

Camel welfare: survey on camel caretakers' perspectives

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Abstract

Animal welfare depends on caretakers' handling and management skills. The study aimed at gaining information on camel caretakers' backgrounds, their perceptions of welfare and management practices and at investigating associations with camel health and behavioural problems. The study was conducted at a camel market in Qatar and 49 caretakers were interviewed (29 questions). Caretakers were male, mainly from Sudan (91.7%; $P < 0.001$), and had mainly learned camel management from family members (81.6%; $P < 0.001$). Camels were mainly from Qatar, reared for milk, breeding or meat. The majority of the caretakers under 30 years took care of camels reared as breeding animals or for milk production ($n=12$, 75.0%), while the caretakers over 40 years took care of camels for dual-purposes ($n=7$, 46.7%; $P < 0.05$) or meat ($n=4$, 26.7%). Camels received rationed feed and water (87.6%, 53.1%, $P < 0.001$), and were dewormed regularly (96.8%, $P < 0.001$) but not vaccinated (72.9%; $P < 0.001$). Respondents experienced at least one camel with a behavioural (45.8%) and a health (87.8%) problem and associations between management practices and those problems were found. Behavioural problems were associated with the number of health problems, suggesting that sick camels tended to show behavioural modifications. Caretakers ranked their ability to recognise a camel in distress/pain as high, reporting that the first sign was a change in behaviour. The caretakers' understanding of animal welfare was, however, low, missing the overall meaning of the concept; most caretakers defined animal welfare according to only one (52.2%) welfare principle. Overall, early and appropriate treatment of camels with health and behavioural problems, an increased presence of veterinarians at camel farms, and education on camel behaviour and welfare are recommended.

Keywords: behaviour, dromedary camel, health, management, welfare

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1. Introduction

Old World camels are large animals of the Camelidae family including two domesticated species, one-humped dromedaries (*Camelus dromedarius*), and two-humped Bactrian camels (*Camelus bactrianus*). According to the latest Food and Agriculture Organization of the United Nations (FAO) statistics in 2018, the total number of camels in the world was around 35 million head, mainly distributed in Asia and Africa. Qatar had over 95,000 camels and, similarly to countries like Algeria, Syria, and UAE, has experienced recently

a significant increase in the number of head (FAO, 2020). This progressive increase could be a consequence of climate changes making prohibitive the breeding of other species vulnerable to frequent droughts, like cattle (Wako et al., 2017). Thanks to efficient physiological mechanisms, dromedary camels are productive even under extremely harsh conditions, so non-camel herding pastoralists are also breeding this species as an adaptation strategy to the climate changes (Wako et al., 2017). Other than to its extraordinary adaptability, the potential of the camel is also due

to its wide range of productions: milk, meat, wool, skin, fat, transport, race, agricultural work, riding, tourism, and many cultural events (Faye, 2014; Zarrin et al., 2020). Consequently, it may become very popular in other countries in the future.

Camel husbandry has been the core of some pastoralists' culture. However, farming systems not only change according to the breeding purpose, but also to the local ecology, preferences, and cultures of the pastoral communities (Faye, 2013). The camels for meat production, for example, are slaughtered at a young age in some regions, whereas adults are preferred in others (Burger et al., 2019). Usually, milk is consumed fresh in camel countries (Faye, 2018) but its excellent nutritional qualities have recently attracted the attention of the urbanised world (Faye et al., 2008; Burger et al., 2019). Thus, the diversification of camel dairy products is developing and many of its beneficial properties have been identified (Mirmiran et al., 2017; Ayyash et al., 2020; Ming et al., 2020; Yasmin et al., 2020). Despite this growing global interest, many aspects of camel husbandry are overlooked, including those related to animal welfare in different production systems.

The "Terrestrial Code" of the World Organisation for Animal Health (OIE), for example, defines specific recommendations for several species, indicating general directives for animal transport and slaughtering, but not taking into account the camelid species. Like other guidelines for the welfare evaluation of livestock, the "Terrestrial Code" recognises the "five freedoms" concept as valuable guidance in animal welfare (Brambell, 1965; McCulloch, 2013). The OIE pointed out that disease diagnosis, surveillance, and prevention as well as the quality of veterinary treatments are crucial to ensuring good animal welfare. The role of disease susceptibility, in addition to abnormal behaviours, was also emphasized in the list of welfare measurements proposed by Broom (Broom, 1991; Broom, 2006). However, this aspect has been poorly investigated in camels (Sazmand and Joachim, 2017; Pastrana et al., 2020). Camels have also been overlooked by the largest-ever European research project on animal welfare, the Welfare Quality® project (Blokhuis et al., 2010). The latter focuses primarily on the animal-based

indicators and proposes four welfare principles that can be considered a useful guideline for achieving animal welfare: good feeding, good housing, good health, and appropriate behaviour. Welfare Quality® researchers also developed standardised measures, specific for several species, to check compliance of farms to these welfare criteria, but the camel is missing (Blokhuis et al., 2010) even though camel farming tourist activities and camel owners' associations are rising in Europe (Faye et al., 2013).

Importantly, the Terrestrial Code underlined that the responsibility for the humane handling and care of the animals belongs to the caretakers and they should have sufficient skills and knowledge to ensure that animals are treated following animal welfare principles (OIE, 2019). In this context, the spontaneous questions are: Who are the camel caretakers? Are they able to identify basic aspects of welfare such as pathologies and abnormal behaviours? What does animal welfare mean to them?

Consequently, hypothesizing that the demographic characteristics of the caretakers and their management choices would influence camel health, behaviour, and welfare, this study aimed at describing the main features of the camel caretakers working in a camel market in Qatar, including their opinions on animal welfare, and exploring possible associations between their demographic characteristics and backgrounds, as well as their management choices, and health and behavioural problems reported in the camels in their care.

2. Materials and methods

2.1 Respondents

The study was carried out at the Doha dromedary camel market in Qatar from the 11th to the 18th of September 2019. The target population of the survey was workers taking care of the camels. The market is composed of 92 paddocks, with some areas equipped with shelters, pens, water, and cooking facilities, where the majority of the caretakers used to live. During the study, only 76 pens were occupied with animals, with a variable

number of animals per pen (average: 7, range: 1-37 animals). The more crowded pens housed young camels for meat production. During the study, a total population of 528 camels was present at the market. A native Arabic speaker (AZ) approached the camel caretakers (caretakers of the camels kept at the market), asking for voluntary consent to take part in a research project and to reply to some simple questions. Before starting the interview, participants were informed that the research project was run with the permission of the Department for Agriculture Affairs & Fisheries of the Ministry of Municipality and Environment of the State of Qatar and their identity would be kept anonymous. For the first three days, caretakers (particularly if young) showed some reluctance to take part in the survey, suggesting involving more experienced (older) caretakers. A young man, popular at the market, was then involved as a guide (or cultural facilitator) for introducing AZ to caretakers and for better explaining to them the main idea behind the interview. Interviews were run in a friendly manner over 11 days, conducted in the caretakers' housing during resting or convivial moments (breakfast, teatime). Most of the interviews were carried out in the morning before or after the working activities, whereas, for some caretakers with another job (i.e., work at a nearby sheep market), interviews were carried out in the afternoon. Each interview usually lasted about 20 minutes, but some lasted longer because the caretakers often told personal stories or were pleased to show their animals or to talk about routinely used equipment or medicaments with AZ. Approximately 4-5 interviews were completed per day. The caretakers were chosen randomly day by day, and all the caretakers working at the market in that period (n=49) were interviewed before the end of the study. During interviews, answers were recorded in Arabic then translated into English, during the afternoon, for the subsequent analysis.

