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1 **The incidence and risk factors for shipping fever in horses transported by air to Hong**
2 **Kong: Results from a 2-year prospective study**

3
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18 **Highlights**

19

- 20 • Data were collected from 81 shipments of horses transported to Hong Kong by air.
- 21 • The incidence risk of shipping fever was 10.8 per 100 horses.
- 22 • The proportion of shipments that contained horses with shipping fever was 60%.
- 23 • Risk factors identified were country of origin and month of arrival.
- 24 • Recognition of at-risk shipments helps focus attention on preventative strategies.

25 **Abstract**

26 A 2 year prospective study was performed between February 2011 and January 2013
27 to determine the incidence and risk factors for shipping fever (SF) in horses transported by air
28 to Hong Kong (HK). Using a questionnaire, data were collected from professional flying
29 grooms regarding the journey to HK and horses in the shipment. Horses were monitored in
30 quarantine for 2 weeks after arrival in HK, and clinical signs of SF recorded. Poisson and
31 logistic regression models were used to identify risk factors for SF at the horse and shipment
32 level.

33

34 The study analysed data from 869 horses on 81 flights arriving from Australia ($n =$
35 24), New Zealand (NZ; $n = 18$), the United Kingdom (UK; $n = 33$) and the United States of
36 America (USA; $n = 6$). The incidence risk of SF was 10.8 per 100 horses and the proportion
37 of shipments with at least one horse that developed SF was 49/81 (60%). The study identified
38 that the rate per shipment of SF in shipments of horses originating from NZ, the USA and the
39 UK was 2.40 (95% confidence interval [CI] 1.22 – 4.71), 2.43 (95% CI 0.66 – 8.89) and 3.08
40 (95% CI 1.60 – 5.93) times the rate of SF compared to Australia. Shipments arriving in HK
41 during March and May were 5.61 (95% CI 1.55 – 20.31) and 4.51 (95% CI 1.43 – 14.26)
42 times more likely to contain horses that developed SF compared to shipments arriving in
43 January. The identification of these risk factors and the recognition of at-risk shipments will
44 help focus attention on preventative strategies.

45

46 *Keywords:* Equine; Logistic and Poisson regression; Pleuropneumonia; Travel sickness

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48 Introduction

49 Shipping fever (SF) is a common respiratory disease of horses associated with
50 transport over long distances by road, rail, sea, or air (Racklyeft et al., 2000). Horses affected
51 by this condition typically first develop a fever, followed by other clinical signs as the
52 condition progresses. These clinical signs may include inappetance, lethargy, coughing, nasal
53 discharge, dyspnoea, tachycardia, abducted elbows, reluctance to move and a stiff gait (Mair
54 and Lane, 1989; Wilkins, 2003; Davis et al., 2014). When SF is identified and treated in the
55 early stages of the infection, affected horses usually recover quickly (Raidal, 1995; Seltzer
56 and Byars, 1996; Racklyeft et al., 2000). However, if the infection spreads and
57 pleuropneumonia develops, intensive medical treatment is necessary and the prognosis for a
58 horse returning to its former level of activity becomes poor (Racklyeft et al., 2000; Davis et
59 al., 2014). Horses with severe SF may develop secondary complications, such as pulmonary
60 abscessation, colitis and laminitis, which can be fatal (Raidal, 1995; Hudson et al., 1999;
61 Sprayberry and Byars, 1999). The stress associated with long distance travel, confinement in
62 adverse environmental conditions, an elevated head position, and pre-existing lower
63 respiratory disease, are well-known risk factors that contribute to the development of SF in
64 horses (Racklyeft and Love, 1990; Leadon, 1995;¹; Racklyeft et al., 2000; Davis et al.,
65 2014).

66
67 The Hong Kong Jockey Club (HKJC) is responsible for the administration of
68 Thoroughbred flat racing in Hong Kong (HK). There is no breeding industry in HK and
69 consequently, all horses are imported by air. Shipments of horses arrive continuously

¹ See Leadon, D., 1999. Horse Transport: History, Current Practices, the Future and Veterinary Recommendations. Rural Industries Research and Development Corporation, Kingston, ACT, Australia.
<https://rirdc.infoservices.com.au/downloads/99-073.pdf> (accessed 12 August 2014).

