Dromedary camel health care practices reported by caretakers working at a permanent market

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ABSTRACT

Traditional health care practices and ethnoveterinary medicine are still common in camels. This study aimed at describing camel health issues reported by caretakers including their management and treatment practices. Associations between the health issues and caretakers' background, management practices, and facilities were also investigated. Camel caretakers (n = 49) at a permanent market in Qatar were interviewed and data related to the camel pens (e.g. presence of shelters, water, and feeding points) collected. During the interview, questions sought to elicit the following information; i) caretaker's background (age, level of education, experience, and how they identify when a camel is sick), ii) caretaker's management practices (feeding, watering, and health care practices), iii) caretaker's description of the last health problem (camel details, recalled diagnosis/clinical signs, possible cause, treatment, and outcome). The majority of the caretakers were middle-aged (31-50 years old) and they used to identify a sick camel mainly observing its behavioural modifications (p < 0.001). Treatment for endo- and ectoparasites were usually administered by caretakers, health checks routinely performed by veterinarians, while vaccinations were not conducted in most of the pens (p < 0.001). A total of 38 health problems were described and the high environmental temperature was the most reported possible cause (43.2%; p < 0.001). Among the recalled health problems, sunstrokes were the most common (11/38; p = 0.046), followed by fever (9/38). Sunstroke was more likely to affect males (OR: 5.04; CI95%: 1.87-23.38; p = 0.039), while fever younger animals (OR: 0.68, CI95%: 0.47-1.00; p = 0.050). Sunstrokes were more likely managed by non-veterinarians (OR: 4.75; CI95%: 1.05-21.34; p = 0.042). The majority of the cases were early identified and had a full recovery, but 11/38 camels died. Interestingly, drugs were the most common treatment (73.7%, p < 0.001), but often bought and administered directly by caretakers. Duty of care, infectious disease prevention, early and appropriate treatments could be recommended to guarantee the principle of good health and consequently animal welfare. Education on how to identify a sick camel and how to manage it should be also promoted.

Key works: Dromedary camel; Health; Practices; Sunstroke; Welfare

INTRODUCTION

Camel population is growing and should reach 60 million heads in 25 years (Faye, 2020). This growth is mainly due to the increased use of dromedary camels as a production animal worldwide thanks to the high level of sustainability of camel farming and the ability of camels to cope with heat stress (El Harrak et al., 2011; Hoffmann, 2010; Wako et al., 2017). However, this is leading to a shift from extensive to intensive farming systems of those animals which often have shown difficulties in coping with those changes (Fatnassi et al., 2014a; Padalino et al., 2014; Zappaterra et al., 2021). Epidemiological surveys have pointed out that the incidence of infectious diseases could also rise in intensive camel farms (Al-Ahmadi et al., 2020) as well as pathologies induced by improper management (Agab, 2006). Despite this, vaccinations are still not a common practice, and many vaccines tested for other livestock are used, albeit with risks (i.e. abortion) in camels (Ahmed Kamal, 2011; Aziz et al., 2020). The need for more research to implement camel health and welfare under intensive and semi-intensive management has been raised (Padalino and Menchetti, 2021; Pastrana et al., 2020).

Camel disease and health problems are well known and diagnoses are very often correctly made in both pastoralism and semi-intensive and intensive camel farming (Aziz et al., 2020; Basheir et al., 2012; Volpato et al., 2015).

However, camels often are far from diagnostic facilities and laboratories, so treatments have to be based on the diagnosis reached using only clinical signs and/or changes in behaviour such as reluctance to move, restlessness, and vocalizations (Basheir et al., 2012; Volpato et al., 2015; Schwartz and Dioli, 1992). Veterinarians are often consulted and veterinary service is for free in some countries (Basheir et al., 2012; Menchetti et al., 2021). Drugs are commonly used and the pharmacokinetics of a variety of antibiotics and antiparasitics has been deeply investigated in camels (Ibrahim et al., 1997; Oukessou et al., 1990; Rutagwenda and Munyua, 1983). Consequently, there are many drugs available for camels on the market and in some countries they can be sold without prescriptions (Ali, 1988).

Ethnomedicine is, however, still very common and many health problems are treated with herbal preparations for oral administration, ointments, rinses, and disinfectants for external application. The latter are cheap, readily available, and some of those are applied very efficiently (Aziz et al., 2020; Volpato et al., 2015; Gupta et al., 2015). In India, a survey was conducted during the Pushkar animal fair, showing that 43 ethnoveterinary plants were used for the treatment of 30 diseases (Galav et al., 2010). Cauterization, known also as branding, and amputations are also frequently applied (Schwartz and Dioli, 1992; Volpato et al., 2015). Branding is often used in case of lameness and infections, while amputations are commonly used for tick in the nose or other necrosis of the distal part (Wosene, 1991; Schwartz and Dioli, 1992; Volpato et al., 2015). Those methods are a matter of debate because they have been included in the category of pain-induced management practices (EFSA, 2010).

The health and welfare status of livestock is associated not only with housing and health care practices but also with caretakers and farmers background, experience, and decision making (Hemsworth et al., 1993; Padalino et al., 2018; Rushen and Passillé, 2017). The link between management and health issues of camels has been still poorly investigated. The aim of this study was consequently to document, interviewing the caretakers, health problems of dromedary camels kept at a permanent market, criteria used for their identification and the health practices applied. The present study also aimed at investigating possible associations among the recalled health problems and caretakers' background, management practices, and camel housing conditions.