2.2 Survey

Key design features required to ensure valid questionnaire results, recently reviewed by Dean (2015) and Christley (2016), were addressed in the study design. The survey (Appendix A) consisted of 27 closed and 2 open-ended questions that sought to elicit from respondents the following points: i) their demographic details (gender, age,

country of origin, length of permanence in Qatar and at the market, level of education); ii) information on their involvement with the camel industry (the nature of their involvement with camels (professional or amateur) and the specific type of activities in which they participated); iii) their camel or other animal handling related experience, education and training (experience in animal and camel handling, from where they learned about camel management, understanding of animal welfare); iv) their ability to recognise a camel in distress; v) their pen and camel details (number of camels in their care, management practices and decision-making processes related to camel health). In addition to soliciting the information described above, survey respondents were asked to respond to questions that described whether their camels suffered from behavioural and health problems over the previous year. The survey was developed by a process of iterative review by the researchers, piloted by AZ with 5 camels' breeders/caretakers. During the pilot, it was realised that the understanding of animal welfare (Q11) was very low, so AZ decided to skip Q11 and ask directly "What is animal welfare to you?" after introducing the concept of animal welfare using a *hadith* (talk/discourse) of the Prophet. Contrariwise, all caretakers easily replied to Q12, about ranking their ability to recognize a camel in distress/pain, replying to the other open-end question with confidence.

2.3 Data analysis

All analyses were performed using SPSS version 25.0 statistical analysis software (IBM Inc., Chicago, IL, USA) while GraphPad Prism, version 7.0 (GraphPad Software, San Diego, California USA), was used for data visualization. A P-value < 0.05 was considered statistically significant.

Descriptive statistics were used to present data as mean and standard deviation (SD), median and range or interquartile range (Mdn), number and percentage. The age and background of caretakers were further categorized in fewer levels as shown in Table 1. Then, a chi-square goodness of fit test was used to compare the observed distributions

with the expected probability distributions (each assuming all categories equal).

The mutual associations between the demographic characteristics, productive purposes and management choices of the caretakers were assessed using a chi-square test of independence. Independence tests were also used to evaluate the association between these variables and welfare perception. In addition, Generalized Linear Models (GLMs) were used to investigate whether demographic features, productive purpose and management choices of caretakers as well as their perception of animal welfare influence the health and the behaviour of camels (as perceived by the caretaker). The odds ratio (OR), 95% confidence interval (95%CI), and the P-value of the Wald statistic were calculated.

2.3.1 Outcome variables included in the Generalized Linear Models

Items related to health and behavioural problems as well as the question about the caretakers' ability to identify camel distress were included as dependent variables. The zero-one coding was used for each of the following variables: pathology, colic, diarrhoea, respiratory problems, skin problems, overheating, behavioural problems, aggression, anxiety, escaping from the pen. Then, they were treated as binary variables by using binomial distribution and logit link function in the GLMs. Furthermore, the number of the reported pathologies was calculated; normal distribution and identity link function were used to analyse the factors associated with the number of pathologies. Finally, the question "*How do you grade your ability in identifying a camel in distress/pain?*" (3 valid levels, *Moderate to Very high*) was treated as an ordinal dependent variable so that multinomial and cumulative logit were, respectively, the distribution and the link function used in the GLM.

2.3.2. Predictive variables included in the Generalized Linear Models

The main variables included as a predictor are listed in Supplementary Table 1 (see also Table 5). For statistical purposes, the variables relating to

feeding and watering management have been further categorized as "rationed" and "ad libitum" supply. The number of pathologies was treated both as the dependent and independent variable. When the question "*How do you grade your ability in identifying a camel in distress/pain?*" was the outcome, all the pathologies coded zero-one were also considered as independent variables.

In addition to the items of Table 5, the effect of the caretakers' welfare perception was investigated. Thus, the answers to the open question "*What is animal welfare to you?*" were categorized according to the Welfare Quality® scheme. The four categories were the four principles: (1) good feeding, (2) good housing, (3) good health, and (4) good behaviour. The last category (good behaviour) included responses like "good treatment of camels", "love them", and "respect them" (Table 2). Each caretaker's answers could be included in one or more categories. Thus, four different zero-one coded variables were created and analyzed separately. Finally, the number of principles indicated by each caretaker was calculated and included as an independent variable (4 levels: 1-4 principles).

3. Results

3.1. Demographic data of participants

Table 1 shows the demographics and backgrounds of the participants. All the caretakers were male while the distribution in the age categories was heterogeneous ($P > 0.1$). Almost all had previously worked with animals (95.9%; $P < 0.001$) and, in particular, with camels (87.2%; $P < 0.001$). About half of the respondents claimed to have more than 15 years of experience in the management of camels (49.0%; $P < 0.001$) and almost all had learned to take care of them from family members (81.6%; $P < 0.001$). Most of the caretakers were from Sudan ($n=44$, 91.7%; $P < 0.001$) and had moved to Qatar for more than a year ($n=45$, 91.8%, $P < 0.001$).

Table 1. Demographic data of participants (n=49). Participants' backgrounds and professional expertise

Variable	Category	Count	N %	P value
Age	<30 ys	16	33.3%	.939
	31-40 ys	17	35.4%	
	>40 ys	15	31.3%	
Level of education?	No school	19*	38.8%	P<0.001
	Elementary	12*	24.5%	
	Medium	2	4.1%	
	High school	14*	28.6%	
	University	2	4.1%	
When did you start working at the camel market in Doha?	Less than 1 y	5	10.2	<0.001
	More than 1 y	44*	89.8%	
Did you work with animals before starting working at the market?	No	2	4.1%	<0.001
	Yes	47*	95.9%	
What species have you worked with?#	Camels	41*	87.2%	<0.001
	Cow	19*	40.4%	
	Buffalo	5	10.6%	
	Goats	9	19.1%	
	Sheep	21*	44.7%	
	Horses	2	4.3%	
How long years have you worked with animals before working at the market?	0-5 y	10	21.7%	0.026
	6-10 ys	10	21.7%	
	11-15 ys	6	13.0%	
	>15 ys	20*	43.5%	
How many years of experience with handling camels?	0-5 ys	11	22.4%	0.001
	6-10 ys	8	16.3%	
	11-15 ys	6	12.2%	
	>15 ys	24*	49.0%	
Where have you learned to take care of camels?	Father or relatives, friends, family business or nomads	40*	81.6%	<0.001
	During this job	9	18.4%	