70 throughout the year, with flights originating from Australia, New Zealand (NZ), the United
71 Kingdom (UK), or the United States of America (USA). Due to the long flight times
72 associated with travel from these destinations, horses imported into HK are at a risk of
73 developing SF.

74

75 To date, research relating to the air transport of horses has investigated areas such as
76 the recovery and acclimatisation following air transport (Marlin et al. 2001) and the effects of
77 air transport on behaviour and heart rate (Stewart et al., 2003). Few studies have been
78 performed to identify risk factors for SF that could be specific to air transport (Leadon et al.,
79 1990; Thornton, 2000; Ohmura et al., 2012; Maaskant et al., 2013). The objectives of the
80 current study were to determine the incidence risk of SF in horses imported into HK and to
81 identify factors that may contribute to the development of this condition. Both objectives
82 were addressed at the horse- and shipment-level, with this data having potential relevance in
83 determining future best practice for the management of horses travelling long distances by
84 air.

85

86 **Materials and methods**

87 *Study design and data collection*

88 A 2 year prospective study was performed between February 2011 and January 2013
89 on all routine shipments of horses imported into HK. Horses travelling temporarily to HK to
90 compete in international race meetings were not included in the study. Flying grooms
91 accompanying these shipments completed a detailed questionnaire that provided information
92 about the journey from the quarantine unit of origin to arrival at the airport in HK. This
93 questionnaire is available from the authors on request.

94

95 All horses were quarantined for at least 3 weeks before departure to HK and received
96 no pre-travel treatments, such as antimicrobials or other medications. Horses were
97 transported in dedicated jet stalls, each typically containing three horses, by one of four
98 airlines (British Airways, Cathay Pacific, Singapore Airlines or Qantas) in either a Boeing
99 747-400 F or 747-8 F freighter.

100

101 During the compulsory 2 week post-arrival quarantine period, the rectal temperature
102 of each horse was recorded twice daily, and abnormal clinical signs and treatments were
103 documented on quarantine charts by veterinarians from the Department of Veterinary Clinical
104 Services (DVCS) at the HKJC.

105

106 The questionnaire completed by flying grooms for this study was authorised by
107 the HKJC and endorsed by the airfreight divisions of New Zealand Bloodstock,
108 International Racehorse Transport and BBA Shipping & Transport Limited.

109

110 *Shipping fever case definition*

111 Horses were diagnosed with SF if they developed one or more clinical signs of lower
112 respiratory tract infection associated with air transport to HK. Clinical signs included fever
113 ($>38.6\text{ }^{\circ}\text{C}$), inappetance, depression, coughing, nasal discharge, increased respiratory rate or
114 effort and adventitious lung sounds.

115

116 *Statistical analysis*

117 All data on individual horses and shipments were entered into a customised database
118 (Microsoft Access 2010). Shipment-level explanatory variables included the country of
119 origin, the number of horses in the shipment, the date of departure and arrival, the month of

120 the shipment, the thermostat setting in the cargo hold, position of the horses in the aircraft,
121 total time in the aircraft, total travel time between quarantine units, as well as details of any
122 delays and stopovers that occurred during the shipment. Horse-level explanatory variables
123 included the age, sex and whether the horse was imported for racing or for use at one of the
124 riding schools located in HK.

125

126 The outcome variables were determined at the horse and shipment level. The horse-
127 level outcome variable was the presence of SF in an individual horse. The shipment-level
128 outcome variable was the number of horses with SF per consignment. Continuous
129 explanatory variables were described using medians and interquartile ranges (IQR) for non-
130 normally distributed variables and mean and standard deviations (SD) for normally
131 distributed variables. Nominal explanatory variables were described using counts and
132 percentages. A mixed effect logistic regression was used to determine those factors that were
133 associated with whether or not a horse developed SF, including the horse-level variables of
134 age and horse use. Country of origin was retained in the final model. Biologically plausible
135 two-way interaction terms between variables were considered for inclusion in the
136 multivariable model. Model diagnostics were conducted using summary measures of the
137 goodness-of-fit of the final model (Hosmer and Lemeshow, 2000). To account for the
138 clustering of horses, a random effect term for shipment was used.

