Original Article

A clinical survey investigating the dental disorders of jennies in China

Wuyan Jiang[1] Bo Liu[1] Yipeng Jin[1] Liang Deng[2] Qingchao Liao[2] Jing Li[1*]

Abstract

Recent clinical studies have documented a high prevalence of dental disorders in donkeys. However, there are few studies about the same topic in China. A cross-sectional study was performed to investigate the prevalence of clinically diagnosed dental disorders of donkeys in China. A total of 101 jennies which had never received any dental care were examined for the presence of dental disorders under small-holder farm conditions. The prevalence of dental disorders was analyzed by Chi-square test or Fisher's exact correlation test. The strength of association was evaluated using Cramer's V test. Jennies between 2 and 15 years of age were categorized into four age groups. The most common dental disorders were sharp enamel points (100%), incisor diastemata (90.1%) and focal overgrowths (72.3%). Age was moderately related to the presence of ventral convex curvatures, focal overgrowths, wave mouth and canine calculus accumulation （P <0.05，0.3 <Cramer's V <0.5）. The prevalence of shear mouth (P <0.01，Cramer's V> 0.5) was significantly associated with age group. Common dental disorders were found in all groups and the prevalence was higher in aged groups. This study indicated that donkeys should receive proper dental care to improve their welfare.

Keywords: donkeys, clinical survey, dental disorders, welfare, China

[1]*Equine Clinical Diagnostic Center, College of Veterinary Medicine, China Agricultural University, Beijing 100193, People's Republic of China*

[2]*College of Animal Science and Veterinary Medicine, Shenyang Agricultural University, Shenyang 110866, People's Republic of China*

****Correspondence**: jlivet@cau.edu.cn* (J. Li)

Received June 20, 2020.
Accepted December 25, 2020.
doi: 10.14456/tjvm.2021.13

Introduction

There has been a long history of working donkeys used for carrying and drafting in rural areas of China. Currently, China owns 2.68 million donkeys, most of which are raised in extensive small-holder farms. In recent decades, large numbers of donkeys have changed into production animals for their meat and milk purposes in China (Wu, 2017). Donkeys are one of the most important animal species in China and there is a close interlink between donkeys and humans; however, the welfare of donkeys is often neglected (McGorum *et al*., 2018).

Dental disorders are believed to be a threat to animal welfare, frequently resulting in oral pain, decreased food intake and lower feed efficiency. Some dental disorders may even cause colic and other systemic diseases. Dental disorders are common oral disorders in donkeys, with a high prevalence of around 70%-95% (Du Toit *et al*., 2008a; Du Toit *et al*., 2009; Du Toit and Dixon, 2012; Rodrigues *et al*., 2013a; Rodrigues *et al*., 2013b). In a clinical survey of 203 working donkeys in Mexico, 62% of the donkeys had dental disorders, with sharp enamel points presenting at 98%. A high prevalence (13%-14%) of buccal ulcers and calluses has also been found in a clinical survey (Du Toit *et al*., 2008a). A higher prevalence of diatemata, peridontal diseases and caries has been reported in Zamorano-Leonés and Mirandês donkeys and there were about 74% donkeys diagnosed with insicor disorders (Rodrigues *et al*., 2013b). Sharp enamel points were the most common dental disorders in donkeys and the prevalence of dental disorders increased with age group (Du Toit *et al*., 2008a; Du Toit *et al*., 2009; Rodrigues *et al*., 2013a; Rodrigues *et al*., 2013b). In addition, dental disorders, especially diasmetama, could cause some significant systemic diseases like colic, which might increase welfare implications in donkeys (Du Toit *et al*., Du Toit *et al*., 2008b).

However, very little is known about dental disorders of donkeys in China and the owners have not recognized the significance of dental disorders in donkeys. Owing to economic reasons, the regular donkey production in the rural areas of China has jennies for reproduction and selling foals. In our previous study, we discovered that most of the jennies were under 15 years old in China (Deng *et al*., 2020). This study aimed to determine the prevalence of dental disorders in visited populations of jennies in rural areas of China and to investigate the association between age and the prevalence of dental disorders.

