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ORIGINAL RESEARCH

Survey of current UK alpaca husbandry practices: Vaccination, treatment and supplementation

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Abstract

Background: The popularity of alpacas in the UK is increasing, with the British Alpaca Society (BAS) estimating that there are currently 45,000 registered alpacas and a further 15,000 unregistered alpacas. This research set about to investigate what husbandry procedures are currently undertaken on alpacas in the UK.

Methods: An online survey of 47 questions was created using Jisc and was available for 4.5 months.

Results: All 116 holdings implemented shearing and foot trimming (100.0%), and most vaccinated against clostridial disease (95.7%) and supplemented with vitamin D (91.4%). There was no obvious pattern in vitamin D dosing. A significant positive association was found between the size of the holding and whether injectable or oral vitamin D was used ($p = 0.034$), with smaller holdings preferring oral vitamin D products.

Limitations: The survey was distributed online, including via the BAS e-Newsletter. The percentage of BAS-registered alpacas was not clarified, so it is unknown if the data are skewed by this.

Conclusion: Although owners are ensuring that routine interventions are implemented, variation in responses implies there is no current standard protocol. This highlights that these differences may be due to logistical choices, training or varied advice, which may be due to the lack of published literature.

INTRODUCTION

The number of alpacas kept in the UK has been rising over the years, increasing from around 145 in 1992[1] to 8000–10,000 in 2000/2001[2] and to an estimated 60,000 (per comms: D. Pullar, CEO British Alpaca Society [BAS]; ceo@bas-uk.com) in February 2023. BAS-registered alpacas are required to be microchipped, but this husbandry procedure is not essential in order to own an alpaca. As with other species, a variety of husbandry procedures are required to maintain a good standard of welfare.

Currently, in the UK, it is essential to shear huacaya alpacas yearly and suri alpacas biennially, and it is recommended to vaccinate all alpacas against clostridial diseases.[3] However, in 2000/2001, the majority of owners reported using sheep vaccines due to the lack of a vaccine specifically licensed for camelids.[2] This is also the case in Germany, again due to the lack of licensed products.[4] For UK alpacas, there is no other recommended routine vaccination, as vaccination against other diseases is dependent on circumstances.[3]

Reduced mortality after vaccination against clostridial diseases has been evidenced in various studies.[5–7] Mortality, in general and specifically due to enterotoxaemia, decreased after vaccine administration[5,7] and continued to fall after consistent annual use.[7] The types of vaccines used in these studies were combined,[6] multivalent[7] or comprised of toxoid antigens from clostridial species isolated predominantly from sheep,[5] which implies that multiple different vaccines could be successful. An oral vaccine for clostridial enterotoxaemia has also been investigated, with efficacy demonstrated by increased levels of immunoglobulin A in the gut of vaccinated cria.[8]

However, one study showed that the effect of the injectable vaccine is short-lived and, therefore, requires frequent or strategic dosing.[6] In the past, it was advised to give a primary course, but with the

decision on booster vaccinations being dependent on clostridial burden.[9] More recently, annual boosters are always recommended.[3,10,11] There is a lack of investigation into the age at which to start the primary course of vaccination, but evidence shows that vaccinating the dam before parturition is better than vaccinating cria only.[5] It is advised to dose pregnant females 4–6 weeks prior to parturition,[7,11] but with a warning to reduce stress at the time of vaccination because alpacas are susceptible to stress-induced abortion.[3,9,10] Currently, practising vets advise following sheep dosing schedules,[12] aligning with advice from 2006[9] supporting the use of sheep vaccines, although the suggested frequency of vaccinations may vary.

Most vaccines and injectable drugs are administered via the subcutaneous route in alpacas, although there is some debate around which site is best for subcutaneous injections in this species. Despite varying injection site location descriptions, the two recommended areas for injection are the axilla region and the region of the lower neck.[3,9,10,13] However, it has been noted that subcutaneous injections of certain vaccine formulations[10] can lead to a localised reaction at the injection site,[3,14] in the form of a small lump.

