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1 **Preventative services offered by veterinarians on sheep farms in England and Wales: opinions**
2 **and drivers for proactive flock health planning**

3 C Bellet^{a,*}, J Woodnutt^a, L E Green^b, J Kaler^a

4 1. Camille Bellet^{a,*},

5 2. Joanna Woodnutt^a,

6 3. Laura E Green^b,

7 4. Jasmeet Kaler^a,

8 ^a School of Veterinary Medicine and Science, University of Nottingham, Sutton Bonington Campus,
9 Sutton Bonington, Leicestershire, LE12 5RD, United Kingdom.

10 ^b School of Life Sciences, University of Warwick, Coventry, CV4 7AL, United Kingdom

11

12 Corresponding author: phone: +447462894477; email address: camille.bellet@nottingham.ac.uk

13 **Complete correspondence address including email address to which the proofs should be sent:**

14 Camille Bellet, School of Veterinary Medicine and Science, University of Nottingham, Sutton

15 Bonington Campus, Sutton Bonington, Leicestershire, LE12 5RD, United Kingdom,

16 camille.bellet@nottingham.ac.uk

17 Email addresses:

18 JW: svyjwt@exmail.nottingham.ac.uk

19 LEG: Laura.Green@warwick.ac.uk

20 JK: jasmeet.kaler@nottingham.ac.uk

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23

24 **Abstract**

25 Recent independent UK government reports and studies have highlighted the importance, but lack,
26 of flock health services provided by veterinarians. Qualitative interviews were analysed by thematic
27 analysis to construct belief statements to understand veterinarians' opinions on preventative advice
28 and drivers for current services to sheep farmers. A postal questionnaire was sent to 515 sheep
29 practices registered with the Royal College of Veterinary Surgeon (RCVS) in England and Wales in
30 2012 to gather quantitative data on these belief statements and to gather demographic information
31 and current services provided by the veterinarian. Exploratory factor analysis with heuristic
32 approaches was conducted on the respondents' belief statements to identify common factors of
33 veterinarian beliefs. Three main factors were identified: motivation for proactiveness, perceived
34 capability to offer preventative services and perceived opportunity to deliver these services. A beta
35 regression model was built to identify the factors significantly associated with the time veterinarians
36 spent in an advisory role. The relative proportion of time increased by 10% (1.01-1.19), 16% (1.03-
37 1.30) and 29% (CI: 1.09-1.53) for each unit increase in score for factor 1 motivation, factor 2
38 capability and factor 3 opportunity respectively, indicating that these latent factors explained time
39 veterinarians spent in an advisory role with sheep clients. There was a significant correlation
40 between these factors suggesting influence of the associated beliefs between factors. This study
41 provides insight into the nature and drivers of veterinarians' current behaviour and beliefs. These
42 results could be further tested in behaviour intervention studies and help in designing efficient
43 strategies aiming at promoting proactive health services offered by veterinarians on sheep farms in
44 England and Wales.

45

46 **Keywords: Sheep, Farmer, Veterinarians, Preventative services, Factor analysis, Beta**
47 **regression modelling, Behaviour**

48

49

50

51 **1. Introduction**

52 A government report in 2009 (Lowe, 2009) highlighted that farm animal veterinarians needed to
53 orientate their services away from treatment of individual sick animals to preventative advice. The
54 reasons for this shift to preventative advice were identified as increasing farm sizes, diminishing
55 profit margins, higher expectations from consumers' for high health status meat products, increased
56 farmers' demand and needs by farmers for differentiated veterinary services. Preventative advice
57 included farm specific monitoring of health and disease of livestock and providing action plans on
58 health, nutrition, genetic selection and husbandry to prevent disease. In addition, the advice needed
59 to be bespoke to a farm business and individual farmer's attitudes and beliefs (LeBlanc et al., 2006;
60 Lowe, 2009).

61

62 The Department for Environment Food and Rural Affairs (DEFRA) has been developing strategies,
63 such as the Farm Health Planning Initiative, to encourage preventative advisory services (i.e. an
64 active process measuring, managing and monitoring livestock to maximize the health and welfare of
65 farm animals) in England and Wales since 2004. One of the main aims of these strategies is the
66 development of close partnerships between farmers and veterinarians to facilitate and improve the
67 implementation of preventative practices on farms (DEFRA, 2004; Osmond, 2009). There is, to
68 date, no evidence that preventative advisory services are being used more on sheep farms. Recent
69 surveys showed that sheep farms were the predominant farm businesses not receiving preventative
70 advice from veterinarians, with only 22% of sheep farmers reporting all-year-round contact with
71 their veterinarian whilst 68% contacted them for emergencies only (ADAS, 2007; DEFRA, 2013).

72

73 Although sheep farmers believe their veterinarians are their most useful source of new information
74 (i.e. a disease in the flock unrecognised by the farmer), they also consider veterinarians'
75 inconsistent service, high turnover and lack of both expertise and independence in advice as key

76 barriers to using them in preventative advice for their flocks (Kaler and Green, 2013). There is no
77 information on veterinarians' beliefs about the services that they offer to their sheep clients and
78 veterinarians' views of their sheep clients' use of their vet. Because the perception of both farmers
79 and veterinarians is crucial to develop an effective proactive relationship and to fulfil both parties'
80 objectives to improve sheep health, there is a need to understand better the views and beliefs of
81 veterinarians on the services they currently offer to sheep farmers and how they believe these are
82 received.

83

84 There are over 83 psychosocial theories that have been developed in human health to explain
85 behavioural processes and how to change various health behaviours (Sutton, 2001; Michie et al.,
86 2014) with considerable overlap between the theories. The use of these theories to understand
87 behaviour is relatively new in veterinary science and most of the studies to date have focused on
88 farmer behaviour (Ellis-Iversen et al., 2010; Garforth et al., 2013). However, without fully
89 understanding the most relevant and common underlying factors or constructs of a behaviour, for a
90 particular population, the choice of theory can be challenging (Michie et al., 2014); currently, there
91 is no evidence on the underlying beliefs or important constructs for veterinarians' behaviour
92 towards preventative services on sheep farms.

