

# Systematic review of the prevalence of suicide in veterinary surgeons

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<b>Background</b>	An accumulating body of research demonstrates that risk of suicide varies between occupational groups. Identification of the occupations at risk, and the factors that contribute to the increased risk of suicide in these groups is essential for the development of effective suicide prevention strategies. There is preliminary evidence to suggest that veterinary surgeons are a group at risk.
<b>Aims</b>	To conduct a systematic review of studies of rates and methods of suicide in the veterinary profession.
<b>Methods</b>	A systematic search of the international research literature was performed in May 2008. The data from the 19 studies of the prevalence of suicide in the veterinary profession were extracted by two independent reviewers and analysed.
<b>Results</b>	Between 0 and 43% of veterinary surgeon deaths were due to suicide. In all but one of the 15 studies presenting risk of suicide in veterinary surgeons with a comparison population, an elevated risk was found. The better quality studies with the lowest risk of bias indicated that in the UK, the rate of suicide in the veterinary profession was at least three times the general population rate. Studies of the methods of suicide veterinary surgeons use suggest that self-poisoning and firearms are particularly common.
<b>Conclusions</b>	There appears to be an elevated risk of suicide for veterinary surgeons in several countries. Access to means of suicide influences the methods used and may contribute to increased risk.
<b>Key words</b>	Epidemiology; occupation; suicide.

## Introduction

Internationally around a million people die by suicide each year, making it a leading cause of death in both developing countries and the Western world [1]. Suicide has important emotional, social and economic consequences and understanding the risk factors associated with suicidal behaviour is essential if effective preventive measures are to be developed. A substantial body of research shows that members of certain occupational groups are at greater risk of suicide than others.

Observational studies from across the world have established elevated rates of suicide in doctors [2–4], nurses [2], dentists [4,5] and farmers [6–9]. In these studies, national mortality databases have been used to study suicide rates as well as methods of suicide. Both doctors and farmers are significantly more likely to use methods of suicide obtained through work than those in the general population [10,11]. Easy access to a relatively lethal

means of suicide is one factor that may explain why these occupations are at particularly elevated risk.

Increasing attention has been paid to suicide in the veterinary profession, since veterinary surgeons may also have easy access to lethal drugs. Early indications of an increased risk of suicide in the veterinary profession came from observational studies conducted in the USA [12–15]. However, elevated rates of suicide have also been found in observational studies of veterinary surgeons in England and Wales [16–18], Scotland [8], Norway [3] and Australia [19]. Preliminary research suggests that veterinary surgeons may be exposed to high levels of occupational stress [20] related to client relations and time and work management [21], long working hours [22] and delivering bad news [23].

We have conducted the first systematic review of the research literature on risk of suicide in the veterinary profession. The aim of the study was to gain a reliable and

accurate indication of the extent to which the prevalence of suicide is elevated in the veterinary profession by aggregating data from the international research literature. In order to gain a better understanding of the contribution that access to a means of suicide has on suicide rates within the profession, studies that present data on the methods of suicide were also collated and summarized.

## Methods

The search strategy used to identify studies of the prevalence and methods of suicide was carried out as part of a wider systematic review of the research literature on suicidal behaviour and wellbeing of the veterinary profession. Studies not reporting suicide prevalence data, or which report data on the wellbeing of veterinary students, will be reported elsewhere. The systematic review procedure is illustrated in Figure 1.

An electronic search of the databases MEDLINE (1950-present), EMBASE (1980-present), AMED (1982-present), BNI (1985-present), CINAHL (1982-present), PsycINFO (1806-present), SCOPUS, Web of Science (1945-present) and IBSS (1951-present) was conducted in May 2008. The terms ‘wellbeing’, ‘emotion\*’, ‘anxiet\*’, ‘psycholog\*’, ‘mortalit\*’, ‘mental illness’, ‘mental health’, ‘stress\*’, ‘depress\*’, ‘self harm’, ‘suicid\*’ were combined with ‘veterinar\*’ and ‘vets’ in a free-text search. In addition, the subject headings

associated with suicide- and veterinary-related terms were searched in order to identify any references not coded with the appropriate terms by the managers of the electronic reference databases. No restrictions were made about the language of the publication.