MATERIAL AND METHODS

The study was carried out at a dromedary camel market in Qatar in September 2019. The research project was approved by the Department for Agriculture Affairs and Fisheries of the Ministry of Municipality and Environment of the State of Qatar. The investigated camel market was a permanent market with 92 paddocks, where about 600 heads were kept and sold for breeding, milk, and meat production. A native Arabic speaker (AZ) approached the camel caretakers working at the market for at least one year (n=49), informed them about the aim of the study asking the voluntary consent to take part in a research project replying to some simple questions. All caretakers agreed to take part in the study and interviews were run in a friendly manner. Approximately 5 interviews were run per day, over 10 days. Each interview lasted about 20 minutes, the caretakers were pleased to show their animals and the paddocks where they were kept. While the interview was conducted, the other authors (BP, DM) took measurements of the paddock (length and wideness), assessed the quality of the fence (i.e. broken); recorded the presence and the measures of the shelters and number, position (i.e. in the sun or the shade) and measures of water and feeding points, presence of salt blocks and rubbish. The possible risk of injuries based on the presence of dangerous tools (e.g. broken fence, broken glasses, pointy or sharp sticks) was also recorded.

The questionnaire used during the interview was designed following key design features required to ensure valid questionnaire results, as reported in the literature (Christley, 2016; Dean, 2015). The questionnaire (Appendix A) consisted of 10 closed and 2 open-ended questions that sought to elicit from respondents the following points; i) their details (age, level of education, experience in camel management, and how they identify when a camel is sick), ii) management (feeding and watering practices, health care practices); iii) information related to the last health problem experienced by one of the camels in their care, reporting the details of the camel, the recalled diagnosis/clinical signs (if any), the possible causes and treatment (Table 1). Interviews' questions and answers were recorded in Arabic then translated into English.

Data analysis
The open answers to question 10 (i.e. When do you think a camel is sick?) were categorised into the three categories shown in Table 2.

A new binary category (Health problem: yes/no) was created based on the responses to Q12. The responses to questions 12.2 reporting the different type of health problems were categorized into the following categories: Cough, Fever, Gastro-enteric disorders (e.g. diarrhoea, colic), Skin disorders (e.g. skin disease, injury), Sunstroke, Other (e.g. tumour, placenta retention), and None. Variables with at least 10 events (Peduzzi et al., 1996) were

Table 1: Question 12 related to the last health issue and how it was managed by the caretaker interviewed at a camel market in Qatar

Please describe the last time your camel experienced an illness
المرجو وصف آخر مرة عانى فيها جملك من مرض
12.1 Camel details (i.e. age, origin/type, sex):_____
12.1 تفاصيل الجَمَل (السن، الفصيلة، الجنس):_____
12.2 Type of Illness (i.e. clinical sign, possible diagnosis):_____
12.2 المرض (علامات المرض، تشخيص محتمل):_____
12.3 Possible cause:_____
12.3 السبب المحتمل:_____
12.4 Management (i.e. veterinarian, self-treatment, type of treatment, slaughter, death): _____
12.4 طريقة التعامل (طبيب بيطري، العلاج الذاتي، نوع العلاج، الذبح، النفوق):_____

Table 2: Definition of category and examples of respondents' reply for the identification of a sick camel

Category	Definition	Examples of typical responses to the Question: "When do you think a camel is sick?"
Behavioural modifications	The camel shows a change in the behavioural repertoire	1. When I see that the animal does not walk properly when he does not stand up and lie down properly; 2. When the animals do not eat and ruminate 3. When they don't eat and drink, when the animal is very tired and always are looking for the shade 1. أعرف أن الحيوان مريض عندما أرى أنه لا يمشي بشكل صحيح وعندما لا يقوم ويستلقي بشكل طبيعي 2. من طريقة الأكل، لا يأكل كعادته. ولا يقوم بعملية الإجترار. 3. عندما ينقطعون عن الأكل والشراب وعندما يكون الحيوان متعبًا جدًا ويبحث دائمًا عن الظل
Clinical abnormality	The camel shows a clinical sign (e.g. abnormal breathing, higher rectal temperature, change in the consistency of faeces and urine, hair loss)	1. By their way of breathing, the type of faeces, loss of appetite. 2. From his temperature. 3. From his eyes and tongue. 1. من خلال طريقة تنفسهم و نوع البراز و فقدان الشهية 2. من درجة حرارته. 3. من عينيه ولسانه.
Combination of behavioural modifications and clinical abnormalities	The camels show behavioural modifications, abnormal behaviours and clinical signs	1. When the camel does not eat or drink and has diarrhoea. Also when the camel wants to leave the pen ; 2. When the animal does not eat as usual and with loss of hair 3. From his eyes and abdomen, his way of walking and the way to lie down, his way to sleep 1. عندما ترى أن الجمل لا يأكل ولا يشرب و عندما يصاب بالإسهال. وكذلك عندما يريد ويحاول الخروج من الشباك (الحظيرة) 2. عندما لا يأكل الحيوان بشكل طبيعي. وعند تساقط شعر الجمل 3. من عينيه ومن بطنه ومن طريقة مشيه وطريقة الاستلقاء وطريقة النوم

dichotomized and coded as 0-1 to treat them as dependent variables in logistic regressions (see below). In addition to the Sunstroke, Fever was also dichotomous although only 9 events were recorded.

The responses to questions 12.3 reporting the possible causes were categorised as follow: Dirty and/or broken pen, High environmental temperature, Infection, Feeding problems, I do not know.