It has been established that vitamin D levels in camelids vary throughout the year, with lower levels in late winter and early spring[15] and higher levels after summer.[16] Lower levels of vitamin D have been linked with changes in bone density that could lead to rickets, predisposing alpacas to pathology such as valgus deformities, enlarged costochondral junctions and fractures,[17,18] highlighting the need for supplementation in at least part of the year. It has also been recognised that adult black-coated alpacas have lower blood vitamin D levels than lighter-coated alpacas[15,16] but without any indication of a change in vitamin D dose for alpacas with different coat colours. Although lighter-coated cria are also at risk of vitamin D deficiency, reducing their growth rate,[15] dark-coated cria are more likely to suffer clinically from rickets.[18]

A subcutaneous injection of vitamin D at a dose of 1000–2000 IU/kg has been shown to increase plasma vitamin D concentration.[15] Over 20 years later, this dose is still being recommended by camelid veterinarians (1000 IU/kg as prevention and 2000 IU/kg as treatment),[19,20] with oral products dosed at 1000 IU/kg.[21] There is, however, a slight discrepancy in dosing frequency; some veterinarians recommend dosing every 2 months[21] and others advise a one-off dose mid-winter.[10,15] There is caution around overdosing vitamin D,[10,21] with one report of mortality from dosing at 6300 IU/kg[20] and further mortalities recorded in three cria given a higher average injectable dose of 75,000 IU/kg.[22] As of January 2023, Belavit AD3E (Bimeda) was the only licensed injectable vitamin D product in the UK; however, cascade use is required, as there is no camelid licence for this product.[20]

Details can be found on recommended methods to trim alpacas' feet; however, information is vague about how often it is required. Some literature simply states that they need to be trimmed regularly,[3] while others elaborate that the frequency of trimming depends on the climate.[10] The literature appears to be lacking regarding whether the frequency of foot trimming should be routine for a herd or dependent on the individual. However, there is anecdotal evidence that light nails require trimming more frequently than dark nails.[23]

With the rapid growth of the alpaca population in the UK and the lack of an evidence base regarding routine procedures, including foot trimming frequency, vaccination and vitamin D administration, this study aimed to investigate what, if any, routine husbandry procedures are performed on alpacas in the UK. These procedures also included shearing and microchipping.

MATERIALS AND METHODS

The survey was created using Jisc Online Surveys and tested by a farm veterinarian and alpaca owner prior to distribution. It consisted of 47 questions (open [n = 6] and closed [n = 41]), 14 of which were compulsory. The survey was split into the following sections: demographics (n = 7), husbandry and management procedures (e.g. shearing, microchipping, foot trimming, vaccinating, vitamin D) (n = 32) and anthelmintic usage (n = 8). Throughout, participants had the option to provide more detail about their answers and make further comments about each section.

The online survey was distributed via the BAS e-Newsletter (estimated at 1500 members), social media (Facebook and Instagram) and word of mouth. The survey was available between 9 March and 27 July 2022.

Data analysis

Within the survey, data were collected on anthelmintic husbandry procedures. These are not presented in the current paper, but will form a subsequent manuscript.

The data from Jisc Online Surveys were manually exported to Microsoft Excel (Microsoft 365 MSO, version 2210) to consider any answers given under the 'other' option that fit into a predefined category. With these data, graphs were made using Excel. The geographic heatmap was created by manually inputting the data into www.mapchart.net/uk.html. The injection site heatmap was made using the application Paint (Microsoft Windows 8, version 6.3, 2013). Vitamin D dose data, with an assumption of the average weight of an alpaca to be 65 kg (average of both sexes),[24] have been converted to the same units to allow for comparison (with results being rounded to the nearest 500 IU/kg). Of the 63 participants that answered this question, there were 85 individual responses, but 36 were excluded due to doses indicated for yearlings and cria, non-specific or unknown doses. Where a range was provided the upper value was used. The average weight of 65 kg was calculated

