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1 **Factors associated with owner-reported euthanasia in equids in France**

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16

17 **Abstract**

18 There is limited evidence regarding the proportion of dead equids in France that were euthanized and
19 the factors influencing the decision-making of euthanasia. The better understanding of which could
20 facilitate research on improvement of welfare, especially on end of life issues.

21 The aim of this study was to estimate the proportion of euthanasia and identify associated factors in
22 equids in France.

23 A web-based survey was created and distributed by the French horse and riding institute to owners
24 who reported an equine death between April 2017 and April 2018 (n=5 158). Factors associated with
25 euthanasia were identified using a multivariable logistic regression model.

26 The percentage of responses was 10.6% (n=548/5 158; 95% CI 9.8% to 11.5%). The proportion of
27 euthanasia was 71.0% (n=389/548; 95% CI 67.2% to 74.8%). The factors “age category”, “cause of

28 natural death or reason for euthanasia” and “the length of time during which the animal was reported
29 to be ill by the owner” were significantly associated with euthanasia ($P < 0.001$).

30 The results highlighted that a large majority of owners faced euthanasia decisions and our findings
31 could support veterinarians and owners to better prepare for such an eventuality.

32

33 **Keywords:** equids; euthanasia; mortality; end of life

34

35 **1. Introduction**

36 Euthanasia represents a procedure with high responsibility for veterinarians in equine practice and has
37 received increasing attention in recent years. The decision making process involved is highly
38 contextual and multifactorial [1,2]. Then, veterinarians need to consider not only their professional view
39 in regards to the animal's interests but also the owner's views and wishes. Currently, there is limited
40 evidence regarding the proportion of dead equids that were euthanized in France and factors
41 influencing the decision. As in other species in several countries (e.g., in dogs in United Kingdom and
42 in dairy cattle in United States), the better understanding of euthanasia in the equine sector could help
43 focus future welfare-related research to make euthanasia decision making standardized and
44 consistent and then to prevent abuse of euthanasia [3,4]. In this context, the aim of this study was to
45 estimate the proportion of French dead equids that were euthanized and identify factors associated
46 with the recourse to euthanasia.

47

48 **2. Material and methods**

49 *2.1 Survey design*

50 An online questionnaire was designed using Sphinx iQ2® and distributed by the French horse and
51 riding institute (IFCE) to the 5 158 owners throughout France who reported an equine death between
52 April 2017 and April 2018 and used the web service of the IFCE's ATM-équidés ANGEE Association
53 (ATM) to organize the cadaver removal. In the event of death (natural or by euthanasia), owners are
54 legally obliged to return the equine's passport to the IFCE for invalidation within 30 legal days to i)

55 prevent any later fraudulent use (Commission Regulation [EC] No. 262/2015) and ii) update the live
56 equine population's information in the French national identification database managed by the IFCE.
57 Regarding ATM, it is available for all owners and the advantages of using these services are cheaper
58 removal and direct registration of the equine's death in the French national identification database.
59 However, owners still have to return the equine's passport to the IFCE for invalidation.
60 The 5 158 deaths declared via ATM represented 13.0% (95% CI 12.7% to 13.3%) of all equids
61 removed by the rendering companies in France during this period. More details on the survey design
62 are available in Merlin et al. [5]. Information about the equine characteristics (sex, age category and
63 group of breeds), its activity and environment, the mode of death (natural or by euthanasia) and the
64 cause of natural death or the reason for euthanasia were collected through closed questions.

65

66 *2.2 Statistical analysis*

67 All the responses were extracted from Sphinx iQ2®. R software version 3.5.0 was used for overall
68 data processing and analyses [6]. A univariate analysis was conducted between the outcome
69 ("euthanasia") and each available predictor variable ("sex", "age category", "group of breeds",
70 "activity", "environment", "cause of natural death or reason for euthanasia" and "length of time during
71 which the animal was reported to be ill by the owner"). All variables with a $P < 0.20$ were retained.
72 Then, the variables selected from the univariate analysis were tested for collinearity, through a
73 multicollinearity analysis to ensure a mean variation inflation factor (VIF) < 5 , before being used in a
74 multivariate analysis (function `vif` available in the package `car`). Lastly, factors associated with
75 euthanasia were identified performing a multivariable logistic regression model with variables used as
76 simple effect and interacting with each other in pairs. The function `StepAIC` (available in the package
77 `MASS`, `direction="both"`) was implemented to select the model with the lowest Akaike information
78 criterion. The error threshold was set at 0.05. The odds ratios, their confidence intervals and p-values
79 of the final model were represented using the function `forestmodel` (available in the package
80 `forestmodel`).