From the open answers to question 12.4 regarding the management of the health problem, four new variables and their categories were created (Table 3).

The areas of the pen, shelter, feeding and watering points were calculated and then categorised using statistical binning (Altman, 2014). Space allowance in the paddock and feeding and watering space were calculated splitting the area by the number of animals kept in the pen. All categorical variables created from the interview are summarized and defined in Table 4, while Table 5

summarises and defines the categorical variables created from the data collected in the pen.

Descriptive statistics of numerical and categorical variables were conducted. Data of the numerical variables are presented as mean and standard deviation (SD), minimum (Min), maximum (Max), median, first quartile (Q1), third quartile (Q3). Data of the categorical variables are reported as number and percentage. On the latter, the chi-square goodness of fit test was used to compare the observed distributions with the expected probability distributions (each assuming all categories equal).

Possible associations among the occurrence of a health problem, fever and sunstroke (binary outcomes) and the caretaker's background, management practices, health care practices, and pen facilities were investigated using univariable logistic regression.

All analyses were performed using Gen Stat® Version 14 (VSNi International). When missing data were present,

Table 3: Examples of respondents' replies on the management of the last case of illness experienced by one of the camels in care of the caretaker and relative categorizations

Variable	Category	Example of typical responses to the question: "Describe the management of the last case of a sick camel"
Timing of the intervention	Early	1. I gave him an injection to reduce the temperature 2. As soon as I saw she-camel looking for shade, I called the vet, soon he gave her an injection and she recovered <div dir="rtl">1. أعطيته حقنة لخفض درجة الحرارة 2. بمجرد ما لاحظت أن الناقة تبحث عن الظل، اتصلت بالبيطري... ولما أعطاها حقنة، صحتها تعافت</div>
	Late	1. I called a veterinarian but it was too late and in the end, the animal has died <div dir="rtl">1. اتصلت بالطبيب البيطري ولكن لم يفدي بشيء لأن الناقة ماتت</div>
Carer	Veterinarian	1. The vet removed the placenta <div dir="rtl">1. الطبيب البيطري ساعدها في إزالة الكيس</div>
	Non-veterinarian	1. I went to the pharmacy and explained the case to them and they gave me a medication 2. I have showered him to reduce his body temperature but after 3 hours he died <div dir="rtl">1. رحت إلى الصيدلية وشرحت لهم الموقف وأعطوني دواء لها 2. قمت برشه بالماء لتخفيض درجة حرارة جسمه ولكنه مات بعد 3 ساعات</div>
Treatment	Drugs&Surgery	1. I called a vet who gave an injection with drugs and after it, the camel got better <div dir="rtl">1. اتصلت بالطبيب. أعطها حقنة بالدواء ومن تم تحسنت صحة الجمل</div>
	Traditional health care practices	1. I gave him a ginger drink with water but it didn't work 2. The she-camel lost her sight; I gave her a cold shower, then I called the vet but in the end, she died 3. Self-treatment, cauterization with fire <div dir="rtl">1. اعطيته شراب زنجبيل مخلط بالماء ولكنه لم ينفع بشئ 2. الناقة فقدت بصرها، وبعد ذلك قمت برشها بالماء البارد ومن تم اتصلت بالدكتور ولكن في الأخير الناقة ماتت 3. قمت بعلاجها بنفسي: بالكي بالنار</div>
	Nothing	1. I could not do anything, the camel died two days after he got sick <div dir="rtl">1. لم أستطع فعل أي شيء. الجمل مات بعد يومين بعد أن كان يعاني من المرض لمدة يومين</div>
Recovery	Full recovery	1. I went to the pharmacy and I bought four penicillin injections, and it got better <div dir="rtl">1. رحت إلى الصيدلية واشتريت 4 حقن من البنسلين و تحسنت وضعيتها بكثير بعد ذلك</div>
	Death	1. I called the owner and then he called the veterinarian who performed surgery, but the camel died <div dir="rtl">1. اتصلت بالمالك (رب العمل) وبدوره اتصل بالطبيب البيطري الذي أجرى للجمل عملية جراحية لكن في الأخير الجمل مات</div>

they were not considered in the statistical model. For all statistical analyses, p were considered significant at ≤ 0.05, while p between 0.10 and 0.05 were considered as tendencies (Averós et al., 2010).

RESULTS AND DISCUSSION

Housing conditions

The housing conditions of the camels varied a lot depending on the pen where they were kept. Pens were rectangular, the majority had a shelter, but the shaded areas only covered about 20% of the pen areas. All pens had at least a feeding point, but some pens had no water point. The number of camels per pen also varied a lot, ranging from 1 to 46; consequently, space allowance, feeding, and water space were also very variable (Tables 5 and 6; Fig. 1).