139

140 Shipment-level explanatory variables were screened using univariable Poisson
141 regression to determine those factors that were associated with the rate of SF in a
142 consignment of horses and those with $P < 0.20$ were included in a multivariable model, offset
143 by the number of horses on the shipment. Continuous exposure variables were modelled as
144 categorical variables based on terciles in the univariable analyses. A preliminary

145 multivariable model was built using a manual backwards method of elimination in which
146 variables were retained in the model if the likelihood ratio test statistic was significant at
147 $P < 0.05$. Continuous variables were examined for best fit, as described by Parkin et al. (2005)
148 and as categories based on terciles. Biologically plausible two-way interaction terms between
149 the main effect variables were considered for inclusion in the multivariable model.
150 Significance was assessed using the likelihood ratio test statistic. Over dispersion was
151 checked using deviance and Pearson goodness-of-fit measures. All statistical analyses were
152 performed using Stata version 11.1 (Statacorp LP).

153

154 **Results**

155 *Descriptive statistics*

156 During the study period, data were collected from 869 horses on 81 flights arriving
157 into HK, with a median of 10 (IQR 5 - 14) horses per shipment. Flight data were not provided
158 for six flights that also arrived during this period. Shipments departed from one airport in NZ,
159 two airports in Australia, and three airports in both the UK and the USA. The median
160 number of shipments per month was 3 (IQR 2 - 4; Fig. 1) and the median number of horses to
161 arrive in HK per month was 35 (IQR 26 - 47.8; Fig. 2). The descriptive summary of
162 shipments and the number of horses imported is shown in Table 1. Of the horses that were
163 imported, 840/869 (96.7%) were Thoroughbreds destined for racing in HK and the remaining
164 29 were a variety of horse breeds destined for riding schools. All 29 riding school horses
165 came from the UK. The age of the horses imported ranged from 2 - 18 years of age with all
166 horses imported for racing aged less than 6 years old. Male horses comprised 97.9% of the
167 horses imported into HK.

168

169 The descriptive statistics for the shipment-level variables are shown in Table 2. In
170 total, 39/81 (48%) shipments had a stopover on the way to HK lasting between 1 h 30 min
171 and 3 h. All shipments from the USA had a stopover, 23/33 (70%) from the UK, 9/18 (50%)
172 from NZ and 1/24 (4%) from Australia. Overall, 22/81 (27%) of shipments were delayed
173 during the journey, with delays lasting between 1 and 7 h. Horses were positioned in the front
174 third of the aircraft for 38/81 (47%) flights, 23/81 (28%) were positioned in the rear third of
175 the aircraft and 20/81 (25%) in the middle third.

176

177 During the 2 week quarantine period, 94/869 (10.8%) horses, from 49/81 (60%)
178 flights, developed clinical signs of SF (Table 3), resulting in an incidence risk of 10.8 cases
179 per 100 horses. Of the SF cases, 36/94 (38%) were diagnosed immediately upon arrival in
180 quarantine, and within 24 h 84/94 (89%) of all cases had been identified. Nearly all horses
181 diagnosed with SF (90/94, 96%), had a fever of ≥ 38.6 °C, and in 62/94 (66%) cases this was
182 the only clinical sign; 18/94 (19%) had two clinical signs and 14/94 (15%) had three or more
183 clinical signs. Apart from fever, horses diagnosed with SF were recorded as being dull, quiet
184 or depressed ($n = 21/94$; 22%); having an increased respiratory rate ($n = 15/94$; 16%);
185 adventitious lung sounds ($n = 6/94$; 6%); and inappetence (6/94; 6%). Other clinical signs
186 included nasal discharge ($n = 3/94$; 3%), coughing ($n = 2/94$; 2%), congested mucous
187 membranes ($n = 2/94$; 2%) and mild colic ($n = 2/94$; 2%). All 94 affected horses were treated
188 by DVCS veterinary surgeons and all cases recovered uneventfully. On flights where horses
189 were identified with SF, the number of cases per shipment ranged from one to six. The
190 median number of affected horses on these shipments was 1 (IQR 1-2).

191

192 *Logistic regression modelling*

193 Taking into account clustering at the shipment-level, the presence of SF was not
194 significantly associated with the age ($P=0.96$) or type of horse ($P=0.31$), but the country of
195 origin was significantly associated with the outcome factor ($P<0.01$; Table 4). The goodness
196 of fit for the model without shipment showed no evidence of a lack of fit ($P>0.05$), nor were
197 any influential observations observed.