93

94 The aims of the current study were to use psychosocial approaches to i) understand better
95 veterinarians' beliefs on providing advice on flock health, ii) use exploratory factor analysis to
96 identify common constructs that explain veterinarians' beliefs, and iii) identify whether those
97 factors are associated with the relative proportion of time veterinarians spent in an advisory role on
98 sheep farms.

99

100 **2. Materials and methods**

101 **2.1. Study Design**

102 **2.1.1. Interviews**

103 In the first part of the study, 12 face-to-face semi-structured individual interviews with sheep
104 veterinarians were conducted by JK. Veterinarians were selected using a non-probability
105 snowballing technique to ensure the collection of key information related to the specific purpose of
106 the study. The discussion guide covered areas around current contact with sheep farmers, services
107 offered and views on how these were received and the veterinarian's perception of their expertise.
108 The interview was pilot tested on two veterinarians before commencing the study. Interviews lasted
109 for 60 to 90 minutes and were audio-recorded and transcribed.

110

111 **2.1.2. Postal questionnaires**

112 In 2012, a list of all Royal College of Veterinary Surgeon (RCVS)-registered practices was used to
113 select the sample. From the 4642 practices on the list, any that did not register treating sheep were
114 discarded. Practices registered as 'branch practices' or 'supporting practices' were also discarded to
115 avoid contacting the same veterinarian twice, as well as those with an address outside England and
116 Wales. This resulted in 515 veterinary practices selected for the postal questionnaire study.

117 Based on themes identified by veterinarians from analysis of the interviews and previous work with
118 sheep farmers (Kaler and Green, 2013), thirty belief statements relating to veterinarians'
119 preventative advisory services were formed. A five-point Likert-based scale with descriptors from 1
120 to 5: 'strongly agree', 'agree', 'neither agree nor disagree', 'disagree', 'strongly disagree' was used
121 to collect scores on the belief statements. Veterinarians were also asked to provide the proportion of
122 time they spent in an advisory role (defined as 'preventative, non-emergency work on a regular
123 basis') to sheep farmers, together with general demographic data and number of sheep clients they
124 had. The questionnaire was pilot tested and then sent by post with a cover letter and a prepaid
125 envelope; postal reminders including a copy of the questionnaire were sent within twelve working
126 days of no response from the practice and an additional two-week period was given for the
127 respondents to reply.

128

129 **2.2. Qualitative analysis**

130 Thematic analysis (Braun and Clarke, 2006) was used relying on the constant comparative method
131 (Maykut and Morehouse, 1994) to examine the perceptions of veterinarians on the advisory role
132 they played with their sheep clients. The first step consisted of reading and re-reading transcripts
133 and becoming familiar with the content. Interesting features of the data were then systematically
134 generated using general non-overlapping codes across the dataset. Further sub themes were
135 generated after reviewing the codes. The transcripts were double coded to enhance the reliability
136 and data saturation across the themes was assessed (Kaler and Green, 2013). The qualitative
137 analysis was performed using NVivo 10.0 (QSR International) software.

138

139 **2.3. Quantitative analysis**

140 Data from the questionnaires were coded, checked and entered into a database (Microsoft Access,
141 2010). The data were analysed using STATA 12.1 (STATA Inc., Texas, USA). A first stage
142 descriptive analysis was conducted to summarize the data.

143

144 **2.3.1. Exploratory Factor Analysis**

145 An exploratory factor analysis (EFA) was then performed on the belief statement variables to
146 explore which of the veterinarians' belief statements loaded together to form a common
147 construct/latent variable and to understand their relationship to the core dimension/construct
148 identified. Statement variables were standardized prior to the analysis and the appropriateness of the
149 correlation matrix was checked (Ferguson and Cox, 1993). The Kaiser-Mayer-Olkin (KMO) test of
150 sampling adequacy was conducted for both the entire correlation matrix and each variable
151 individually (weighted value > 0.5). The Bartlett test of sphericity (weighted p value for $\chi^2 < 0.05$),
152 indicating the strength of association among variables was conducted (Ferguson and Cox, 1993). In
153 order to avoid any violation of distributional assumptions, the estimation of factor loadings was

154 made using iterated principal factor analysis (IPFA). Both the scree test and parallel analysis using
 155 eigenvalues from the reduced correlation matrix were used to determine the number of factors. An
 156 oblique factor rotation (promax) was performed, to allow any correlation between factors (Fabrigar
 157 et al., 1999; Costello and Osborne, 2005). Factor loadings greater than ± 0.3 were considered and
 158 statement variables with low reliability (i.e. high uniqueness) were discarded from the analysis
 159 (Fabrigar et al., 1999). Complex variables (i.e. loading on two or more factors) were avoided, either
 160 excluding the item from the analysis or, in the case of large discrepancy (>0.2), considering the
 161 highest loading variable (Ferguson and Cox, 1993). A minimum criteria of four items per factor was
 162 retained (Fabrigar et al., 1999). Finally, for model diagnostics, the resulting sets of items per factor
 163 were examined for internal consistency, using both Cronbach's alpha and inter-item covariance
 164 (Cronbach, 1951; Tavakol and Dennick, 2011).