The great variability in rearing conditions recorded at the examined market is in line with the description of other camel farms (Al-Ahmadi et al., 2020; Traoré et al., 2014). The typology of camel farming systems was investigated in Saudi Arabia by Abdallah and Faye (2013). Those authors

Fig 1. Pen with adequate space allowance (Panel A) and overcrowed pen (Panel B) at the examined permanent camel market.

identified several categories of camel farms which greatly differed not only in the number of animals raised, their purpose, nutritional strategy, and health management but also in the lifestyle of farmers. To date, typologies of camel farming systems may vary from the more traditional farms in the desert, with a nomadic lifestyle, to farms managed by owners living in the city with modern commercial purposes (Abdallah and Faye, 2013). It is worth noting that the structural and management characteristics of facilities, such as the space allowance, feeding and water points, could affect several aspects of camel welfare (El-Shoukary et al., 2020; Menchetti et al., 2021; Padalino and Menchetti, 2021). Thus, the description of the camel rearing conditions

Table 4: categorical variables related to caretaker details, management practices and last case details

Name	Description	Categories
Caretaker details		
Age	Age of the caretaker	≤30 years, 31-50 years, >50 years
Education	Level of education of the caretaker	No school, Elementary/ medium school, Above the medium school
Experience	Years of experience in working with camels	≤ 5 years, 6-15 years, > 15 years
Identification of sick camel	How the caretaker identifies a camel suffering from a health problem	Behavioural modification (Beha), Clinical parameters (Clinical), A combination of behavioural and clinical parameters (Beha&clinical)
Management practices		
Feeding regime	Practices to feed the camels	*Ad libitum*, Rationed
Watering regime	Practices to water the camels	*Ad libitum*, Rationed
Health check	Who assesses the health of the camels?	Myself, Veterinarian (Vet), Not conducted
Vaccinations	Who vaccinates the camels?	Myself, Veterinarian (Vet), Not conducted
Deworming	Who drenches the camels?	Myself, Veterinarian (Vet), Not conducted
Ectoparasites treatments	Who treats the camels for ectoparasites?	Myself, Veterinarian (Vet), Not conducted
Veterinary support	Whether a veterinarian is called in case of a sick camel	No, Yes
Health problem	Whether the caretaker recall a health problem in the last year in one of the camels	No, Yes
Last case details		
Camel sex	The gender of the sick camel	Female, Male
Camel origin/type	The origin or the type of the sick camel	Kuwait, Omani, Omani-Sudanese, Qatari, Sudanese
Type of health problem	The type of health problem experience by the camel	Cough, Fever, Gastro-enteric disorders, Skin disorders, Sunstroke, Other, None
Possible cause	The cause behind the health problem believed by the caretaker	Inappropriate facilities (i.e. broken pen, rubbish), Feeding problems (excess), High temperature, Infection, I don't know
Timing of the intervention	Whether the sick camel was identified and treated or not tempestively	Early, Late
Carer	Who treated the sick camel	Veterinarian (Vet), Non-veterinarian (Non-vet)
Treatment	Type of treatment used	Drugs&Surgery, Traditional health care practices, Nothing
Recovery	How the health problem ended	Death, Full recovery

Table 5: categorical variables related to the pen where the camels were kept

Name	Description	Categories
Fence	Quality of the fence, in particular, whether it was or not broken	Entire, Broken
Pen area	The total area of the pen, calculated taking length and wideness	≤110 m², 111-160 m², > 160 m²
Space allowance	The space allowance calculated by splitting the pen area by the number of animals kept in it	≤15 m², >15 m²
Shelter	Whether the pen was equipped by a shelter	No, Yes
Shelter area	The total area of the shaded areas calculated multiply the length and wideness of the shelter	0 m², 1-20 m², 21-35 m², >35 m²
Water point	Presence of at least one water point	No, Yes
Number of water points	Number of water points in each pen	0 water points, 1 water point, 2 water points
Water point location	If there was a water point, the location of the water point	No water point, Shade, Sun
Water size/animal	The space that each animal had for drinking, calculated by splitting the total areas of the drinking point by the number of camels kept in the pen	0.0 (no water point), 0.1-0.6 m², >0.6 m²
Feeding point	Presence of at least one feeding point	No, Yes
Number of feeding points	Number of feeding point in each pen	1 feeding point, 2 feeding points, >3 feeding points
Feeding point location	The location of the feeding point	Shade, Sun
Feeding size/animal	The space that each animal had for eating, calculated by splitting the total areas of the feeding points by the number of camels kept in the pen	≤3.0 m², 3.1-5.0 m², >5.0 m²
Salt	Whether at least one salt block was inside the pen	No, Yes
Rubbish	Whether there was any type of rubbish inside the pen	No, Yes
Risk of injury	The possible risk of injuries based on the presence of dangerous tools (e.g. broken fence, broken glasses, pointed sticks) inside the pen	No, Yes

Table 5: Descriptive statistics of the numerical variables related to the pen and pen facilities

Variable name	Mean	SD	Min	Q1	Median	Q3	Max
Pen area (m²)	134.50	38.95	43.95	107.13	150	178.80	209.92
Shelter area (m²)	22.79	15.29	0	12	22.565	33	64
Percent of shaded areas (m²)	18.45	13.16	0	9.59	20	30.09	50.81
Water point space/animal (m²)	0.56	0.31	0	0.45	0.48	0.6	1.31
Feeding point space/animal (m²)	3.74	1.32	1.23	2.9	3.63	4.5	7.19
Number of camels per pen (n)	10.79	10.87	1	4	6	14	46
Space allowance (m²)	31.25	33.17	2	8	22	35	161

Table 6: Distribution of the categorical variables related to the pens where the camels were kept