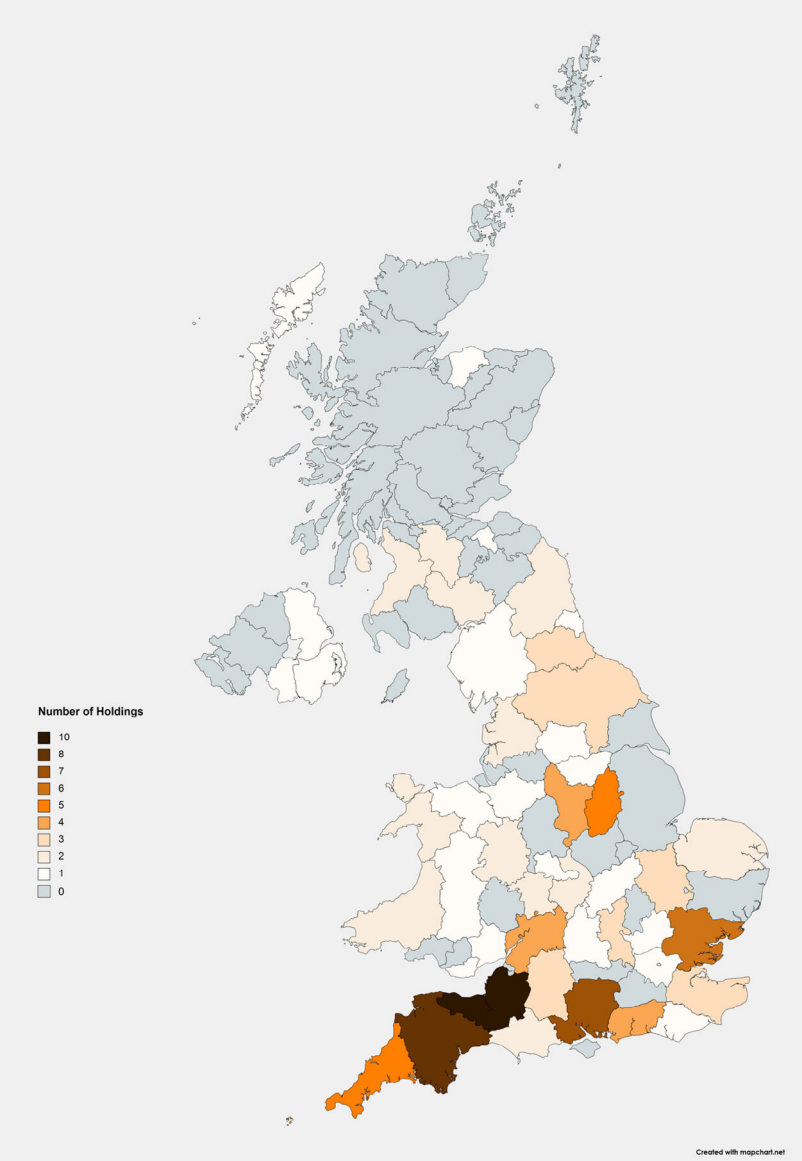

FIGURE 1 Heatmap depicting the geographical spread of respondents according to the county they reside in. The darker the colour, the more respondents from that county. Respondents came from all four countries of the UK, with a heavier distribution in the south of England

by averaging the minimum and maximum weight ranges from four papers and rounding to the nearest 5 kg.[9,15,17,25] The authors would like to highlight that the dose for Eggs-Port Triple D paste (Eggs-Port) may be an underestimate. The product contains three types of vitamin D; however, the doses stated have been calculated using only one of the formulations of cholecalciferol. The medicine details for the vaccines and vitamin D products were sourced from the data sheets[26–39] or, where unavailable, from personal communication with a representative of the manufacturer. Two responses were removed from the optional question regarding clostridial disease diagnosis by a veterinarian due to conflicting answers, owing to the fact they previously answered no to vaccinating their alpacas.

In regards to vaccine disposal practices, the following three categories, 'Discard it immediately as I always use the whole bottle in one go', 'Discard unused vaccine after the recommended period of time for use stated on the bottle has passed' and 'Discard unused vaccine on the day of broaching' for vaccine disposal, were grouped into 'Discard unused vaccine on the day of broaching' for clarity of results and to align with previous work.[40] The seasons were not defined in the survey, but following data analysis, we refer to spring as March to May, summer as June to August, autumn as September to November and winter as December to February.

Data from the survey were inputted into SPSS Statistics (IBM Corp., version 25, 2017). A crosstabulation table was formed for holding size and vitamin D administration route. Holdings were recategorised into two groups: less than or equal to 20 and 21 or more alpacas. The crosstabulation table was then used to perform a chi-square test on holding size versus use of injectable or oral vitamin D products. Statistical significance was considered if the p-value was less than 0.05.

RESULTS

Survey response

There were 119 responses, three of which were excluded. Two responses were excluded for being

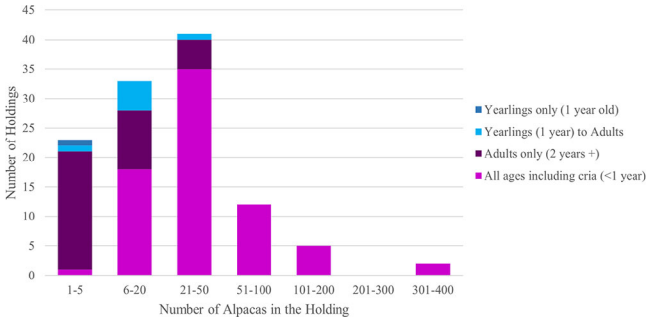

FIGURE 2 Number of alpacas on holdings in this survey, subdivided into age ranges of alpacas. For holdings with 1–5 alpacas, the predominant age is 'Adult only', whereas for holdings larger than this, 'All ages including cria' was the predominating category