#multiple choice answer; * higher observed number with respect to expected (all categories equal)

Table 2. Categorisation of answers to the question “What is animal welfare to you?” into the four welfare principles with examples taken from the original responses

Question	Welfare principle	Examples of an answer in English	Example of an answer in Arabic
What is animal welfare to you?	Good feeding	Give the feed and drink	تقدم لها الأكل والشراب
	Good housing	It means that the animals are comfortable; clean the pen	تعني راحة الحيوان؛ تنظف له المحل
	Good health	Treat the animals when they are sick; If the animals are sick I treat them	تعالجوا لما يكون مريض؛ اذا كان مريض تداويه
	Good behaviour	Do not hit them, treat them kindly; treat them with affection; Give them compassion and love, I don't tolerate when other persons hurt them	لا تضرب الحيوان وتعاملوا لطيف؛ تعامل الحيوان بلطف؛ تشفق على الحيوانات وتحبهم، أنا لا أتسامح عندما يؤذيهم أشخاص آخرون

Table 3. General management of camels

Variable	Category	Category	N %	P value
Why are the camels at the market? #	Slaughtered	5	10.2%	0.002
	As live (Milk, Breeding or Race)	25	51.0%	
	Both utilisation	19*	38.8%	
Who decides about the management of the camels?	Experience	33*	70.2%	<0.001
	Owners	14	29.8%	
How often do you feed them?	Once a day	1	2.0%	<0.001
	Twice a day	31*	63.3%	
	Three times a day	6	12.2%	
	Feed always available	11	22.4%	
How often do you water them?	Once a day	2	4.1%	<0.001
	Twice a day	23*	46.9%	
	Three times a day	1	2.0%	
	Water always available	23	46.9%	
	Escape from male	2	6.1%	
	Lift tail	17*	51.5%	
	Belly swollen	3	9.1%	

#multiple choice answer; * higher observed number with respect to expected (all categories equal)

3.2. Origin and management of camels

The camels reared at the market mainly originated in Qatar (n=46, 50.5%), Sudan (n=15, 16.5%), and Oman (n=14, 15.4%; multiple choice answers; P<0.001). Some subjects had been purchased in Saudi Arabia (n=4, 4.4%), United Arab Emirates (n=4, 4.4%), Kuwait (n=3, 3.3%), Pakistan (n=3, 3.3%) and Somalia (n=2, 2.2%).

Each caretaker took care of 2±1 paddock/s and almost everyone (n=43, 87.8%; P<0.001) split their job with other people (3±2). Most of them managed up to 10 (n=21, 42.9%) or up to 30 (n=22, 44.9%; P=0.007) camels. Only six caretakers claimed to manage more than 30 camels (12.2%).

The responses to the questions related to general management practices are shown in Table 3. The prevalent use of camels was for production as live animals (milk, wool, breeding; 51.0%) or as both live and slaughtered animals (meat; 38.8%; P=0.002). The chi-square test of independence showed that a greater proportion of the caretakers under 30 years old reared animals for milk or breeding (n=12, 75.0%), while the caretakers over 40 years old mainly reared animals for dual-purposes (milk and meat; n=7, 46.7%; P<0.05) or only for meat (n=4, 26.7%). Independence tests showed no other significant associations.

In most cases, camels were fed and watered twice a day (P<0.001). After categorization in “rationed” and “ad libitum”, it resulted that most camels were not fed ad libitum (38/49, 77.6%; P<0.001), while there was no difference between the number of caretakers who watered rationed (n=26, 53.1%) or ad libitum (n=23, 46.9%; P=0.668).

Responses to the questions related to health management are shown in Table 4. Most of the respondents stated that the health of the camels was assessed by a veterinarian (63.8%, P<0.001) called whenever an animal was sick (87.8%, P<0.001). The caretakers or members of their staff mainly used feeding (92.9%) and drinking (71.4%) behaviours as well as the body temperature (57.1%) as parameters to check camel health (P<0.05). In most cases, vaccinations were not conducted (72.9%), while deworming and treatments for ectoparasites were performed

regularly either by the caretakers themselves or by veterinarians (P<0.001).

Most of the respondents declared that their camels suffered from some pathology (87.8%, P<0.001) and half of them reported at least two different health problems in the previous year.

3.3. Health problems of camels and their associations with demographic aspects and managerial choices of the caretakers

Skin problems (51.0%), overheating (46.9%) and colic (36.7%; P<0.05) were the most frequently reported health problems, followed by diarrhoea (22.4%) and respiratory problems (22.4%; Figure 1A). Twelve caretakers (24.5%) reported other health problems such as cough, fever, neurological symptoms, brucella, blindness, injury, mastitis or muscular problems.

Risk factors for health problems are reported in Table 5 and Figure 1B. Caretakers under 40 years of age were more likely to report skin problems (OR=4.800; 95%CI=1.074-21.447; P=0.040) and a higher number of pathologies (OR=2.388; 95%CI=1.019-5.599; P=0.045) than caretakers over 40 years old. Years of working experience were negatively associated with colic (OR=0.932; 95%CI=0.870-0.999; P=0.048), while caretakers with fewer than 15 years of experience were more likely to report respiratory problems than those with over 15 years of experience (OR=11.000; 95%CI=1.270-95.178; P=0.029). Respiratory problems were also affected by breeding purpose as production for slaughter resulted as a protective factor (OR=0.065; 95%CI=0.008-0.563; P=0.013). Moreover, a lower odd of colic was reported when the camel management decisions were taken by experienced caretakers instead of the owners (OR=0.208; 95%CI=0.055-0.792; P=0.021).

Providing rationed feed was a risk factor for pathologies compared to ad libitum supply (OR=10.286; 95%CI=1.569-67.447; P=0.015) and it was positively associated with the number of pathologies (OR=3.191; 95%CI=1.446-7.042; P=0.004). Rationed water was a risk factor for overheating (OR=8.100; 95%CI=2.220-29.553;

P=0.002) and for comorbidity (OR=2.246; 95%CI=1.140-4.428; P=0.019).

