptom reported	% (n=839)
Eye, nose, or throat irritation to dust	86.3 ±1.2
Cough	77.4 ±1.4
Phlegm	56.7 ±1.7
Chest tightness	43.4 ±1.7
Wheezing	31.6 ±1.6
Shortness of breath	23.1 ±1.4
Headache	20.5 ±1.4
Chronic bronchitis	12.6 ±1.1
Other symptoms*	7.6 ±0.9
Chest pain	6.4 ±0.8
Dizziness	6.1 ±0.8
Nausea	4.8 ±0.7
Vomiting	0.8 ±0.3
No symptoms	6.6 ±0.9

* Included flu-like symptoms of aching muscles and fever, sinus problems, headache, nose bleeds, laryngitis or hoarseness, two reports of asthma attacks, tiredness, abdominal cramps, diarrhea, and confusion. Respondents may report more than one symptom ; therefore, percentages do not sum to 100.

irritation in a few people, and Roccal D® (Upjohn Company. Animal Health Division. 7000 Portage Rd., Kalamazoo, Michigan 49001) caused skin irritation and respiratory irritation as a spray.

Infections

Respondents reported a variety of infectious diseases requiring treatment. Types of diseases included Q fever, toxoplasmosis, brucellosis, ringworm, and enteric bacterial infections such as *Escherichia coli*, salmonellosis, and *Campylobacter*. The most commonly reported ailments were respiratory infections. Examples include sore throat, colds, strep throat, pneumonia, and mononucleosis.

Thirteen percent of respondents reported a swine-related zoonosis during their career (Table 5). The years in practice were related (P=.023) to contracting a zoonotic infection. Also, retired males were 2.6 times (95% CI: 1.49–4.62, P<.004) more likely to have contracted a zoonotic disease even when adjusted for years in practice.

Preventive measures

Eighty-eight percent (±1.1) of 837 respondents have been vaccinated for rabies and 98% (±0.4) have been vaccinated for tetanus. The percentage of respondents with up-to-date vaccinations is not known. Hygiene practices and personal protective equipment, categorized into the percentage of time used, are displayed in Figure 5. Eighty-two percent (±1.3) of 841 respondents felt that they currently have adequate resources (knowledge and/or equipment) needed to protect

themselves against occupational hazards.

Finally, respondents were asked if they would like to receive any of four services if they were offered at, for example, an AASP meeting. Seventy percent (±1.6) of 819 respondents would like a hearing test, 58.4% (±1.7) a pulmonary function test, 38.5% (±1.7) a cholesterol screen, and 20.8% (±1.4) a blood glucose screen. Twenty-three percent (±1.5) wanted none of the services listed. Fifty-seven percent (±1.7) of 802 respondents would be willing to pay for these services and 4.6% (±0.7) stated that it depended on the price.

Discussion and conclusions

Injuries

Veterinarians, especially those in large animal practices, are often physically injured when treating their patients. Landercasper found that 64.6% of the approximately 1000 American Veterinary Medical Association (AVMA) members in Minnesota and Wisconsin had suffered a major animal-related injury, defined as one for which medical treatment was sought or self-administered.[3] Similarly, in a survey of licensed veterinarians in North Carolina, 67.8% of 699 respondents reported a major animal-related injury during their career and veterinarians in large animal practices experienced the most animal-related injuries.[4] Even though swine practitioners are large animal practitioners, it is impossible to determine from these studies whether the percentage of swine-related injuries they experience is correspondingly high.

Table 5

Percentage of respondents who reported a zoonoses from handling swine

Zoonotic infection reported	% (n=840)
No zoonotic infection	86.8 ±1.2
Erysipeloid *	3.0 ±0.6
Ringworm	2.7 ±0.6
Swine influenza	2.3 ±0.5
Other **	2.1 ±0.5
Staphylococcal infection	1.9 ±0.5
Brucellosis	1.5 ±0.4
Salmonella enteritidis	1.1 ±0.4
Scabies	0.7 ±0.3
Leptospirosis	0.6 ±0.3
Streptococcus suis meningitis	0.6 ±0.3
Ascarids	0.6 ±0.3
Salmonella choleraesuis	0.5 ±0.2
Toxoplasmosis	0.1 ±0.1

* Caused by *Erysipelothrix rhusiopathiae.*

** Includes swine lice, *Haemophilus influenzae, Klebsiella pneumoniae, Mycoplasma hyopneumoniae*, shigellosis, and undetermined bacterial infections.