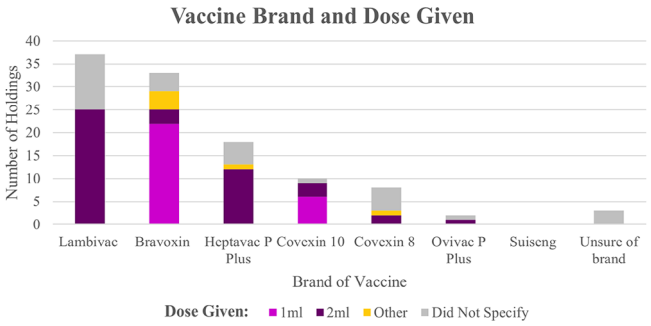

FIGURE 3 Number of holdings that use each type of vaccine, subdivided into the dose at which each vaccine is given. Lambivac (MSD) is most commonly used, with a 2 mL dose favoured for Lambivac (MSD), Heptavac P Plus (MSD), Covexin 8 (Zoetis) and Ovivac P Plus (MSD) and a 1 mL dose favoured for Bravoxin (MSD) and Covexin 10 (Zoetis)

from outside of the UK and another was excluded for ambiguous data. Of the remaining 116 responses, 111 respondents (94.8%) were the owners of their alpacas, four respondents (3.4%) were farmhands and one respondent (0.9%) described themselves as a student. A large proportion of respondents were based in south-west England (Figure 1).

The most common holding size was 21–50 alpacas, with most holdings owning alpacas of all ages (Figure 2). However, 48.2% of respondents had a herd size under 20, and only 6.0% had over 100 alpacas on their holdings.

General husbandry procedures

Of the 116 respondents, 106 (91.4%) reported microchipping their alpacas. Most holdings sheared their alpacas in the months of May and June (88.8%, 103/116), and all holdings sheared their alpacas between April and July.

Vaccination

Of the 116 respondents, 111 (95.7%) vaccinated their alpacas against clostridial disease. The most common brands of clostridial vaccine used were Lambivac (MSD) (33.3%, 37/111), Bravoxin (MSD) (29.7%, 33/111) and Heptavac P Plus (MSD) (16.2%, 18/111), at a 1 or 2 mL dose depending on the vaccine used (Figure 3).

Most alpacas are vaccinated yearly against clostridial disease (Table 1). The majority of holdings (95.5%, 105/110) had not knowingly had animals suffer from clostridial disease despite vaccinating with a clostridial vaccine (Table 1). Respondents were not asked if they changed vaccine products following veterinary diagnosis of clostridial disease.

Additional voluntary comments made in this section included the use of a different brand in cria (n = 3), vaccination of pregnant dams prior to parturition (n = 4) and that there is a notable lack of knowledge regarding vaccines for alpacas (n = 4).

TABLE 1 Participants' responses to the question regarding vaccination against clostridial disease

	Category	% (n)
How often do you vaccinate your alpacas against clostridial disease? (n = 111)	Primary course only	0.9 (1)
	Yearly	76.6 (85)
	Every 6 months	22.5 (25)
Veterinary diagnosis of clostridial disease despite vaccinating (n = 110)	Yes	4.5 (5)
	No	95.5 (105)

The majority of alpaca owners (77.8%, 84/108) disposed of their vaccine on the day of broaching (Table 2).

Subcutaneous injections

The most common injection site was the axilla region (37.9%, 44/116, Table 3 and Figure 4). Skin thickening around a previous injection site was noticed by 29.0% (31/107) of respondents, with 38.7% (12/31) occurring after injection of a particular product (Table 4).

Additional voluntary comments made in this section included certain individuals being more prone to skin thickening (n = 2), alternating sides for injection, that is, left and right (n = 3) and varying injection sites dependent on each alpaca and their loose skin (n = 4).

Vitamin D

Of the 116 respondents, 106 (91.4%) administered vitamin D to their alpacas. There is a trend (p = 0.034) for smaller holdings with less than 20 alpacas to use oral vitamin D products, compared to larger holdings with 21 or more alpacas who tend to administer injectable vitamin D preparations. Over half of respondents (54.3%, 57/105) administered vitamin D via injection (Table 5).

Additional voluntary comments made in this section included administration of a higher dose to dark adults (n = 1), previous suspicion of rickets in their

TABLE 2 Participants' responses to the question regarding vaccine disposal

	Category	% (*n*)
What do you do with your vaccine bottle once opened? (*n* = 108)	Discard unused vaccine on the day of broaching	77.8 (84)
	Discard unused vaccine 48 hours after broaching	1.9 (2)
	Discard unused vaccine after a week or more since broaching	4.6 (5)
	Keep unused vaccine to use next time	5.6 (6)
	Other	10.2 (11)

TABLE 3 Participants' responses to the question regarding which subcutaneous injection site they used

	Category		% (*n*)
Where on the alpaca do you administer under the skin (subcutaneous) injections? (*n* = 116)	1	Head	0.0 (0)
	2	Upper neck	0.9 (1)
	3	Lower neck	16.4 (19)
	4	Along the back	4.3 (5)
	5	Tail and tail base	0.0 (0)
	6	Over the thigh	16.4 (19)
	7	Groin area/in front of the back leg	0.9 (1)
	8	Over the abdomen	2.6 (3)
	9	Over the rib cage	20.7 (24)
	10	Area of the armpit/behind the front leg	37.9 (44)
	11	Over the shoulder	37.1 (43)
	12	Front leg	0.0 (0)
	13	Back leg	0.0 (0)

Percentages may exceed 100% as multiple answers could be chosen.