Variable name	Category	Count	Percent	P value#
Fence	Entire	7	14.6	<0.001
	Broken	41	85.4*	
Pen area	≤110 m²	15	31.9	0.918
	111-160 m²	17	36.2	
	> 160 m²	15	31.9	
Space allowance	≤15 m²	20	42.6	0.307
	>15 m²	27	57.4	
Shelter	No	9	18.8	<0.001
	Yes	39	81.3*	
Shelter area	0 m² (no shelter)	8	16.7	0.120
	1-20 m²	11	22.9	
	21-35 m²	19	39.6	
	>35 m²	10	20.8	
Water point	No	5	10.4	<0.001
	Yes	43	89.6*	
Number of water points	0 water points	5	10.4	<0.001
	1 water point	40	83.3*	
	2 water points	3	6.3	
Water point location†	No water point	5	10.4	<0.001
	Shade	1	2.1	
	Sun	42	87.5*	
Water point size/animal	0.0 (no water point)	5	10.4	<0.001
	0.1-0.6 m²	31	64.6*	
	>0.6 m²	12	25.0	
Feeding point	Yes	48	100*	<0.001
	No	0	0.0	
Numer of feeding points	1 feeding point	10	20.8	0.019
	2 feeding points	25	52.1*	
	>3 feeding points	13	27.1	
Feeding point location†	Shade	4	8.3	<0.001
	Sun	44	91.6*	
Feeding point size/animal	≤3.0 m²	19	39.6*	0.019
	3.1-5.0 m²	22	45.8*	
	>5.0 m²	7	14.6	
Salt	No	41	85.4*	<0.001
	Yes	7	14.6	
Rubbish	No	20	41.7	0.248
	Yes	28	58.3	
Risk of injury	No	12	25.0	<0.001
	Yes	36	75.0*	

*higher observed number respect to expected (all categories equal)
#P value from chi-square goodness of fit test
†when more than one trough was present, it refers to a trough chosen at random

at markets and farms is of considerable importance not only to understand the welfare issues of both animals and farmers but also to evaluate current trends of this livestock sector (Abdallah and Faye, 2013; Menchetti et al., 2021). To enhance camel welfare, future studies are needed to define standard management methods and facilities for camel keeping and farming.

Demographic characteristics of caretakers and criteria they use to identify camel health problems

Caretaker details and management practices investigated in this study are shown in Table 7.

Most of the caretakers were between 31 and 50 years old (p = 0.018) while the distribution of data related to the level of their education and experience was homogeneous (p > 0.05). This was expected. Contrariwise, the answers related to the criteria that caretakers used to identify a sick camel should be deeply discussed. Most of them reported that they use behavioural modifications as health problem alert (p < 0.001) such as decreased eating behaviours, prolonged resting behaviour and lethargy. Typical caretakers' responses were: "[…] the animal does not walk properly, does not stand up and lie down properly"; "The animal doesn't eat and drink, is very tired and always is looking for the shade". Many of the criteria described by our respondents were included in the protocol for the clinical examination of camels suggested by Schwartz and Dioli (1992). The ability of a farmer to identify a health problem is important for both animal welfare and farm productivity. In the context of camel rearing, moreover, this ability plays an even bigger role as veterinary checks may often be limited by logistical and economic factors. Thus, pastorals have acquired a considerable knowledge of camel's manifestations of poor health and those have been handed down over generations (Volpato et al., 2015). Our results confirmed, however, that this traditional knowledge is mainly based on recognizable clinical signs but not on the ethio-pathogenesis of the disease (El Harrak, 2014). A complication in the behavioural assessment of health problems of camels, for example, is their extreme resistance: they can bear the pain and continue to work until exhaustion without showing signs of suffering (Padalino and Menchetti, 2021; Previti et al., 2016). The use of clinical

Table 7: Distribution of the categorical variables related to caretaker details, and the management practices reported during interviews of camels' caretakers in a market in Qatar

Variable Name	Category	Count	Percent	P-value
Caretaker details				
Age	<30 years	16	33.3	0.018
	31-50 years	24	50.0*	
	>51 years	8	16.7	
Education	No school	19	38.8	0.679
	Elementary/ medium	14	28.6	
	Above medium	16	32.7	
Experience	<5 years	11	22.4	0.059
	6-15 years	14	28.6	
	>15 years	24	49.0	
Identification of sick camel	Beha	28	57.1*	<0.001
	Clinical	5	10.2	
	Beha&clinical	16	32.7	
Management practices				
Feeding regime	Ad libitum	11	22.4	<0.001
	Rationed	38	77.6*	
Watering regime	Ad libitum	23	46.9	0.668
	Rationed	26	53.1	
Health checks	Myself	14	29.8	<0.001
	Vet	30	63.8*	
	Not conducted	3	6.4	
Vaccinations	Myself	7	14.6	<0.001
	Vet	6	12.5	
	Not conducted	35	72.9*	
Deworming	Myself	23	47.9*	<0.001
	Vet	23	47.9*	
	Not conducted	2	4.2	
Ectoparasites treatments	My self	35	74.5*	<0.001
	Vet	7	14.9	
	Not conducted	5	10.6	
Veterinary support	No	6	12.2	<0.001
	Yes	43	87.8*	

* higher observed number respect to expected (all categories equal)

parameters should be encouraged though it also requires species-specific knowledge due to the peculiar physiological features of camels (e.g. marked diurnal fluctuation of body temperature, intermittent irregular pulse (Schwartz and Dioli, 1992)). As recommended by the OIE-World Organisation for Animal Health (El Harrak et al., 2011), the development of specific diagnostic tests for camels should be also promoted. Moreover, camel farming is shifting towards intensive techniques and its geographical areas are expanding (Faye, 2014; Zarrin et al., 2020). These factors could widen and differentiate the range of health (and behavioural) problems compared to those present in extensive or more typical conditions, making traditional knowledge even more inadequate (Al-Ahmadi et al., 2020; Fatnassi et al., 2014a; Khalafalla, 2017). According to El Harrak (2014), indeed, several unexplained diseases with high mortality rates have appeared in the camel population during the last decades. In this context, the greater use of

clinical and diagnostic tools, a higher number of specialized professionals, the definition of a species-specific pain scale, and specific training of caretakers could be desirable.