165

166 **2.3.2. Beta regression modelling**

167 A maximum likelihood regression technique based on beta regression modelling (Ferrari and
 168 Cribari-Neto, 2004; Smithson and Verkuilen, 2006) was used to identify significant factors
 169 associated with the relative proportion of time veterinarians spent in an advisory role (outcome),
 170 which was assumed to follow a beta distribution. The beta regression model used was the one
 171 described by Ferrari and Cribari-Neto (2004), where the outcome y follows the density:

$$172 \quad f(y; \mu, \Phi) = \frac{\Gamma(\Phi)}{\Gamma(\mu\Phi)\Gamma((1-\mu)\Phi)} y^{\mu\Phi-1} (1-y)^{(1-\mu)\Phi-1}$$

173 where $0 < y < 1$, μ is the mean of y and Φ the unknown precision parameter of its distribution, and
 174 $\Gamma(\cdot)$ is the gamma function. Considering the n outcome data $y_1 \dots y_n$, the beta regression model
 175 assumes that each y_t , ($t=1, \dots, n$) follows a beta distribution and the mean of these random variables
 176 can be written as:

$$177 \quad g(\mu_t) = \sum_{i=1}^k x_{ti} \beta_i + \beta_0 = \eta_t$$

178 where β_0 represents the intercept, β_i the coefficient of the i predictor variables, x_i are observations
179 on i predictor variables, η_ϵ is a linear predictor and $g(\cdot)$ the link function (Ferrari and Cribari-Neto,
180 2004). A logit link function was used to build the model (Ferrari and Cribari-Neto, 2004; Smithson
181 and Verkuilen, 2006). Outcome observations, i.e. reported proportion of time spent by veterinarians
182 in an advisory role were transformed to the open unit interval (0, 1), adding a very small amount
183 (0.0001) to the 0-valued observations and subtracting the same amount to the 1-valued observations
184 (Smithson and Verkuilen, 2006).

185 Predictor variables included general demographic characteristics of veterinarians and the 3 factors
186 generated from EFA of belief statements. Each of the 3 factors comprised scores, which were
187 computed using a non-refined method of weighted sum scores, thereby taking into account the
188 strength (or lack of strength) of each factors' items (DiStefano et al., 2009). Predictor variables with
189 a category wise Wald test p value ≤ 0.05 were retained in the model.

190 The measure of association between the predictor variables and the outcome from the beta
191 regression was expressed as a relative proportion ratio (STATA). The fit of the model was
192 evaluated by visual examination of the residuals and identification of the potential outliers (Ferrari
193 and Cribari-Neto, 2004; Smithson and Verkuilen, 2006).

194

195 **3. Results**

196 **3.1. Qualitative analysis**

197 The 12 vets that were included in the study consisted of 5 males and 7 females with age range of 28
198 to 50 years and were from practices in central England ($n=5$), south-west England and Wales ($n=4$)
199 and north of England ($n=3$). After final coding of the data there were 4 key themes: i) services
200 offered, 2) knowledge and expertise, 3) sheep farmer clients, and 4) ways of interacting with sheep
201 farmers. Data saturation among the themes was achieved.

202

203 **3.1.1. Services offered**

204 Veterinarians perceived a problem with the contact they currently had with farmers. The
205 veterinarians used phrases such as “a ‘fire-brigade’ service” and “only after several sheep have
206 died”, showing an awareness of the limited nature of the contact. There was a general feeling
207 among the veterinarians that the result of not doing advisory work that prevented diseases was
208 delivering reactive services when disease events occurred, as expressed in the quote below:

209 “I suppose most of what we do sheep-wise, as I say, is lambings or post-mortems unfortunately
210 because we don’t get called to sheep farms to do preventative work. And I suppose because we’re
211 not being proactive enough in getting the preventative medicine out to them which is why we then
212 end up doing this... we have a very reactive service, what one of my old lecturers would’ve called a
213 ‘fire brigade service’ rather than a preventative”.

214

215 There was also a feeling among veterinarians that lack of records was a key contributor to them
216 being unable to offer the preventative services, for example as highlighted in this quote:

217 “I think if we got on the farm more we could add value offering proactive services, we could tighten
218 things up, we could see where things were going wrong. But I think the main thing is records, if a
219 farmer doesn’t have any records then you can’t see where things are going wrong, and we’ve got a
220 few clients who have got very good records and I can see how to add value to their flocks, but I
221 can’t necessarily see how to add value if the record keeping isn’t there and that’s something the
222 farmers need to do”.

223

224 Most veterinarians had negative emotions towards reactive care of sheep indicating that they were
225 not happy with their current situation. The quote below demonstrates their state of mind towards
226 this:

227 “I think as a practice we find that we’ve got a lot of sheep on our books but we very rarely see
228 them. I think you’d probably find that around a lot of the country, I don’t think we’re unique in that

229 but it's something that's been niggling at myself and one of the other vets a bit recently that we've
230 not got enough contact with our sheep farmers".

231

232 Flock health plans (FHP) were mentioned by veterinarians as a form of service but the availability
233 and structure of FHPs varied among interviewees from static FHPs - "We have got a sheep health
234 plan which we can offer if people are interested"- to active ones requiring two visits a year - "I've
235 set up a flock health initiative scheme thing so I see them twice a year, they pay an amount per
236 month for two visits a year so I certainly see them at least twice a year [...] They will have written
237 flock health plans, once I've set up an original plan every time I go back after that they get a written
238 review".

239

240 Most of the veterinarians described not charging for all the time they spent on a FHP for fear of it
241 being too expensive, as shown by these comments:

242 "I'd always think 'he's never going to pay for this'".

243 "We're sort of almost obliged to do it but it's impossible to charge a realistic rate, so when work
244 gets busy that's the first thing that then suffers".

245 "The difficult thing was balancing cost, how much you thought farmers would be prepared to pay
246 against our own economics".

247

248 **3.1.2. Knowledge and expertise**

249 Most veterinarians believed that they did not have sufficient knowledge and expertise and this
250 affected their confidence to be proactive on farms. They blamed lack of contact with sheep farmers
251 and their own lack of enthusiasm for this gap in knowledge and expertise. The quotes below
252 describe these views:

253 “I think that a lot of us don’t necessarily have invested enough time in getting enough knowledge
254 and I think we’ve not necessarily enough knowledge to really supply the farmer with something that
255 he really thinks ‘wow that was really useful, I didn’t know that’”.