Materials and Methods

Sesame samples and laboratory handling*:** A total of 8 ***Study design and animals: The study was conducted in September and October 2019 in small-holder farms in mixed crop-livestock production systems in Liaoning Province. A total of 101 Liaoxi jennies (Deng *et al*., 2020) in 10 villages were visited by a mobile veterinary clinic team from the China Agricultural University and Shenyang Agricultural University. A complete physical examination was performed on each donkey. Donkeys with no obvious clinical abnormalities other than dental disorders were included in this study. The basic information on each donkey is provided in Table S1. These jennies had no history of previous dental examination and treatment. The jennies were fed with native grass hay or crop residue (corn stalk and millet stalk) supplemented with a small amount of home-made concentrate (maize, bran, soybean meal and salt).

Accurate age was determined in jennies less than 7 years old, based on the eruption of deciduous and permanent teeth. Since individuals more than 7 years were only aged by changes in the appearance of the occlusal surfaces of the lower incisors, the age estimation was less accurate (Muylle S, 2011). Based on the age ranges of Liaoxi jennies investigated in our previous study (Deng *et al*., 2020), age was classified into four groups: < 2.5 years old (G1); 2.5-5 years old (G2); 6-10 years old (G3); 11-15 years old (G4). There were five-year intervals, except for G1 and G2, as this age is the period corresponding to the exchange of deciduous teeth (both incisors and CT) and the eruption of definitive teeth. The body condition of the jennies was scored on a 5-point scale (1–5, where 1 represented lean minus and 5 represented fat plus) according to the guidelines described by the Donkey Sanctuary (Evans L, Crane M, 2018).

Dental examination: The examination started with a visual examination of skull symmetry followed by the flushing of the oral cavity to increase visibility. The jennies were all placed in stocks for restraint during the examination. About 1.1 mg/kg xylazole (an α-2 agonist sedative) was used intravenously for sedation in some jennies. A conventional speculum (Hausmann speculum) was applied to facilitate the oral examination. A head light, a dental mirror, a dental explorer and a periodontal probe were used to examine dental disorders. A dental chart was also applied and dental abnormalities were marked with specific symbols on the chart.

In this study, the following developmental and acquired dental disorders were recorded if present: craniofacial abnormalities (CA, consisting of overjet, overbite, underjet, and underbite), retained deciduous teeth, hypodontia, supernumerary teeth, displacements, fractures, abnormalities in the occlusal surface of the incisors [including ventral convex curvatures (VC), dorsal convex curvatures (DC) and diagonal mouth], calculus accumulation, diastemata, sharp enamel points (SEPs), focal overgrowths, wave mouth, step mouth, shear mouth and periodontal disease (PD). The presence of dental-related soft tissue injuries (ulcers, buccal calluses or chronic scaring) were also recorded. Wave mouth, step mouth and shear mouth were recognized as significant dental disorders in this study. A modified Triadan system was used in this study (Floyd MR, 1991).

Definitions were as follows:

1) CA: uneven upper and lower incisor occlusion resulting from growth abnormalities in the craniofacial bones, including overjet (occlusal aspects of the maxillary incisors lie rostral to that of the mandibular incisors, with contact between teeth); overbite (maxillary incisors lying rostral and in front, without any occlusal contact); underjet (the opposite of overjet); underbite (the opposite of overbite) (Rodrigues *et al*., 2013a).
2) Diastemata: abnormal interdental space, with or

without food impaction (Rodrigues *et al*., 2013a).