198

199 *Poisson regression modelling*

200 The results of the univariable Poisson regression analyses are shown in Table 5. The
201 country of origin and the month of travel were both significant in the multivariable model.
202 The overall significance of the model was $P<0.001$ (Table 6). One shipment from NZ
203 containing 25 horses and no horses with SF, had a residual value <-2.5 and a highest Cook's
204 distance. This value was evaluated and not removed from the final model.

205

206 **Discussion**

207 The objectives of this study were to determine the incidence risk of shipping fever in
208 horses imported into HK and to identify factors contributing to the development of this
209 condition. The second objective was achieved using logistic regression analysis at the horse
210 level and Poisson regression analysis at the shipment level. In both regression analyses, the
211 country of origin was a significant factor for the development of SF in the individual or in the
212 shipment. Additionally, the month of travel was identified as a factor that was associated with
213 increased rates of SF on flights arriving into HK.

214

215 The single most important predisposing factor for SF is transportation over long
216 distances (Racklyeft et al., 2000). While this has been demonstrated for horses transported by

217 road (Oikawa and Kusunose, 1995), this is the first study to quantify this risk factor for
218 multiple shipments of horses from different countries of origin travelling by air. Country of
219 origin was identified as a risk factor for SF, both at the individual horse level and at the
220 shipment level. Compared to shipments from Australia, NZ shipments were more than twice
221 as likely, and shipments from the UK more than three times as likely to contain horses that
222 developed SF. Horses in lower risk Australian shipments travelled for less time than other
223 countries, usually under 10 h on the aircraft and under 17 h total travel time. However, with
224 the inclusion and influence of country of origin in the final model, transport time was not
225 identified as a risk factor for SF. In terms of minimising risk, the effects of country of origin
226 are difficult to substantially modify or mitigate. Further investigation is warranted regarding
227 the cause of this effect.

228

229 In the current study the incidence risk of SF in horses was 10.8 per 100 horses. In
230 contrast, a lower figure was reported by Leadon et al. (1990) who found that following a
231 flight from the UK to Australia, 7/112 (6.3%) of horses developed clinical signs of SF. In the
232 Leadon et al. study, 112 horses were transported on a chartered flight, in open wooden stalls,
233 and the total flight time, including three stopovers, was 39 h (Leadon et al., 1990). This
234 contrasts with the current study where the median shipment sizes and flight times were less,
235 and the horses travelled in modern, enclosed, jet stalls on commercial flights with other
236 cargo. It has been suggested that despite recent advances in the ease of equine air transport,
237 the use of modern enclosed jet stalls might have resulted in an increased incidence of SF¹.
238 However, this could not be investigated in the current study, as we did not compare different
239 types of stalls.

240

241 As the incidence risk of SF in individual horses and the proportion of shipments that
242 have horses with SF is high, horses from all shipments arriving in HK are carefully monitored
243 so that cases can be identified and treated as early as possible. All SF cases in the current
244 study were mild and resolved without complication following treatment. Prior to the
245 introduction at the HKJC in the 1990's of routine rectal temperature monitoring of all
246 imported horses, it was not uncommon for horses with SF to require treatment for
247 pleuropneumonia, as pyrexia (one of the early clinical signs of SF) had gone undetected (W.
248 H. Chan, personal communication). The value of rectal temperature monitoring as an aid to
249 the early detection of SF has been demonstrated by the current study, where the majority of
250 SF cases were identified either on arrival or within 24 h of arriving in HK.

251

252 The racing season in HK starts in September and finishes the following July.
253 Shipments arrive continuously throughout the year, with horse arrivals peaking between July
254 and October to coincide with the start of a new racing season. Shipments arriving in HK
255 during the spring months of March and May were found to be nearly 6 and 5 times more
256 likely to contain horses that developed SF, compared to shipments arriving in January. In
257 March and May, horses are travelling from either spring conditions (UK and USA) or autumn
258 conditions (NZ and Australia). It has been suggested that hot and humid environmental
259 conditions in the country of origin could lead to an increased susceptibility to SF after a long-
260 distance flight (Maaskant et al., 2013). This is an area that warrants further investigation, as
261 in the current study, climatic conditions in the country of origin were not measured.