256 “If you graduate and all you do is a couple of lambings each year and talk to the odd farmer that
257 comes in to collect some drugs then a) you’re going to feel that that’s how it is and not aspire to
258 doing anymore, and b) you quickly don’t see enough sheep to be able to feel confident in your
259 knowledge when you’re giving advice”.

260

261 There were two veterinarians, who mentioned they invested time and effort to gain this knowledge
262 and expertise, and mentioned that support from their boss was crucial in this. The quote below
263 describes this:

264 “I had to look a lot of stuff up and learn a lot from reading around the subject, talking to other
265 people and learning from the sheep farmers as well. Just trying to keep it quite simple initially,
266 work out what they do, work out what their aims are, work out what their initial problems are, stick
267 to three things that I think I can make a difference on starting with the obvious and hopefully
268 building on it”.

269 “I was perfectly prepared and luckily I’ve got a boss who’s perfectly prepared for me to take this by
270 the horns and go with it and not worry too much. But I could be very confident in saying in the last
271 year we’ve done more sheep work than we have done in previous years”.

272

273 Veterinarians also believed that sheep farmers did not trust in their knowledge and expertise and
274 how veterinarians could add value to the farm. The two quotes below describe both these beliefs:

275 “I think they (sheep farmers) probably think that generally we’ve got the same knowledge level as
276 they’ve got <chuckles> or slightly more or slightly skewed towards the medicine side but I don’t
277 know that most of them aren’t aware of what else we can offer them”.

278 “I think a lot of the farmers around here seem to give the impression that they know what they’re
279 doing and we can’t tell them anymore”.

280

281 **3.1.3. Sheep farmer clients**

282 There were general feelings among veterinarians that their sheep farmer clients were just not
283 prepared to pay for the services. For example this quote below highlights this:

284 “We do have trouble getting the farmers to pay for education. So they will pay for you to go and see
285 a sick ewe but they don’t want to pay you to educate them to prevent them getting a sick ewe, do
286 you see what I mean?”.

287

288 Most of those interviewed assumed that sheep farmers would not pay for advice without asking
289 them. This was identified by one vet as being a problem, as shown in the following quote:

290 “I think the reason it’s hard is, and I’m myself really to blame here, is assuming farmers won’t pay
291 for it and that’s exactly the same as trying to charge them for coming to meetings, is we assume that
292 farmers, you know for so long they’ve got it for free or ... yeah so it’s possibly a lack of self-
293 confidence and lack of trying”.

294

295 Most veterinarians mentioned that in their view, their sheep clients did not wish to engage with
296 them and veterinarians were frustrated with this, for example the quotes below describe these views
297 clearly:

298 “Our farmers are not wanting to engage with us, I think it’s almost like they don’t feel there’s a
299 need to somehow”.

300 “[...] that’s the frustration, for instance, quite recently we tried to have a farmer forum and selected
301 some key farmers to come in and, not with me there or anyone necessarily, but to talk about what
302 they would like and we had a very poor response turning up so we didn’t hold it”.

303

304 **3.1.4. Ways of interacting with sheep farmers**

305 Telephone contact and meetings were the two most common ways veterinarians interacted with
306 their sheep farmer clients.

307 Most veterinarians acknowledged that free telephone advice was the most common way they
308 interacted with their sheep clients and the fact it was free meant farmers would use it quite often.

309 Where some veterinarians thought free telephone advice was a barrier to them getting onto the
310 farms, others thought that free telephone advice sometimes gave them an opportunity to initiate a
311 farm visit. The quotes below express veterinarians' views:

312 "I think that we should (not give free telephone advice) because I think that's where we end up not
313 being able to get onto the farm, because if they feel that they can glean as much information as they
314 need just by talking to you then that negates the need for you to go out to the farm".

315 "[...] often you'll end up on a visit through the telephone; we do a mixed practice, so each of them
316 (farmers) will have maybe five collies in working dogs and we end up doing their farm work".

317

318 There were mixed views among veterinarians on the subject of charging for telephone advice.

319 Some were of the opinion that telephone advice should be charged because of the time taken and
320 knowledge given, but were not sure of how to charge and were fearful of losing the only contact
321 they had with sheep farmers. This is illustrated in the quotes below:

322 "It's really difficult because I suppose being creatures of habit we've never charged for it
323 (telephone advice) and I sort of think well why should we start? But at the same time it is time out
324 of my day and it should be seen as valuable advice I suppose, ultimately they're seeking my opinion
325 as a professional and thus there should be some charge; quite how you'd go about instigating that
326 I'm not sure".

327 "I would hate to think that people didn't want to ring me if they had a problem, and sheep guys are
328 reluctant to get you to come out anyway, if you then started charging for your phone advice god
329 knows what would happen out there".

330

331 There were others who thought offering free telephone advice was traditional and that there was
332 goodwill associated with it, as described by this veterinarian below:

333 “I guess it’s traditional and historical that’s possibly why you don’t (charge for telephone advice)
334 and also there’s a lot of other goodwill that comes off the back of it”.

335

336 Veterinarians organised farmers’ meetings and saw these as an opportunity to engage more and
337 build relationships with farmers:

338 “[...] through the meetings really and any opportunity if they’re coming in or anything, just trying
339 to engage”.

340 “I think if we can offer them a training meeting or just even an evening meeting talking about
341 worms or something. Even just something to pull them back in and we can start off that relationship
342 again then I think there is the potential to develop it”.

343

344 However, they felt since most of these meetings were sponsored and free for farmers, farmers did
345 not see value:

346 “Yeah we tend to do a fair bit in conjunction with drug companies”. “And I think with hindsight not
347 charging is probably a mistake, because I don’t think they value it enough”.