References retrieved in this search were randomly distributed to reviewers 1–4 (K.H., S.S., R.M., L.S.) who independently screened reference abstracts (according to the study inclusion criteria; see Table 1). In addition, the abstract for each reference was screened by reviewer 5 (B.P.). On occasions when reviewers disagreed, the decisions of a sixth independent reviewer (L.H.) were used to determine whether the reference was identified for review at the full-text level or not. In total, 970 references were forwarded for full-text screening. Each of these reports was then randomly assigned to reviewers 1–3 and reviewer 5 for screening. Full-text screening required reviewers to categorize each paper as described in Table 1.

When there was disagreement about the category to which a reference should be assigned, the respective reviewers discussed their views until a consensus decision could be reached. Papers that were not available in English were translated and categorized according to the above criteria in a collaborative effort between a native speaker of the respective language and reviewer 5. Additional search methods included hand-searching the references of studies that fell into Category 1, asking international experts in the field to review the final list of studies in Category 1 and searching a weekly updated

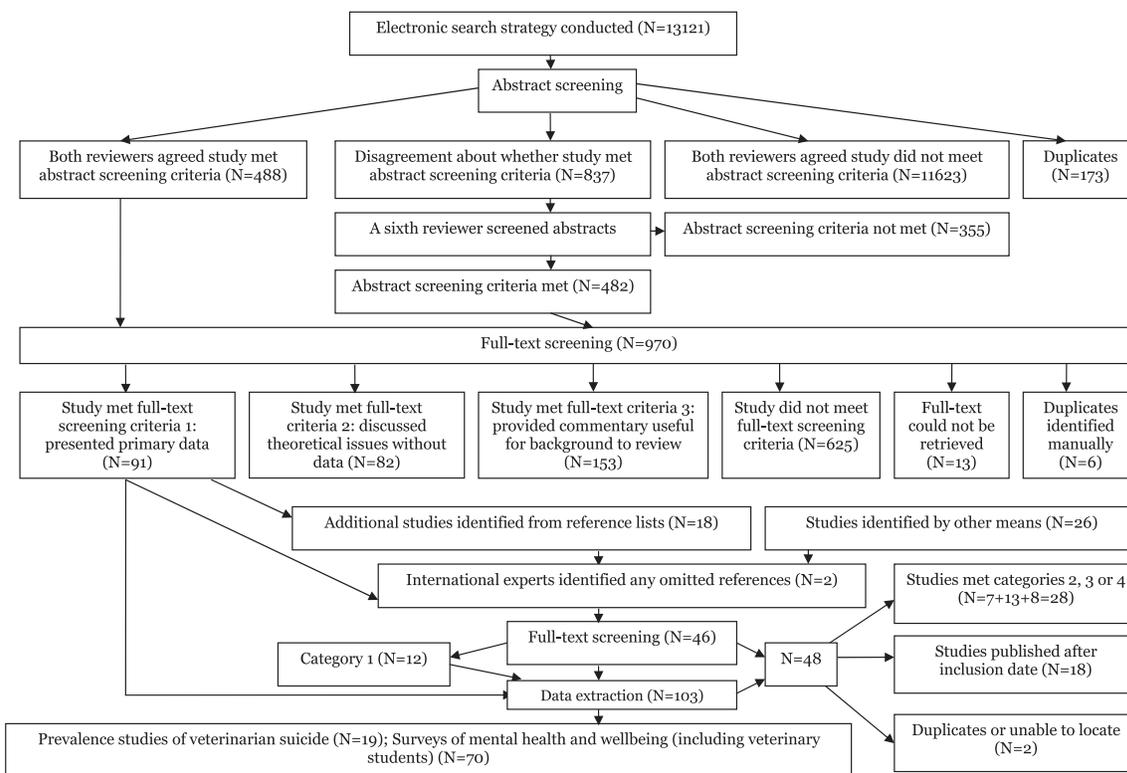


Figure 1. Flow chart of systematic review process.