81

82 **3. Results**

83 A total of 548 equine owners completed the questions related to the mode of death among the 5 158
84 questionnaires sent. The characteristics of the corresponding equine population are presented in

85 Table 1. The three main causes of death or reasons for euthanasia reported by owners were colic,
86 senescence (e.g., age-related deterioration) and traumatic accidents.

87 The proportion of equids euthanized was 71.0% (95% CI 67.2% to 74.8%; Table 1). At the end of the
88 univariate analysis, the variables “group of breeds” and “environment” were discarded ($P \geq 0.20$). No
89 multicollinearity was detected among selected variables from the univariate analysis (all variation
90 inflation factors were around 1). In the multivariate analysis, the factors “age category”, “cause of
91 natural death or reason for euthanasia” and “the length of time during which animal was reported to be
92 ill by the owner” were significantly associated with euthanasia ($P < 0.001$). The odds of euthanasia
93 increased significantly with increasing age category (Figure 1). For equids more than 20 years old, the
94 proportion of euthanasia reached 79.6% (95% CI 74.8% to 84.3%). The recourse to euthanasia was
95 lower (OR=0.23) among animals suffering from heart or unknown problem than in animals suffering
96 from colic.

97 When the animal was reported to be ill by the owner during 3-30 days or 1-6 months the odds of
98 euthanasia was significantly higher (2.2 and 5.7 times respectively) than for the reference category, >6
99 months (Figure 1).

100

101 **4. Discussion**

102 To our knowledge, this study is the first to have investigated the subject of euthanasia in the French
103 equine sector. Through this study, the results showed that i) the majority of the equids reported to be
104 dead by owners through the ATM services were euthanized and ii) some specific factors (“age
105 category”, “cause of natural death or reason for euthanasia” and “the length of time during which
106 animal was reported to be ill by the owner”) were significantly associated with the recourse to
107 euthanasia.

108 The high proportion of recourse to euthanasia identified in our owner population (71.0%) could
109 arguably be a positive point, as natural death, unless sudden, is not usually the most welfare-friendly
110 way to die. However, this proportion appears lower than those reported in Great Britain; 97.6% of
111 equine mortalities in Pollard et al. [7] and 94.1% in Ireland et al. [8] but it is difficult to compare results
112 across studies using different populations and study designs. Anyway, the significant remaining

113 proportion of natural death observed in our study would deserve to be furthered in order to check that
114 this figure does not reflect a welfare issue.

115 Regarding the factors associated with euthanasia, in accordance with McGowan et al. [9] and Lochner
116 et al. [10] the proportion of euthanasia increases significantly with increasing age category. This result
117 can be explained by the fact that aged equids are more susceptible to develop chronic diseases, such
118 as pituitary pars intermedia dysfunction (Cushing's disease) and chronic laminitis and then to deserve
119 special care or prolonged medical therapy, which can be costly and heavy for the owners but also
120 questionable at the level of animal welfare [11,12]. Therefore, the owners of aged equids are more
121 likely to be confronted with the possibility of euthanasia. Besides, several authors highlighted that the
122 level of management practices of equids (e.g., suitable diet, hoof care and exercise) declines with age
123 as well as appropriate preventive healthcare such as vaccination and deworming [8,13]. These factors
124 may influence the quality of life of aged equids and further increase the risk of poor state or even
125 diseases and consequently the risk to be faced with euthanasia decision.

126 Among the health-related factors associated with higher odds of euthanasia, chronic recurrent pain
127 (e.g., poor state, senescence), incurable disease (e.g., tumor), accident (e.g., traumatic accident) and
128 acute disease (e.g., colic) were highlighted.

129 Even if the frequency of euthanasia for equids with a poor state was the highest, it was not
130 significantly different from that of equids, which suffered from colic. Several underlying causes of the
131 poor state condition are possible. For instance, it can be induced by a poor quality of life, which has
132 been reported by Ireland et al. [14] as an important factor contributing to the decision for euthanasia in
133 horses. In any case, it would be interesting to further investigate other underlying causes of poor state.

134 The high odds of euthanasia for equids diagnosed with a tumor, a serious traumatic accident such as
135 limb fracture or senescence could be explained by the irreversible character of the health condition of
136 the animal and the fact that owners might have wanted to protect their animals from suffering and
137 could not afford to maintain a decent quality of life for their horses.

