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Risk factors in equine transport-related health problems: A survey of the Australian equine industry

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8 Risk factors in equine transport-related health problems: a survey of the Australian equine

- 9 industry.
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- 24
- 25 Keywords: horse; transportation; illness; risk; journey duration; survey.
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Background: Transportation can affect equine health and is a potential source of economic lossto the industry.

31 **Objectives:** To identify journey (duration, vehicle, commercial/non-commercial) and horse (sex,

32 age, breed, use, amateur or professional status) characteristics associated with development of

- 33 transport-related health problems.
- 34 Study design: Cross-sectional online survey.

35 Methods: An online survey was conducted targeting amateur and professional participants in the 36 Australian equine industry; eligible respondents organised horse movements at least monthly. 37 They provided details of the last case of a transport-related health problem that had affected their 38 horse(s). Associations between type of health problem, journey and horse characteristics were 39 examined with multivariable multinomial regression analysis.

40 Results: Based on 214 responses, health problems were classified as injuries, muscular 41 problems, heat stroke, gastrointestinal and respiratory problems, or death/euthanasia. Respiratory problems were reported most frequently (33.7%) followed by gastrointestinal problems (23.8%) 42 43 and traumatic injuries (16.3%). The type of health problem was associated with journey-duration (P < 0.001) and horse breed (P = 0.001). Injuries were more likely to occur on short journeys, 44 45 while more severe illnesses (gastrointestinal and respiratory problems or death/euthanasia) were more likely to occur on long journeys. Using Standardbreds as the reference group, 46 47 Thoroughbreds, Arabians and Warmbloods were more likely to experience a severe illness than 48 Ø injury.

Main limitation: Self-selected participation in the study and self-reported nature of transport related problems.

51 **Conclusion:** Horses undertaking journeys longer than 24 hours were at greater risk of developing 52 severe disease or dying. Further studies are needed on long-haul transportation effects to 53 safeguard the welfare of horses moved over long distances.

54

#### 55 Introduction

56 Transportation is an integral part of many horse related activities, with horses being moved 57 frequently [1] and for a wide range of reasons [2]. Horses transported frequently may become 58 habituated to travel [3]. However, for other horses, the challenges associated with transport, such 59 as confinement, noise and vibration [4] may trigger fear [5]. The physical and mental stressors 60 associated with transportation can result in adverse effects on the horses' health [6]. Fear may 61 also trigger behaviours that put horses at risk of injury [7], ranging from small abrasions to 62 catastrophic fractures [8]. The stress associated with transport, and the way in which horses are 63 managed during transport [9-11], can contribute also to the development of potentially fatal 64 infections of the respiratory [12] or gastrointestinal systems [13].

65 Transport's effects on physiological [14], behavioural [15], endocrine [16], reproductive [17], 66 muscular [18], gastric [19], inflammatory [20] and respiratory parameters [9] have been described in many observational studies. In contrast, few epidemiological studies have been 67 conducted. The incidence of and risk factors for health problems has been reported in horses 68 69 being transported for slaughter [21-23]. The only epidemiological study on risk factors for the 70 development of transport-related health problems during long haul transportation of horses for 71 other purposes identified journey duration (more than 20 hours) and season (spring) as risk 72 factors. However, the study reported only 47 cases [24]. Consequently, the relationship between journey and horse characteristics, and the risk of developing disease remains poorly defined. We 73 74 collected data with an online questionnaire and examined associations between transport related 75 health problems and journey and horse characteristics across a number of Australian equine industry sectors. 76

77

#### 78 Material and methods

79 Study design and data collection

80 The study was a cross-sectional online survey conducted in Australia from June to September 2015. Detail of the design and distribution of the cross sectional survey and the description of the 81 82 demographic characteristics of the study population have been reported previously [25]. Briefly, the survey was digitised using SurveyMonkey<sup>a</sup>. The target population was people involved in 83 84 any equine industry sector who had organised or participated in the movement of horses 85 (commercially or non-commercially) at least monthly over the past two years. The respondents 86 classified themselves as either professionals (people who were involved for financial reward, such as trainers, stud/farm managers) or amateurs (people involved as a hobby, such as riders, 87 88 owners). An invitation letter and the link to the survev 89 (https://www.surveymonkey.com/r/SM9F9SJ) were provided to several Australian horse sport associations and were published on their websites. The link was also promoted through several
horse magazines, relevant Facebook pages and online horse forums.

