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1 **Confidence of veterinary surgeons in the United Kingdom in treating and**
2 **diagnosing exotic pet species**

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31 **ABSTRACT**

32 **Background:** With exotic pet species commonplace in the United Kingdom, owners
33 are increasingly seeking veterinary advice regarding the health and welfare of their
34 small mammals and reptiles. This study aimed to assess the confidence of
35 veterinarians in the UK in treating and diagnosing rabbits, guinea pigs, small mammals
36 and reptiles.

37 **Methods:** A forty-one question survey was promoted via social media, including on
38 interest groups focussed specifically at veterinary professionals. A total of $n = 131$
39 practicing veterinarians in the United Kingdom completed the questionnaire.

40 **Results:** There was a significant effect ($p < 0.01$) of frequency of presentation of exotic
41 pets to a practice on the confidence of the veterinarian in treating them. Veterinarians
42 that were presented with exotics more frequently had increased self-reported
43 knowledge of their health and disease and were more confident treating, diagnosing
44 and anaesthetising them. Knowledge of and confidence in diagnosing and treating
45 exotic pets was significantly less than for dogs and cats ($p < 0.001$). Veterinarians that
46 had been qualified longer were more confident in treating these species ($p < 0.01$).

47 **Conclusions:** Increased provision and engagement with CPD may increase
48 veterinary confidence in diagnosing, treating and anaesthetising exotic pet species
49 that are less commonly encountered in practice.

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66 INTRODUCTION

67 Current figures indicate that 0.6 million rabbits, 0.4 million guinea pigs, 0.5 million small
68 rodents (hamsters, gerbils and rats), 0.8 million reptiles are kept as household pets in
69 the UK [1]. Whilst these numbers are much lower than reported for dogs (9.0 million)
70 and cats (7.5 million), when combined, they still represent a significant number (2.3
71 million) of animals that could be presented for veterinary treatment. These may also
72 be conservative figures as a recent survey conducted by the PDSA suggested that 0.9
73 million rabbits are currently owned in the UK [2]. Consequently, the demand for
74 appropriate veterinary care of a range of exotic pet species has increased [3]. For
75 diagnosis and treatment of exotic pet species to be successful, all veterinary staff
76 should have an understanding of species-specific normal and abnormal behaviour
77 [3,4], biology, husbandry and medical parameters as well as being able to effectively
78 monitor anaesthesia [5]. Furthermore, it has been proposed that the majority of health
79 problems occurring in exotic species are due to inadequate husbandry provided by
80 owners [6]. Therefore, it is crucial that veterinary surgeons provide practical education
81 to owners regarding husbandry [7]. This is of particular importance considering that
82 owners may obtain incorrect or contradictory information from internet resources [8,9].

83 Current attitudes and knowledge towards exotic species are purportedly similar to cats
84 twenty-five years prior, where treatment of the feline patient was still a relatively under-
85 researched area with lower levels of veterinary confidence [10]. Concerns have also
86 been raised regarding the lack of awareness of the differing clinical requirements
87 amongst exotic species, with one author suggesting that treating guinea pigs (and
88 other rodents) as 'small rabbits' is a common but harmful misconception that prevails
89 among some clinicians [11]. Another factor that complicates the effective clinical
90 treatment of exotic species is that many are prey species which exhibit a tendency to
91 hide illness and pain better than cats and dogs [12,13]. Consequently, patients are
92 often not seen by a veterinary surgeon until they are a critical case [3]. Studies have
93 also demonstrated that during anaesthesia, the mortality rates of exotic patients are
94 much higher than of cats and dogs [14,15] possibly as a result of a smaller scope for
95 elective surgeries and a lack of specific exotic patient anaesthetic equipment [15].

96 It has been proposed to the American Veterinary Medical Association (AVMA) that the
97 problem of lack of specialist knowledge amongst veterinary graduates in the United
98 States could be mitigated though increased specialism in education and specific
99 licenses being allocated based on a student's chosen area of academic focus
100 (including companion exotics as an option) [16]. However, detractors suggest that this
101 approach might prevent unanticipated career changes for graduates [17]. A
102 questionnaire based study conducted in the Netherlands identified a higher than
103 anticipated percentage (10%) of consultations involving exotic species and
104 recommended that in order to prepare veterinary students appropriately for companion
105 animal practice, an attempt should be made to increase clinical exposure to avian and
106 exotic animal diseases [18].