Table 4. Animal's health management

Variable	Category	Count	N %	P value
Who assesses the health of the camels?	Myself	14	29.8%	<0.001
	Vet	30*	63.8%	
	Not conducted	3	6.4%	
If you or your staff members conduct the health check, please tick the specific parameters that you assess#	Heart rate	0	0%	0.017
	Temperature	8*	57.1%	
	Feeding behaviour	13*	92.9%	
	Drinking behaviour	10*	71.4%	
	Weight	2	14.3%	
	General health	3	21.4%	
Who administers vaccinations?	Myself	7	14.6%	<0.001
	Vet	6	12.5%	
	Not conducted	35*	72.9%	
Who administers deworming?	Myself	23*	47.9%	<0.001
	Vet	23*	47.9%	
	Not conducted	2	4.2%	
Who administers treatments for ectoparasites?	My self	35*	74.5%	<0.001
	Vet	7	14.9%	
	Not conducted	5	10.6%	
If an animals is sick, what do you do?#	Call a veterinarian	43*	87.8%	<0.001
	I treat the animals by myself	12	24.5%	
	Call the owners and he decides	14	28.6%	
	Call a friend with experience in camels	1	2.0%	
	Let it heal alone	0	0%	
Pathology (yes/no)	No	6	12.2%	<0.001
	Yes	43*	87.8%	
No of pathologies	Median and range	2 (0-6)		-

multiple choice answer; * higher observed number with respect to expected (all categories equal).

Other aspects affecting the pathologies were related to the veterinarian's intervention. First, the caretaker was more likely to report the presence of pathologies among his animals (OR=28.00; 95%CI=1.709-458.817; P=0.020; Table 4) and overheating in particular (OR=4.318; 95%CI=1.090-17.112; P=0.037) when the evaluation was conducted by a veterinarian compared to pens where animals were not monitored. Moreover, the monitoring conducted by

a veterinarian increased the number of diseases reported by the caretakers (OR=5.294; 95%CI=1.241-22.596; P=0.024). A higher number of pathologies was reported by the respondents taking care of camels vaccinated by a veterinarian (OR=3.704; 95%CI=1.313-10.450; P=0.013). Conversely, respiratory problems were less likely when the health assessment was conducted by a veterinarian (OR=0.205; 95%CI=0.046-0.913; P=0.038).

Table 5. Significance of Generalized Linear Models to evaluate the associations between demographic aspects and managerial choices of the caretakers and pathologies of camels

Variable†	Pathology #	Colic#	Diarrhoea#	Respiratory problems #	Skin problems #	Overheating #
Age of caretaker*	.514	.679	.810	.209	.119	.356
<30 ys vs >40 ys	.573	.833	.916	.194	.350	.350
31-40 ys vs >40 ys	.254	.530	.540	.078	.040	.154
How long have you worked with animals before working at the market? (years)	.088	.048	.796	.489	.190	.879
What is your relationship with camels before working at the market? Professional vs amateur	1.000	.595	1.000	.033	.931	1.000
How many years of experience with handling camels?*	.976	.998	.855	.133	.866	.476
0-5 ys vs >15 ys	.769	.949	.886	.058	.633	.656
6-10 ys vs >15 ys	1.000	1.000	.468	.238	.418	.226
11-15 ys vs >15 ys	.789	.850	.668	.029	.855	.211
Where have you learned to take care of camels?*	.909	.815	.093	.382	.764	.868
How many paddocks are you taking care of?	.356	.806	.208	.884	.961	.348
In your busiest week of the year, how many camels do you take care of?	.653	.236	.908	.934	.714	.977
Why are the camels at the market? Slaughter#	.364	.284	.084	.013	.067	.470
Why are the camels at the market? As live#	.240	.271	.334	1.000	.176	.541
Who decides about the management of the camels? Experience vs owner	.999	.021	.153	.587	.076	.465
Feeding management: rationed vs ad libitum	.015	.463	.252	.999	.084	.428
Watering management: rationed vs ad libitum	.089	.391	.148	.428	.879	.002
Who assesses the health of the camels?*	.065	.649	.933	.110	.748	.114
Myself vs not conducted	.085	1.000	1.000	.762	.464	1.000
Vet vs not conducted	.020	1.000	1.000	.038	.588	.037
Are the she camels mated? #	.423	.688	.677	.297	.262	.262
Do your camels show behavioural problems? #	.287	.456	.169	.475	.157	.754
Who administers vaccinations? *	1.000	.313	.293	.415	.957	.250
Who administers deworming? *	.989	.108	.522	.463	.612	.839
Who administers treatments for ectoparasites? *	.201	.196	.924	.799	.817	.446
If an animal is sick, what do you do? #	.118	.477	.719	.500	.957	.481
N° of pathologies	-	.002	.027	.072	<0.001	.007

† included as independent variables; *overall effect; # yes vs no; Bold values denote statistical significance at the $p < 0.05$ level. Relevant odds ratios with 95% confidence interval are reported in the text.

Finally, colic (OR=3.257; 95%CI=1.533-6.918; P=0.002), diarrhoea (OR=2.075; 95%CI=1.085-3.968; P=0.027), skin problems (OR=6.010; 95%CI=2.245-16.087; P<0.001), and overheating (OR=2.252; 95%CI=1.249-4.059; P=0.007) were positively associated with the number of pathologies, showing comorbidity.

3.4. Behavioural problems of camels and their associations with demographic aspects and managerial choices of the caretakers

Overall, about half of the respondents claimed that their camels exhibited behavioural problems (n=26, 45.8%; P=0.546). Most of them reported episodes of biting (35.4%) and kicking (20.8%), but aggression (16.7%) and anxieties (8.3%) were also reported (multiple choice answer; P=0.028; Figure 2A).

Risk factors significantly associated with behavioural problems are shown in Figure 2B. Caretakers under 40 years of age more likely reported behavioural problems in their camels (OR=4.800; 95%CI=1.074-21.447; P=0.040) than caretakers over 40 years. Moreover, feed rationing (OR=8.308; 95%CI=1.557-44.320; P=0.013) and the number of pathologies (OR=2.181; 95%CI=1.092-4.355; P=0.027) were positively associated with behavioural problems. In particular, the model estimated 2.5 ± 0.3 and 1.7 ± 0.3 pathologies for caretakers referring and not referring behavioural problems, respectively (mean \pm standard error). No other significant factors were found.

3.5 What is animal distress for camel caretakers and their ability to identify it?

Figure 3A summarizes the answers given to indicate how distress is identified by caretakers. The most frequent ones were “Animals not eating and drinking as usual or not ruminating” (77.6%), “Animals sleeping more and being tired” (36.7%), and “Animals lying down not walking well” (32.7%; P<0.001).

Caretakers were then asked to indicate their ability in identifying a camel in distress/pain. More than half (n=27, 57.4%; P=0.002) judged their ability as “High”, followed by “Very high” (n=12, 25.5%) and “Moderate” (N=8, 17.0%). None of them admitted that they had little or no ability in identifying distressed animals.

The factors influencing the caretakers' ability to identify distress were assessed with GLMs and are shown in Figure 3B. The caretakers under 30 years old were more likely to attribute a lower assessment capacity (OR=0.140; 95%CI=0.029-0.666; P=0.014). Similarly, the score was lower for caretakers with fewer than 6 years of experience with handling camels (OR=0.167; 95%CI=0.035-0.802; P=0.025) and working with animals for fewer than 6 years (OR=0.117; 95%CI=0.021-0.646; P=0.014) when compared with caretakers with over 15 years of experience in working with animals. Moreover, the ability to identify a camel in distress was lower in caretakers working at the camel market for less than a year (OR=0.042; 95%CI=0.004-0.482; P=0.011). Conversely, caretakers who raised camels for slaughter tended to attribute a higher score (OR=4.085; 95%CI=1.192-13.997; P=0.025). The score also increased when the health assessment was conducted by a veterinarian (OR=14.525; 95%CI=1.125-187.460; P=0.040). Finally, respiratory problems were less likely as the score increased (OR=0.202; 95%CI=0.046-0.890; P=0.034).