348

349 **3.2. Quantitative analysis**

350 A total of 162 out of 515 questionnaires were returned, representing a response rate of 31%. Fifteen
351 questionnaires were returned empty or with apologies for not having been completed due to the
352 practice no longer treating sheep, resulting in 147 questionnaires included in the analysis.

353

354 **3.2.1. Demographic characteristics of the respondents**

355 The majority (76%) of veterinarians had at least five years professional experience with 60% having
356 ten or more years of experience. The majority graduated from the UK; the top-five Universities
357 being the Royal Veterinary College of London (24%), Liverpool (18%), Bristol (16%), Edinburgh
358 (14%) and Glasgow (10%); 10% of the veterinarians graduated from abroad.

359

360 **3.2.2. Veterinarians' current practice**

361 Overall, the median number of sheep clients per practice was 53 (IQR 20 - 130). The median
362 percentage of clients that ran their sheep business as a primary enterprise was 30%, with the
363 remaining enterprises being secondary or tertiary. A total of 78% (114/147) of veterinarians
364 reported their relative proportion of time spent in an advisory role with their sheep clients; the
365 median time spent reported was 20% [IQR: 5-50]. Ninety-five per cent (139/147) of the
366 veterinarians reported providing advice to their clients by telephone, of which only 4% (5/139) ask
367 their clients to pay a fee. Approximately 40% of the veterinarians reported attending Continuing
368 Professional Development on sheep in 2012.

369

370 **3.2.3. Belief statement scoring and exploratory factor analysis**

371 Of the 147 veterinarians who answered the questionnaire, 26 had ten sheep clients or fewer and
372 were removed from the EFA. The suitability of the belief statements for EFA, assessed by the
373 overall Kaiser-Meyer-Okin value, was meritorious (KMO=0.81), with no items having an
374 individual sampling adequacy of less than 0.5, and by the Bartlett's test of sphericity, which was
375 statistically significant $\chi^2 = 644.3$ (df = 153, $p < 0.001$), supported the factorability of the resulting
376 items correlation matrix (Kaiser, 1974; Ferguson and Cox, 1993).

377

378 The IPFA on the belief statements after inspection of a scree plot and parallel analysis, considering
379 factor loadings, gave a three factor solution with eigenvalues exceeding 1.0 (5.02, 1.64, 1.30). This
380 three-factor solution accounted for 65.1% of the total variance of the veterinarians' belief

381 statements. The factors were: factor 1 (with 10 items), factor 2 (with 4 items) and factor 3 (4
382 items). The factor loading for the three-factor solution, items for the factors along with measures of
383 internal consistency and mean scores of the given items are presented in table 1. There were
384 positive correlations between factors: $r=0.4$ between factor 1 and 2; $r=0.3$ between factor 2 and 3
385 and $r=0.2$ between factor 1 and 3. All factors had good internal consistency taking into account both
386 the number of items and the inter-item covariance measure (Cronbach, 1951; Tavakol and Dennick,
387 2011). The higher factor scores were related to the individuals either agreeing or strongly agreeing
388 with the related items (data not shown).

389

390 Within factor 1 (“motivation”) were items related to veterinarians’ motivation (table 1). The
391 majority of veterinarians “agreed” or “strongly agreed” (65-75%) that they provided a good service
392 to their sheep clients and that either their boss/colleagues or their sheep clients were happy with the
393 services they offered. Approximately 44% of veterinarians “agreed” or “strongly agreed” that they
394 offered sufficient preventative advice. However, only 6% of veterinarians “agreed” or “strongly
395 agreed” that they were seeing their clients enough and 24% that they were the primary source of
396 advice to their sheep clients. About 18-23% of the veterinarians either “agreed” or “strongly
397 agreed” that their sheep clients were aware or prepared to pay for their services or that veterinarians
398 themselves had enough marketing skills to promote their services.

399

400 In factor 2 (“capability”) were items related to the veterinarians’ capability (table 1). About 45-53%
401 of the veterinarians believed they knew enough about their clients’ needs, had enough knowledge
402 about non-veterinarian aspects of sheep enterprises and that their clients were interested in the
403 additional services they could offer. Approximately 70% of the veterinarians “agreed” or “strongly
404 agreed” that they had sufficient sheep health expertise.

405

406 Within factor 3 (“opportunity”) were items related to external components or opportunities (table
407 1). The majority of veterinarians “agreed” or “strongly agreed” that proactive services could provide
408 additional income to the practice (74%) and thought what their sheep clients (97%) or
409 boss/colleagues (58%) thought was important to them. There was general agreement (92% either
410 “agreed” or “strongly agreed”) that veterinarians would not prefer external consultants to provide
411 these services to the sheep clients.

412

413 **3.2.4. Beta regression modelling**

414 The multivariable beta regression model results are presented in table 2. All three factors were
415 significantly associated with the proportion of time sheep veterinarians spent in an advisory role.
416 The relative proportion of time veterinarians spent in an advisory role increased by 10% (1.01-
417 1.19), 16% (1.03-1.30) and 29% (CI: 1.09-1.53) with each unit of increase in score for factor 1
418 “motivation”, factor 2 “capability” and factor 3 “opportunity”, respectively. There was no
419 significant association between any demographic factor and the proportion of time veterinarians
420 spent in an advisory role.