107 Veterinarians in the UK are required to engage in mandatory Continued Professional
108 Development (CPD) [19]. In a study investigating attitudes of veterinarians towards
109 CPD in the UK, recent graduates were more intrinsically and extrinsically motivated to

110 participate. Perceived barriers to participation in CPD included it not being provided at
111 a convenient time, location or level and a lack of workplace support [20]. If more recent
112 graduates are more motivated to participate in CPD it could be hypothesised that they
113 are more confident in dealing with exotic pet species, conversely, more experienced
114 graduates may have encountered more cases of these species in clinical practice over
115 time.

116 The aim of this study was to investigate whether UK based first opinion veterinary
117 surgeons report a lack of knowledge and confidence when dealing with exotic species
118 and whether they feel willing and able to undertake CPD to increase their confidence
119 when presented with these species in practice.

120

121 **MATERIALS AND METHODS**

122 Ethical approval for this study was granted from Hartpury University ethics committee
123 on 6th November 2018 (ETHICS2018-08).

124 **Questionnaire Distribution**

125 A forty-one question questionnaire was created and published online from 2nd January
126 2019 to the 30th April 2019. Distribution of the online survey was achieved via the
127 social media site Facebook, alongside promotion by The Veterinary Times and the
128 Rabbit Welfare Association and Fund. The questionnaire was also promoted directly
129 to practices in which industry contacts had already been established. There was no
130 incentive to complete the survey; it was entirely at the discretion of individuals as to
131 whether they wished to participate in the research. Inclusion criteria dictated that
132 participants had to be a currently practicing RCVS registered veterinary surgeon
133 resident within the UK and working in a first opinion small animal or mixed practice.

134 **Informed Consent**

135 All participants were over the age of eighteen and were required to read an informed
136 consent paragraph prior to clicking to start the survey. The introductory paragraph also
137 included information on the purpose of the survey and data protection. All participants
138 were made aware that they had the right to withdraw their responses up to the point
139 of data processing. Respondents were asked to create a unique six-digit identifier so
140 that their responses could be identified if they wished to withdraw.

141 **Questionnaire Design**

142 The questionnaire included multiple choice, Likert scale and open-ended questions
143 divided into four sections. The first section asked respondents to provide some basic
144 demographic information including the location of their practice, how long they had
145 been qualified, their age and the country in which they completed their veterinary
146 degree. The second section asked respondents to provide some information about the
147 frequency with which they are presented with different exotic species in practice.
148 Options available included 'daily', 'twice weekly', 'weekly', 'fortnightly', 'monthly', 'yearly'
149 and 'never'.

150 Section three asked respondents to rate on a scale of one to ten their knowledge and
151 confidence in diagnosing and treating cats and dogs, rabbits, guinea pigs, small
152 rodents (mice, rats, gerbils, hamsters and degus) and reptiles individually. For
153 questions rating knowledge, one equalled least knowledgeable and ten equalled most
154 knowledgeable. For questions rating confidence, one equalled not at all confident and
155 ten equalled fully confident. For the question where respondents were asked to rate
156 their knowledge, feline and canine health and disease were separated, whereas for
157 questions assessing confidence cats and dogs were combined.

158 In the final section, respondents were asked what they thought were the main barriers
159 to developing knowledge confidence in treating exotic pet species presented with in
160 practice (for example; low numbers of these pets seen in practice, lack of interest in
161 these species amongst veterinary professionals). Respondents were asked to state
162 whether they felt current opportunities for exotic pet CPD were sufficient, whether they
163 would be interested in engaging with further CPD and if their veterinary degree had
164 contained sufficient content on these species. Veterinarians were also asked to state
165 whether they felt that exotic patient welfare is compromised by a lack of knowledge
166 and confidence among veterinary professionals.

167 **Data Analysis**

168 Data collected were non-parametric due to the categorical and ordinal options for
169 questions. All statistical analyses were performed in the statistical software package
170 R version 3.5.1; packages FSA, plyr, pastecs and PMCMR [21]. The effect of
171 demographic factors and frequency of species presented to the practice on veterinary
172 confidence was tested using Kruskal-Wallis tests. Where categories contained five or
173 less respondents, these were removed from statistical analysis. Where significance
174 was identified in the main test ($p < 0.05$) Dunn's post-hoc tests with the Bonferroni
175 correction applied were used to identify significant differences between categories,
176 reported adjusted p-values were significant at $p < 0.05$. To test for an effect of species
177 on veterinary confidence, a Friedman ANOVA was performed, where significant
178 differences were identified, a Nemenyi post-hoc was performed, this test is
179 conservative and accounts for a family-wise error hence no p-value adjustment was
180 performed.