The questionnaire was divided into four parts: respondent details; management strategies pre-, during and post-transport; transport-related behavioural and health problems identified during and after transportation in the past two years; details of the most recent case including horse sex, ge, breed, the use of the horse, the vehicle in which the horse was transported, the journey duration, and whether the horse was moved by a commercial or non-commercial carrier. The results for the first three parts are presented elsewhere [25]. The data collected within the first and fourth part of the questionnaire (Supplementary Item 1) are presented in the current report.

99 <u>Risk factors and outcome</u>

100 Horse-level predictive variables were sex (mare/filly, gelding, stallion/colt), age (8-24 months, 2-

5 years, 6-10 years, >10 years), breed (Arabian, Quarter horse, Standardbred, Thoroughbred,
Warmblood, use (breeding, recreational non-competitive activities, Standardbred racing,
Thoroughbred racing, endurance, equestrian competitive sport), and amateur or professional
status.

Journey-level predictive variables were categorised according to the type of vehicle used (truck, 105 horse trailer) and operator (commercial versus non-commercial transporter). The journey 106 107 duration was categorised as: short (less than 8 hours), intermediate (8-24 hours) and long (more 108 than 24 hours). These cut-offs were chosen on the basis of the European and Australian Code of 109 Animal Transportation, in which the maximum journey durations without watering are of 8 and 110 24 hours respectively [26; 27]. In Australia a rest stop of 12 hours is recommended after 12 and 111 compulsory after 24 hours of journey [26]. Thus all reported multiday trips in this dataset 112 included mandatory rest stops.

To categorise outcome, there was an open question in which the respondents reported a description of the signs and their veterinarians' diagnosis of any transport-related health problem that affected the horse. Based on the respondent's description, health problems were classified into six categories (injuries, muscular problems, heat stroke, gastrointestinal problems, respiratory problems, death/euthanasia) by an experienced equine veterinarian (B.P.; Table 1).

118 Data analysis

119 Initial descriptive analysis was undertaken using statulor<sup>beta</sup> 120 (<u>http://statulator.com/descriptive.html</u>). Associations between the predictive variables were 121 explored using Contingency tables and  $\chi^2$  tests using GenStat<sup>®</sup> Version 14<sup>b</sup>.

A multivariable multinomial regression analysis was constructed using SPSS Version 22<sup>c</sup> with 122 123 health problem category as outcome with injuries as the reference level for comparisons. Vehicle and operator were excluded as they were found to be collinear with journey duration. Horse age, 124 125 breed, sex, use, amateur or professional status and journey-duration were considered for inclusion in the final multinomial model. A stepwise backward elimination was then conducted 126 to remove the least significant variable one at a time until all variables within the model had P 127 128 value < 0.05. The data met with all assumptions for multinomial regression including that of IIA. 129 The findings are presented as odds ratio (OR), confidence interval (95% CI) and P value for each 130 predictive variable value.

131

## 132 Results

133 Population

Of the 797 responses to the survey, 214 included details of a transport-related health problem and
these 214 records make up the database. The distribution of the data (including missing values)
is reported in Supplementary Item 2.

The frequency of the health outcomes according to the predictive variables is shown in Supplementary Item 3. Ten horses died during transit: 8 were humanely destroyed due to fractures (5 limb, 1 pelvis, and 2 neck), and 2 were found dead. A further 15 horses were humanely destroyed within one week after the journey due to colic (5 cases), colitis (5 cases), and pneumonia (5 cases). Additionally, 7 deaths occurred within 24 hours after arrival, of which 5 underwent post mortem examination, one was diagnosed with water intoxication; no cause of death was identified in the other four cases.

#### 144 Journey variables

Journey duration was associated with vehicle (Pearson chi-square: 71.51, df = 2; P<0.001) and transport by a commercial company (Pearson chi-square: 78.74, df = 2; P<0.001). Companies transported fewer horses on short journeys and more horses on long journeys. The number of horses moved by horse trailer was larger for short journeys, and smaller for long journeys (Supplementary Item 4).