3) PD: pathological process affecting the periodontium, ranging from gingivitis without attachment loss to severe, deep periodontal pocketing. The periodontal sulcus depth was measured by periodontal probe.
4) SEPs: the presence of protruding enamel points on the buccal edges of maxillary cheek teeth and lingual edges of the mandibular cheek teeth (Du Toit *et al*., 2009).
5) Focal overgrowths: focal overgrowths of 06s and 11s (Du Toit *et al*., 2009).
6) Shear mouth: an excessive angulation of the CT occlusal surfaces (>35^{o}) in the buccolingual plane (Du Toit *et al*., 2009).
7) Wave mouth: an undulating appearance of the occlusal surface of cheek teeth (Du Toit *et al*., 2009).
8) Step mouth: a supra-eruption, classically rectangular shape of individual CT, usually opposite a missing cheek tooth (Du Toit *et al*., 2009).

Jennies with significant sharp enamel points were treated by floating. Trapped food in diastemata was cleaned out. Removal of overgrown transverse ridge opposite diastema was performed to reduce food impaction. Dramatic dental disorders such as shear mouth, step mouth and focal overgrowth were treated by dental floating at this time, however, more episodes of treatment with regular evaluation will be required. Very loose teeth and diseased teeth were extracted in order to help with periodontal diseases (Dixon *et al*,2005). Owners of donkeys having a poor BCS were given feeding advice. This study was approved by the Animal Care and Use Committee of China Agricultural University (Animal Use License Number: AW09010202-2).

Statistical analysis: The clinical data from the study was put into Microsoft Excel 2007 (Microsoft Corporation). After checking for possible mistakes and typing errors, the data was exported to the SPSS (version 25.0, IBM Corporation). A Chi-square test, or Fisher's exact test, were performed to evaluate the association between dental disorders and age group if the cell frequency was < 5. Strength of association was evaluated using Cramer's V, where > 0.5 indicates high association, 0.3–0.5 moderate association, 0.1–0.3 low association and 0–0.1 little if any association.

Results

A total of 101 jennies were examined. The age ranged from 2 to 15 years (median, 6 years), the largest age group was the 6–10 years' age group.

Incisor disorders: Of the 101 jennies examined, 93.1% of the donkeys had incisor disorders, such as diastemata, CA and abnormities of the occlusal surface (Table 1).

Incisor diastemata was recorded at a prevalence of 90.1% (91 of 101). Some permanent mats of fibrous food in the interdental space were commonly observed. Permanent mats formed because of the impaction of food fibers in incisor diastemata and were really hard to clean.

Overjet was present in 15.8% (16 of 101), with 68.8% (11 of 16) having focal overgrowths in 106 and 206, 37.5% (6 of 16) having VC, and 6.3% (1 of 16) having diagonal mouth. There were 2.0% (2 of 101) of jennies with underjet, one of which had DC and focal overgrowths in 106, 206, and 406. VC without overjet occurred in four jennies.

Incisor factures (14.9%, 15 of 101) found in this study were all non-complicated fractures, which were simply examined by dental probe and there were no signs of affecting the pulp cavities. Incisor displacement was recorded in 10.9% (11 of 101) and all the cases recorded were caudal displacement, most of which were 03s caudal displacement. Other incisor disorders, such as calculus accumulation, retained deciduous teeth and hypodontia were occasionally found (Table 1).

Cheek teeth disorders and soft tissue injuries: The prevalence of cheek teeth disorders and soft tissue injuries in the jennies is summarized in Table 2.

Table 1 Prevalence of incisor disorders of 101 jennies in China.

Incisor Disorders	Number of jennies	Total prevalence	Maxillary/Mandibular Triadan positions most commonly affected
Diastemata	91	90.1%	02s-03s
Overjet	16	15.8%	/
Underjet	2	2.0%	/
VC	10	9.9%	/
DC	1	1.0%	/
Diagonal Mouth	2	2.0%	/
Fractures	15	14.9%	01s
Displacements	11	10.9%	03s
Calculus Accumulation	4	4.0%	303
Retained Deciduous Teeth	3	3.0%	403
Hypodontia	1	1.0%	403

Abbreviations: VC, ventral convex curvatures; DC, dorsal convex curvatures

Table 2 Prevalence of cheek teeth disorders and soft tissue injuries of 101 jennies in China.