421

422 Visual examination of the Pearson residuals suggested the model fit was reasonable (data not
423 shown).

424

425 **4. Discussion**

426 To the authors’ knowledge this is the first study to explore veterinarians’ beliefs towards the
427 services they offer to their sheep clients and the impact of those beliefs on the time they spend in an
428 advisory role. In the current study, EFA generated three factors that described the veterinarians’
429 beliefs with good internal consistency. These three factors map to the three components proposed
430 by the COM-B system of behaviour: Capability, Opportunity and Motivation (Michie et al., 2011).
431 According to the COM-B model (Michie et al., 2011), a behaviour occurs as a result of these three

432 necessary factors (capability, opportunity and motivation). Capability is defined as the
433 psychological and physical abilities to perform behaviour, and includes knowledge. Motivation
434 includes 'reflective' processes that direct behaviour - e.g. evaluations, beliefs - and 'automatic'
435 processes that involve emotions and impulses. Opportunity involves factors that are external to an
436 individual that may influence behaviour; this could be physical (time, resources, environment or
437 'affordance') or social (interpersonal influences, social environment). The COM-B model and
438 previous research has highlighted that motivations, capabilities and opportunities are correlated and
439 influenced by the behaviour itself (Michie et al., 2011). Results from the current study also indicate
440 this because these three factors were correlated with each other and significantly influenced the
441 veterinarians' current behaviour, measured as the relative proportion of time spent in an advisory
442 role. These factors are discussed below in context of this framework.

443

444 Items included in factor 1 demonstrated both the automatic motivation (e.g. 'my clients/boss or
445 colleagues are happy with my services') and reflective motivation (e.g. 'I think I am my clients'
446 primary source of advice' or 'my clients are prepared to pay for services') among veterinarians. The
447 reflective evaluation included not only veterinarians' own actions (e.g. I see my sheep clients
448 enough) but also their sheep clients' actions (e.g. my sheep clients are prepared to pay to use the
449 services I could offer), suggesting some associations between these two sets of motivations.
450 Veterinarians' perception of their sheep farmer clients' unwillingness to pay could be a reflection of
451 economics of sheep farming and/or their own assumption due to lack of trying, as highlighted by
452 the qualitative interviews in the current study. However, for sheep farmers to be willing to pay for
453 veterinarians' advisory services, they first need to be able to see how these services could add value.
454 In the current study, most veterinarians believed that sheep farmers were not aware of the services
455 they could offer. This could be a consequence of poor marketing skills by veterinarians and/or lack
456 of record keeping on sheep farms, as reported in the current and previous studies (Kaler and Green,
457 2013), making farmers unable to see the value of veterinarians' services.

458

459 Despite the fact that most veterinarians believed they did not visit their sheep clients sufficiently
460 often and that their clients were not aware of the services they, the veterinarians, could offer, vets
461 still believed they had sufficient knowledge, were providing a good service and that their sheep
462 clients were happy with their service. This is an example of cognitive bias (Burke, 2006), where
463 there is disparity between associated beliefs. This has been reported previously in sheep farmers'
464 management of lameness (Wassink et al., 2010), where footbathing and foot trimming
465 managements were reported to be an unsatisfactory use of time and money by farmers, but also
466 identified as the optimal way to manage lameness. These biases can present an impasse in changing
467 behaviour.

468 Other studies have demonstrated associations between motivations and behaviours (e.g. farmers'
469 perceptions of control of mastitis (Jansen et al., 2009)) and perception of having biosecurity
470 measures on farm (Gunn et al., 2008) have been linked to effective mastitis control and action to
471 improve biosecurity respectively. In the current study, veterinarians with relative higher factor
472 scores on the common factor 'motivation' spent significantly higher proportion of time in an
473 advisory role, suggesting that veterinarians, with positive beliefs about their service and positive
474 beliefs about how their clients perceived their service, tended to spend more time doing advisory
475 work with their sheep farmer clients.

476

477 Items in factor 2 demonstrated veterinarians' awareness of their 'capability' to engage in the
478 advisory role. These were measures related to psychological capability; for example, knowing
479 enough about client needs, having sufficient expertise in sheep health with knowledge about non-
480 veterinary aspects of sheep husbandry and farming. Veterinarians' lack of knowledge of sheep
481 husbandry and farming was highlighted by sheep farmers (Kaler and Green, 2013) and, in the
482 qualitative analysis, by veterinarians as their key barrier for working proactively with sheep
483 farmers. The findings from the quantitative study suggest that only half of the veterinarians agreed

484 that they had sufficient knowledge of sheep husbandry and farming and of their sheep clients'
485 needs. However, it is difficult to see how veterinarians could develop their knowledge, gain
486 expertise and know enough about their clients' needs without being on farms given that 80% of the
487 veterinarians stated in the current study that they did not see their sheep clients sufficiently often.
488 The veterinarians in the qualitative interviews also highlighted this lack of contact with sheep
489 farmers, which impacted on their confidence and was a barrier to them developing their expertise.
490 The factor 'capability' was significantly associated with the proportion of time veterinarians spent
491 in an advisory role on sheep farms. This suggested that veterinarians, who were more aware of their
492 clients' expectations and had stronger capability in sheep health and non-health related areas of
493 expertise, were spending more time doing advisory work.

494

495 Factor 3 included both physical opportunity (for example in terms of source of additional income
496 and external consultants as competitors) and social opportunity (importance of what boss/colleagues
497 or sheep clients' opinions). Sheep farmers have highlighted that there is a lack of availability of
498 routine flock health plans or models demonstrating benefits to them and that veterinarians, not
499 farmers, should instigate these (Kaler and Green, 2013). The results from the current study suggest
500 that most veterinarians are aware of having to make such an opportunity because it could provide
501 them with additional income and they would prefer external consultants not to provide these
502 advisory services. However, there is not only a need to create such opportunities but also, as
503 highlighted above, veterinarians would need to gain marketing skills to sell those opportunities. The
504 majority of veterinarians also considered that their boss/colleagues and sheep clients' views were
505 important, suggesting strong impact of social and interpersonal influences on the preventative
506 services they offered. This was also highlighted in the qualitative interviews, where support from
507 the boss appeared to have influenced veterinarians to take a more proactive role with their sheep
508 farmer clients. The factor score 'opportunity' had the strongest association with the relative
509 proportion of time veterinarians spent in an advisory role, indicating that veterinarians with stronger

510 beliefs in the income opportunity of their services, who did not want external consultants to provide
511 these services and who felt supported by their boss and clients, spent relatively more time in
512 advisory services with their sheep clients.