Health management practices
Although this study was conducted in an intensive context and almost all the caretakers had veterinary support (p < 0.001), most of them carried out deworming and ectoparasites treatments by themselves (p < 0.001) while over 70% did not vaccinate their camels (p < 0.001). In agreement with our results, Abdallah and Faye (2013) found that most of the farmers interviewed in Saudi Arabia did not vaccinate camels against pox (jedari) or treat them to control ectoparasitic infestations. Similar results have been found in studies describing animal health practices in Sudan (Basheir et al., 2012) and Pakistan (Aziz et al., 2020). The implementation of systematic vaccinations and the improvement of surveillance systems are, therefore, two major challenges for disease control in camels, although further studies are needed to prove the efficacy and safety of many vaccines in this species (Ahmed Kamal, 2011; El Harrak, 2014; El Harrak et al., 2011; Mohammadpour et al., 2020). Camel vaccination has also a key role in public health to prevent the outbreak of zoonotic diseases (Al-Ahmadi et al., 2020; Mohammadpour et al., 2020; Perlman and Vijay, 2016), a very important topic in light of the recent pandemic events.

Health problems of camels referred by their caretakers
In the final part of the interview, the caretakers were asked to describe the latest health problem observed in their camels. The majority of the caretakers (38/49, 77.5%, p < 0.001) reported that at least one camel suffered from a health problem in the last year. The odds of reporting a health problem was higher when the feeding was rationed (OR: 4.44; CI95%: 1.02-19.34; p = 0.047), while other associations were not found. Although it depends on many factors (e.g. age, physiological status, purpose, activity), in general, camels have no high energy requirements, are skilled in selecting the richest plants, can adapt to low-protein content regimes, and accept a high number of forage species (Previti et al., 2016; Schwartz and Dioli, 1992). Feeding practices adopted in intensive systems can however may impair important ethological features of the camel, such as browsing and ruminating (Dereje and Udén, 2005; Khan et al., 1998), with potential implications both on behavior and metabolism. Aubè et al. (2017) have indeed shown that restricted access to food, limiting eating habits, could cause abnormal behaviours. Our results suggest that rationed feeding may lead to a higher risk of health problems.

Details on the type of health problem and other related variables are reported in Table 8.

Table 8: distribution of the categorical variables related to the last case details

Variable name	Category	Count	Percent	P-value
Camel sex	Female	26	68.4*	0.023
	Male	12	31.6	
Camel origin/ type	Kuwait	1	2.8	<0.001
	Omani	20	55.6*	
	Omani-Sudanese	3	8.3	
	Qatari	7	19.4	
	Sudanese	5	13.9	
Type of health problem	Cough	5	10.4	0.136
	Fever	9	18.8	
	Gastro-enteric disorders	4	8.3	
	None	11	22.9	
	Other	4	8.3	
	Skin disorders	4	8.3	
	Sunstroke	11	22.9	
Possible cause	Inappropriate facilities	3	8.1	<0.001
	Feeding problems (excess)	3	8.1	
	High environmental temperature	16	43.2*	
	I don't know	13	35.1	
	Infection	2	5.4	
Timing of intervention	Late	12	32.4	0.033
	Early	25	67.6*	
Carer	Non-vet	15	39.5	0.194
	Vet	23	60.5	
Treatment	Traditional	7	18.4	<0.001
	Drug&surgery	28	73.7*	
	Nothing	3	7.9	
Recovery	Death	11	28.9	0.009
	Full recovery	27	71.1*	

* higher observed number respect to expected (all categories equal)

Most of the camels affected by the health problem reported by the caretakers were females ($p = 0.023$) of Omani type ($p < 0.001$), while their age varied from 1 to 10 years (Median: 6 years). Among the health problems reported, sunstroke was the most common (11/38, 28.2%, $p = 0.046$) while the possible cause most frequently indicated by caretakers was the high environmental temperature ($p < 0.001$). These findings may be surprising because the camel is known for its extraordinary ability to adapt to arid climates (Bengoumi and Faye, 2002; Bouâouda et al., 2014). This skill is still today the object of research and inspiration for studies on homeostatic mechanisms (Hoter et al., 2019; Saadeldin et al., 2020). However, it is well known that camels can experience sunstroke (Gupta et al., 2015; Tilahun et al., 2013; Volpato et al., 2015). The present study showed that sunstroke was more likely managed by non-veterinarians than by veterinarians (OR: 4.75; CI95%: 1.05-21.34; $p = 0.042$) and that the odds of sunstroke tended to be higher in males than in females (OR: 5.04;

CI95%: 1.87-23.38; $p = 0.039$). This could be due to the different hormonal patterns which may be lead males to be more active, aggressive or spend more energy on sexual behaviour. It has been shown that bulls may suffer from poor libido when the temperature is high (Fatnassi et al, 2014b). In the literature, the following predisposing factors for sunstroke have been identified: hot and humid weather, lack of shelter, exhaustion, and stall-fed farming (Khan et al., 2003). Based on our results, male dromedary camels should be monitored more closely in these situations. Avoiding the prolonged use of camels as draught animals, providing adequate shaded areas (Fig. 2), and offering ad libitum water and feed, mineral and vitamin supplements should be also recommended (Khan et al., 2003; Menchetti et al., 2021; Zappaterra et al., 2021).