Respondents may report more than one zoonosis; therefore, percentages do not sum to 100.

In our survey, swine were involved in very few injuries and hospitalization for a swine-related injury was rare. As expected, there was an increase in prevalence as the years in practice increased. No females reported being hospitalized but one cannot say that males have a higher risk because:

- no females in this study have been in practice long enough, and
- many more female practitioners would be needed to assess their true risk.

Swine-related injuries can potentially be avoided by working with a helper and anticipating the hog's reactions. Except for a few reported bites, most injuries were acquired indirectly from hogs. Accidents occurred when the practitioner happened to be in the flight path of the hog, in which case it ran either between the legs or directly into the practitioner. When moving hogs, cutting boards can be used to protect the legs. Hog snares caused a number of head injuries. Presumably they occurred as a result of the snare slipping out of the helper's hand and hitting the practitioner who is kneeling or bending over the snared hog. The seriousness of the injuries was not assessed.

Needlestick Injuries

This investigation is the first to report needlestick injuries in swine veterinarians, who experience a high number of needlesticks due to the nature of their job. Recapping needles might partially explain this high percentage, because it is possible to pierce one's thumb or forefinger when replacing the cap on the needle. This is a dangerous work practice in human health care and is associated with nosocomial transmission of bloodborne pathogens. Swine practitioners expressed mixed feelings about the value of recapping a needle. It seems that most were aware of the recommendations for human health care but some thought the needle posed a greater risk of injury by leaving it uncapped. Refilling a syringe, involving similar motions to recapping, may also be responsible for causing the reported needlestick injuries.

Recapping devices used by those in human health care are, for the most part, impractical for swine practitioners. A multi-dose vaccination gun with retractable needle would be the optimum solution; however, cost may be a limiting factor.

For the most part, exposure to products used for swine vaccination by healthy practitioners does not represent a serious health hazard. Based on one report, the modified live bacterial products for *Pasteurella*, erysipelas, and *Bordetella* are not associated with human health problems.[5] However, individuals who are immunosuppressed have a greater risk of harm from exposure to many of the live bacterial or viral agents.[5] Hypersensitivity is an adverse effect that can occur to antigens or antibiotics used in vaccines, bacterins, or diagnostics.[5] In our survey, fewer than 2% of the 407 respondents experienced needlestick injuries with exposure to prostaglandins in the past 2 years. This is a very low prevalence; however, it is a major concern for pregnant females because it has an abortive effect on the fetus. Besides accidental injection, prostaglandins can be absorbed through the skin.[6] Therefore, pregnant females should avoid all direct physical exposure to this drug.