**Table 1.** Abstract screening criteria and full-text screening categories

Abstract screening criteria	
1	Paper includes information on suicide, mental illness, stress and other related issues and
2	Paper reports the above issues in relation to veterinary surgeons or students of veterinary medicine
Full-text screening categories	
1	The paper presents empirical data in relation to suicidal behaviour or wellbeing in veterinarians and/or veterinary medical students
2	The paper presents theoretical accounts of suicidal behaviour or wellbeing in veterinarians and/or veterinary medical students e.g. models of suicide
3	The paper presents non-theoretical accounts of suicidal behaviour or wellbeing in veterinarians and/or veterinary medical students e.g. personal account of suicidal thoughts
4	The paper is irrelevant to the study protocol.

electronic database of injury prevention research literature. Any references identified by these additional methods were randomly allocated to reviewers 1–3 and reviewer 5 for full-text screening.

A standardized form containing 106 items was developed by the authors specifically for the purpose of extracting data from papers on the prevalence and methods of suicide in the veterinary profession. In addition, a form was developed to assess the overall quality and risk of bias associated with each paper. The quality rating scale contained 12 items, which were rated by two independent reviewers on a binomial scale and summed to give an overall indication of quality (Table 2).

Scores between 0–4 were taken to represent relatively low quality, 5–8 moderate quality and 9–12 relatively high quality. Five items from the quality rating scale were related to risk of bias: (i) the definition of suicide, (ii) the source of numerator data, (iii) the source of denominator

**Table 2.** Quality rating scale

Item number	Description of quality rating item	Score
1	Definition of suicide	
	Clear definition of suicide used e.g. International Classification of Diseases codes identified	1
	Unclear definition of suicide e.g. 'cases where death was due to suicide'	0
2	Source of numerator data	
	National or official source of mortality data e.g. Office for National Statistics	1
	Regional or unofficial source of mortality data e.g. obituaries	0
3	Source of denominator data	
	National or official source of population data	1
	Regional or unofficial source of population data	0
4	Study duration	
	>5 years	1
	≤5 years	0
5	Study period	
	Clear definition of study period e.g. 1966–2000	1
	Study period unclear e.g. '10 year period'	0
6	Veterinary population data	
	No. suicides/no. all deaths reported or rate of suicide reported	1
	No. suicides/no. all deaths not reported or rate of suicide not reported	0
7	Comparison population data	
	No. suicides/no. all deaths reported or rate of suicide reported	1
	No. suicides/no. all deaths not reported or rate of suicide not reported	0
8	Number and type of comparisons made	
	Statistical comparisons made with general population and a specific occupational group	1
	None or one comparison made	0
9	Appropriateness of comparison group (gender)	
	Comparisons made by gender or comparison group statistics adjusted for gender	1
	Comparisons not made by gender or comparison group not adjusted for gender	0
10	Appropriateness of comparison group (age)	
	Comparisons made by age or comparison group statistics adjusted for age	1
	Comparisons not made by age or comparison group not adjusted for age	0
11	Significance of comparison statistics	
	<i>P</i> -values or confidence intervals reported	1
	<i>P</i> -values or confidence intervals not reported	0
12	Study limitations	
	Authors identify possible sources of bias	1
	Authors do not identify possible sources of bias	0

data, (iv) the appropriateness of the comparison population in terms of gender and (v) the appropriateness of the comparison population in terms of age. The scores on these items were summed to give an indication of the likelihood that data on the prevalence of suicide were biased. Score of 4 or 5 indicated a relatively low risk of bias.

Each report of prevalence of suicide and methods of suicide was randomly allocated to reviewers 1–3 and reviewer 5 for independent data extraction. Any resulting disagreements were discussed between the reviewers until a joint decision could be reached. Data were entered into an Excel spreadsheet, which was used for descriptive analyses.

## Results

The initial electronic search strategy identified 12 948 references, once duplicates had been removed. Disagreement between reviewers existed in relation to 837 (7%) of the references at the abstract screening level ( $\kappa = 0.504$ ; moderate agreement [24]). There was disagreement about whether 42 (5%) of the studies at the full-text level presented data that met review criteria 1 (presenting data) or not ( $\kappa = 0.717$ ; substantial agreement [24]).