138 Colic was also identified as one of the main causes of euthanasia in studies carried out in United
139 States, Great Britain and in Germany [7,10,15]. Indeed, when colic cannot be resolved by medical
140 treatment, a surgery becomes necessary but number of contributory factors are involved in an owner's
141 decision to consent to this surgery such as the age of the horse and the cost [16]. Indeed, sometimes

142 the financial value or utility of the animal is then evaluated against the cost of surgery and post-
143 surgical care and could result in owners opting for refusing the surgical treatment. In that case,
144 euthanasia is used to avoid potential animal suffering.

145 Furthermore, it is not surprising that heart problems and unknown causes of mortality were associated
146 with lower odds of euthanasia because they were probably related with the most sudden and/or
147 unexpected deaths.

148 Surprisingly, the interaction between the cause of natural death or the reason for euthanasia and the
149 length of time during which the animal was reported to be ill did not influence the odds of euthanasia.
150 This result suggests that our cutting of the duration categories may mask the information or that other
151 underlying processes could interact. For example, the number of comorbidities that equids had,
152 certainly influenced the decision-making of euthanasia due to complexity and difficulty in managing
153 and treating multiple diseases, and/or due to increased costs of treatment [17]. Furthermore, the
154 highest odds of euthanasia identified for the durations of 3-30 days and 1-6 months suggest that the
155 time effect on the decision-making of euthanasia is not linear. Emotional and economical barriers may
156 come into play, as well as the possible evolution of the health status or possible therapeutic failures.

157 This study presented some limitations. Firstly, ATM users represent a minority of owners probably
158 over-represented by professionals (i.e. whose main income is from equestrian activities) who could
159 have a different perception of and attitude towards euthanasia and the decision to euthanize their
160 equids in comparison to non-professionals [5]. Secondly, the percentage of responses was low
161 because no follow-up could be carried out. Thirdly, the collect of categorical variables for continuous
162 variables such as age did not allow the study of the effect of these variables in a continuous form.
163 Lastly, few details concerning the decision-making of euthanasia and the cause of death were
164 requested. This drawback can be explained by the fact that we wanted to implement a short and a
165 simple survey to maximize the number of responses.

166

167 **5. Conclusion**

168 This study highlighted the first proportion of the recourse to euthanasia in a French owner population
169 and some specific associated factors. To go further, this study is planned to be strengthened,

170 expanded to more owners, and complemented by other studies (e.g., surveys towards veterinarians),
171 to i) refine the estimation of the proportion of euthanasia, ii) measure the impact of the recent
172 enhancement of the traceability regulation (Commission Regulation [EC] No. 262/2015) on the
173 recourse to euthanasia, especially regarding equid exclusion from the food chain, and iii) better
174 understand factors associated with euthanasia. This last point is crucial; it will allow improving health-
175 and welfare-related research particularly on end-of-life issues. Quantitative questionnaires could be
176 complemented by qualitative approaches (e.g. semi-structured interviews and expert group
177 discussions) to best serve the purpose of understanding the equine owners' decision-making
178 processes in regards to euthanasia.

179

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183 questionnaire.

184

185 **COMPETING INTERESTS**

186 The authors declare that they have no competing interest.

187

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190

191 **CONTRIBUTORSHIP STATEMENT**

192 AM conducted and supervised this study. JPA, JT, NF, ML, MD, JF and BF participated in the
193 questionnaire design. MD, JS and BF distributed also the survey to the owners. MM, CS and GC
194 participated in the statistical analysis. JT and JPA contributed to the result analysis. Then, all authors
195 contributed to this article.

196

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255 **Table 1**

256 Number and proportion (with confidence interval) of sampled equids according to individual
 257 characteristics and circumstances surrounding the death as reported by the owners