262

263 The location of jet stalls in the cargo hold was not a significant risk factor for horses
264 developing SF in this study. However environmental conditions, such as relative humidity
265 (RH) and ambient temperature (AT), do vary throughout the cargo hold and might contribute

266 to the development of SF. A previous study conducted in a Boeing 747 F, flying from the UK
267 to Australia (Leadon et al., 1990), identified that during the in-flight period, the mean RH
268 was 25% and the mean AT was 13 °C in the front section of the aircraft and 41% and 16 °C,
269 respectively, in the rear section of the aircraft. During the stationary phase on the same flight
270 the mean RH was 78% and the mean AT 21 °C in the front section of the aircraft and 91%
271 and 33 °C, respectively, in the rear section of the aircraft. Although it is possible that the
272 incidence of SF could be reduced by manipulating these parameters, in reality the RH is not
273 easily controlled, and depends on many factors such as altitude, flight duration, the number of
274 horses being carried, and the humidity during the ground phase at the departure and stopover
275 airports (Captain E. Oon, personal communication). Although no absolute guidelines for RH
276 are currently recommended by the International Air Transport Association (IATA)² when
277 transporting horses, the general advice is to control high RH with adequate ventilation to
278 reduce the risk of heat stress when temperatures are high, and to reduce the risk of cold stress
279 when temperatures are low. A limitation of the current study was that RH was not measured
280 and the thermostat setting was used as a proxy for AT. The thermostat setting for each
281 shipment was selected by flying grooms based on their personal preference and ranged from
282 12 °C to 18 °C. These values are within the range currently recommended for the
283 transportation of horses by the IATA of 10 - 19 °C. One consideration regarding thermostat
284 settings is that the actual temperature in a jet stall may differ from the AT in the cargo hold.
285 Thornton (2000) demonstrated during four international flights, that the temperature was
286 significantly warmer inside a fully enclosed, insect proof, jet stall than in the surrounding
287 cargo hold. Further research is required to determine if there is an optimal combination of RH
288 and AT when transporting horses by air over long distances for the maintainence of both
289 health and welfare.

² See: <http://www.iata.org/Pages/default.aspx> (Accessed 17 December 2015)

290

291 Conclusions

292 With the increasing number of high value, elite horses being transported by air to
293 competitions and for racing, the protection of these horses from potentially performance
294 limiting and possibly life-threatening SF is important. As the majority of horses imported to
295 HK are destined for the racing industry, any conditions that could have a detrimental effect
296 on future performance are of concern. In this study, the incidence risk of SF in horses being
297 transported into HK was high, with the country of origin and the month of travel being
298 associated with the rate of SF in a shipment. Shipments of horses traveling from the UK had
299 three times the rate of developing SF, compared to shipments traveling from Australia. The
300 identification of these additional risk factors and the recognition of at-risk shipments will
301 help focus attention on preventative strategies. While factors such as country of origin cannot
302 be altered, extra care of horses at a higher risk or with other risk factors for SF could be
303 managed, with particular emphasis on the early detection of the condition, to reduce the effect
304 that SF has on the health and welfare of horses arriving into HK.

305

306 Conflict of interest statement

307 None of the authors of this paper has a financial or personal relationship with other
308 people or organisations that could inappropriately influence or bias the content of the paper

309

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323 Equine Veterinary Conference, Budapest, 3rd-5th October 2013.