Nineteen studies presented primary empirical data on the prevalence of suicide in the veterinary profession (Table 3). Data are presented in the format in which they appear in the paper they are extracted from. Where comparative statistics were not reported in the paper but there were sufficient data available to calculate these, the present authors have performed the relevant statistical tests.

Data on the absolute rate of suicide in the veterinary profession were provided in the majority of papers. The proportion of all deaths that were from suicide (proportional mortality; PM) varied from 0/3195 (0%) in a study of veterinarians in Denmark [2] to 6/14 (43%) in a study of female veterinary suicides in California [30]. The lowest absolute rate of suicide (per 100 000) was 41.8 (95% CI: 19.9–87.7) for veterinarians in Victoria, Australia [19] and the highest rate was in veterinarians in Western Australia, 52.6 (95% CI: 19.7–140.1) [19]. Eleven studies compared veterinary suicide PM with a comparison population (proportional mortality ratio; PMR). All of these indicated that the proportion of veterinary deaths that were suicides was elevated compared with the proportion in the general population. Seven of these studies reported that the elevated rate was significant at the  $P < 0.05$  level [13,14,16,26,28,30,31].

In two studies, the relative risk (RR) of suicide in the veterinary profession was presented [25,27]. These showed an elevated risk of suicide compared with the general population. Two studies reported standardized mortality ratios (SMR) [19,29]. Neither found the risk

of suicide in the veterinary profession to be significantly greater than that of the general population.

The included studies varied greatly in their relative quality and risk of bias. The findings of the four studies that scored 9–12 on the 12 point quality scale and 4 or 5 on the 5 point risk of bias scale are discussed in more detail below as more robust conclusions about the extent to which the rate of suicide is truly elevated in the veterinary profession can be drawn from them [2,8,16,25].

A case–control study of suicide in the national population of Denmark between 1991 and 1997 identified 3195 cases of suicide and 63 900 controls (alive when the case died) [2]. While 49 of the controls were veterinary surgeons, none of the cases of suicide were and therefore it was not possible to calculate the RR of suicide in the veterinary profession.

In a second case–control study, the number of cases of suicide in veterinary surgeons in England and Wales between 1990 and 1992 was compared with the number of suicides by controls (not employed in 1 of 10 highest professional groups at risk of suicide) [25]. The RR of suicide was significantly elevated in female veterinarians aged 16–64 years (RR = 7.62, 95% CI: 1.04–55.94,  $P < 0.05$ ), male veterinarians aged 16–44 years (RR = 4.61, 95% CI: 1.49–14.25,  $P < 0.01$ ) and male veterinarians aged 45–64 years (RR = 5.62, 95% CI: 1.6–19.74,  $P < 0.01$ ).

A third study investigated suicides in veterinary surgeons in England and Wales between 1979 and 2000 [16]. Male and female veterinary surgeons were at significantly increased risk of suicide (PMR = 361, 95% CI: 252–503 and PMR = 414, 95% CI: 166–853, respectively). Male veterinarians were significantly more likely to die by suicide than dentists or doctors. When deaths with an open verdict were also included, the risk of suicide for male and female veterinary surgeons was even greater (PMR = 374, 95% CI: 244–548,  $P < 0.0005$  and PMR = 1240, 95% CI: 446–2710,  $P < 0.05$ , respectively).

The final study compared the relative numbers of deaths due to suicide in male Scottish veterinary surgeons with other males in Scotland [8]. An elevated risk of suicide for veterinary surgeons was reported in those aged 16–45 years (PMR = 293, 95% CI: 80–749) and 46–64 years (PMR = 301, 95% CI: 36–1088). This was not statistically significant, probably due to relatively few cases of suicide.

Data on the methods of suicide in the veterinary profession were provided in 8 of 19 studies (Table 4). The two most common methods of suicide used by veterinary populations were poisoning and firearms. Three studies showed that firearms were the most common method of suicide; two of these were from the USA [13,14,18]. In five studies, self-poisoning was the most common method of suicide [19,26,30–32], although the percentage of self-poisoning cases ranged from 23 [31] to 100% [19,26].