Back injuries

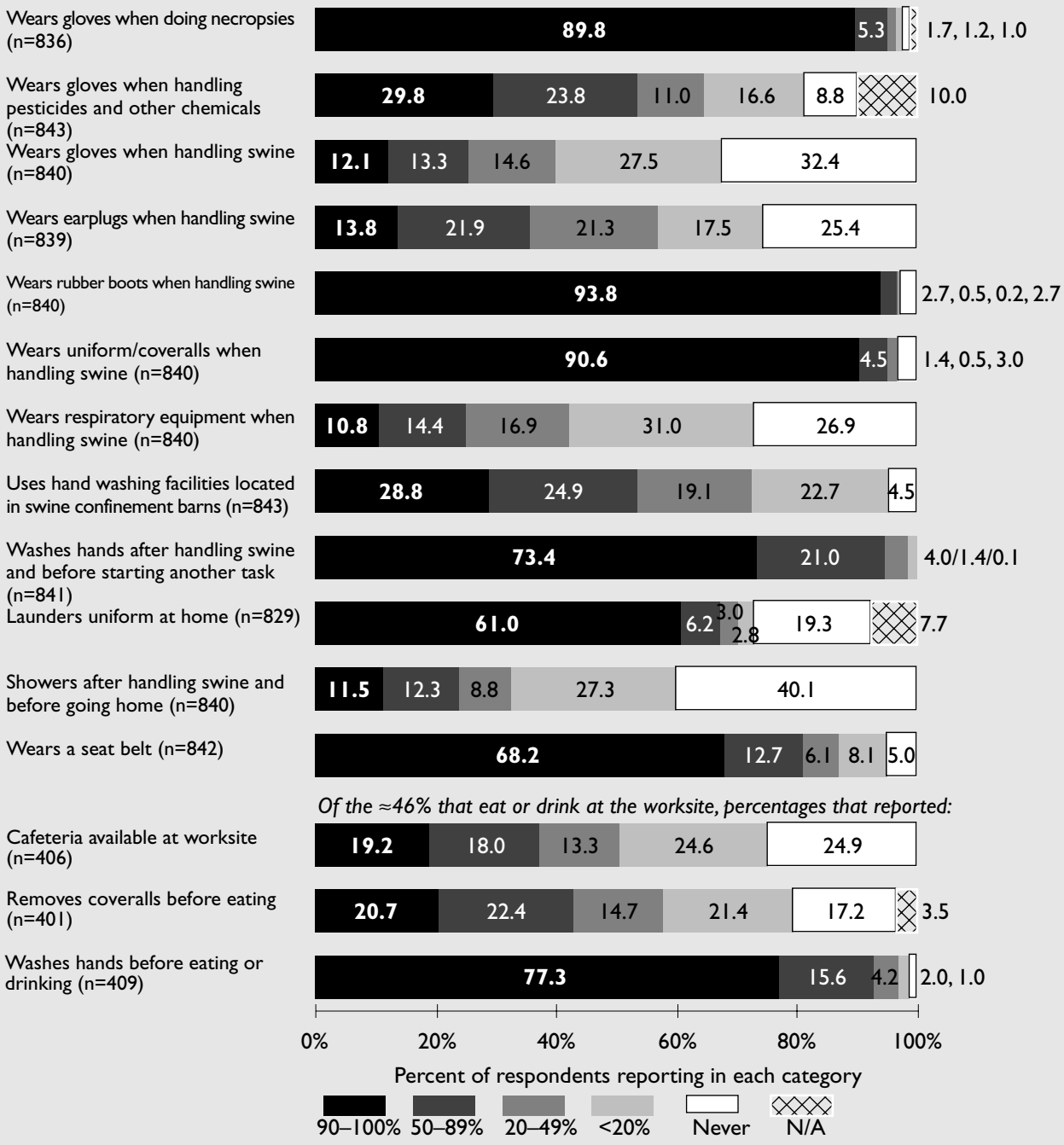
It can be difficult to prevent back problems that result from lifting or moving swine. They may be the result of the weight of the pig, fatigue, and overexertion, the posture when lifting or moving, or a combination of these factors.[7] A worksite analysis of the tasks causing back problems should be performed. Whenever lifting, it is best to lift at the knees without twisting, keeping the load close to the body.[8]

Other injuries

Over half the respondents experienced pain associated with performing frequent injections and/or bleeding swine. If the recovery time between these activities is insufficient, and the repetitious action is compounded with forceful and awkward postures, the practitioner is at risk for developing a repetitive motion disorder.[9]

Many practitioners may be experiencing mild forms of trigger finger or trigger thumb, whereby extending or flexing the digit is halted momentarily and completed with a jerk. This is caused by repeated, localized contact stresses from using a pistol grip syringe or other types of syringe. More severe cases may result in tenosynovitis (inflamma-

Figure 5



Percentage of respondents who follow various hygiene practices
n is the number of respondents who answered the question.

tion of a tendon sheath) in the finger or de Quervain's syndrome (special case of tenosynovitis in the thumb).[10] Practitioners may also be at risk for carpal tunnel syndrome, caused by compression of the median nerve in the carpal tunnel of the wrist. At colder temperatures, the risks are greater because a person exerts more force than usual to prevent an object from slipping out of the hand.[9] Repeated kneeling may cause bursitis of the knees.[10] Chronic back strain can result from repetitive bending and lifting.

Generally, symptoms do not progress to these levels because the activities do not occur on a daily basis. This gives the muscles and joints time to recover. These activities do cause temporary pain and soreness that can be partially alleviated through tool design, physical conditioning, and/or work hardening.[9] To decrease pain in fingers and thumbs, periodically switch the hands or fingers used. Sore wrists should be kept at a neutral position to decrease nerve compression. Symptoms of nerve compression, often worse at night, may be relieved with the aid of a wrist splint.[9] Knee pads will decrease the amount of direct pressure on the knee. If possible, practitioners should alternate between squatting or kneeling and bending over to prevent back strain. Ideally, pain associated with activities involving repetitive motions can be alleviated by rotating job duties. If this is not an option, frequent short breaks to stretch muscles are recommended.[8]

Many equipment injuries were cuts and bruises from overhead objects, either repeated enough or serious enough to be remembered. The prevalence of this injury type is probably underestimated because minor injuries were less likely to be reported. Electrical hazards can cause other less common but nonetheless severe or fatal injuries. Poor installation and/or maintenance can result in faulty wiring, stray voltage, and improperly grounded circuits. Damaged cords on equipment are also a concern. The wet surfaces and metal pens are good electrical conductors that can make conditions even worse. Shocks, electrocutions, or fires may result.