Fever was reported by 9 out of 38 caretakers and was negatively associated with the age of the camel (OR: 0.68, CI: 0.47-1.00, P=0.050). Fever, moreover, tended to be experienced more likely by camels living in pen with a space allowance ≤15 m² (OR: 4.38, CI: 0.76-24.13, P=0.097). Despite a limited sample size, these results are not surprising as in line with the etho-pathogenesis of infectious diseases (Abbas and Omer, 2005). They also emphasize the importance to ensure an adequate space allowance for camels in intensive systems. Recently, El Shoukary et al. (2020) showed that overcrowding could have negative effects on several behavioural and physiological parameters, such as an increase in aggressive behaviour and a decrease in eating behaviour, resulting in poor body conditions and reproductive performance. Offering adequate space allowance is crucial to safeguard camel welfare (Menchetti et al, under review).

Among the gastroenteric problems, colic was reported and one case happened during the study (Fig 3). This syndrome was one of the health problems which more often leads to fatality. Early identification of colic is important to increase the recovery rate (Schwartz and Dioli, 1992).

Surprisingly, few caretakers reported skin problems or injuries as last cases happened in their camels. These health problems are well documented in camels (Agab and

Fig 2. Camels kept without (Panel A) and with insufficient shaded areas (Panel B) at the examined camel market.

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Fig 3. A camel suffering from colic syndrome during the study.

Fig 4. Skin problems (Panel A) and hobble-induced injuries (Panel B) shown by two of the camels kept in the pens during the study.

Abbas, 1999; Abera et al. 2010; Abdallah and Faye, 2013; El Harrak, 2014) and could also be noted among camels kept at the market during the investigation (Fig 4). The fact that these health problems were reported more rarely could be because the interviewers could not have perceived them as serious problems or they were just not recently happened since we asked only for the last case.

Health care and outcome

Drugs were the most common treatment (73.7%, p < 0.001), but often bought and administered directly by caretakers. Similarly, a broader study conducted in Kenya by Lamuka et al. (2017) found that most of the pastoralists self-medicated their camels and chose drugs based on their own experience or the advice of the shop attendant. Our study was also in line with the results of a questionnaire conducted in Ethiopia (Tilahun et al., 2013). The authors found that most of the camels received veterinary assistance, but about a third of the farmers administered drugs to their animals by themselves and 5% used traditional practices. In our study, the traditional therapeutic procedures were used in 7 out of 38 cases where caretakers indicated cauterizations, showers, or ginger drinks as remedies. In agreement with our findings, Abdallah and Faye (2013) found that about 19% of farmers in Saudi Arabia used traditional medicine, in particular, to treat camel parasite disease as mange or ringworm. The ethnoveterinary, especially in remote areas where conventional veterinary services cannot be guaranteed

or when the costs are unaffordable, is of considerable importance for animal survival and farmers' livelihood (Aziz et al., 2020; Gupta et al., 2015; Volpato et al., 2015). Several treatments could also be suitable alternatives for modern drugs, but further studies on their scientific basis and more training of caretakers could optimize their use as well as limit their misuse and consequently the spread of diseases (Aziz et al., 2020; Basheir et al., 2012).

The last question of the interview concerned the outcome of the health problem. Although the majority of the cases were early identified and had a full recovery, 11/38 (28.9%) camels died. This mortality rate is not indicative as this is not an epidemiological study and could be over- or under-estimated by questionnaire bias (Dean, 2015). However, it does not differ much from the mortality rate (21.8%) recorded by Agab and Abbas (1999) in 15 camel herds in Sudan, where the main causes of death were Helminth infections, tick paralysis, and calf diarrhoea. Even though associations with death were not investigated, it is worth highlighting that about 40% of caretakers stated that they had not requested the intervention of a veterinarian and 3 of them had not carried out any kind of treatment. The lack of veterinary intervention, thus, could be considered as a matter of concern as it could result in inefficient and uncontrolled use of veterinary drugs. This may indeed contribute not only to the spread of diseases but also to the development of drugs resistance and increased risk of drug residues in food-animal products (Basheir et al., 2012; Lamuka et al., 2017). A prompt intervention of veterinarians and correct drug administration could be recommended.

Limitations of the study

Our results need to be interpreted with caution because they are based on interviews. Dean (2015) has identified sampling bias, non-response bias, recall bias, and social acceptability bias as factors that may confound the interpretation of interview and survey data, and all may apply to this study. Although strenuous efforts were made to recruit the highest number of responses at the market, it is not possible to exclude sampling bias. Certainly, a face-to-face interview may have selected for participants with more curiosity or a stronger personality. However, respondents who have experienced more health problems may have been more motivated to participate (response bias). Conversely, potential respondents who are utilising practices that effectively limit the incidence of such problems may not have responded. In the absence of objective data on disease incidence, recall bias may have influenced findings and some observations, particularly the high number of adverse events (i.e. deaths) might be explained by this factor. In the present study was not possible to check the diagnoses reported, nor was there any standardisation

of the processes by which the diagnoses were made. As there was no means to document whether a veterinary diagnosis informed participant perceptions or recall, the caretakers' reported diagnosis/clinical signs of specific problems must be treated with some circumspection. However, to mitigate this risk, health problem categories were deliberately defined in broad terms, used by the respondents, and designed to be meaningful to lay people in the industry. Moreover, respondents, although anonymous, may have been reluctant to disclose some aspects of their practice during the interview (accountability bias). Finally, considering the small number of respondents, our regression model may have suffered from small sample bias and more importantly our associations cannot prove cause-effect relationships (Cohen et al., 2005). Notwithstanding those limitations, which are common to all questionnaires, our study has increased our knowledge on health care practices in camels highlighting the need for education on how to identify a sick camel, early intervention, duty of care and responsible ownership.