**Table 3.** Observational studies of the prevalence of suicide in the veterinary profession

Study and country of research	Quality rating (risk of bias)	Time period	Veterinary study population			Comparison population	Comparative statistics
			Data source (verdict)	Description [studies with overlapping population]	Prevalence of suicide		
Charlton [25] England and Wales	10 (5)	1990–92	National/official (suicide and open)	Male veterinarians aged 16–44 [16,26]		Married males in general population aged 16–44, not in 10 highest occupational groups <sup>b</sup>	RR = 4.61 (1.49–14.25), $P < 0.01$
				Male veterinarians aged 45–64 [16,26]		Married males in general population aged 45–64, not in 10 highest occupational groups <sup>b</sup>	RR = 5.62 (1.6–19.74), $P < 0.01$
				Female veterinarians aged 16–64 [16,26]	2 suicides 3 deaths from natural causes	Married females in general population aged 16–64, not in 10 highest occupational groups <sup>b</sup>	RR = 7.62 (1.04–55.94), $P < 0.05$
Stark <i>et al.</i> [8] Scotland	10 (5)	1981–99	National/official (suicide and open)	Male veterinarians aged 16–45		Males in general population	PMR = 293 (80–749), ‘not significant’
				Male veterinarians aged 46–64			PMR = 301 (36–1088), ‘not significant’
Mellanby [16] England and Wales	10 (4)	1979–90 except 1981	National/official (suicide)	Female veterinarians aged 20–74	PM = 7/30 (23%)	General population	PMR = 414 (166–853) Higher than medical practitioners ( $X^2 = 8.3$ , $P < 0.005$ )
		1991–2000	National/official (suicide and open)	Female veterinarians aged 20–74 [25]	PM = 6/36 (17%)	General population	PMR = 1240 (446–2710) Higher than medical practitioners ( $X^2 = 4.5$ , $P < 0.05$ )
		1979–90 except 1981	National/official (suicide)	Male veterinarians aged 20–74 [17]	PM = 35/383 (9%)	General population	PMR = 361 (252–503) Higher than medical practitioners ( $X^2 = 32.1$ , $P < 0.0001$ ) and dentists ( $X^2 = 13.7$ , $P < 0.001$ )
Agerbo <i>et al.</i> [2] Denmark	9 (5)	1991–97	National/official (suicide)	Veterinarians aged 25–60	0 suicides	Suicides controls ( $N = 3195$ ) in general population (matched for gender and year of birth)	
Lange [27] USA	9 (3)	1965–89	Regional/official (suicide)	Veterinarians on active duty in commissioned corps	PM = 1/3 (33%)	General population adjusted for age, race, ethnicity (PM = 24/118, 20%)	RR = 4, ‘significant’

Table 3. (Continued)