Cheek Teeth Disorders	Number of jennies	Total prevalence	Maxillary/Mandibular Triadan positions most commonly affected
SEPs	101	100.0%	06s-11s
Lingual Ulcers	34	33.7%	/
Buccal Ulcers	55	54.5%	/
Focal overgrowths	73	72.3%	106,206
Diastemata	38	37.6%	09s-10s
Wave Mouth	6	5.9%	206-211, 306-311
Step Mouth	11	8.9%	109,409
Shear Mouth	8	7.9%	206-211, 306-311
Displacements	3	3.0%	406, 410
Supernumerary Teeth	1	1.0%	112, 212
Retained Deciduous Teeth	3	3.0%	208, 306, 308

Abbreviations: SEPs, sharp enamel points

Sharp enamel points (Fig. 1A) were found in all the donkeys examined. Buccal and lingual ulcers was present in 54.5% and 33.7%, respectively. The location of the soft tissue lesions was consistent with the location of SEPs. Focal overgrowths were recorded in 72.3% (73 of 101), with 106 and 107 most commonly affected (91.8%, 67 of 73), followed by mandibular 11s (15.1%, 11 of 73).

Diastemata in cheek teeth was present in 37.6%（37 of 101）of jennies and some food fibers could be seen in the interdental space (Fig. 1B). Diastemata was mostly found in the interdental spaces between 08s-10s, especially 09s-10s and only 7.9% (8 of 101) of jennies had diastemata in the interdental spaces between 06s- 07s.

Severe dental disorders, including wave mouth (5.9%, 6 of 101), step mouth (8.9%, 9 0f 101), and shear mouth (7.9%, 8 of 101) (Fig. 1C) had a relatively low prevalence. A supernumerary tooth was observed in one case, presenting supplemental 112 and 212. Hypodontia was recorded in one jenny whose 403 was missing.

Canine teeth: Although the presence of canine and wolf teeth are not recognized as dental disorders, the data was also recorded. The prevalence of the presence of canine teeth was high, about 38.6% (39 of 101), and even 23.8% of the 101 jennies had four canine teeth. The prevalence of canine teeth calculus accumulation was recorded at 7.9% (8 of 101).

Dental Disorders and Age Prevalence: Comparison of proportions by Chi-square test for each group showed that age group was moderately related to the presence of focal overgrowths, wave mouth, shear mouth and canine teeth calculus accumulation（P <0.05, 0.3 <Cramer's V <0.5）; however, no or low association was found between age groups and other dental disorders. According to the Cramer's V test, a high association was shown with shear mouth (P <0.01, Cramer's V> 0.5). The prevalence of incisor or canine teeth and cheek teeth disorders in different age groups is summarized in Table 3 and Table 4.