#### 150 Factors associated with Health Outcomes

The final multivariate multinomial model for risk factors associated with health problems 151 included journey-duration ( $\chi^2$ : 88.153, df:10, P<0.001) and breed ( $\chi^2$ : 46.087, df:20, P = 0.001). 152 None of the other predictive variables considered for inclusion reached significance. Figure 1 153 154 shows the distribution of the different transport-related illness according to the journey duration 155 category. Using injuries as reference, death/euthanasia (odds ratio, OR: 101.6, 95% confidence interval (CI):10.2-1010.5, P<0.001), gastrointestinal (OR:14.2, CI:1.5-133.8, P = 0.02) and 156 respiratory (OR:113.9; CI:12.2-1060.7, P<0.001) problems were more likely to occur on long 157 journeys than on short journeys. Respiratory problems were also more likely (OR: 15.7, CI:4.3-158 159 56.7, P<0.001) to occur on intermediate journeys than on short journeys. Using the injury group 160 as the reference, muscular problems were more likely to occur on an intermediate journey than 161 on a short one (OR:5.8, CI:1.1-29.5, P = 0.03). There was no significant difference among the 162 journey-duration categories comparing injuries versus heat stroke (Supplementary Item 5).

Using injuries as reference group, gastrointestinal problems were more likely to occur in Arabians (OR 95.8, CI: 4.6-1990.3, P = 0.003) and Warmbloods (OR: 43.0, CI; 3.8-485.9, P = 0.002) compared with Standardbreds. Respiratory problems were more likely to occur in Arabians (OR: 20.8, CI: 1.2-345.2, P = 0.034), Warmbloods (OR: 18.5, CI: 2.5-136.89, P = 0.004), and Thoroughbreds (OR: 7.4, CI: 1.2-45.7, P = 0.031) compared with Standardbreds. Death/euthanasia was more likely to occur in Thoroughbreds than in Standardbreds (OR; 7.5, CI: 1.0-56.0, P = 0.048) (Supplementary Item 5).

170 Discussion

This is the first study to investigate whether journey and horse characteristics were associated 171 172 with transport-related health problems across a diverse range of Australian horses used for various activities undertaking different journeys. Journey duration and breed were identified as 173 174 risk factors for the development of transport-related health problems, while horse sex, age, use 175 and amateur or professional status were not predictors. The main finding of this study was the 176 association between journey-duration and the nature of transport-related health problems, 177 confirming that journeys longer than 24 hours pose the greatest risk of horses having serious 178 health outcomes [24; 28]. The association between health problem category and breed should be 179 considered preliminary, and warrants future research using a larger dataset.

The observation that shorter trips are associated with a higher risk of injury is in agreement with previous reports. In an epidemiological study conducted in Australia, injuries occurred more often at the beginning of a 3.5 day journey and that they were often related to behavioural problems [24]. Previous studies have also identified that behavioural problems and movement of the horse within the vehicle are greatest during the first hour of transportation, and that horses become habituated after 5 hours of transport [14; 17; 29; 30]. The higher risk of injuries during short trips is likely to be associated with behavioural problems and lack of habituation.

187 In this study muscular problems were reported to occur more often during non-commercial 188 transport of non-racing horses, and the risk of muscular problem was greater for intermediate 189 journeys compared with short journeys. The reasons for this cannot be ascertained from the 190 available data, although it could be speculated that limitations in driver ability and in horse 191 fitness could have contributed. In an electromyographic study on the effects of transportation on 192 muscle, horses transported by less experienced drivers required more muscular effort to maintain 193 balance compared with horses transported by expert drivers [18]. In another study it was found 194 that the effort required to maintain balance during a 300 km journey had the same impact on muscles as a 1,500 metres canter, and caused a comparable increase in serum muscle enzyme 195 196 activities [31]. The effects of journey-duration on muscular problems warrant future research.

197 Respiratory diseases were the most commonly identified problem in this study, a finding that 198 agrees with previous studies [32; 33]. In our study the likelihood of respiratory problems was 199 approximately 15 times greater on intermediate journeys and approximately 100 times greater on 200 long journeys than on short journeys. The relationship between duration of transport and 201 incidence of respiratory disease has been previously reported [6; 12; 34; 35] and our data 202 confirm it. This relationship may relate to the head position of the transported horses, vehicle 203 ventilation or air quality. If horses are restrained in a way that prevents them lowering their 204 head, mucociliary clearance will be adversely affected [9]. Ventilation may be inadequate in many types of vehicles [36] resulting in an accumulation of dust, bacteria and noxious gases in 205 206 the vehicle as journey length increases [11]. The ongoing high incidence of respiratory diseases 207 suggest that more research is needed to identify how ventilation systems can be improved and 208 how any periods of enforced head elevation can be shortened.