Prevention can begin with awareness of the potential hazards. Practitioners should look up and take notice of overhanging objects. They may want to suggest to their clients the use of warning signs on low-hanging objects and proper shielding of fans.

Postmortem swine-related injuries

Knife wounds from postmortem injuries usually required some type of medical treatment. Wearing cut-resistant Kevlar gloves underneath latex gloves might prevent these knife injuries as well as infections. Evaluate the techniques involved in examining swine postmortem. Perhaps modifying work practices can prevent these injuries.

Heat- and cold-related problems

Practitioners are often exposed to temperature extremes. In the winter, practitioners can work in either very low temperatures or move from a heated indoor environment to a freezing outdoor environment. In the summer, practitioners must work in excessive heat.

Working in extreme temperatures can present many health hazards to swine practitioners. Very cold conditions aggravate existing health problems, such as Raynaud's disease (an episodic digital ischaemia characterized by blanching, cyanosis, or redness of the fingers and toes), asthma, and diabetes, and cold can cause cooling of the body that could result in frostbite or hypothermia. Snow and ice on roads and walkways increase the risk of accidents.[11]

Cold temperatures were responsible for most of the problems related to temperature extremes. In ambient temperatures of 46°F (8°C) and lower, the risk is high for frostbite on the face, hands, or feet.[12] Always wearing gloves, earmuffs, and thermal socks will decrease the risk of frostbite to these areas. Glove warmers might also help if carried in the pockets. Wearing a hat will decrease the majority of body heat loss. Wear a face mask in windy conditions. Dress in layers to make it easier to adjust from working outside to working inside a swine building.

Physical exertion at high temperature and humidity can cause heat emergencies. A healthy swine practitioner can suffer heat exhaustion when activity levels generate body heat that exceeds that dissipated by sweat evaporation.[13] Other major ailments due to elevated temperatures include dehydration, heat rash, heat syncope, heat cramps, and rarely, heat stroke.[14]

Heat emergencies can be prevented by recognizing the symptoms and preventing dehydration. Heat exhaustion is characterized by excessive sweating, headache, dizziness, muscle weakness, and nausea. Some of the individual risk factors for heat emergencies are heavy clothing, prolonged exertion, aging, and alcoholism.[15]

The heat index is a good indicator of potentially dangerous situations. The heat index, often given in weather reports, is a measure of how hot it feels when relative humidity is combined with effects of air temperature. An individual may begin to feel fatigued when working at 80°F (26.7°C); at >90°F (32.2°C) an individual may be at risk for heat exhaustion.[15]

To prevent dehydration, consume 8 oz (237 mL) of water or another fluid that replenishes electrolytes before working and consume moderate amounts of liquid every 20 minutes during activities in heat.[15]

Vehicle injuries

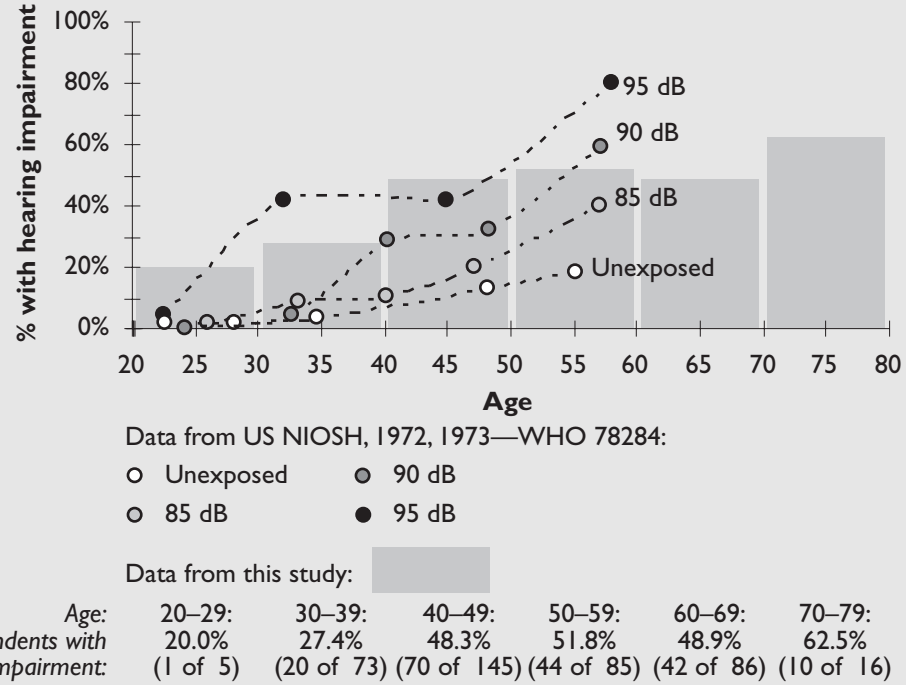
Swine practitioners can cover expansive territories when making visits to clients' farms. The miles driven by practitioners in this study were higher than two previous studies of veterinarians, which reported averages of 106 (±94) and 300 miles driven per week.[3,4] Fatigue, stress, busy schedules, and long-distance travel are likely to increase the probability of an accident.