181 **RESULTS**

182 A total of 131 respondents completed the questionnaire in full. These were all
183 practicing veterinary surgeons working in first opinion small animal practice in the UK.

184 **Respondent demographics**

185 The majority of respondents were from England (80.92%; $n=106$), with the remainder
186 split between Wales (8.40%; $n=11$), Scotland (7.63%; $n=10$) and Northern Ireland
187 (3.05%; $n=4$). Twelve point two percent ($n=16$) of respondents were male, 85.50%
188 ($n=112$) were female and 2.29% ($n=3$) preferred not to say. Of the respondents
189 43.51% ($n=57$) were aged 21-30, 31.30% ($n=41$) were aged 31-40, 15.27% ($n=20$)
190 were aged 41-50, 8.40% ($n=11$) were aged 51-60. The length of time respondents had
191 been qualified varied with 9.16% ($n=12$) qualified for less than 1 year, 29.01% ($n=38$)
192 qualified between 1-5 years, 24.43% ($n=32$) qualified between 6-10 years, 12.98%

193 (n=17) qualified between 11-15 years, 9.16% (n=12) qualified between 16-20 years
 194 and 15.28% (n=20) qualified over 20 years.

195 **The effect of species on knowledge and confidence in diagnosis, treatment and**
 196 **anaesthesia.**

197 There was a significant main effect of species on a veterinarian’s self-rated knowledge
 198 of health and disease ($X^2_5 = 479.62$, $p < 0.001$; Figure 1). There was no significant
 199 difference between knowledge of canine and feline health and disease ($p = 0.735$).
 200 There were significant differences ($p < 0.05$) in knowledge of the health and disease of
 201 all other species (Table 1). There was a significant main effect of species on a
 202 veterinarian’s confidence in treating and diagnosing ($X^2_4 = 383.33$, $p < 0.001$; Figure 1).
 203 There were significant differences ($p < 0.05$) in confidence treating and diagnosing all
 204 species (Table 1). There was a significant main effect of species on a veterinarian’s
 205 confidence in anaesthetising ($X^2_4 = 389.46$, $p < 0.001$; Figure 1). There was no
 206 significant difference in confidence anaesthetising guinea pigs and small rodents
 207 ($p = 0.340$). There were significant differences in confidence anaesthetising all other
 208 species (Table 1).

209 Table 1. Pairwise comparisons of the effect of species on knowledge of health and
 210 disease, confidence treating and diagnosing and confidence anaesthetising. Exact p-
 211 values are shown apart from for $p < 0.001$. Reported p-values are significant at $p < 0.05$
 212 (*), $p < 0.01$ (**) and $p < 0.001$ (***). Categories with less than or equal to five respondents
 213 were not included in statistical analysis.

Knowledge of Health and Disease					
	Dogs	Rabbits	Guinea Pigs	Small Rodents	Reptiles
Cats	0.735	<0.001***	<0.001***	<0.001***	<0.001***
Dogs	-	<0.001***	<0.001***	<0.001***	<0.001***
Rabbits	-	-	0.002**	<0.001***	<0.001***
Guinea Pigs	-	-	-	0.024*	<0.001***
Small Rodents	-	-	-	-	0.019*
Confidence Treating and Diagnosing					
	Rabbits	Guinea Pigs	Small Rodents	Reptiles	
Cats and Dogs	<0.001***	<0.001***	<0.001***	<0.001***	<0.001***
Rabbits	-	<0.001***	<0.001***	<0.001***	<0.001***
Guinea Pigs	-	-	0.005**	<0.001***	<0.001***
Small Rodents	-	-	-	<0.001***	<0.001***
Confidence in Anaesthetising					
	Rabbits	Guinea Pigs	Small Rodents	Reptiles	
Cats and Dogs	<0.001***	<0.001***	<0.001***	<0.001***	<0.001***

Rabbits	-	<0.001***	<0.001***	<0.001***
Guinea Pigs	-	-	-	0.340
Small Rodents	-	-	-	<0.001***

214

215 **The effect of the frequency of exotic pets seen on knowledge and confidence in**
216 **diagnosis, treatment and anaesthesia.**

217 The frequency of presentation of different exotic pet species can be seen in Table 2.

218 Table 2. Frequency of presentation of exotic pet species to the veterinary practice.
219 The percentage of veterinarians (out of a total of n = 131) that selected each category
220 is indicated beneath the number of animals seen. Categories with less than or equal
221 to five respondents were not included in statistical analysis.