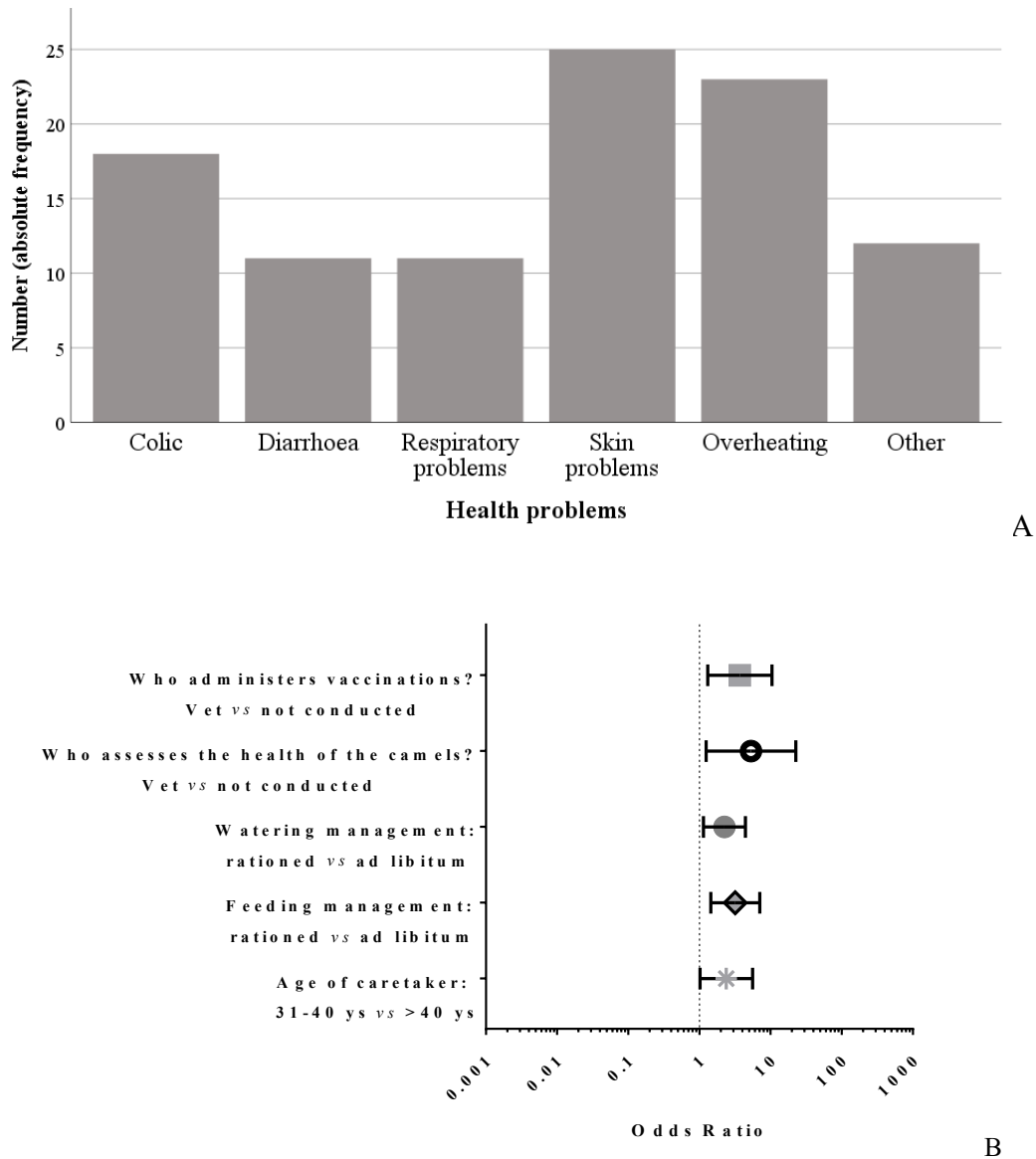


Figure 1. Health problems. The bar graph (Panel A) reports the number of caretaker answers that included the different types of pathologies (each handler could give more than one answer) while the forest plot (Panel B) shows odds ratio and 95% confidence interval for significant factors associated with the number of pathologies.

3.6. What is animal welfare for camel caretakers?

The responses to this question are shown in the word-art of Figure 4. Responses classified according to the four welfare principles of Welfare Quality® are presented in Figure 5A. In most responses, there were references to good behaviour and good feeding ($P < 0.001$). The chi-square test showed that an association of welfare perception and the age of the caretakers as “good feeding” prevailed among caretakers over 40 years old ($n = 6$,

54.5%) compared to the younger ones ($n = 1$, 9.1%; $P < 0.05$).

Most caretakers defined animal welfare according to one (52.2%) or two (28.3%) welfare principles; seven (15.2%) and two (4.3%) respondents indicated three and four principles, respectively ($P < 0.001$; Figure 5B). The number of welfare principles covered in the caretakers’ answers was not associated with any demographic, managerial or pathological factor