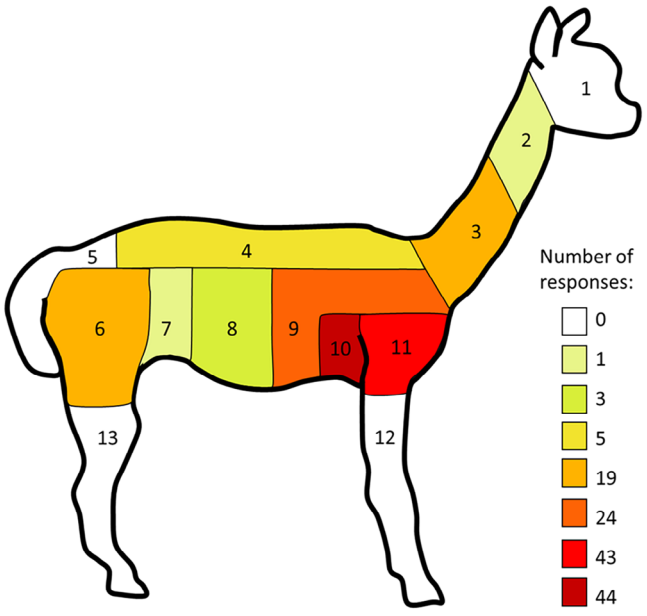

FIGURE 4 Heatmap depicting the choice of subcutaneous injection sites on an alpaca. Participants were able to choose more than one area. The numbers on each area on the diagram refer to the sites listed in Table 3. The colour refers to the number of responses for each area and correlates to the key

alpacas (*n* = 6) and preference of injectable product if available (*n* = 8).

The most popular brands of vitamin D supplement were Belavit AD3E (Bimeda) (37/93) for injectable administration and Eggs-Port Triple D (Eggs-Port) (24/93) for oral administration (Figure 5).

TABLE 4 Participants' responses to the questions regarding skin reactions following subcutaneous injection

	Category	% (*n*)
Have you ever noticed any thickening of the skin around a previous injection site? (*n* = 107)	Yes	29.0 (31)
	No	71.0 (76)
Was this noticed after the use of a particular product or generally after any subcutaneous injection? (*n* = 31)	Generally	41.9 (13)
	Particular product	38.7 (12)
	Unsure	19.4 (6)

The most common dose for injectable vitamin D was 2000 IU/kg; however, there were a variety of dose ranges (Table 6). The doses for oral vitamin D were even more variable and brand dependent (Table 6).

The timing of administration of vitamin D throughout the year and the frequency of administration varied substantially, both with oral and injectable vitamin D products. Only three respondents gave a one-off dose in winter. Most vitamin D administration occured over winter and the least occured over summer, for both oral and injectable products (Figure 6). Injectable products were given more commonly than oral products in autumn, winter and

TABLE 5 Participants' responses to the questions regarding vitamin D administration

	Category		% (*n*)
How do you administer vitamin D? (*n* = 105)	Injection		54.3 (57)
	Orally/on feed		40.0 (42)
	Both		3.8 (4)
	Prefer injection but unavailable		1.9 (2)
Do you administer vitamin D to all of your alpacas or only to certain groups? (*n* = 105)	All alpacas		95.2 (100)
	Cria		1.0 (1)
	Yearlings to adults		1.0 (1)
	Only those exhibiting signs of a deficiency		1.0 (1)
	Other	Cria and yearlings	1.0 (1)
		Cria, yearlings and black adults	1.0 (1)