Species	Frequency of Presentation						
	Daily	Twice Weekly	Weekly	Fortnightly	Monthly	Yearly	Never
Rabbits	n = 42 (32.00%)	n = 35 (26.72%)	n = 20 (15.27%)	n = 18 (13.74%)	n = 13 (9.99%)	n = 2 (1.15%)	n = 1 (0.76%)
Guinea Pigs	n = 12 (9.16%)	n = 34 (25.95%)	n = 23 (17.56%)	n = 26 (19.85%)	n = 32 (24.43%)	n = 2 (1.15%)	n = 2 (1.15%)
Small Rodents	n = 9 (6.87%)	n = 24 (18.32%)	n = 20 (15.27%)	n = 28 (21.37%)	n = 40 (30.53%)	n = 9 (6.87%)	n = 1 (0.76%)
Reptiles	n = 7 (5.34%)	n = 9 (6.87%)	n = 7 (5.34%)	n = 6 (4.58%)	n = 27 (20.61%)	n = 45 (34.35%)	n = 30 (22.90%)

222

223 Rabbits

224 There was a significant main effect ($X^2_4 = 30.24, p < 0.001$) of frequency of rabbits seen
225 on knowledge of rabbit health and disease. There was a significant main effect ($X^2_4 =$
226 $24.14, p < 0.001$) of frequency of rabbits seen on confidence in diagnosing and treating
227 rabbits. There was a significant main effect ($X^2_4 = 30.95, p < 0.001$) of frequency of
228 rabbits seen on confidence in anaesthetising rabbits. Overall, veterinarians that were
229 presented with rabbits more frequently rated themselves as more knowledgeable and
230 were more confident in treating, diagnosing anaesthetising them. Significant effects
231 ($p < 0.05$) of frequency of presentation on knowledge of health and disease, confidence
232 in treating and diagnosing and anaesthetising are shown in Table 3.

233 Table 3. Pairwise comparisons of the effect of frequency of presentation on knowledge
234 of rabbit health and disease, confidence treating and diagnosing and confidence
235 anaesthetising rabbits. Exact adjusted p-values are shown apart from for $p < 0.001$.
236 Reported p-values are significant at $p < 0.05$ (*), $p < 0.01$ (**) and $p < 0.001$ (***).

237 Categories with less than or equal to five respondents were not included in statistical
 238 analysis.

Knowledge of Health and Disease				
	Twice weekly	Weekly	Fortnightly	Monthly
Daily	0.437	0.027*	0.004**	<0.001***
Twice weekly	-	0.403	0.177	0.004**
Weekly	-	-	0.515	0.223
Fortnightly	-	-	-	0.333
Confidence Treating and Diagnosing				
	Twice weekly	Weekly	Fortnightly	Monthly
Daily	0.257	0.216	0.048*	<0.001***
Twice weekly	-	0.760	0.853	0.017*
Weekly	-	-	0.978	0.067
Fortnightly	-	-	-	0.219
Confidence in Anaesthetising				
	Twice weekly	Weekly	Fortnightly	Monthly
Daily	0.312	0.102	0.087	<0.001***
Twice weekly	-	0.762	1.000	<0.001***
Weekly	-	-	0.948	0.022*
Fortnightly	-	-	-	0.028*

239

240 **Guinea Pigs**

241 There was a significant main effect ($X^2_4 = 28.18, p < 0.001$) of frequency of guinea pigs
 242 seen on knowledge of guinea pig health and disease. There was a significant main
 243 effect ($X^2_4 = 19.31, p < 0.001$) of frequency of guinea pigs seen on confidence in
 244 diagnosing and treating guinea pigs There was a significant main effect ($X^2_4 = 25.27,$
 245 $p < 0.001$) of frequency of guinea pigs seen on confidence in anaesthetising guinea
 246 pigs. Overall, veterinarians that were presented with guinea pigs more frequently rated
 247 themselves as more knowledgeable and were more confident in treating, diagnosing
 248 anaesthetising them. Significant effects ($p < 0.05$) of frequency of presentation on
 249 knowledge of health and disease, confidence in treating and diagnosing and
 250 anaesthetising are shown in Table 4.

251 Table 4. Pairwise comparisons of the effect of frequency of presentation on knowledge
 252 of guinea pig health and disease, confidence treating and diagnosing and confidence
 253 anaesthetising guinea pigs. Exact adjusted p-values are shown apart from for
 254 $p < 0.001$. Reported p-values are significant at $p < 0.05$ (*), $p < 0.01$ (**) and $p < 0.001$ (***).

