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

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Summary

Background: Transportation can affect equine health and is a potential source of economic loss to the industry.

Objectives: To identify journey (duration, vehicle, commercial/non-commercial) and horse (sex, age, breed, use, amateur or professional status) characteristics associated with development of transport-related health problems.

Study design: Cross-sectional online survey.

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

Results: Based on 214 responses, health problems were classified as injuries, muscular problems, heat stroke, gastrointestinal and respiratory problems, or death/euthanasia. Respiratory problems were reported most frequently (33.7%) followed by gastrointestinal problems (23.8%) 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, 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, Thoroughbreds, Arabians and Warmbloods were more likely to experience a severe illness than injury.

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

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

Introduction

Transportation is an integral part of many horse related activities, with horses being moved frequently [1] and for a wide range of reasons [2]. Horses transported frequently may become habituated to travel [3]. However, for other horses, the challenges associated with transport, such as confinement, noise and vibration [4] may trigger fear [5]. The physical and mental stressors

associated with transportation can result in adverse effects on the horses' health [6]. Fear may also trigger behaviours that put horses at risk of injury [7], ranging from small abrasions to catastrophic fractures [8]. The stress associated with transport, and the way in which horses are managed during transport [9-11], can contribute also to the development of potentially fatal infections of the respiratory [12] or gastrointestinal systems [13].

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

Material and methods

Study design and data collection

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 demographic characteristics of the study population have been reported previously [25]. Briefly, the survey was digitised using SurveyMonkey[a]. The target population was people involved in any equine industry sector who had organised or participated in the movement of horses (commercially or non-commercially) at least monthly over the past two years. The respondents 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, owners). An invitation letter and the link to the survey (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, age, 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.

Risk factors and outcome

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, horse trailer) and operator (commercial versus non-commercial transporter). The journey duration was categorised as: short (less than 8 hours), intermediate (8-24 hours) and long (more than 24 hours). These cut-offs were chosen on the basis of the European and Australian Code of Animal Transportation, in which the maximum journey durations without watering are of 8 and 24 hours respectively [26; 27]. In Australia a rest stop of 12 hours is recommended after 12 and compulsory after 24 hours of journey [26]. Thus all reported multiday trips in this dataset 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).

Data analysis

Initial descriptive analysis was undertaken using statulor[beta] (http://statulator.com/descriptive.html). Associations between the predictive variables were explored using Contingency tables and χ^2 tests using GenStat® Version 14[b].

A multivariable multinomial regression analysis was constructed using SPSS Version 22[c] with 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, 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 to remove the least significant variable one at a time until all variables within the model had P value < 0.05. The data met with all assumptions for multinomial regression including that of IIA. The findings are presented as odds ratio (OR), confidence interval (95% CI) and P value for each predictive variable value.

Results

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.

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).

Factors associated with Health Outcomes

The final multivariate multinomial model for risk factors associated with health problems included journey-duration (χ^2: 88.153, df:10, P<0.001) and breed (χ^2: 46.087, df:20, P = 0.001). None of the other predictive variables considered for inclusion reached significance. Figure 1 shows the distribution of the different transport-related illness according to the journey duration 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 respiratory (OR:113.9; CI:12.2-1060.7, P<0.001) problems were more likely to occur on long journeys than on short journeys. Respiratory problems were also more likely (OR: 15.7, CI:4.3-56.7, P<0.001) to occur on intermediate journeys than on short journeys. Using the injury group as the reference, muscular problems were more likely to occur on an intermediate journey than on a short one (OR:5.8, CI:1.1-29.5, P = 0.03). There was no significant difference among the 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).

Discussion

This is the first study to investigate whether journey and horse characteristics were associated 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 risk factors for the development of transport-related health problems, while horse sex, age, use and amateur or professional status were not predictors. The main finding of this study was the association between journey-duration and the nature of transport-related health problems, confirming that journeys longer than 24 hours pose the greatest risk of horses having serious health outcomes [24; 28]. The association between health problem category and breed should be 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.

In this study muscular problems were reported to occur more often during non-commercial transport of non-racing horses, and the risk of muscular problem was greater for intermediate journeys compared with short journeys. The reasons for this cannot be ascertained from the available data, although it could be speculated that limitations in driver ability and in horse fitness could have contributed. In an electromyographic study on the effects of transportation on muscle, horses transported by less experienced drivers required more muscular effort to maintain balance compared with horses transported by expert drivers [18]. In another study it was found 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 activities [31]. The effects of journey-duration on muscular problems warrant future research.

Respiratory diseases were the most commonly identified problem in this study, a finding that agrees with previous studies [32; 33]. In our study the likelihood of respiratory problems was approximately 15 times greater on intermediate journeys and approximately 100 times greater on long journeys than on short journeys. The relationship between duration of transport and incidence of respiratory disease has been previously reported [6; 12; 34; 35] and our data confirm it. This relationship may relate to the head position of the transported horses, vehicle ventilation or air quality. If horses are restrained in a way that prevents them lowering their 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 the vehicle as journey length increases [11]. The ongoing high incidence of respiratory diseases suggest that more research is needed to identify how ventilation systems can be improved and 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

livestock the association between adverse outcomes and journey duration is influenced by the physiological and clinical state of the animal before and during journey, the management of feeding and watering, the opportunities animals have to rest and the thermal environment rather than journey length per se [28]. These factors may also be important in determining whether horses experience adverse outcomes as a result of transport. However, the reasons why some horses develop fatal diseases during and after a multi-day journey, while others remain healthy under the same conditions are unknown. Protracted transport stress may compromise the immune system and lead to psychological and physical exhaustion and death [35]. The use of immunostimulants before shipping has been found to be useful in reducing the incidence of transport-related pneumonia in horses transported for more than 24 hours [37]. Thus, the higher risk of severe diseases in horses transported for longer than 24 hours might be related to immunosuppression, and the relationship between long journeys and the immune system requires 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.

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

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.

Authors' declaration of interests

No competing interests have been declared.

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]*.

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Authorship

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. Hall, S. Raidal, P. Knight, L. Jeffcott, and G. Muscatello edited the paper.

Manufacturers' addresses

[a]SurveyMonkey Inc., California, USA. (www.surveymonkey.com)

[b]VSNi International, Hemel Hempstead, Hertfordshire, UK.

[c]IBM SPSS

Supplementary Information

Supplementary Item 1: Questionnaire.

Supplementary Item 2: Data distribution.

Supplementary Item 3: Health outcomes.

Supplementary Item 4: Associations between journey variables.

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.

Health problem 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.