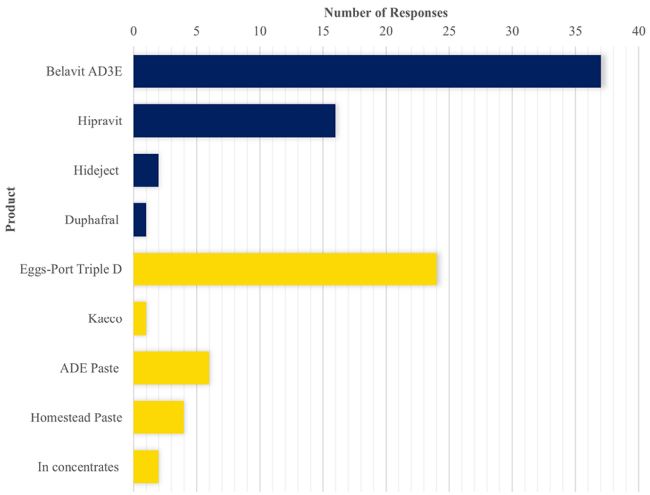

FIGURE 5 Number of respondents that used each type of vitamin D product (*n* = 93). Injectable products are shown in blue and oral products are shown in yellow

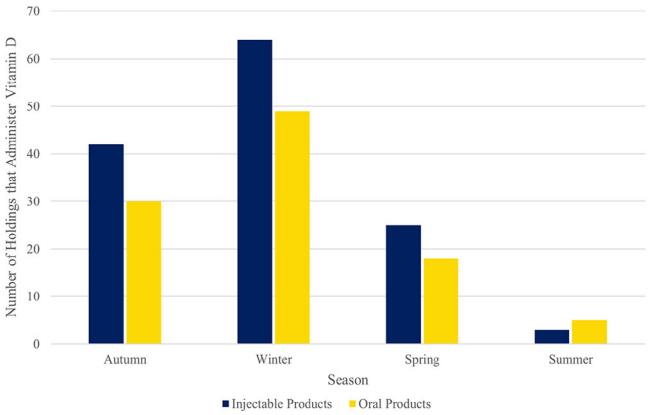

FIGURE 6 Number of holdings that administer injectable and oral vitamin D in each season. More than one season could be chosen. The range for each season was not defined in the survey. Spring is defined as March to May, summer is June to August, autumn is September to November and winter is December to February

spring. However, in summer, the use of vitamin D products, although very low compared to other seasons, had higher use of oral products than injectable products.

TABLE 6 Vitamin D doses by brand.

	Dose (IU/kg)	% (*n*)
Injectables		
Belavit AD3E (Bimeda) (*n* = 37)	1000	16.2 (6)
	1500	8.1 (3)
	2000	19.0 (7)
	2500	13.5 (5)
	3000	5.4 (2)
	10,000	2.7 (1)
Hipravit (Hipra) (*n* = 16)	1000	6.3 (1)
	1500	12.5 (2)
	2000	18.8 (3)
	2500	18.8 (3)
Hideject (Bayer) (*n* = 2)	11,500	50.0 (1)
	50,000	50.0 (1)
Duphafral (Zoetis) (*n* = 1)	2000	100.0 (1)
Oral		
Kaeco (Kaeco Group) (*n* = 1)	3000	100.0 (1)
Homestead Paste (Homestead Farm Supplies) (*n* = 4)	1000	25.0 (1)
	1500	25.0 (1)
Eggs-Port Triple D (Eggs-Port) (*n* = 24)	128,500	4.2 (1)
	334,000	4.2 (1)
	385,500	29.2 (7)
	8,350,000	4.2 (1)

Proportions may not equal 100.0% as not all respondents provided a dose. To standardise and enable comparison, an assumed adult weight of 65 kg was used to convert the total dose to IU/kg to the nearest 500. A total of 63 respondents answered this question, for which 85 individual doses were provided. A total of 16 responses were excluded due to nonspecific or unknown doses

Foot trimming

Of the 116 respondents, 116 (100.0%) trimmed their alpacas' feet. The majority were trimmed as needed (75.9%, 88/116). On average, foot trimming occured every 3–4 months (every 3 months 39.3%, three times a year 29.5%), regardless of whether it was performed routinely or as needed (Table 7).

Additional voluntary comments made in this section included giving access to harder ground to

TABLE 7 Participants' responses to the questions regarding foot trimming

	Category	% (*n*)
Are their feet trimmed routinely or as needed? ($n = 116$)	Routinely	24.1 (28)
	Individually as needed	53.4 (62)
	All alpacas as needed	22.4 (26)
If previously answered 'routinely', how often are their feet trimmed? ($n = 28$)	Yearly	10.7 (3)
	Every 6 months	3.6 (1)
	Every 3 months	39.3 (11)
	Monthly	25.0 (7)
	Other	21.4 (6)
If previously answered 'as needed', how often do you need to trim their feet? ($n = 88$)	Once a year	9.1 (8)
	Twice a year	15.9 (14)
	Three times a year	29.5 (26)
	More than three times a year	27.3 (24)
	Once a month	1.1 (1)
	Other	17.0 (15)

increase wear on toenails ($n = 3$), carrying out foot trimming at shearing with checks in between ($n = 8$) and that lighter-coloured toenails need trimming more often than dark-coloured toenails ($n = 19$).