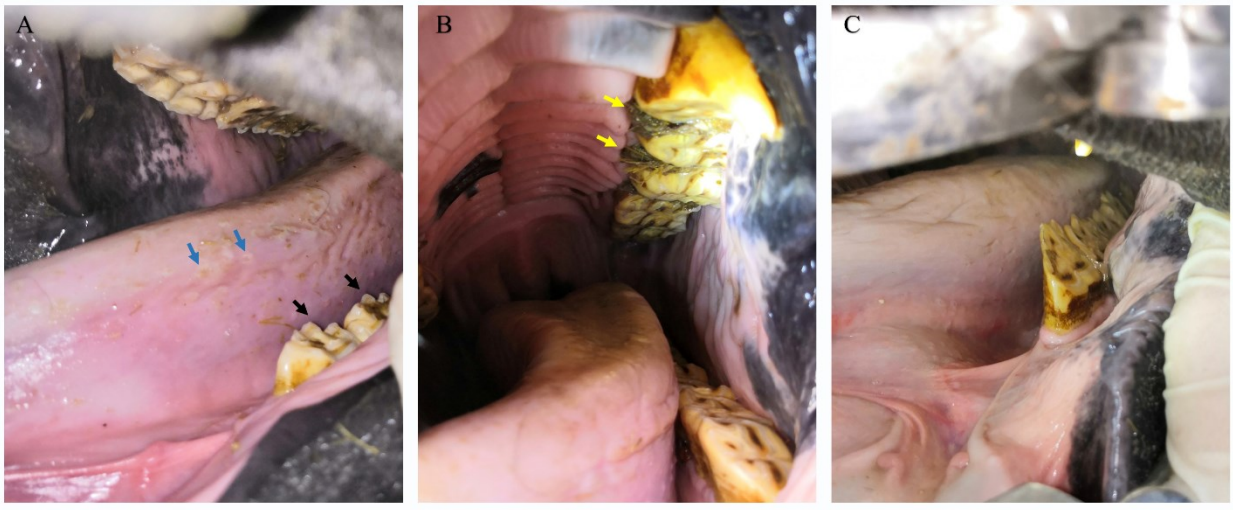

Figure 1 A) Sharp enamel points (dark arrows) and lingual ulcers (blue arrows) in a three-year-old jenny; B) Cheek teeth diastemata (yellow arrows) in a nine-year- old jenny; C) Shear mouth in a six-year-old jenny.

Table 3 Prevalence of incisor and canine teeth disorders in each age group with Pearson chi-square and Cramer's V test

Incisor and canine teeth Disorders	0-2.5y (n=9)	2.5-5y (n=35)	6-10y (n=51)	11-15y (n=6)	Fisher's exact correlation	*P* value	Cramer's V (*P* value)
Incisor							
Diastemata	66.7%	88.6%	92.2 %	100%	5.903	0.094	0.242 (0.094)
Overjet	22.2%	11.4%	19.6%	0%	2.062	0.555	0.156 (0.485)
Underjet	11.1%	2.9%	0%	0%	5.000	0.185	0.226 (0.185)
VC	0%	0%	17.6%	25.0%	8.794	0.021	0.291 (0.032)
DC	11.1%	0%	0%	0%	6.336	0.149	0.320 (0.149)
Diagonal Mouth	0%	0%	3.9%	0%	2.204	0.647	0.141 (0.647)
Calculus Accumulation	0%	2.9%	5.9%	0%	15.389	0.001	0.428 (0.001)
Displacements	0%	5.7%	19.6%	0%	4.505	0.170	0.248 (0.093)
Hypodontia	0%	0%	2.0%	0%	2.867	1.000	0.099 (1.000)
Canine teeth							
Calculus Accumulation	0%	0%	11.8%	33.3%	8.715	0.019	0.317 (0.019)

Abbreviations: VC, ventral convex curvatures; DC, dorsal convex curvatures

Table 4 Prevalence of cheek teeth disorders in each age group with Pearson chi-square and Cramer's V test

Cheek Teeth Disorders	0-2.5y (n=9)	2.5-5y (n=35)	6-10y (n=51)	10-15y (n=6)	Fisher's exact correlation	*P* value	Cramer's V (*P* value)
Focal overgrowths	33.3%	54.3%	88.2%	83.3%	18.515	0.000	0.432 (0.000)
Diastemata	22.2%	40.0%	37.3%	50%	1.416	0.716	0.117 (0.717)
Wave Mouth	0%	5.7%	2.0%	50.0%	11.567	0.003	0.476 (0.002)
Step Mouth	11.1%	0%	13.7%	33.3%	9.343	0.16	0.258 (0.088)
Shear Mouth	0%	0%	7.8%	66.7%	17.270	0.000	0.564 (0.000)
Displacements	0%	2.9%	3.9%	0%	0.901	1.000	0.078 (1.000)
Supernumerary Teeth	0%	0%	2.0%	0%	2.867	1.000	0.099 (1.000)

Table S1 Basic information of 101 jennies in China.