Always wear a seat belt to reduce the risk of harm if in an accident. Vehicles with airbags will also reduce risk. The prevalence of vehicle accidents among swine practitioners, as well as other veterinarians, needs continued investigation and characterization.

Hearing impairment

Noise levels in swine confinement barns can become quite high due to squealing pigs, fans, feeding equipment, and feed mills. Noise levels can range from 95–115 decibels (dB) during feeding time or when the hogs are disturbed.[16,17] Occupational Safety and Health Administra-

Figure 6



Age:	20–29:	30–39:	40–49:	50–59:	60–69:	70–79:
Respondents with hearing impairment:	20.0% (1 of 5)	27.4% (20 of 73)	48.3% (70 of 145)	51.8% (44 of 85)	48.9% (42 of 86)	62.5% (10 of 16)

Percentage of workers with a hearing impairment as a function of age[28]
Hearing impairment is defined as average hearing loss > 25 dB at 1, 2, and 3 kHz.

tion (OSHA) limits general industry noise exposure to an average of 90 dB over an 8-hour work shift with an action limit of 85 dB.[18] The recommended maximum daily unprotected exposure (MDE) to 100 dB is 2 hours, for 115 dB the MDE is 15 minutes or less. Exceeding these levels repeatedly can result in psychological and physiological damage, including noise-induced hearing loss.

In 1973, the National Institute of Occupational Safety and Health (NIOSH) compared the percentages of workers with a hearing impairment exposed to loud noise with the percentages of workers with a hearing impairment who were unexposed (Figure 4).[19] In our study, the percentage of respondents with a diagnosed hearing impairment, broken down into age groups, most closely follows the trend of workers occupationally exposed to 90 dB (Figure 6).

Temporary hearing loss was not evaluated but is suspected to occur frequently in swine practitioners based on the prevalence of diagnosed hearing impairments. Wearing properly fitted earplugs or earmuffs is a simple measure to prevent both temporary and permanent hearing loss.

Practitioners should seriously consider at least using hearing protection during the activities expected to have the highest noise exposure, such as bleeding swine, or during feeding time. Preventive use does reduce the risk of noise-induced hearing loss. The reasons this study failed to find an increased risk for hearing impairment among men who never wear earplugs is probably multifactorial:

- some practitioners may have started wearing earplugs only after an impairment was diagnosed;
- those who never wear earplugs could spend less time in swine confinement barns than those who wear earplugs; and/or
- the sample size (n=401) may be too small to detect a difference.

Allergic or irritant reactions

Glove reactions

Gloves should be worn when handling dead swine. They should also be worn when doing obstetric work, because contact with amniotic fluid is associated with dermatitis in veterinarians.[20] Increased glove use, however, might increase the existing prevalence (5%) of glove reactions seen among respondents. These allergic reactions can be prevented by wearing vinyl instead of latex gloves. However, a double pair of vinyl gloves should be worn for procedures that involve considerable manual manipulation or stress to the gloves or when handling highly infectious materials.[21] A less costly alternative would be to wear a cotton or vinyl glove under the latex gloves and launder or replace when necessary.[22]

Swine allergies

There was a high prevalence of swine allergies among respondents. From this study, it is impossible to predict the true prevalence of swine allergies in respondents because the reported allergies may be due to antigens other than swine dander, urine, and feces. Prevalence is presumed to be lower than what was reported because symptoms experienced could also be caused by exposure to non swine-related confinement-barn dust. Regardless, even in previous allergy studies, it has been difficult to associate increased antibody levels, from both swine house and pig-derived antigens, to the respiratory symptoms experienced.[23,24]

Swine confinement barn dust and gases symptoms

Poor indoor air quality is probably the most recognized hazard of all types of swine confinement work because of its correlation to respiratory health. Much work has been done to identify the effects of exposure to airborne dust, endotoxins, and gases in this environment.