513

514 Due to the nature of the current study there are some limitations; the response rate was typical for a
515 postal questionnaire to a non-engaged target population (Kaler and Green, 2008) and there is a
516 possibility of response bias to the survey and to specific questions (e.g. the proportion of time spent
517 in an advisory role); However, there was no significant difference between the respondents and
518 non-respondents with respect to their geographical location. Data on beliefs and time spent were
519 collected by self-report, which is the most common method of assessment used in psychological
520 research; however, there is a possibility of self-presentational and recall biases (Horne and
521 Weinman, 1999). As recommended in the literature (Rand and Wise, 1994), we took steps to
522 diminish the biases by phrasing belief statements in a non-judgmental way and assuring participants
523 that responses were anonymous and confidential. The question on the outcome (i.e. proportion of
524 time spent by veterinarians) was asked in a separate section (with few other questions between) to
525 where belief statements were asked; thus limiting the possibility of any recall.

526 In addition, EFA is driven by the set of items included and additional factors not identified in the
527 analysis may exist. However, there was consistency in some beliefs expressed by veterinarians with
528 previous work done with sheep farmers (Kaler and Green, 2013) and the common factors identified
529 map to all three main behavioural components of the COM-B framework that explains behaviour,
530 thus the results are plausible. The factors explain differences in the amount of time veterinarians
531 spent in an advisory role with their clients and these might be predictive - i.e. improving expertise
532 might increase the time spent advising sheep farmers. However, this would need to be tested in
533 intervention studies. Finally, the outcome variable was a proportion with a non-normal distribution
534 and so standard models were not suitable. Due to the challenges related to any data transformation
535 (Smithson and Verkuilen, 2006; Schmid et al., 2013) and the highly flexible shape of the beta

536 distribution, a beta regression (Ferrari and Cribari-Neto, 2004), was used and allowed the
537 specification and fit of a model for our continuous proportion outcome (Smithson and Verkuilen,
538 2006).

539

540

541 **5. Conclusions**

542 The study results suggest 3 key correlated factors ‘motivation’ ‘capability’ and ‘opportunity’
543 underlying veterinarians’ beliefs about the preventative services they provide on sheep farms. There
544 was some discrepancy in the associated beliefs because, although most veterinarians believed that
545 they provided a good service, they also believed they did not see their clients sufficiently often nor
546 that their clients were aware of the services they could offer. Increased positive belief in their own
547 motivation, clients’ perception of their services, own perception of their expertise to offer advice
548 and viewing preventative advice as a source of additional income, together with support from boss
549 and clients, significantly increased the proportion of time veterinarians spent in an advisory role.
550 The current study gives us an insight to veterinarians’ current beliefs and how these could be
551 impacting on their behaviour; this remains to be tested in a behaviour intervention study. These
552 results could therefore be used to design effective strategies to target and promote proactive flock
553 health planning on sheep farms.

554

555 **6. Conflict of interest**

556 The authors declare that they have no competing interests.

557

558 **7. Acknowledgments**

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562

563 **References**

- 564 ADAS, 2007. An Independent Evidence Baseline for Farm Health Planning in England. A report
565 prepared for Defra Farm Health Planning Team.
- 566 Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. *Qual Res Psychol* 3, 77-101.
- 567 Burke, A.S., 2006. Improving Prosecutorial Decision Making: Some Lessons of Cognitive Science.
568 *William & Mary law review* 47, 1587-1633.
- 569 Costello, A.B., Osborne, J.W., 2005. Best practices in exploratory factor analysis: Four
570 recommendations for getting the most from your analysis. *Pract Ass Res Eval* 10, 1-9.
- 571 Cronbach, L.J., 1951. Coefficient alpha and the internal structure of tests. *Psychometrika* 16, 297-
572 334.
- 573 DEFRA, 2004. Delivering the Animal Health and Welfare Strategy in England. Implementation
574 Plan 2004.
- 575 DEFRA, 2013. Animal Health and Welfare Practices on Farm 2011/12, England. National
576 Statistics.
- 577 DiStefano, C., Zhu, M., Mindrila, D., 2009. Understanding and Using Factor Scores:
578 Considerations for the Applied Researcher. *Pract Ass Res Eval* 14.
- 579 Ellis-Iversen, J., Cook, A.J.C., Watson, E., Nielen, M., Larkin, L., Wooldridge, M., Hogeveen, H.,
580 2010. Perceptions, circumstances and motivators that influence implementation of zoonotic
581 control programs on cattle farms. *Prev Vet Med* 93, 276-285.
- 582 Fabrigar, L.R., Wegener, D.T., MacCallum, R.C., Strahan, E.J., 1999. Evaluating the use of
583 exploratory factor analysis in psychological research. *Psycholl Meth* 4, 272-299.
- 584 Ferguson, E., Cox, T., 1993. Exploratory factor analysis: a users' guide. *Int J Sel Ass* 1, 84-94.
- 585 Ferrari, S.L.P., Cribari-Neto, F., 2004. Beta regression for modelling rates and proportions. *J Appl*
586 *Stat* 31.

587 Garforth, C.J., Bailey, A.P., Tranter, R.B., 2013. Farmers' attitudes to disease risk management in
588 England: a comparative analysis of sheep and pig farmers. *Prev Vet Med* 110, 456-466.

589 Gunn, G.J., Heffernan, C., Hall, M., McLeod, A., Hovi, M., 2008. Measuring and comparing
590 constraints to improved biosecurity amongst GB farmers, veterinarians and the auxiliary
591 industries. *Prev Vet Med* 84, 310-323.