CONCLUSIONS

Health problems were reported by the majority of caretakers and sunstroke and fever were the most commonly reported health problems among camels reared in intensive systems. In this regard, our findings suggest that simple measures could be useful for their prevention such as avoiding overcrowding and providing *ad libitum* feeding, while adequate shaded areas should be provided in case of very high temperature. Cases of sunstrokes were mainly managed by caretakers but often also using drugs bought directly by them. Thus, the prompt intervention of veterinarians and conscious use of drugs are also desirable. Health problems were mainly identified by monitoring the sick camel's behavioural modifications and often treated by conventional medicine or surgery. However, the intervention was often given too late or was unsuccessful causing a high mortality rate. Infectious disease prevention and education on health management, as well as greater use of diagnostic tools, should be promoted to safeguard camel health and welfare. Further epidemiological studies with risk analysis should be conducted to recommended best health care practices.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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APPENDIX A

Caretaker of Paddock Number(S)_____   رقم/أرقام المسؤول عن المرعى _____

Q1 Age?
- <30
- 31-50
- >50

س1: السن:
- أقل من 30
- 31-50
- أكثر من 50

Q2 Level of education?
- No school
- Elementary and/or Medium
- Above Medium School

س2: المستوى الدراسي؟
- لم أذهب إلى المدرسة قط
- المستوى الابتدائي و/أوالمستوى المتوسط
- المستوى المتوسط وما فوق

Q3 How many years of experience do you have with working with camels?
- < 5 years
- 6-15 years
- >15 years

س3: ما هو عدد سنوات تجربتك في العمل مع الجمال؟
- أقل من 5 سنوات
- سنة 6-15
- أكثر من 15 سنة

Q4 How often do you feed them?
- Food is always available
- I feed them one or more times a day

س4: كم مرة تُطعم الجمال؟
- يتم توفير الغذاء بشكل دائم
- مرّة أو مرتان في اليوم

Q5 How often do you water them?
- water is always available
- I water them one or more times a day

س5: كم مرة تسقي الجمال؟
- يتم توفير الماء بشكل دائم
- مرّة أو مرتان في اليوم

Q6. Who assesses the health of the camels?
1. A veterinarian |_| |_|
2. Non-veterinary staff (myself / my assistant(s) |_| |_|
3. Routine checks are not conducted |_| |_|

س6: من يقيّم الوضعية الصحية للجمال؟
1. طبيب بيطري
2. مستخدمون غير بيطرين (أنا بنفسي/مساعدي)
3. لا يتم القيام بفحوصات روتينية

Q7. Who administers vaccinations?
1. A veterinarian |_| |_|
2. Non-veterinary staff (myself / my assistant(s)) |_| |_|
3. Vaccinations are not conducted |_| |_|

س7: من يقوم بالتلقيح؟
1. طبيب بيطري
2. مستخدمون غير بيطرين (أنا بنفسي/مساعدي)
3. لا يتم القيام بالتلقيح

Q8. Who administers deworming?
1. A veterinarian |_| |_|
2. Non-veterinary staff (myself / my assistant(s)) |_| |_|
3. Deworming is not conducted |_| |_|

س8: من من يقدم علاج طرد الديدان؟
1. طبيب بيطري
2. مستخدمون غير بيطرين (أنا بنفسي/مساعدي)
3. لا يتم تقديم هذا العلاج

Q9. Who administers treatments for ectoparasites?
1. A veterinarian |_| |_|
2. Non-veterinary staff (myself / my assistant(s)) |_| |_|
3. Those treatments are not conducted |_| |_|

س9: من يقدم علاجات الطفيليات الخارجية؟
1. طبيب بيطري
2. مستخدمون غير بيطرين (أنا بنفسي/مساعدي)
3. لا يتم تقديم هذا العلاج

Q 10 When do you think a camel is sick? _____   س10: متى برأيك يكون الجمل مريض؟ _____

Q11. If an animal is sick, do you reach out a veterinarian?
1. Yes
2. No

س11: إذا مرض أحد الحيوانات، هل تتواصل مع طبيب بيطري ؟
1. نعم
2. لا

Q12 Do you recall a health problem in a camel during the last year?
1. Yes
2. No

س12: هل تتذكر مشكلة صحية عاني منها أحد الجمال خلال السنة الماضية؟
1. نعم
2. لا

If yes please describe the last time your camel experienced an illness (e.g pathology, type of camel, type of management)

    12.1 Camel details (i.e. age, origin, sex):_____

    12.2 Illness:_____

    12.3 Your comments about the possible cause: _____
    _____
    _____

    12.4 Management of the illness (veterinarian, self-treatment, type of treatment, slaughter, death):
    _____
    _____

إن كان الجواب "نعم"، المرجو وصف آخر مرة عانى فيها جملك من مرض (مثل المرض، نوع الجمل، طريقة التعامل مع المرض)

12.1   تفاصيل الجَمَل (السن، الأصل، _____ الجنس):

12.2   المرض: _____

12.3   تعليقاتك بخصوص السبب المحتمل_____
_____
_____

12.4   طريقة التعامل مع المرض (طبيب بيطري، العلاج الذاتي، نوع العلاج، الذبح، النفوق):
_____
_____