Knowledge of Health and Disease				
	Twice weekly	Weekly	Fortnightly	Monthly
Daily	0.388	0.021*	0.285	<0.001***
Twice weekly	-	0.251	0.552	<0.001***
Weekly	-	-	0.337	0.414
Fortnightly	-	-	-	0.018*
Confidence Treating and Diagnosing				
	Twice weekly	Weekly	Fortnightly	Monthly
Daily	0.824	0.725	0.778	0.004**
Twice weekly	-	1.000	1.000	0.002**
Weekly	-	-	0.843	0.137
Fortnightly	-	-	-	0.068
Confidence in Anaesthetising				
	Twice weekly	Weekly	Fortnightly	Monthly
Daily	0.628	0.127	0.357	0.002**
Twice weekly	-	0.096	0.293	<0.001***
Weekly	-	-	0.917	0.423
Fortnightly	-	-	-	0.119

255

256 Small Rodents (mice, gerbils, rats, hamsters and degus)

257 There was a significant main effect ($X^2_5 = 29.44$, $p < 0.001$) of frequency of small rodents
258 seen on knowledge of small rodent health and disease. There was a significant main
259 effect ($X^2_5 = 27.52$, $p < 0.001$) of frequency of small rodents seen on confidence in
260 diagnosing and treating small rodents. There was a significant main effect ($X^2_5 = 19.12$,
261 $p < 0.01$) of frequency of small rodents seen on confidence in anaesthetising small
262 rodents. Overall, veterinarians that were presented with small rodents more frequently
263 rated themselves as more knowledgeable and were more confident in treating,
264 diagnosing anaesthetising them. Significant effects ($p < 0.05$) of frequency of
265 presentation on knowledge of health and disease, confidence in treating and
266 diagnosing and anaesthetising are shown in Table 5.

267 Table 5. Pairwise comparisons of the effect of frequency of presentation on knowledge
268 of small rodent health and disease, confidence treating and diagnosing and confidence
269 anaesthetising small rodents. Exact adjusted p-values are shown apart from for
270 $p < 0.001$. Reported p-values are significant at $p < 0.05$ (*), $p < 0.01$ (**) and $p < 0.001$ (***).
271 Categories with less than or equal to five respondents were not included in statistical
272 analysis.

Knowledge of Health and Disease					
	Twice weekly	Weekly	Fortnightly	Monthly	Yearly
Daily	0.567	0.019*	0.010*	0.002**	<0.001***
Twice weekly	-	0.213	0.101	0.019*	0.003**
Weekly	-	-	0.905	1.000	0.330
Fortnightly	-	-	-	1.000	0.386
Monthly	-	-	-	-	0.439
Confidence Treating and Diagnosing					
	Twice weekly	Weekly	Fortnightly	Monthly	Yearly
Daily	0.581	0.085	0.032*	*<0.05	<0.001***
Twice weekly	-	0.560	0.208	0.106	<0.001***
Weekly	-	-	1.000	1.000	0.066
Fortnightly	-	-	-	0.850	0.080
Monthly	-	-	-	-	0.076
Confidence in Anaesthetising					
	Twice weekly	Weekly	Fortnightly	Monthly	Yearly
Daily	0.802	0.221	0.033*	0.022*	0.004**
Twice weekly	-	1.000	0.422	0.339	0.054
Weekly	-	-	0.893	1.000	0.428
Fortnightly	-	-	-	0.971	0.676
Monthly	-	-	-	-	0.760

273

274 Reptiles

275 There was a significant main effect ($X^2_6 = 66.96$, $p < 0.001$) of frequency of reptiles seen
276 on knowledge of reptile health and disease. There was a significant main effect ($X^2_6 =$
277 66.38 , $p < 0.001$) of frequency of reptiles seen on confidence in diagnosing and treating
278 reptiles. There was a significant main effect ($X^2_6 = 68.63$, $p < 0.001$) of frequency of
279 reptiles seen on confidence in anaesthetising reptiles. Overall, veterinarians that were
280 presented with reptiles more frequently rated themselves as more knowledgeable and
281 were more confident in treating, diagnosing anaesthetising them. Significant effects
282 ($p < 0.05$) of frequency of presentation on knowledge of health and disease, confidence
283 in treating and diagnosing and anaesthetising are shown in Table 6.

284 Table 6. Pairwise comparisons of the effect of frequency of presentation on knowledge
285 of reptile health and disease, confidence treating and diagnosing and confidence

286 anaesthetising reptiles. Exact adjusted p-values are shown apart from for $p < 0.001$.
 287 Reported p-values are significant at $p < 0.05$ (*), $p < 0.01$ (**) and $p < 0.001$ (***).
 288 Categories with less than or equal to five respondents were not included in statistical
 289 analysis.