324

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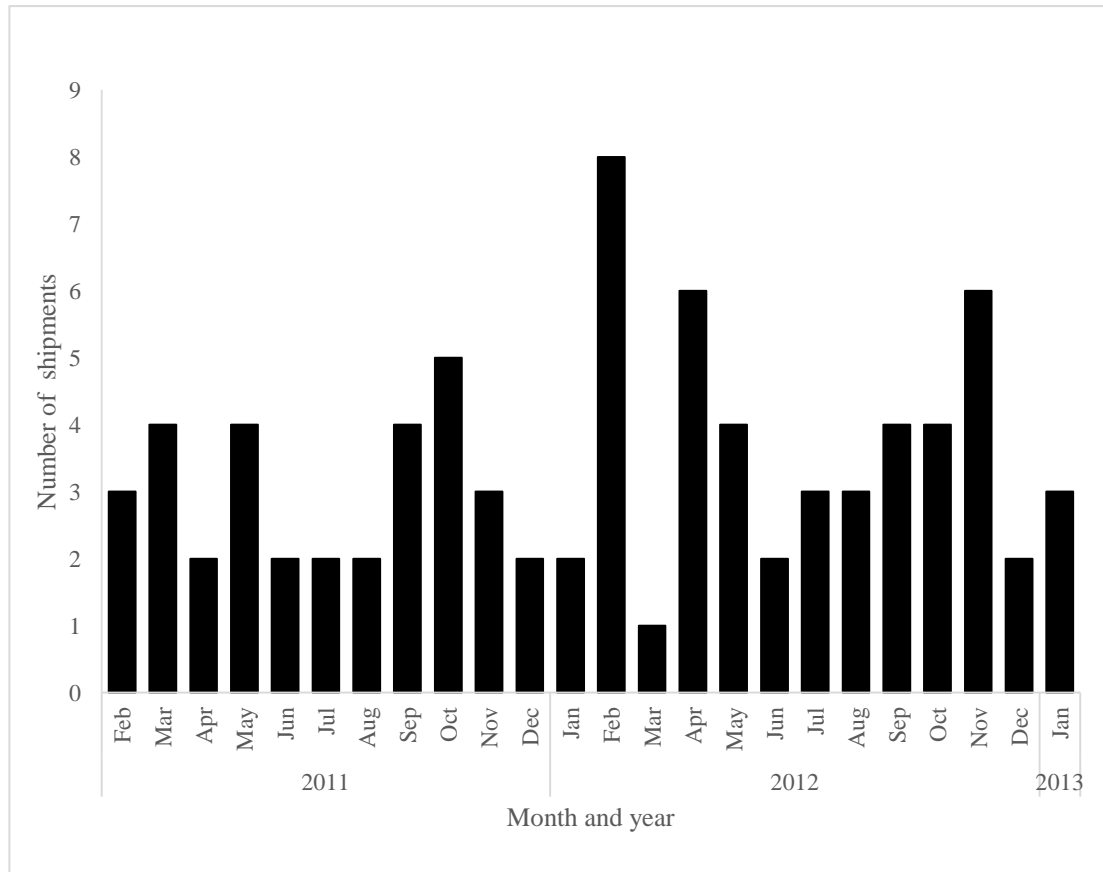
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393 **Figure legends**

394

395 Fig. 1. The number of horse shipments arriving into Hong Kong, by month, during the study

396 period (February 2011 to January 2013)