Study and country of research	Quality rating (risk of bias)	Time period	Veterinary study population			Comparison population	Comparative statistics
			Data source (verdict)	Description [studies with overlapping population]	Prevalence of suicide		
Milham and Ossiander [28] USA	9 (3)	1950–99	Regional/official (suicide)	Male Washington state veterinarians aged >19	19 suicides	Male Washington state residents aged ≥20 (18 736 suicides)	PMR = 197 ( $P = 0.00156$ )
		1974–99		Female Washington state veterinarians aged >19	3 suicides	Female Washington state residents aged ≥20 (2128 suicides)	PMR = 180 ( $P = 0.23326$ )
Kelly and Bunting [26] England and Wales	8 (4)	1982–87	National/official (suicide and open)	Male veterinarians aged 20–64 [16,25]	17 suicides	General population (adjusted for age and gender)	PMR = 349 (203–559), 'significant'
		1991–96		Male veterinarians aged 20–64 [16,25]	9 suicides	General population (adjusted for age and gender)	PMR = 324 (148–615), 'significant'
		1991–96		Female veterinarians aged 20–59 [16,25]	4 suicides	General population (adjusted for age and gender)	PMR = 500 (136–1279), 'significant'
Kinlen [18] Great Britain	8 (4)	1949–75	National/unofficial (suicide)	Male veterinarians	PM = 27/699 (2%)	Males in social class 1 aged <75	PMR = 206 <sup>a</sup>
Blair and Hayes [13] USA	8 (3)	1966–77	National/unofficial (suicide)	White male veterinarians [14]	PM = 65/1551 (4%)	White males matched for age and time period	PMR = 216 ( $X^2 = 42.91$ , $P < 0.005$ )
Blair and Hayes [14] USA	8 (3)	1947–77	National/unofficial (suicide)	White male veterinarians [13]	PM = 137/5016 (3%)	White males matched for age and time period	PMR = 170 ( $X^2 = 41.31$ , $P < 0.005$ )
Hem <i>et al.</i> [3] Norway	8 (3)	1960–2000	National/official (suicide)	Male veterinarians age >20	13 suicides, 43.7 per 100 000 deaths (25.4–75.2)	Males in the general population >20 (15 705 suicides) Medical practitioners	RR = 1.87 <sup>a</sup> RR = 1.02 <sup>a</sup>
Charlton <i>et al.</i> [17] England and Wales	7 (4)	1979–90	National/official (suicide and open)	Male veterinarians aged 16–64 [16]	35 suicides	Males in the general population aged 16–64	PMR = 364
Fasal [29] USA	7 (3)	1950–62	Regional/unofficial (suicide)	White male veterinarians in California [30]	PM = 4/148 (3%)	White males in general population of California in 1960 (adjusted for age)	SMR = 79, 'not significant'
Miller and Beaumont [30] USA	7 (2)	1960–92	Regional/unofficial (suicide)	Californian veterinarians	PM = 42/450 (9%)	General population	PMR = 263 (199–347), $P < 0.05$
				Californian male veterinarians	PM = 36/436 (8%)	General male population	PMR = 248 (183–335), $P < 0.05$
				Californian female veterinarians	PM = 6/14 (43%)	General female population	PMR = 5 (302–1148), $P < 0.05$

**Table 3.** (Continued)

Study and country of research	Quality rating (risk of bias)	Time period	Veterinary study population			Comparison population	Comparative statistics
			Data source (verdict)	Description [studies with overlapping population]	Prevalence of suicide		
Jones-Fairnie <i>et al.</i> [19] Australia	6 (2)	1990–2002	Regional/official (suicide and open)	Veterinarians in Victoria	61 deaths, 41.8 per 100 000 deaths (19.9–87.7)	Adults in Victoria (matched for age)	SMR = 3.8
				Veterinarians in Western Australia	26 deaths, 52.6 per 100 000 deaths (19.7–140.1)	Adults in Western Australia (matched for age)	SMR = 4
				Veterinarians in Western Australia and Victoria	PM = 11/89 (12%), 45.2 per 100 000, deaths (25–81.6)		
Schnurrenberger <i>et al.</i> [12] USA	6 (1)	1950–73	Regional/unofficial (suicide)	White male Illinois state veterinarians	PM = 13/481 (3%)	Illinois white male veterinarians in 1950	PMR = 168.3 (72.0–394.4) <sup>a</sup>
						Californian veterinarians [28]	PMR = 129.3 (55–304.8) <sup>a</sup>
						Illinois white male veterinarians in 1960	PMR = 193.0 (78.1–479.2) <sup>a</sup>
						Illinois white male veterinarians in 1970	PMR = 223.7 (86.4–581.5) <sup>a</sup>
Botts <i>et al.</i> [15] USA	4 (0)	1949–64	Regional/unofficial (suicide)	Male veterinarians in Missouri	PM = 2/127 (2%)		
Mammerickx [31] Belgium	4 (0)	Not stated	Not stated (suicide)	Veterinarians in Belgium	PM = 13/367 (4%)	Non-veterinarians in general population (PM = 918/57 814, 2%)	PMR = 223 (130.6–377.2) <sup>a</sup>
				Veterinarians in Belgium who died at age <70	PM = 13/206 (6%)	Non-veterinarians in general population who died at age <70 (PM = 918/23 567, 4%)	PMR = 162 (95.3–270.6) <sup>a</sup>
Jeyaretnam <i>et al.</i> [32] Australia	2 (0)	10 year period not stated	Regional/unofficial (suicide)	Veterinarians in Western Australia	PM = 4/20 (20%)		

<sup>a</sup>Comparative statistics were calculated by the authors of the review based on available data.

<sup>b</sup>Age range of comparison population appears incorrect in original report; we have included what we believe to be likely correct age range.