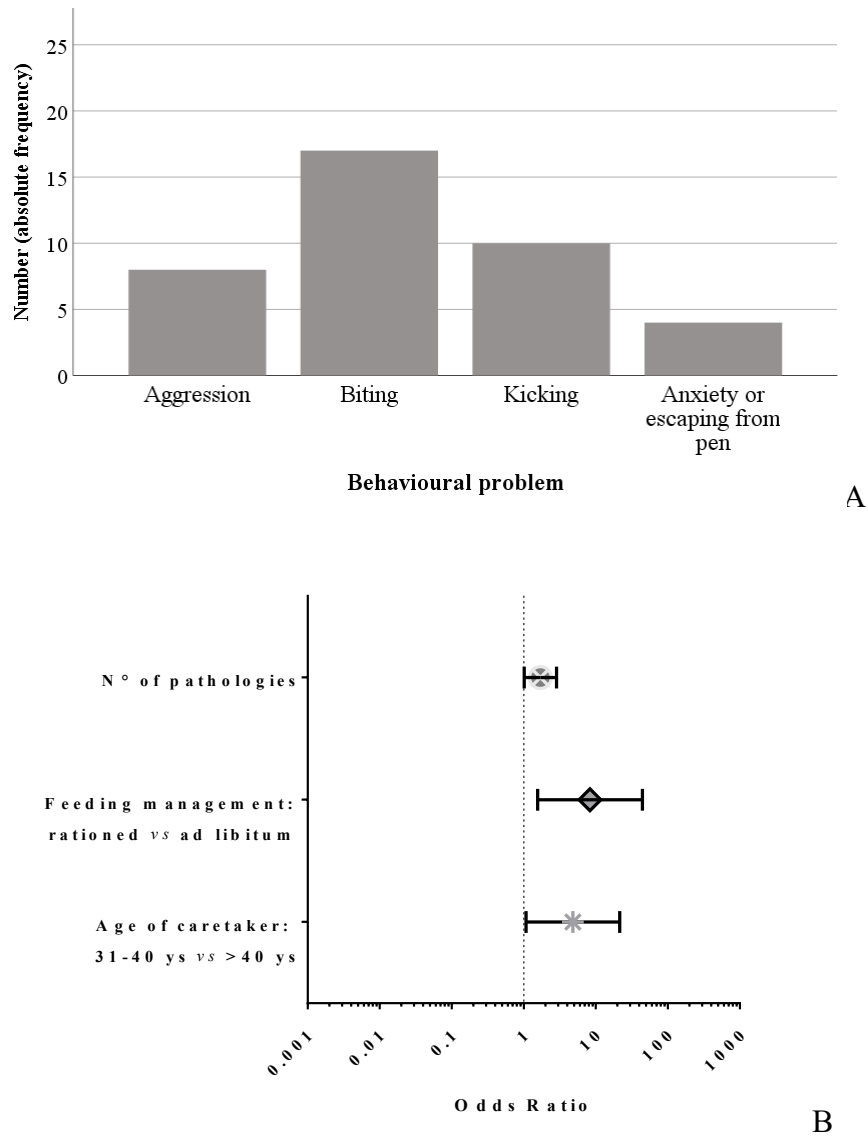
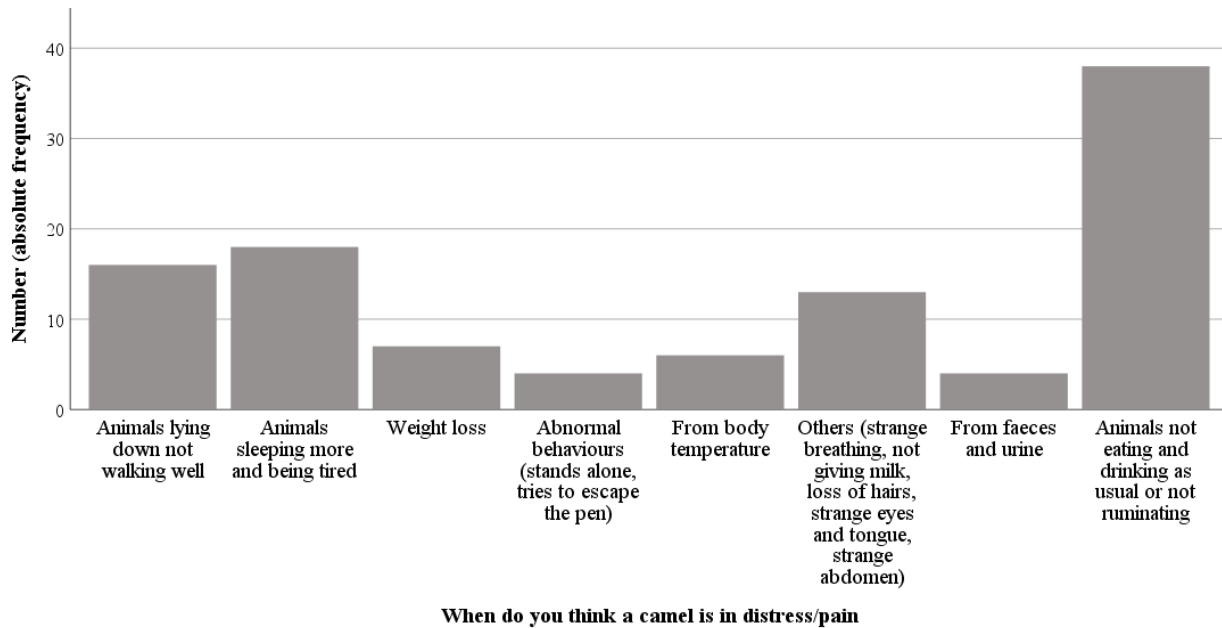
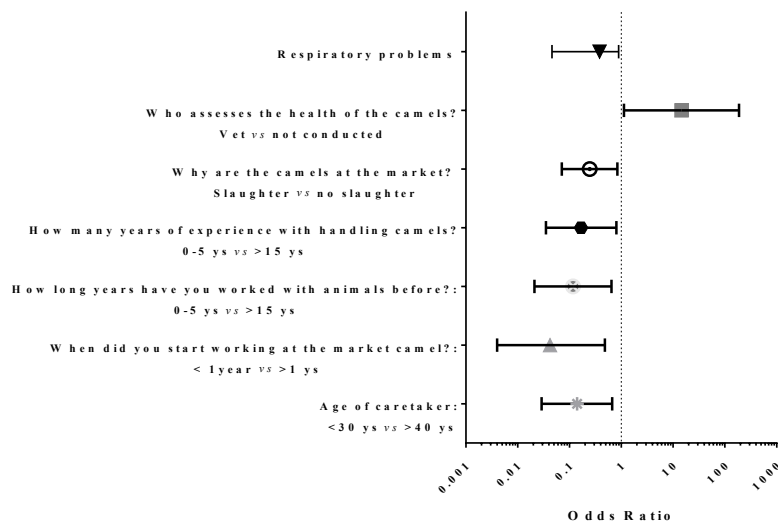


Figure 2. Behavioural problems. The bar graph (Panel A) reports the number of handlers' answers that included the different types of behavioural problems of camels (each handler could give more than one answer) while the forest plot (Panel B) shows the odds ratio and 95% confidence interval for significant factors associated with behavioural problems.



A



B

Figure 3. Distress. The bar graph (Panel A) reports the number of handlers' answers that included the different criteria used to identify distress (each handler could give more than one answer) while the forest plot (Panel B) shows the odds ratio and 95% confidence interval for significant factors associated with the handler's ability in identifying a camel in distress/pain (score from "Low" to "Very high").

4. Discussion

This study documented, for the first time, the camel caretakers' demographic characteristics and backgrounds, their management practices, as well as their perceptions of welfare and distress, and health and behavioural problems suffered by the camels in their care. Possible associations between caretakers' demographic characteristics and backgrounds, as well as their management choices and perception of welfare, and health and behavioural problems reported in the camels in their care, were also found. Our findings supported the hypothesis of the study and may be used for enhancing camel welfare within the camel industry through the use of specific recommendations and guidelines. Our findings also highlight key areas that require further empirical research. It is worth highlighting that the nature of the relationships identified between behavioural and health problems and the camel caretakers' backgrounds and management routines in this study cannot be clearly defined, as in many other similar surveys (Cohen et al., 2005). For instance, management practices may have been applied in an attempt to identify problems rather than being the cause. Thus, some of the associations between monitoring strategies and problems (e.g. health check conducted by the veterinarian) are more likely a reflection of good practices for prompt identification of these problems, and have been interpreted in this way.