DISCUSSION

Respondents originated from all four countries in the UK, with more situated in southern England. From this survey, it appears that alpaca herd size has increased over the past 30 years, with herd size rising from an average of four in 1992[2] to the most common herd size of 21–50 in 2022 within this study. The majority of respondents' alpacas are microchipped, which may reflect the distribution of the survey via the BAS e-Newsletters, as a microchip is a requirement of being registered with the society.[41] All respondents reported shearing their alpacas annually, which follows the recommended best practice for alpaca welfare.[42]

Vaccination

Alpaca owners are continuing to use farm animal vaccines against *Clostridia*, aligning with previous guidance to use sheep vaccines.[9] Although different brands of vaccines are used, currently the most popular is Lambivac (MSD). However, this choice may have been affected by the availability of vaccines, as Heptavac P Plus (MSD) was difficult to obtain at the time of the survey.[4,41] Multiple vaccines have proven successful in reducing mortality in previous trials,[5–7] which is reflected in the fact that only five respondents within our survey (4.5%) reported a possible vaccine failure. It is unknown whether the failure was confirmed by laboratory diagnosis as this question was not included in the survey. However, education around vaccine disposal may be of value, as Table 2 shows that around a quarter of alpaca owners do not discard open vaccine bottles within the correct time frame. Further studies into storage, method of administration and immune response to vaccines, as well as research into gastrointestinal clostridial diseases and how they affect alpacas, are required to help guide vaccine recommendations in alpacas.

The lack of licensed products and dosing regimens has resulted in the majority of respondents in this study following sheep dosing regimens regardless of the brand they used. Over 75% of owners gave boosters annually, as per recommendations,[3,10] with a further 22.5% dosing every 6 months. This 6-month interval may be excessive, as one study found that a higher antibody titre still remained after a year.[11] However, this study only included seven alpacas, and no challenge study was performed; therefore, no specific dosing interval can be recommended from these limited data. A design flaw in the present survey is that there was no question referring to prepartum booster vaccination. Therefore, a further survey could investigate if implementation of prepartum boosters is routine for breeding herds, to better define if owners perceive the immunological benefit for the cria to outweigh the risk of stress-induced abortions.[3,9,10]

Subcutaneous injections

As recommended by various professionals over the years,[9,10,13] the axilla remains the most common site for subcutaneous injections. The second most common site was over the proximal aspect of the forelimb, which has not been recommended in recent years but has been suggested in the past.[9] However, this may reflect faults in the design of the question, as respondents could select multiple sites in their answer and this location is adjacent to the most popular and recommended site. Within the same area of the alpaca, over the ribs was the third most popular site, corresponding with the thoracic region recommendations.[3,13]

Interestingly, the injection site over the thigh was selected by 19 respondents, which has not been recommended in past literature. It is likely that this area has not been recommended due to the risk of injury from a kick. To avoid potential injury, and as training opportunities are becoming available for alpaca owners,[44] safe use of medicines training with alpacas could be offered, since training on vaccine administration has been both beneficial and wanted in other farm species.[40]

As owners report that they alternate sides and sites of subcutaneous injections, having several options for injection sites may benefit the alpacas themselves due to injection site reactions that have been reported in previous papers[3,14] and by almost a third of respondents in this study. One study attributed thickening to certain vaccines,[10] which all data sheets warn of.[26–39] Two respondents found that certain alpacas were more

prone to skin thickening than others, so it is plausible that these reactions are due to animal factors rather than drug factors. Future research into vaccine protocols, including efficacy and reactions in alpacas, would be valuable.

Vitamin D

Despite the issue of skin thickening, most owners used injectable vitamin D preferentially over oral preparations. Eight respondents noted that they preferred injectable preparations, should they be available, but there were difficulties accessing injectable vitamin D during the time the survey was open. It must be noted that questions regarding concurrent drug administration, medicine storage, administration hygiene and climatic conditions, in relation to skin thickening, were not asked as this was out of the scope of the study. It is also statistically significant that respondents favouring oral administration have smaller holdings, which may relate to logistics, as the product of choice, Belavit AD3E (Bimeda), is only available in 100 mL bottles.[45] The majority of respondents administered vitamin D to all alpacas, but the present study omitted to ask if the dose varied by fibre colour. Darker-coloured alpacas need more vitamin D supplementation,[15,16] and two respondents in this survey did provide additional information that they dose differently for lighter- and darker-coated adults.