One study compared methods of suicide between 54 practising and 11 non-practising male veterinarians in the USA between 1966 and 1977 [13]. For practising veterinarians, self-poisoning was a more common method of suicide than firearms, whereas in non-practising veterinarians, the most common method of suicide was firearms. In a replication of this study with a longer study period (1947–77), firearms were still more commonly used by non-practitioners than poisoning but there was little difference between the two methods in practising

veterinarians. Information on the type of drugs with which veterinarians poisoned themselves was limited to three of the studies. Barbiturates were commonly used, particularly by practising veterinarians [13,14].

## Discussion

Following a systematic review of the international research literature, 19 studies were identified as presenting

**Table 4.** Methods of suicide in the veterinary profession

Study and country of research	Time period	Veterinary study population	Number of suicides	Method of suicide (% of all suicide cases)					Modal method of suicide	Suicide cases accounted for (%)
				Poisoning (% barbiturates)	Firearms	Hanging	Drowning	Other		
Blair and Hayes [13] USA	1966–77	White males in clinical practice	54	54 (37)	33				Poisoning	87
		White males not in clinical practice	11	27 (0)	64				Firearms	91
Blair and Hayes [14] USA	1947–77	Practitioners	137	36 (28)	37				Firearms	73
		Non-practitioners		13 (0)	69				Firearms	82
Jeyaretnam <i>et al.</i> [32] Australia	10 year period	Resident in Western Australia	4	50 (100)					Poisoning	50
Jones-Fairnie <i>et al.</i> [19] Australia	1990–02	Western Australians and Victorians	11	82 (not stated)	9	9			Poisoning	100
		Male Western Australian and Victorians	9	78 (not stated)	11	11			Poisoning	100
		Female Western Australian and Victorians	2	100 (not stated)					Poisoning	100
Kelly and Bunting [26] England and Wales	1982–96	Males aged 20–64	38	79 (not stated)	16	5	0	0	Poisoning	100
		Females aged 20–59	9	100 (not stated)	0	0	0	0	Poisoning	100
Kinlen [18] Great Britain	1949–75	Males	27		19				Firearms	19
Mammerickx [31] Belgium	Not stated	Aged <70	13	23 (not stated)	8	15		15 <sup>a</sup>	Poisoning	61
Miller and Beaumont [30] USA	1960–92	Males	36	47 (not stated)	3%	8		6	Poisoning	100
		Females	6	67 (not stated)	0	17		17	Poisoning	100

<sup>a</sup>One train, one car and five unknown.

data on the prevalence of suicide in the veterinary profession. Between 0 and 43% of all deaths were suicides and the rate of suicide per 100 000 members of the profession ranged from 41.8 to 52.6. In the majority of studies, the suicide rate in the veterinary profession was elevated compared with the general population. The quality and risk of bias of these studies varied greatly. In two of the four studies of highest quality, there was no significant difference between the rate of suicide in the veterinary profession and general population [2,8]. In contrast, in a high-quality study conducted in England and Wales, the risk of suicide in the veterinary profession was at least three times that of the general population [16]. The comparison group in the final high-quality study were members of the general population who were employed in occupations with a lower rate of suicide, therefore the increased risk of four to seven times that of the general population was artificially elevated [25]. In the majority of studies that reported methods of suicide, poisoning and firearms were the most common.

One issue associated with validity of the studies in this review is the basis upon which cases of suicide are identified. In England and Wales, a verdict of suicide requires strong evidence that the individual intended to die by suicide. If a coroner is not satisfied beyond reasonable doubt that an act was self-inflicted and intended to cause death, they may give an open verdict. Therefore, researchers in the field frequently include open verdicts when identifying suicide cases [33] and studies that identify suicide cases using verdicts of suicide alone are likely to underestimate the prevalence of suicide. In 13/19 studies in the review, open verdicts were not included as suicides and therefore, the level of suicide was probably underestimated. Different criteria for suicide are used in some countries; this also makes it difficult to directly compare studies of suicide prevalence. Furthermore, some studies used an age range with a lower limit than the age at which veterinary surgeons qualify [8,17,25]. This is because of lack of population data in more narrow age groups.