In agreement with our previous study [24], the risk of gastrointestinal and respiratory disorders and death/euthanasia was greater than the risk of injury for journeys longer than 24 hours. In 211 livestock the association between adverse outcomes and journey duration is influenced by the 212 physiological and clinical state of the animal before and during journey, the management of 213 feeding and watering, the opportunities animals have to rest and the thermal environment rather 214 than journey length per se [28]. These factors may also be important in determining whether 215 horses experience adverse outcomes as a result of transport. However, the reasons why some 216 horses develop fatal diseases during and after a multi-day journey, while others remain healthy 217 under the same conditions are unknown. Protracted transport stress may compromise the immune 218 system and lead to psychological and physical exhaustion and death [35]. The use of 219 immunostimulants before shipping has been found to be useful in reducing the incidence of 220 transport-related pneumonia in horses transported for more than 24 hours [37]. Thus, the higher 221 risk of severe diseases in horses transported for longer than 24 hours might be related to 222 immunosuppression, and the relationship between long journeys and the immune system requires 223 further investigation.

Compared with Standardbreds, Thoroughbred, Arabian and Warmblood horses were more likely to develop gastrointestinal and respiratory diseases than to be injured during transportation. Thoroughbreds were found at higher risk of transport pleuropneumonia in a previous study [12]. Arabians have been found at higher risk of colic compared with other breeds [38]. There might therefore be a breed-predisposition for developing a particular type of transport-related diseases. However, our data should be considered preliminary and a larger data set would be required to determine the actual effects of breed on different types of transport related illnesses.

231 This study has a number of limitations that must be considered in interpreting the results. The 232 problems of bias associated with self-selected participation in the study could not be addressed, 233 nor could the possibility of response bias in the answers provided. It was not possible to check 234 the diagnoses reported, nor was there any standardisation of the processes by which the 235 diagnoses were made. The target population was not estimated and it was not possible to 236 calculate a response rate, a common problem with online surveys [39]. Notwithstanding these 237 limitations, this is the first study which analysed 214 cases with a novel approach and our 238 findings may be important in helping reduce the negative impact of transportation on horse 239 health.

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241 Conclusions

There is an association between transport-related health problems and journey-duration and the likelihood of developing a more severe illness (i.e. respiratory and gastrointestinal problem or death/euthanasia) was higher on journeys over 24 hours than on journeys of less than 8 hours, suggesting the need to decrease the maximum journey time in Australia. This study also highlights the need for further research into the effects of long haul transport on the respiratory, gastrointestinal and immune systems to assist in proposing improved management practices for safeguarding horse welfare during travel, particularly over long distances.

- 249
- 250 Authors' declaration of interests
- 251 No competing interests have been declared.
- 252

# 253

254 Ethical animal research

The ethical aspects of this study have been approved by the Human Research Ethics Committee of the University of Sydney *[2015/308]*.

257

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261

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- 269
- 270 Authorship

- 271 B. Padalino, E. Hall, S. Raidal, P. Knight, P. Celi, L. Jeffcott, and G. Muscatello conceived and
- designed the survey; B. Padalino and E. Hall analysed the data, B. Padalino wrote the paper; E.
- 273 Hall, S. Raidal, P. Knight, L. Jeffcott, and G. Muscatello edited the paper.
- 274
- 275
- 276 Manufacturers' addresses
- 277 <sup>a</sup>SurveyMonkey Inc., California, USA. (<u>www.surveymonkey.com</u>)
- 278 <sup>b</sup>VSNi International, Hemel Hempstead, Hertfordshire, UK.
- 279 <sup>°</sup>IBM SPSS

280 Supplementary Information

- 281
- 282 Supplementary Item 1: Questionnaire.
- 283 Supplementary Item 2: Data distribution.
- 284 **Supplementary Item 3:** Health outcomes.
- 285 Supplementary Item 4: Associations between journey variables.
- 286 Supplementary Item 5: Associations between health outcomes and horse and journey variables.
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 Table 1: Categorisation of health problems observed in transported horses.
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Health pr. bl.m category	Definition
Injuries	Laceration, abrasion, contusion, swelling.
Muscular problems	Typing up, sore muscle, stiffness.
Heat stroke	Rectal temperature >38.5°C, sweating, lethargy.
Gastrointestinal problems	Oesophagal obstruction, gastric ulceration, diarrhoea, colic,
	enterocolitis.
Respiratory problems	Nasal discharge, coughing, inflammation/infection of the
	upper or lower respiratory tract, and pneumonia.
Death	Horses found dead or humanely destroyed.

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Author