Knowledge of Health and Disease						
	Twice weekly	Weekly	Fortnightly	Monthly	Yearly	Never
Daily	1.000	1.000	1.000	0.576	<0.001***	<0.001***
Twice weekly	-	0.972	1.000	1.000	0.003**	<0.001***
Weekly	-	-	1.000	1.000	0.014*	<0.001***
Fortnightly	-	-	-	1.000	0.034*	0.003**
Monthly	-	-	-	-	<0.001***	<0.001***
Confidence Treating and Diagnosing						
	Twice weekly	Weekly	Fortnightly	Monthly	Yearly	Never
Daily	1.000	1.000	1.000	0.394	<0.001***	<0.001***
Twice weekly	-	1.000	1.000	1.000	0.006**	<0.001***
Weekly	-	-	0.905	1.000	0.006**	<0.001***
Fortnightly	-	-	-	1.000	0.024*	0.002**
Monthly	-	-	-	-	0.001**	<0.001***
Confidence in Anaesthetising						
	Twice weekly	Weekly	Fortnightly	Monthly	Yearly	Never
Daily	0.848	0.390	0.748	0.048*	<0.001***	<0.001***
Twice weekly	-	1.000	0.875	1.000	0.006**	<0.001***
Weekly	-	-	1.000	1.000	0.148	<0.01***
Fortnightly	-	-	-	1.000	0.064	0.008**
Monthly	-	-	-	-	0.005**	<0.001***
Yearly	-	-	-	-	-	0.557

290

291 **The effect of length of time qualified on knowledge and confidence in diagnosis,**
 292 **treatment and anaesthesia.**

293 **Rabbits**

294 There was a significant main effect ($X^2_6 = 26.44$, $p < 0.001$) of length of time qualified on
 295 knowledge of rabbit health and disease. Veterinarians that had been qualified less
 296 than a year ($p = 0.018$) or between one and five years ($p = 0.015$) rated themselves as

297 significantly less knowledgeable of rabbit health and disease as those that had been
298 qualified between 16 and 20 years. There was a significant main effect ($X^2_6 = 27.37$,
299 $p < 0.001$) of length of time qualified seen on confidence in diagnosing and treating
300 rabbits. Veterinarians that had been qualified less than a year were less confident than
301 those that had been qualified between 11 and 15 years ($p = 0.014$), between 16 and 20
302 years ($p = 0.002$) and between 21 and 25 years ($p = 0.015$). Veterinarians that had been
303 qualified between one and five years were significantly less confident than those that
304 had been qualified between 16 and 20 years ($p = 0.015$). There was a significant main
305 effect ($X^2_6 = 29.56$, $p < 0.001$) of length of time qualified on confidence in anaesthetising
306 rabbits. Veterinarians that had been qualified less than a year were less confident
307 anaesthetising rabbits than those that had been qualified between 11 and 15 years
308 ($p < 0.001$) and between 16 and 20 years ($p = 0.006$). Veterinarians that had been
309 qualified between one and five years were significantly less confident than those that
310 had been qualified between 11 and 15 years ($p = 0.005$) and 16 and 20 years ($p = 0.014$).

311 Guinea Pigs

312 There was a significant main effect ($X^2_6 = 21.85$, $p < 0.01$) of length of time qualified on
313 knowledge of guinea pig health and disease. Veterinarians that had been qualified
314 less than a year ($p = 0.037$) or between one and five years ($p = 0.037$) were significantly
315 less knowledgeable than those that had been qualified between 11 and 15 years.
316 There was a significant main effect ($X^2_6 = 20.29$, $p < 0.01$) of length of time qualified on
317 confidence in diagnosing and treating guinea pigs. Veterinarians that had been
318 qualified less than a year were significantly less confident in diagnosing and treating
319 guinea pigs than those that had been qualified between 6 and 10 years ($p = 0.048$) or
320 between 11 and 15 years ($p = 0.022$). There was a significant main effect ($X^2_6 = 31.71$,
321 $p < 0.001$) of length of time qualified on confidence in anaesthetising guinea pigs.
322 Veterinarians that had been qualified for less than a year were significantly less
323 confident anaesthetising guinea pigs than those that had been qualified for between
324 11 and 15 years ($p < 0.001$), between 16 and 20 ($p = 0.009$) years and between 21 and
325 25 years ($p = 0.027$). Veterinarians that had been qualified between one and five years
326 were significantly less confident than those that had been qualified for between 11 and
327 15 years ($p = 0.001$).