A final limitation of the studies included in the review is the statistical methods used to assess suicide risk. The most reliable and accurate method of performing relative statistics involves comparing the rate of suicide in the target occupational population to the rate in an appropriate comparison population (RR). Just two studies reviewed presented data in the form of a RR [25,27]. In 11 of the studies, a PMR was calculated. This is an alternative statistical method, used when population denominator data are unavailable. PMR is a relatively crude measure of suicide prevalence; it assumes the relative risk of other causes of death is the same in the two populations. Given that the socio-economic status (SES) of the veterinary profession is likely to be particularly high and hence the risk of deaths from some natural causes reduced, this assumption is unlikely to be valid. However, where the

use of a PMR is unavoidable, additional comparisons with occupational groups matched for SES (such as doctors or teachers) are advantageous.

Our use of a quality rating scale to assess the risk of bias and overall quality of the survey studies enabled more valid generalizations to be made. Unfortunately, it was beyond the scope of the review to test the validity and reliability of this measure. Tests of the inter-reviewer reliability and external validity of the tool would help further development, such that it could be used as a reliable means of assessing the quality of studies in similar reviews.

Based on the findings of this review, several other suggestions can be made about the direction of future research on suicide and issues of wellbeing in the veterinary profession. Updates of suicide prevalence studies from the USA, Denmark, Norway, Belgium and Scotland, as well as other countries would be welcome. At the time the search strategy was conducted (May 2008), just one observational study of suicide in the veterinary profession had been published that reviewed rates of suicide beyond the year 2000 [19]. The existence of more accessible and comprehensive mortality databases should facilitate continued evaluation of the extent to which veterinary surgeons are at risk of suicide. Given that suicide patterns vary across the world and in different cultures, further investigation of cross-cultural differences in suicide rates in the veterinary profession are also warranted. The majority of observational studies in this review were conducted in Western Europe, USA and Australasia. While many studies found suicide risk to be elevated in the veterinary profession, the study of Danish veterinary surgeons found no cases of suicide [2].

Gathering detailed information on methods of suicide in the veterinary profession should also be a focus of future observational studies, as it is important to understand more about how access to a means of suicide may contribute to risk of suicide. In addition, few studies made comparisons with other occupational groups and such studies may provide information on the particular risk factors for suicide to which veterinarians are exposed.

The observational studies in the present review show that the rate of suicide in the veterinary profession is generally higher than in comparison populations, and by at least three times in the UK. Therefore, the veterinary profession is an occupation for which effective suicide prevention strategies should be developed. Preliminary evidence suggests that one factor contributing to the elevated risk in this occupational group may be easy access to a means of suicide. However, more observational studies are needed to confirm that veterinary surgeons use methods of suicide obtained through work. Investigations on the influence that other work-related factors might have on suicide risk in the veterinary profession are also required.

## Key points

- This systematic review demonstrates veterinary surgeons in the UK are at least three times as likely to die from suicide as members of the general population and that risk is also elevated in some other countries.
- The research provides evidence that more in-depth investigation of suicidal behaviour in the veterinary profession is essential and identifies the particular methodological limitations of research conducted to date.
- The study is likely to stimulate further research into the factors associated with veterinary suicide in addition to encouraging the profession to develop strategies to prevent its members from taking their lives.

## Funding

Hill's Pet Nutrition, the Royal College of Veterinary Surgeons Trust Fund and the Veterinary Benevolent Fund (VBF). K.H. is funded by Oxfordshire and Buckinghamshire Mental Health NHS Foundation Trust and the National Institute for Health Research, for which he is a senior investigator. S.S. is funded by a NIHR Programme Grant ('A multi-centre programme of clinical and public health research in support of the National Suicide Prevention Strategy for England').

## Acknowledgements

The authors acknowledge the help of Lesley Sutton and Louise Harriss in the abstract and full-text screening stages of the review. International experts in the field Helen Fairnie, Keren Skegg, Austin Kirwan, Lin Fritschi and Rosie Allister identified any references omitted from the search prior to full-text screening (Figure 1). We are also extremely grateful to Karen Smith who provided advice on the statistical methods used in the review.

## Conflicts of interest

None declared.

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