One study relevant to swine practitioners suggests that pig farmers may develop bronchial hyperactivity after several years of working in swine confinement barns.[29] Thirty-seven percent of farmers had clinically significant bronchial hyperactivity, as determined by a histamine challenge. The prevalence or severity of symptoms was unrelated to the mean number of years in pig farming (12 years), the number of working hours in the swine barn (4.6 hours per day), or the number of swine.

Studies vary as to the prevalence of symptoms associated with swine confinement work. For example, a summary of four studies shows that cough was reported by 16%–67% of swine confinement workers[25,26] and 24.5%–30% of pig farmers.[27,28] Nasal irritation was reported by 23%–45% of workers[25,26] and 16% of pig farmers.[27] Phlegm was reported by 14%–56% of workers[25,26] and 20% of pig farmers.[28] Chest tightness was reported by 5%–36% of workers, while 8%–39% of workers reported eye irritation, and 6%–37% reported headache.[25,26] Shortness of breath was experienced by 9%–30% of workers[25,26] and 3.1% of pig farmers.[27] Wheezing was experienced by 27% of workers[26] and 2%–10% of pig farmers.[27,28]

Many of these symptoms are more prevalent in veterinarians than in swine confinement workers, who may spend up to 40 hours per week in swine confinement barns, and pig farmers who have been reported to spend 4.6 hours daily[29] or approximately 23 hours per week in the buildings. Presumably, the workers develop a tolerance to this environment because of their continuous exposure over the work week.

Our findings agree with a study by Donham, et al.,[30] which found that 91% of 35 veterinarians surveyed reported adverse effects from work in swine confinement barns. Their time spent in confinement units ranged from 1–25 hours per week with an average of 7 hours per week.

Eight (23%) regularly wore respiratory protection designed to protect against dust; however, adverse symptoms were still experienced by some individuals.[30] Findings were similar in a study measuring the prevalence of symptoms of veterinary students after working in a swine confinement barn.[31] Preliminary results revealed that the use of a one-strap face mask did not appear to provide much protection against respiratory symptoms experienced after 3 hours of work.[31]

The percentage of time that respondents use respiratory equipment is low. To alleviate symptoms and prevent chronic respiratory diseases, wear a respirator at all times when in swine confinement barns. Even though the specific agent(s) that cause(s) respiratory symptoms remains unidentified, respiratory protective equipment is the best current preventive measure.

There are various types of respiratory equipment available. Usually, a two-strap disposable dust and mist mask is sufficient for protection. It has been shown that properly fitted NIOSH-approved dust and mist masks have a 97% filter efficiency against particles less than 1 mm in aerodynamic diameter.[32] This means that they can potentially provide protection against zoonotic bacterial infections spread by the aerosol route. A one-strap mask is not recommended. Keep in mind that a respirator that acts as an air filter does not provide protection in an oxygen-deficient environment.

A disposable mask will typically last for 1 day in a swine confinement barn.[17] Reusable dust and mist masks with replaceable filters can also be used. These masks may last from a few months to 1 year and the filters will last approximately 1 week.[17] If a dust mask does not alleviate symptoms, a chemical cartridge respirator can be used to protect from both dust and gases.[17] This mask will last from a few months to a year and the filters will last about a week.

All respirators used should be approved by the Mine Safety and Health Administration (MSHA) and the NIOSH. If symptoms persist, the veterinarian may need to severely restrict or eliminate the time spent inside a swine confinement barn.

Chemical exposures

Chemical hazards

Chemical hygiene is very important to veterinarians who work with hazardous substances. Hazardous substances can be carcinogenic, teratogenic, corrosive, flammable, irritants to the skin or respiratory system, or allergenic. Some hazardous chemicals used by swine practitioners are iodine, phenol, phenobarbital, formaldehyde, and dichlorvos.