Variable	Modalities	Number	% (95%, CI)
Sex	Female	282	51.5 % (47.3%, 55.6%)
	Gelding	214	39.1% (35.0%, 43.1%)
	Stallion	52	9.5% (7.0%, 11.9%)
Age category	≥ 20 years	276	50.4% (46.2%, 54.6%)
	[10-20 years[	142	25.9% (22.2%, 29.6%)
	[2-10 years[	76	13.9% (11.0%, 16.8%)
	< 2 years	54	9.9% (7.4%, 12.4%)
Group of breeds	Saddle horse	234	42.7% (38.6%, 46.8%)
	Pony	126	23.0% (19.5%, 26.5%)
	Trotter ^a	52	9.5% (7.0%, 11.9%)
	Thoroughbred	55	10.0% (7.5%, 12.6%)
	Draft horse	39	7.1% (5.0%, 9.3%)
	Donkey	27	4.9% (3.1%, 6.7%)
	Unknown	15	2.7% (1.4%, 4.1%)
Activity	Retirement	212	38.7% (34.6%, 42.8%)
	Leisure	184	33.6% (29.6%, 37.5%)
	Breeding	100	18.2% (15.0%, 21.5%)
	Racing + Sport	43	7.8% (5.6%, 10.1%)
	Other ^b	9	1.6% (0.6%, 2.7%)
Environment in which equids were kept	Stabling	273	49.8% (45.6%, 54.0%)
	Pasture	54	9.9% (7.4%, 12.4%)
	Pasture + Stabling	221	40.3% (36.2%, 44.4%)
Mode of death	Euthanasia	389	71.0% (67.2%, 74.8%)
	Natural	159	29.0% (25.2%, 32.8%)
Cause of natural death or reason for euthanasia	Colic	109	19.9% (16.6%, 23.2%)
	Senescence	104	19.0% (15.7%, 22.3%)
	Traumatic accident	65	11.9% (9.2%, 14.6%)
	Unknown cause	37	6.8% (4.7%, 8.9%)
	Tumor	30	5.5% (3.6%, 7.4%)
	Heart problem	22	4.0% (2.4%, 5.7%)
	Poor state	18	3.3% (1.8%, 4.8%)
Other ^c	163	29.7% (25.9%, 33.6%)	
Length of time during which animal was reported to be ill by the owner	>6 months	72	13.1% (10.3%, 16.0%)
	1-6 months	55	10.0% (7.5%, 12.6%)
	3-30 days	104	19.0% (15.7%, 22.3%)
	<3 days	317	57.8% (53.7%, 62.0%)

258 ^a Trotter corresponds to "Trotteur français"259 ^b Other activities: production, work, trade and blood donor260 ^c Other causes of natural death or reasons of euthanasia: paralysis, emphysema, dystocia, diarrhoea, myopathy, pneumonia,
261 haemorrhage, Wobbler syndrome, anaphylactic shock, herpesvirus, cyathostomosis, etc.

262 **Figure captions**

263

264 **Figure 1** Odds ratios with confidence intervals of the multivariable logistic regression model on the
265 proportion of euthanasia in equids

266

267 CI, confidence interval; OR, odds ratio.

268 Other causes of death: paralysis, emphysema, dystocia, diarrhoea, myopathy, pneumonia,
269 haemorrhage, Wobbler syndrome, anaphylactic shock, herpesvirus, cyathostomosis, etc.

270 ¹The lowest category (<2 years) was selected as reference to facilitate the reading

271 ²Colic was selected as reference category because it was the most frequent cause of death in our
272 study

273 ³The highest category (>6 months) was selected as reference to facilitate the reading

274

275

276

Variable	N	Odds ratio	OR (95%, CI)	P
Age category ¹				< 0.0001
< 2 years	54		Reference	
[2-10 years[	76		1.88 (0.88, 4.06)	0.102
[10-20 years[	142		2.30 (1.14, 4.70)	0.020
≥ 20 years	276		4.18 (2.04, 8.71)	< 0.001
Cause of natural death or reason for euthanasia ²				< 0.0001
Colic	109		Reference	
Traumatic accident	65		2.09 (1.00, 4.55)	0.055
Senescence	104		1.95 (0.93, 4.24)	0.083
Tumor	30		1.69 (0.54, 6.48)	0.399
Poor state	18		3.16 (0.73, 21.90)	0.172
Heart problem	22		0.23 (0.08, 0.62)	0.004
Unknown cause	37		0.23 (0.10, 0.52)	<0.001
Other	163		0.87 (0.49, 1.55)	0.644
Length of time during which the animal was reported to be ill by the owner ³				< 0.001
> 6 months	72		Reference	
1-6 months	55		5.69 (2.02, 18.94)	0.002
3-30 days	104		2.20 (1.04, 4.70)	0.040
< 3 days	317		1.25 (0.64, 2.41)	0.502
(Intercept)			0.61 (0.23, 1.63)	0.319

0.1 0.2 0.5 1 2 5 10 20