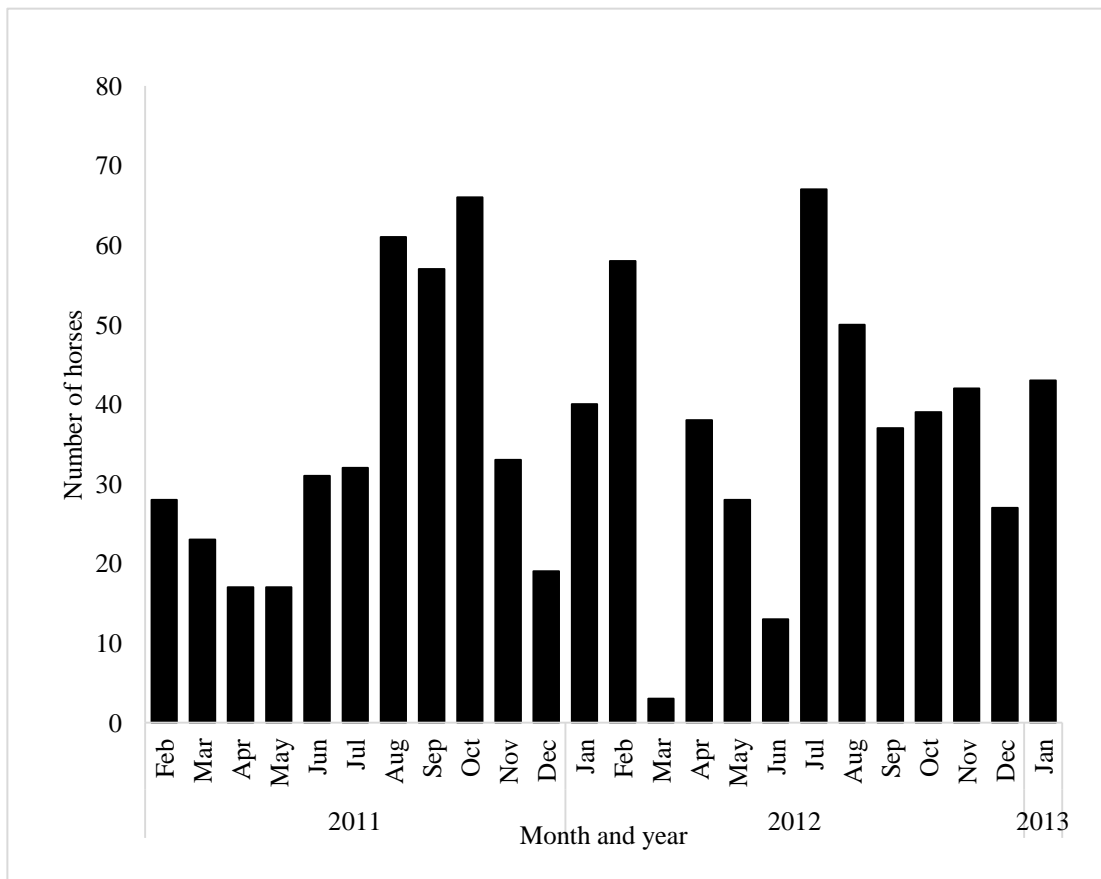


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400 Fig. 2. The number of horses transported into Hong Kong, by month, during the study period
401 (February 2011 to January 2013)



402
403

404

Accepted

405 **Table 1.** Description of the shipments ($n = 81$) and horses ($n = 869$) imported into Hong
 406 Kong between February 2011 and January 2013, stratified by originating country

Country of Origin	Shipments		Horses per shipment				
	n (%)	n (%)	Minimum	25 th percentile	Median	75 th percentile	Maximum
Australia	24 (29.6)	260 (29.9)	3	8	11	13	20
United Kingdom	33 (40.7)	272 (31.3)	1	4	6	12	23
New Zealand	18 (22.2)	319 (36.7)	3	9	14.5	25	48
United States of America	6 (7.4)	18 (2.1)	2	2	3	4	4

407

408 **Table 2.** Descriptive statistics of shipments of horses ($n = 81$) arriving in Hong Kong
 409 between February 2011 and January 2013, stratified by originating country

Variable	Country of origin	Minimum	25 th percentile	Median	75 th percentile	Maximum
Total travel time between quarantine units (h) and min	Australia	13 h 50 min	14 h 25 min	15 h 5 min	16 h 40 min	31 h
	United Kingdom	16 h	18 h 55 min	21 h 50 min	23 h 15 min	27 h 50 min
	New Zealand	17 h	19 h 25min	20 h 55 min	22 h	27 h
	United States of America	22 h	32 h 30 min	33 h 20 min	36 h 55 min	42 h 30 min
Total time on board the aircraft h and min	Australia	8 h 30 min	9 h	9 h 10 min	9 h 48 min	25 h 15 min
	United Kingdom	10 h 45 min	11 h 45 min	15 h 40 min	16 h 28 min	19 h 52 min
	New Zealand	9 h 30 min	11 h 20 min	13 h 10 min	15 h 25 min	16 h 50 min
	United States of America	17 h 20 min	17 h 30 min	18 h 58 min	19 h 15 min	30 h
Thermostat setting in the cargo hold during transport (°C)	Australia	12	14	15	15	16
	United Kingdom	12	13	14	14	17
	New Zealand	12	14	15	15	16
	United States of America	14	15	15	16	18

410

411

412 **Table 3.** Descriptive statistics of horses ($n = 869$) and shipments ($n = 81$) that developed
 413 cases of shipping fever after travelling to Hong Kong, by originating country.

Country of Origin	Shipment		Horse		
	Negative <i>n</i> (%)	Positive <i>n</i> (%)	Negative <i>n</i> (%)	Positive <i>n</i> (%)	Median (IQR)*
Australia	15 (62.5)	9 (37.5)	248 (95.4)	12 (4.6)	1 (1-3)
United Kingdom	10 (30.3)	23 (69.7)	231 (84.9)	41 (15.1)	1 (1-2)
New Zealand	4 (22.2)	14 (77.8)	281 (88.1)	38 (11.9)	2 (2-4)
United States of America	3 (50.0)	3 (50.0)	15 (83.3)	3 (16.7)	1 (1-1)

414 IQR, Interquartile range

415 *Median number of horses with shipping fever when at least one horse with positive clinical
 416 signs for shipping fever was identified on the shipment.