Chemical manufacturers and distributors are required by the federal government under the OSHA Hazard Communication Standard (29 CFR 1910.1200) to provide information to purchasers on the hazardous characteristics of their products, whether a chemical, vaccine, or medication.[33] This information is provided in the form of Material Safety Data Sheets (MSDS), based on available scientific evidence. Handlers of these chemicals should follow manufacturers' guidelines listed on the MSDS, avoiding direct contact whenever possible.[33] An MSDS can be obtained by contacting the manufacturer at the phone number provided on the label of the product.

Infections

Zoonotic infection

The risk of acquiring a zoonotic infection can be high for veterinarians because of their close occupational contact with animals. Bacteria, dermatophytes, viruses, *Chlamydia*, *Rickettsia*, and parasites, carried by animals or in the surrounding environment, can infect the veterinarian. Exposure to these organisms occurs through abraded skin, mucosal tissues, ingestion, inhalation, and injection. Often it is difficult to quantify the occurrence of these infections because many are self-limiting or can be mistaken for a cold or flu without proper diagnosis.

Based on this study, the prevalence of a zoonosis (13%) is not as high in swine practitioners as in other veterinarians. In a study of licensed veterinarians in North Carolina, 35% experienced a zoonotic infection during their career. Similar percentages were observed, however, for those infections relevant to swine practitioners: brucellosis, erysipeloid, leptospirosis, and toxoplasmosis.

Two percent of the North Carolina veterinarians reported a brucellosis infection as compared to 1.5% of swine practitioners. An erysipeloid infection was reported by 1% of North Carolina veterinarians as compared to 3.0% of swine practitioners in our study. Leptospirosis was reported by 0.3% of North Carolina veterinarians versus 0.6% of swine practitioners, and toxoplasmosis was reported by 0.3% of North Carolina veterinarians versus 0.1% of swine practitioners.

Swine brucellosis is not a common zoonosis based on one study that reported that only 5% of the 175 cases of *Brucella* infections in Illinois veterinarians were acquired from swine.[34] Some other zoonoses with low prevalence in our study were *Streptococcus suis* meningitis, ascarids, animal ringworm, scabies, and swine influenza. Generally, *S. suis* meningitis results in few clinical cases but there is evidence of a more common subclinical infection in pig farmers.[34] *Ascaris suum* is also an important swine pathogen, but is a rare cause of zoonosis.[35,36] However, one might expect higher prevalence rates of animal ringworm, and scabies, swine influenza based on information in the literature.

Animal ringworm was experienced by 21%–24% of veterinarians in other studies as compared to only 2.7% in this study.[4,37] *Sarcoptes scabiei* var. suis, is generally host specific but can cause transient infestation of humans.[38,39] Sixty-five percent of 46 pig handlers exposed to swine infested with scabies had clinical manifestations of itching.[39]

Swine influenza virus (SIV), a type-A virus, is a highly contagious swine infection of the upper respiratory tract that primarily occurs in late fall and winter in the midwestern parts of the United States.[40,41] In one study, 75% of 25 people aged 9–19 who were exposed to infected pigs at a county fair in 1988 had serum antibody titers to SIV.[33] One previously healthy 32-year-old pregnant woman, infected with SIV, died of pneumonia. There was some evidence of person-to-person transmission of SIV during this outbreak.

No respondents in this AASP study reported having ever acquired yersiniosis. However, in a study of veterinarians occupationally exposed to pigs, 17 (9.9%) had positive antibody titers to *Yersinia enterocolitica* 0:3.[42] Nine of the veterinarians were employed in meat inspection, two were general practitioners, and six had mixed duties.

In one study, it was suggested that the increased risk (SMR=2.3) of appendectomy observed in abattoir workers and pig farmers compared to grain and berry farmers might be associated with zoonotic infection of *Yersinia* bacteria from swine.[43] The study included both males and females. Using the same method, calculation of an age-standard morbidity ratio, the risk of appendectomy was investigated for swine practitioners compared to grain and berry farmers. No increased risk (SMR=0.86) was observed in male and female practitioners ages 21–55 years old relative to the grain and berry farmers.