328 Small Rodents

329 There was a significant main effect ($X^2_6 = 27.56$, $p < 0.001$) of length of time qualified on
330 knowledge of small rodent health and disease. Veterinarians that had been qualified
331 between one and five years were significantly less knowledgeable than those that had
332 been qualified between 11 and 15 years ($p = 0.01$) and between 16 and 20 years
333 ($p = 0.03$). There was a significant main effect ($X^2_6 = 21.91$, $p < 0.001$) of length of time
334 qualified on confidence in diagnosing and treating small rodents. Veterinarians that
335 had been qualified for less than a year or between one and five years were significantly
336 less confident in diagnosing and treating small rodents than those who had been
337 qualified between 11 and 15 years ($p = 0.048$) and between 16 and 20 years ($p = 0.033$).
338 There was a significant main effect ($X^2_6 = 32.23$, $p < 0.001$) of length of time qualified on
339 confidence in anaesthetising small rodents. Veterinarians that had been qualified for
340 less than a year were significantly less confident in anaesthetising small rodents than

341 those that had been qualified for between 11 and 15 years ($p=0.004$) and between 16
342 and 20 years ($p=0.004$). Veterinarians that had been qualified for between one and
343 five years were significantly less confident than those that had been qualified for
344 between 11 and 15 years ($p=0.004$) and between 16 and 20 years ($p=0.006$).

345 Reptiles

346 There was no significant effect of length qualified on knowledge of reptile health and
347 disease ($X^2_6 = 10.92, p>0.05$). There was no significant effect of length qualified on
348 confidence in diagnosing and treating reptiles ($X^2_6 = 10.12, p>0.05$). There was a
349 significant main effect of length qualified on confidence in anaesthetising reptiles (X^2_6
350 $= 14.33, p<0.05$). Veterinarians that had been qualified between one and five years
351 were significantly less confident anaesthetising reptiles than those that had been
352 qualified for between 16 and 20 years ($p=0.039$).

353 Continued professional development and training

354 The majority of respondents (42.75%; $n = 56$) disagreed that there was adequate
355 content in their veterinary degree on exotic pets, with 29.77% ($n=39$) strongly
356 disagreeing, 13.74% agreeing ($n=18$), 10.69% ($n = 14$) neither agreeing nor
357 disagreeing and 3.05% ($n = 4$) strongly agreeing. The majority of respondents agreed
358 (36.66%; $n=48$) that they had sufficient access to exotic pet CPD, 28.24% disagreed
359 ($n = 37$), 25.20% ($n=33$) neither agreed nor disagreed and 9.92% ($n=13$) strongly
360 agreed. The majority of respondents (86.26%; $n=113$) stated that they would be
361 interested in further training opportunities focussed specifically on exotic pet health
362 and welfare with 13.74% ($n=18$) stating that they would not be interested in this.

363 When questioned on what they felt was the main barrier to development of confidence
364 and knowledge in the diagnosis and treatment of exotic pet species, the majority
365 (44.27%; $n=58$) of respondents selected 'exotic species seen too infrequently in
366 practice to build experience'; 27.48% ($n=36$) chose 'lack of interest in these species
367 amongst veterinary professionals' and 15.27% ($n=20$) chose 'lack of content in
368 degree/university degree programme'. The remaining responses (12.98%; $n=17$) were
369 split between other categories which included options such as "no career benefit" and
370 "limited time for study". The majority of respondents agreed (72.75%, $n=56$) that a lack
371 of confidence and knowledge amongst veterinary professionals compromises the
372 welfare of exotic pet species, 29.77% ($n=39$) strongly agreed, 16.03% ($n=21$) neither
373 agreed nor disagreed, 9.16% ($n=12$) disagreed and 2.29% ($n=3$) strongly disagreed.

374 DISCUSSION

375 In the present study, veterinarians that saw exotic pet species more frequently were
376 more confident in treating, diagnosing and anaesthetising them. Veterinarians that saw
377 rabbits daily rated themselves as significantly more knowledgeable on their health and
378 disease and were more confident in diagnosis, treatment and anaesthesia than those
379 that saw rabbits less frequently. Rabbits were seen more frequently than any other
380 exotic pet species, with the majority of veterinarians surveyed reporting that they saw
381 them daily. However, veterinarians were still significantly less confident in diagnosing,
382 treating and anaesthetising rabbits than cats and dogs. Veterinarians cited lack of
383 frequency of presentation of exotic pet species as the main barrier to them improving