4.1. Participants' features and management of camels

As expected, all the caretakers were male and most of them had considerable experience in the management of camels (Traoré et al., 2014). Almost everyone had learned the craft from family, confirming that camel management is still reserved for pastoral communities as a family tradition that has been handed down from generation to generation (Traoré et al., 2014, Wako et al., 2017). Most of the caretakers were from Sudan, one of the countries where the camel population is more numerous; Sudan has almost 5 million head, and it is second only after Somalia (about 7 million; FAO, 2020). On the other hand, Qatar surpasses Sudan as regards the relative importance of the

camel population among livestock (Faye and Bonnet, 2012). Indeed, half of the caretakers had camels that originated in Qatar. Most caretakers managed fewer than 30 camels but more than one paddock, often splitting the work with other people. This is probably related to the reason why the animals were kept at the market, with more crowded pens when the animals were young and reared for meat. Interestingly, there was a greater proportion of caretakers under 30 years old taking care of animals reared for milk, while the caretakers over 40 years old mainly took care of animals reared for dual-purposes or only for meat. This may be due to the fact that pens with camels reared for meat were more numerous and the animals were younger, as mentioned before, and consequently were more difficult to handle, and hence in need of being managed by older caretakers with more experience. Another reason may be that the owners prefer to rely on more experienced caretakers in order to manage a larger investment of capital (a higher number of animals means also a large investment and revenue). At the market, there were still many animals reared for milk and breeding. In the past, the milk was considered a sub-product mainly used for the producer's consumption, but new opportunities and challenges seem to be opening up (Gebremichael et al., 2019). Our findings showed that the camels kept at the market were prevalently reared for milk production, in line with the recently reported trend (Burger et al., 2019); thus, the researchers' efforts should be further focused on providing management strategies ensuring high welfare standards for dairy camels.

As regards feed management, most camels were fed twice a day and, in any case, rationed, in agreement with the literature (Traoré et al., 2014). Importantly, providing rationed feed was a risk factor for both health and behavioural problems. This finding confirms the behavioural observations and hormonal assessments of Aubè et al. (2017). These authors showed that stereotypies were observed mostly around the hour of feed delivery, and the restrictive feeding was a source of frustration for camels (Aubè et al., 2017). Health and behavioural problems associated with the feed restriction could be due to the interference with the

ethogram of this species as, in the pastoralist conditions of savanna, camels spend most of their time feeding (O'Connor et al., 2015) and ruminating (Khan et al., 1998). Similarly, rationed water was not only an important risk factor for overheating but also for comorbidity. Feeding and drinking ad libitum, therefore, seem the best choice from both health and ethologic points of view despite the known ability of camels to resist fasting and water deprivation. Moreover, to encourage rumination and prolong the time of feed consumption, an appropriate amount of high-fibre alimentation should be offered (Aubè et al., 2017). The type of fiber indeed modulates the microbiota composition of the camel gastrointestinal tract, which plays an important role in its nutrition, physiology, and health (Samsudin et al., 2012; Samsudin et al., 2014). In this context, however, feed contamination and water temperature should still be considered, as providing feed and water ad libitum could expose them to a deterioration in quality.

4.2. Animals' behaviour, health and welfare

About half of the respondents claimed that their camels exhibited behavioural problems and, in particular, they reported episodes of biting and kicking. It is well known that camels reared in inappropriate conditions may develop behavioural problems (Padalino et al., 2014). It has been reported that camels can become wild and violent when improperly handled (Previti et al., 2016). At the market, aggressive camels were often tied with ropes or made to wear hobbles and muzzles. It is worth noting that the practices of further restricting aggressive animals and the use of positive punishment are not recommended in the literature, because they tend to increase abnormal and stereotypical behaviours (Overall, 1997). Moreover, social and spatial restrictions could induce chronic stress that, in addition to a poor welfare condition, increases excitement, aggression, and anxious behaviours (Beerda et al., 1999). In addition to the feed management mentioned above, the housing system could, therefore, explain most of the reported behavioural problems. However, the novelty of this study relies

on the finding that behavioural problems were positively associated with the number of pathologies: caretakers who reported behavioural problems in their camels also reported, on average, one disease or more. The link between pathologies and behavioural problems has several implications. First, behavioural problems can indicate an animal's pain or malaise for some untreated pathology (Overall, 1997). A recent review indicates that in pets, which are usually much more monitored than livestock species, the proportion of behavioural problems caused by pain could exceed 75% (Mills et al., 2020). This suggests that animals with behavioural problems, rather than being punished or isolated, should be subject to more careful health monitoring. Second, behavioural problems have been used as an indication of chronic stress (Padalino et al., 2014). Consequently, the association between abnormal behaviour and comorbidity is a simple consequence, since it is well known that chronic stress predisposes to pathologies impairing the immune system (Broom, 2006; Martin, 2009; Righi et al., 2019). Finally, since the camels were mainly kept at the market for production, it is worth noting that long-term activation of the hypothalamic-pituitary-adrenocortical system may negatively affect livestock productivity; this endocrinological asset delays sexual maturation and retards growth, depresses milk production and worsens meat quality (Fraser and Rushen, 1987). Thus, behaviour, health, pathology, productivity and animal welfare are strictly inter-related, and the behavioural problems should be used as an indicator of poor welfare in camels. The animals suffering from behavioural problems should be quickly identified, and they should be treated and retrained properly, and not further constrained or immobilized with ropes and muzzles (Previti et al., 2016), or hit or sent to slaughterhouses (Moretti, 2008).

As regards the pathologies, skin problems, overheating and colic were most frequently reported. Epidemiological studies on camel herds and dairy farms in Saudi Arabia, Sudan and Ethiopia have reported a mortality rate ranging from 22% to 37%. The major causes of death were helminth infections, tick paralysis, mange, calf

diarrhoea, mastitis, contagious ecthyma, skin wounds and abscesses, pneumonia, and papillomavirus infection (Agab and Abbas, 1999; Agab, 2006; Awoke and Seid, 2015). However, to date, modern research, including research on zoonoses, as well as surveillance programmes are lacking (Sazmand and Joachim, 2017; Sazmand et al., 2019; Monaco and Lacalandra, 2020).