In regard to frequency of administration, there was no specific regimen that owners were following, and it varied with each herd. Only three respondents followed the advice to give a one-off dose in winter,[10,15] with all other holdings giving more frequent dosing. Overall, owners administered vitamin D more during winter and autumn, regardless of whether it was oral or injectable. This corresponds with alpacas having low levels of vitamin D in late winter and early spring,[15] and the autumn and winter dosing should help avoid this decrease. The decreased supplementation in summer is supported by the evidence that alpacas have high levels of vitamin D after summer.[16]

The most popular injectable vitamin D product was the only product that is currently licensed,[20] Belavit AD3E (Bimeda), and the most popular oral product was Eggs-Port Triple D (Eggs-Port) (n.b. as stated in the methods, doses for this product may have been underestimated). The most common injectable dose administered was 2000 IU/kg, which is the top end of the recommended dosing range,[15,19] yet in the present study there were several holdings that dosed higher. This may be due to limitations in rounding of converted data, as all respondents with 2500 IU/kg rounded answers would round to 2000 IU/kg if an average weight of 70 kg is used. In the future, establishing holdings' estimated weight of their alpacas is essential to reduce possible errors in conversion. Further variation was seen with oral product dosing, but despite a recommendation of 1000 IU/kg,[12,20] many were dosing substantially higher than this. One study found that the oral bioavailability of vitamin D is lower than expected,[46] but many professionals are reasonably concerned about overdosing.[10,20,21] The most common oral dose of vitamin D reported was 385,500 IU/kg, yet no respondent reported vitamin D toxicity in their alpacas. However, the authors acknowledge that antemortem signs can be both subtle and nonspecific in camelids and other farm species.[22,47,48] Data have shown that camelids are more resistant to acute vitamin D toxicity, with intramuscular doses as high as 64,000 IU/kg given without detrimental effects,[46] supporting the idea that these higher oral doses may not result in toxicity in alpacas. Care should always be taken to prevent iatrogenic vitamin D toxicity, but evidence suggests that the oral dose range could be investigated further in relation to vitamin D absorption, in order to aid in correct dosing and avoid the development of rickets.

Foot trimming

All alpaca owners surveyed were undertaking regular foot trimming, with over 75% of owners undertaking the procedure as required. Eight respondents who trimmed as needed elaborated further to state that they also routinely foot trim at shearing and adopt the as-needed approach otherwise.

Regardless of whether implemented as a routine or as-needed procedure, foot trimming is performed every 3–4 months. Climate has been thought to affect the frequency of trimming,[10] so further studies could investigate if the location of a herd affects the frequency of foot trimming. However, some respondents do give access to harder ground in order to wear down toenails. A curious aspect is that one in six respondents had noted that lighter-coloured toenails need trimming more often than darker-coloured toenails. In cattle, white hooves have been shown to have a higher incidence of sole ulcers than dark hooves.[49] A review of cattle hoof quality comments on darker claws being harder than lighter ones.[50] Establishing the growth rate of toenail wear in both light- and dark-coloured nails of alpacas could be investigated further.

Limitations

Despite a lengthy survey questionnaire, the authors would like to highlight potential limitations due to a lack of questions surrounding management procedures not covered, including ear tagging, body condition scoring and dental trimming. Additionally, specific detailed questions on the dosing of vitamin D dependent on fibre colour were not asked. As highlighted, a high proportion of alpacas in this study were microchipped, which is likely to be linked to the sharing of the survey by BAS. In future surveys, widening participation from non-registered alpaca owners will be important, and a clarifying question regarding BAS registration will help inform this. Another area for future investigation would be to determine the reasoning behind vitamin D product choice.

CONCLUSION

All alpaca holdings, regardless of size, implemented routine husbandry procedures, with 100.0% undertaking shearing and foot trimming. The majority of holdings also vaccinated against clostridial disease and supplemented with vitamin D. However, there was variation in the type and frequency of clostridial vaccination. Vitamin D administration was extremely variable and showed no clear pattern in supplementation protocols. Some of these differences may be due to logistics, as holding size was significantly associated with the decision to use injectable or oral vitamin D products, with smaller holdings preferring oral products. It is clear that further research is required to establish gold standard vaccine and vitamin D supplementation protocols in the UK.

AUTHOR CONTRIBUTIONS

Study idea, planning and design were undertaken by Beth Reilly and Abby Middleton. Abby Middleton designed the survey with input from Nicola Blackie, James Patrick Crilly and Beth Reilly. Abby Middleton analysed the data. Abby Middleton prepared the manuscript, with support from Nicola Blackie, James Patrick Crilly and Beth Reilly. The revisions to the final manuscript were done by Abby Middleton, Nicola Blackie and Beth Reilly.

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CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

Ethical approval was given by the Royal Veterinary College's Social Sciences Research Ethical Review Board (URN: SR2022-034).

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