384 their confidence and knowledge, yet rabbits were seen relatively frequently. However,
385 this question was not sub-divided for different species, so there may have been
386 different barriers for species seen more frequently (e.g. rabbits) compared to reptiles
387 which most respondents saw yearly. In this survey, we did not question veterinarians
388 on how often they saw cats and dogs, but research has shown them to be presented
389 more frequently than rabbits and other species [22]. It is suggested that perhaps
390 seeing a case daily is insufficient to build knowledge through experiential learning as
391 has been reported for other species [23]. The majority of respondents to this survey
392 disagreed that there was sufficient content on exotic pets within the veterinary degree
393 which supports research that suggests that recent graduates need to obtain a number
394 of clinical skills in their first year in practice as opposed to from taught content [24,25].
395 Therefore, it can be proposed that more formalised taught content in veterinary
396 degrees may be beneficial in building confidence rather than reliance on experience
397 gained during clinical placements and post-graduation.

398 The second most frequently seen species was guinea pigs, followed by small rodents,
399 then reptiles which is in agreement with current pet ownership statistics for the UK
400 [1,2]. Veterinarians that saw guinea pigs more frequently were more confident in their
401 knowledge and ability. The majority of respondents stated that they saw guinea pigs
402 twice weekly, yet veterinarians were significantly less confident in all areas for this
403 species than for rabbits. This suggests that the difference between presentation daily
404 and twice weekly may result in decreased levels of knowledge and confidence.
405 Rabbits and guinea pigs represent a substantial proportion of patients being presented
406 to the veterinary practice and there is a legislative responsibility for veterinarians to
407 ensure that they are up to date with developments in the care of these species [26].
408 Over a quarter of respondents felt that a lack of interest in exotic pet species was the
409 greatest barrier to development of knowledge and confidence, yet the majority stated
410 that they would be interested in further CPD opportunities if available. This is positive
411 as CPD enables veterinarians to adapt to developments in the profession and deliver
412 the high quality of care that owners expect [19]. Consequently, exotic pet specific CPD
413 needs to be convenient [20] in addition to practices encouraging exotic interests within
414 the team to develop areas of specialism. Previous research has suggested that
415 increased clinical exposure to exotic species is required for veterinary students and
416 that veterinary curricula should reflect the increasing importance of these species [18].

417 Veterinarians that had been qualified between eleven and twenty years were the most
418 knowledgeable and confident demographic in treating, diagnosing and anaesthetising
419 exotic pet species. Interestingly, with the exception of treating and diagnosing guinea
420 pigs, veterinarians that had been qualified between six and eleven years were no more
421 confident or knowledgeable than those who had been qualified less than six years.
422 However, caution must be maintained in the interpretation of knowledge data as this
423 was self-reported and more confident, experienced clinicians may perceive
424 themselves to be more knowledgeable than those who have recently graduated.
425 However, veterinarians that had been qualified for longer than twenty years rated
426 themselves as no more knowledgeable or confident than recent graduates. It has been
427 proposed that recent graduates should be provided with appropriate CPD and
428 examples of good practice from experienced veterinarians to build their confidence

429 and knowledge in a supportive environment [27]. The exception to length of time
430 qualified having a significant effect on knowledge and confidence was in diagnosing
431 and treating reptiles. This is likely related to the infrequent presentation of reptiles and
432 possibly due to veterinarians referring reptiles to a specialist rather than treating and
433 diagnosing them themselves. The RSPCA recommend identifying a reptile
434 veterinarian prior to purchasing a reptile, whereas they do not specify the requirement
435 for an exotic veterinarian in their guidance on pet rodents or rabbits [28].

436 Knowledge of and confidence in treating, diagnosing and anaesthetising exotic pet
437 species was significantly less than for cats and dogs, with the majority of respondents
438 agreeing that this represented a welfare concern for these species. Consequently,
439 work needs to be done to understand how this can be addressed, particularly for
440 rabbits and guinea pigs that are seen frequently by small animal vets. This survey only
441 surveyed 131 veterinarians practicing within the UK and as such, the results are not
442 generalisable to all clinicians within the UK, with further research required to identify
443 whether the results are consistent with other countries. Future work could assess the
444 knowledge of veterinarians surrounding the health and disease of these species to
445 identify a potential skills gap.

446

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452

453 **FIGURE CAPTIONS**

454 Figure 1. Species difference in veterinary knowledge and confidence. Mean values
455 are shown for knowledge of health and disease, confidence diagnosing and treating
456 and confidence anaesthetising all species. Error bars represent standard error of the
457 mean. Knowledge and confidence were rated on a scale of one to ten. For knowledge,
458 one equalled least knowledgeable and ten equalled most knowledgeable. For
459 questions rating confidence, one equalled not at all confident and ten equalled fully
460 confident.

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