Popular beliefs, conventional veterinary medicine, ethnoveterinary and human ethnomedicine practices seem rather alternate and overlap seamlessly. Most of the caretakers claimed that the health of their animals was assessed by the veterinarian and that they request his intervention whenever a health problem arises. However, they managed many practices such as deworming and treatments for ectoparasites themselves. Moreover, in most cases, vaccinations were not carried out. Although the role of the veterinarian was highly taken into account at the market, many caretakers reported that the veterinarian was called into question later, by the owner, if the traditional treatments were not effective. The caretakers showed and explained to the interviewer what they usually use to treat sick camels; parts of local trees, herbs, salt, vegetable oils, coca-cola, drugs and cauterization to treat the camels were reported. In agreement with our results, a survey carried out in Sudan reports that 75% of nomads use traditional treatments but, at the same time, 89.6% of them also use veterinary drugs (Basheir et al., 2012). A recent study conducted in Pakistan shows that ethnoveterinary practice includes over 2000 remedies (Aziz et al., 2020), but reliable studies that evaluate their therapeutic and side effects are lacking. Inappropriate treatments lead to useless sufferance by the animals and should be avoided.

From our results, it seemed that constant monitoring of animals by the veterinarian was helpful for the early identification of diseases. Indeed, when the health check was routinely conducted by a veterinarian, the caretaker was more likely to report the presence of pathologies among his animals and in greater numbers. These findings could be just explained by the greater accuracy in diagnoses performed by the veterinarian or greater involvement of the veterinarian when the owner/caretaker understand

that his business is at risk. Risk-assessment also highlighted frequent comorbidity, especially in the case of colic, diarrhoea, skin problems, and overheating. Thus, the early identification of pathology by the veterinarian could also limit spread and comorbidity. From our survey, it emerges that to monitor and manage health problems the constant presence of veterinarians at camel markets should be recommended.

Caretakers indicated the criteria they used to identify an animal in distress. This answer was open, but a good homogeneity of the answers was found. Eating and drinking habits, as well as lethargy, were those most frequently indicated. Changes in behaviour are indeed one of the first and most common signs also in other species (Broom, 2006), and from our point of view, it would be essential that caretakers know about the normal behaviour of their animals so that they can recognise early a shift and treat the animal. Luckily, the majority of the caretakers judged their ability in identifying a camel in distress as "high". In general, the self-scored ability to identify distress reduced as the age and experience of the caretaker decreased, confirming that older people were more confident in their ability than the younger ones. It is worthwhile noting that the younger and less experienced caretakers also reported a higher number of pathologies, colic, respiratory and skin problems in particular, and greater behavioural problems in their camels. These results could be because different aspects of camel management improve when managed by older and more experienced caretakers, and consequently, the risk of pathologies decreases as the caretaker experience increases. However, a bias linked to the overestimation of older people's abilities cannot be excluded. Another possible explanation for the association with age and experience may be related to the local culture, where the age-related hierarchy is very common and an important feature. At the Qatar market, as in many working contexts, older people are strongly respected and represent solid points of reference for the younger, not only regarding animal management but also for general conduct and lifestyles. Indeed, as previously stated, most of the young people refused to be interviewed at first and

asked the interviewer to contact senior colleagues. The ability to identify a camel in distress was also associated with other factors. Caretakers who raised camels for slaughter tended to attribute a higher score, but this may be a collinearity effect because those respondents were always older caretakers with more experience. Importantly, the score increased when the health assessment was conducted by a veterinarian. Perhaps, the constant presence of a veterinarian on the farm could represent an opportunity for training; the caretakers could learn from the professional to identify the animal in distress and gain confidence in their abilities. However, it is important to highlight that the self-scoring during an interview may be biased as the caretaker may have over ranked his ability since the survey was face-to-face and not an anonymous online survey. Overall, these findings suggest the need for training, especially for younger and inexperienced caretakers, as the early identification of abnormal behaviours and subjects in distress could have implications for camel health and welfare.

This is the first manuscript documenting the perception of animal welfare by camel caretakers. There was an open-ended question, and their answers were categorized according to the four animal welfare principles proposed by Welfare Quality® (Blokhuys et al., 2010). It is worth noting, as already stated, that the participants had difficulty in understanding this question possibly because the concept of animal welfare is not mentioned in the daily lives of workers at the market. The interviewer had to intervene to introduce the concept of welfare in order to obtain a valid response, trying to not influence the responses. The results of the survey suggest that, for the young caretakers, welfare means above all treating the animals gently and feeding them. However, for older caretakers, welfare was more related to good feeding (providing water and feed). This could be related to an old conception of good management where the provision of the physical need was the most essential (Previti et al., 2016). However, it may be noted that most caretakers indicated only one or two principles while, it is well known, the animal welfare is a multidimensional concept and all criteria are important to ensure both the

psychological and physical needs of the animals (Blokhuys et al., 2010; EFSA Panel on Animal Health and Welfare, 2012). It must be emphasized that also the scientific attention to the welfare of the camel is very poor (Pastrana et al., 2020). A limiting aspect could be a lack of knowledge about the physiology and behaviour of camels. Moreover, maybe stakeholders are not fully aware of the benefits that greater attention to welfare could give to the entire production system. Under the welfare quality framework, the definition of welfare standards and the diffusion of these principles among all operators in the sector is urgent and indispensable and shall be implemented through adequate information campaigns, training and workshops.

A number of limitations, many of which are common to survey-based studies (Dean, 2015), may be identified in the current study. Dean (2015) has identified sampling bias, non-response bias, recall bias and social acceptability bias as factors that may confound the interpretation of survey data, and all may apply to this study. Health and behavioural problems were identified by participant recall, hence the diagnosis and incidence of problems may not be accurate, and the technique is vulnerable to recall bias. In the absence of objective data on disease incidence, recall bias may have influenced the findings and some observations, particularly the apparent association between respondent age and the number of adverse events, might be explained by this factor. Moreover, participants may have been reluctant to disclose some aspects of their practice in this face-to-face survey (accountability bias). Finally, the survey was conducted only in a camel market in Qatar, with only 49 respondents. Consequently, most of the analysis may have suffered from small sample size and it is important to highlight that our findings represent only a small part of the camel industry and need to be ascertained by spreading the survey to more farms, markets and countries where camels are bred. Notwithstanding these limitations, this study has generated important insights into participants' current understanding and implementation of strategies relating to camel management. This is the first survey ever conducted for exploring

perceptions of the welfare by camels' caretakers and it may be a useful tool to collect information regarding behaviour, health, production and welfare of camels worldwide.

Overall, our findings suggest that the understanding of animal welfare and the basic needs of the camels is still limited and needs to be extensively enhanced in the camel industry. The education of camel-related people is a key factor to improve and safeguard animal welfare and health. It is highly recommended, therefore, that scientists, owners, breeders' associations, governmental and non-governmental associations implement a shared strategy to ensure optimal breeding standards moving toward more ethical and sustainable production systems.

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Conflict of interest

The authors declare no conflict of interest.

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Author Contributions

Conceptualization, B.P. and D.M.; methodology, B.P., D.M., and A.Z.; formal analysis, L.M. and B.P.; data curation, B.P., A.Z., and L.M.; writing—original draft preparation, L.M.; writing—review & editing, L.M., D.M., B.P.; project administration, B.P.; funding acquisition, B.P. All authors have read and agreed to the published version of the manuscript

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