Slight associations were found in our study between a major swine-related injury and zoonotic infection, and a needlestick injury and zoonotic infection. The risk ratio for an exposure of a major swine-related injury and the outcome of a zoonosis is 2.29 with a 95% confidence limit between 1.56 and 3.36 (P=.001). The risk ratio for an exposure of a needlestick injury and the outcome of a zoonosis is 1.70 with a 95% confidence interval between 1.07 and 2.68 (P=.027). This agrees with a previous study that suggested both injury from animals and accidental self injection are associated with the risk of zoonotic infection.[39]

Even though swine practitioners appear to have a lower prevalence of zoonotic infection than veterinarians in general, always wear gloves when handling infected swine to prevent contact transmission, particularly if there are open cuts on the hands. In most cases, good hygiene practices, such as always washing one's hands before eating, prevent the risk of infections. Practitioners should also seek early medical evaluation of suspected infections, especially if immunocompromised.

Showering and laundering clothes should be done at work if at all possible. If this is not an option, contaminated clothing should be removed at work and placed in a bag to take home, or removed outside the home to be laundered separately. This will decrease potential exposure of family members to infectious agents and chemicals.

Rabies vaccination

Eighty-eight percent of respondents have been vaccinated for rabies at some point in their life. Immunity can last from an average of 2–8 years, but previous vaccination may not always protect an individual from a known rabies exposure.[44] In cases of exposure, immediate medical evaluation is suggested. The veterinary occupation is considered a high-risk group for rabies exposure. Rabies booster vaccinations are recommended for swine practitioners if they work with animals other than swine known to carry the virus.

Tetanus vaccination

Immunization with tetanus toxoid is recommended at least every 10 years. It is important that practitioners maintain their immunization status because of the frequent occurrence of cuts and lacerations. In New Zealand, the majority of tetanus cases now seen are in people 45 years and older who have not had adequate immunization.[45] Swine veterinarians who are 45 years old and older should be particularly careful to maintain their immunization status.

Limitations of the study

A series of questions were asked concerning the use of protective clothing when handling live swine or when in swine confinement housing. These percentages may be inaccurate because respondents interpreted the question differently. Some interpreted the question to mean the time spent on certain activities. Therefore, it was not possible to distinguish whether the percentage of time that personal protective equipment was worn reflected the total time spent in the facility

or the time spent on a specific activity. For example, a respondent might report wearing earplugs every time s/he bleeds swine, but might only conduct this type of activity 50%–89% of the time. This applies mainly to the use of gloves and earplugs.

Practitioners also had different interpretations regarding the availability of hand washing facilities at the swine units they visit. Some answered that hand washing facilities were available 100% of the time because they washed their hands in their trucks.

There are also some weaknesses in this survey methodology that might bias the results. Inherent in a retrospective survey is a recall bias that can lead to either an over- or underestimation of the prevalence of health hazards in swine practitioners. Additionally, selection bias may be introduced by limiting the survey to United States members of the AASP. Interviewer bias could result during interpretation of information reported by study participants. For example, some types of employment were inferred by the investigator based on information from the respondent or from mailing addresses. However, consistent interpretations were obtained by having only one person involved in the data entry process, using uniform criteria.

The survey also did not originally take into account employment types other than private practice. Although most practitioners fell into the listed categories of private practice, some have responsibilities in swine production management, research and development, nutrition, and/or regulatory functions.

Although no relative risk differences were found among employment types for health hazards, except for retired males, it is difficult to accurately assess this risk. Few respondents were in employment types other than private practice. Many nonrespondents probably excluded themselves because the questionnaire was geared towards those in private practice and there was no space provided for reporting a practice other than the ones listed. The AASP members in these groups that did respond to the survey probably had more contact with swine than those who did not. This would tend to bias any differences seen among employment types towards the null.

Measures of association among employment types were not stratified by sex because any observations in females among practice types would be hindered by the small data set. Additionally, any reported relative risks of males versus females, calculated using contingency tables, must be considered rough estimates because of the small number of females in the survey.

Implications

- Use respiratory protection (e.g., a two-strap dust mask) to decrease symptoms experienced from working in swine confinement buildings.
- Wear hearing protection whenever in a swine confinement building, or at least during activities expected to cause loud noise.
- Stretch muscles frequently and/or space activities associated with repetitious motions throughout the day to help alleviate pain.
- Use a seat belt and air bag to decrease the risk of harm in a vehicle accident.
- Wear layers of protective clothing to reduce cold-related problems. Prevent dehydration to decrease problems related to heat.
- Wear gloves to protect against infection, hazardous chemicals, and skin reactions to disinfectants. Wearing Kevlar gloves will protect against lacerations as well.
- Periodically undergo pulmonary function tests and hearing tests to detect any deterioration and to reinforce the use of protective equipment.
- Perform worksite analyses for tasks causing needlesticks, back injuries, and postmortem swine injuries.

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