592 Horne, R., Weinman, J., 1999. Patients' beliefs about prescribed medicines and their role in
593 adherence to treatment in chronic physical illness. *J Psychosom Res* 47, 555-567.

594 Jansen, J., van den Borne, B.H., Renes, R.J., van Schaik, G., Lam, T.J., Leeuwis, C., 2009.
595 Explaining mastitis incidence in Dutch dairy farming: the influence of farmers' attitudes and
596 behaviour. *Prev Vet Med* 92, 210-223.

597 Kaiser, H., 1974. An index of factorial simplicity. *Psychometrika* 39, 31-36.

598 Kaler, J., Green, L.E., 2008. Naming And Recognition Of Six Foot Lesions Of Sheep Using Written
599 And Pictorial Information: A Study Of 809 English Sheep Farmers. *Prev Vet Med.* 83, 52-
600 64.

601 Kaler, J., Green, L.E., 2013. Sheep farmer opinions on the current and future role of veterinarians in
602 flock health management on sheep farms: a qualitative study. *Prev Vet Med* 112, 370-377.

603 LeBlanc, S.J., Lissemore, K.D., Kelton, D.F., Duffield, T.F., Leslie, K.E., 2006. Major advances in
604 disease prevention in dairy cattle. *J Dairy Sci* 89, 1267-1279.

605 Lowe, P., 2009. Unlocking potential. A report on veterinary expertise in food animal production.

606 Maykut, P., Morehouse, R., 1994. *Beginning Qualitative Research: A Philosophical and Practical*
607 *Guide*. The Falmer Press, London, 195p.

608 Michie, S., van Stralen, M.M., West, R., 2011. The behaviour change wheel: a new method for
609 characterising and designing behaviour change interventions. *Implement Sci* 6, 42.

610 Michie, S., West, R., Campbell, R., Brown, J., Gainforth, H., 2014. *ABC of Behaviour Change*
611 *Theories: An Essential Resource for Researchers, Policy Makers and Practitioners*. 499p.

612 Osmond, J., 2009. Defra Farm Health Planning Initiative. Review Of Pump-Priming Expenditure.
613 IHPC.

614 Rand, C.S. Wise, R.A., 1994. Measuring adherence to asthma medication regimens. Am J Respir
615 Crit Care Med 149, S69-S76.

616 Schmid, M., Wickler, F., Maloney, K.O., Mitchell, R., Fenske, N., Mayr, A., 2013. Boosted beta
617 regression. PloS one 8, e61623.

618 Smithson, M., Verkuilen, J., 2006. A better lemon squeezer? Maximum-likelihood regression with
619 beta-distributed dependent variables. Psychol Meth 11, 54-71.

620 Sutton, S., 2001. Health Behavior: Psychosocial Theories. Int Encycl Soc Behav Sci, 6499-6506.

621 Tavakol, M., Dennick, R., 2011. Making sense of Cronbach's alpha. Int J Med Educ 2, 53-55.

622 Wassink, G.J., George, T.R., Kaler, J., Green, L.E., 2010. Footrot and interdigital dermatitis in
623 sheep: farmer satisfaction with current management, their ideal management and sources
624 used to adopt new strategies. Prev Vet Med 96, 65-73.

625

626

627 **Tables**

628 **Table 1.** Exploratory factor analysis of 147 English and Welsh veterinarians' belief statements
629 regarding their advisory role on sheep farms (Only loadings > 0.30 are displayed)

630

631 **Table 2.** Beta regression model outcomes of psychosocial factors associated with the time sheep
632 veterinarians spent in an advisory role on farms

633

634

635 **Table 1.**

Items	Scores Mean \pm SD	Exploratory Factor Analysis		
		Factor 1 “Motivation”	Factor 2 “Capability”	Factor 3 “Opportunity”
I think I provide good services to my clients	2.18 \pm 0.77	0.608		
I see my clients often enough	4.10 \pm 0.94	0.642		
I think I offer sufficient preventive advice	2.69 \pm 0.89	0.517		
I think I am my clients’ primary source of advice	3.17 \pm 0.99	0.557		
My boss/colleagues are happy with my services	1.97 \pm 0.72	0.667		
My clients are happy with my services	2.18 \pm 0.74	0.635		
My clients wish to use the services I could offer	2.40 \pm 0.86	0.442		
My clients are prepared to pay for my services	3.26 \pm 1.09	0.429		
My clients are aware about services I could offer	2.77 \pm 1.00	0.425		
I have enough marketing skills to encourage uptake of advice	3.12 \pm 0.93	0.411		
I believe I know enough my clients’ needs	2.48 \pm 1.16		0.534	
My clients are interested about additional services	2.66 \pm 1.08		0.495	
I have enough sheep health expertise to provide advice	2.14 \pm 0.93		0.578	
I know enough about non-vet aspects of sheep enterprises	2.60 \pm 1.12		0.700	
Preventive services could provide additional income	2.05 \pm 1.02			0.385
What my boss/colleague thinks is important	2.40 \pm 1.09			0.387
What my clients think is important	1.40 \pm 0.56			0.494
I wouldn’t prefer external consultants providing advice	1.39 \pm 0.76			0.671
	Cronbach’s alpha	0.82	0.70	0.60
	Average Inter-item covariance	0.30	0.40	0.20

636 **Table 2.**

Predictors	Coefficients	SE	RPR*	95% CI**
Factor 1 “Motivation”	.0955	.0421	1.1002	[1.0130-1.1948]
Factor 2 “Capability”	.1466	.0609	1.1580	[1.0276-1.3048]
Factor 3 “Opportunity”	.2562	.0870	1.2920	[1.0894-1.5323]
Precision parameter phi (Φ)	2.1593	.2854		

637 *RPR- Relative Proportion Ratio; **CI – Confidence Interval

638

639