417

418 **Table 4.** Mixed effect multivariable logistic regression results for the outcome of whether an
 419 individual horse developed shipping fever after travelling to Hong Kong ($P < 0.01$)

Variable	Level	Odds ratio	95% CI	<i>P</i>
Country of origin	Australia	REF		
	United Kingdom	4.02 ^a	1.94 - 8.34	<0.001
	New Zealand	2.99	1.41 - 6.31	0.004
	United States of America	4.2	0.99 - 17.8	0.05
Age		0.99	0.69 - 1.42	0.96
Type of horse	Riding School	REF		
	Racehorse	2.55	0.42 - 15.26	0.31
Random effect for shipment		0.43	0.16 - 1.18	0.12

420 95% CI, 95% confidence interval

421 ^a Interpretation: when the clustering of horses at the shipment level is accounted for and all
 422 other variables in the model are held constant, horses from the United Kingdom are at 4.02
 423 (95% CI 1.94 - 8.34) times the odds of developing shipping fever after travelling to Hong
 424 Kong compared to horses from Australia

425

426 **Table 5.** Poisson regression results for the outcome of the rate per shipment of shipping fever
 427 in horses travelling to Hong Kong

Variable	Level	Incidence rate ratio	95% CI	<i>P</i> ^a
Country of origin	Australia	REF		0.001
	United Kingdom	3.27 ^b	1.72 - 6.21	<0.001
	New Zealand	2.58	1.35 - 4.94	<0.001
	United States of America	3.61	1.02 - 12.8	0.05
Location of jet stalls	Front	REF		0.01
	Middle	1.49	0.93 - 2.38	0.09
	Rear	1.15	0.67 - 1.95	0.62
Month	January	REF		0.02
	February	2.41	0.76 - 7.69	0.14
	March	4.79	1.35 - 16.97	0.02
	April	1.51	0.38 - 6.03	0.56
	May	5.07	1.62 - 15.93	0.01
	June	0.47	0.05 - 4.22	0.50
	July	2.52	0.81 - 7.80	0.11
	August	2.62	0.86 - 7.95	0.09
	September	2.65	0.85 - 8.21	0.09
	October	2.37	0.76 - 7.35	0.14
	November	1.94	0.57 - 6.62	0.29
	December	0.45	0.05 - 4.04	0.48
Total travel time	<17 h	REF		0.002
	17 to 22 h	2.18	1.14 - 4.19	0.02
	>22 h	3.13	1.58 - 6.20	<0.001
Total time in aircraft	<10 h	REF		0.05
	10 to 16 h	1.60	0.92 - 2.78	0.10
	>16 h	2.22	1.17 - 4.23	0.02
Thermostat setting		0.86	0.71 - 1.03	0.11
Stopover during transport	No	REF		0.01
	Yes	1.79	1.19 - 2.69	0.01

428 95% CI, 95% confidence interval

429 ^a *P* values that are left aligned are Likelihood ratio tests, those right aligned are Wald tests

430 ^b Interpretation: The rate per shipment of SF in shipments from the United Kingdom is 3.27
 431 (95% CI 1.72 - 6.21) times that when shipments arrive from Australia

432 **Table 6.** Multivariable Poisson regression results for the outcome of the rate per shipment of
 433 shipping fever in horses travelling to Hong Kong ($P < 0.001$)

Variable	Level	Incidence rate ratio	95% CI	<i>P</i>
Country	Australia	REF		
	United Kingdom	3.08 ^a	1.60 - 5.93	<0.001
	New Zealand	2.40	1.22 - 4.71	0.01
	United States of America	2.43	0.66 - 8.89	0.18
Month	January	REF		
	February	2.27	0.71 - 7.28	0.17
	March	5.61	1.55 - 20.31	0.01
	April	1.65	0.40 - 6.78	0.49
	May	4.51	1.43 - 14.26	0.01
	June	0.47	0.05 - 4.23	0.50
	July	2.65	0.85 - 8.29	0.09
	August	2.75	0.90 - 8.34	0.08
	September	2.52	0.80 - 7.89	0.11
	October	2.18	0.69 - 6.88	0.19
	November	1.91	0.55 - 6.69	0.31
	December	0.65	0.07 - 5.94	0.70

434 95% CI, 95% confidence interval

435 ^a Interpretation: The rate per shipment of SF in shipments from the United Kingdom is 3.08
 436 (95% CI 1.60 - 5.93) times that when shipments arrive from Australia

437