Number	Estimated Age (years)	BCS	Height (cm)
1	2	3.5	127
2	6	4.5	141.5
3	6	2.5	140
4	3	3	133
5	2	3.5	124
6	4	3	134
7	6	3.5	141
8	4	3	144
9	7	5	126
10	8	3.5	135
11	8	4	123
12	8	3.5	134
13	5	3.5	144
14	9	3	123
15	6	2.5	143

16	2.5	3.5	144
17	4	3	145.5
18	3	3	129.5
19	9	3.5	127
20	9	3	129
21	2	3.5	128
22	6	3.5	136
23	7.5	3	145
24	3	3	147
25	8	3	125.5
26	6	3.5	137
27	5	3.5	137
28	9	3.5	124
29	4	3.5	140.5
30	8	2	133
31	7	3.5	130
32	4	3	137
33	4	3.5	144
34	8	4	135.5
35	2	3.5	132
37	4	4	134.5
38	6	3	135
39	2	3.5	133
40	6	4	135.5
41	6	4	138
42	10	1.5	136
43	7	4.5	123
44	7	4	124.5
45	4	3.5	132.5
46	7	4	140
47	5	3.5	149
48	5	3	149.5
49	3	3.5	129.5
50	6	4	134.5
51	6	3.5	141.5
52	11	4	126
53	6	3	139
54	5	4	144
55	5	5	134
56	6	4	138
57	15	4.5	133
58	10	3.5	130
59	4	3.5	146
60	11	2.5	134.5
61	9	4.5	128
62	3	3.5	130
63	5	3	140
64	5	3.5	141
65	7	3.5	131
66	6	4.5	126

67	4	3.5	136
68	6	4.5	135.5
69	4	4.5	128
70	2	3.5	132.5
71	4.5	4.5	137
72	15	3.5	118
73	9	4	136
74	3	5	124.5
75	5	4.5	132.5
76	7	4.5	132
77	9	4.5	130.5
78	2	4	122.5
79	9	3.5	128.5
80	4	4	134.5
81	6	4	153.5
82	6	4	131.5
83	6	4.5	133
84	6	3.5	131.5
85	4	4.5	137
86	2	3	121
87	8	3.5	129.5
88	9	3	127
89	9	5	123
90	7	4	142
91	7	4.5	131
92	13	5	110.5
93	9	3.5	125.5
94	4	4	140
95	3	4.5	132.5
96	10	3.5	127
97	7	2.5	141
98	15	2.5	127.5
99	5	5	136.5
100	4	3.5	135
101	4	4	135.5

Discussion

This study investigated the prevalence of dental disorders in donkeys in China and the association between age group and dental disorders. To our knowledge, this is the first report about dental disorders of donkeys in China. The donkeys selected in our study were all jennies, because the owners tend to sell male donkey foals shortly after their birth and keep the females, and also reproduction is often accomplished by government owned special breeding stations. According to the previous study (Deng *et al*., 2020), most of the donkeys in China were reported to be under 15 years. This may explain why the age distribution of the jennies investigated in this study was much younger (2.5-15 years of age) than that of the donkeys in other clinical surveys (Du Toit *et al*., 2008a; Du Toit *et al*., 2008b; Du Toit *et al*., 2009; Du Toit *et al*., 2010; Rodrigues *et al*., 2013a; Rodrigues *et al*., 2013b). Similar to Mexican working donkeys (Du Toit *et al*., 2008a), the most common age group in China was the 6–10 years of age group, thus the results of this study were more comparable to the 0-10 years age group of British donkeys (Du Toit *et al*., 2009) and Zamorano-Leonés and Mirandês Donkeys (Rodrigues *et al*., 2013a; Rodrigues *et al*., 2013b). Additionally, dental care is not a common veterinary service for donkeys in China.

Although the jennies examined were relatively younger (median age 6 years) compared to other studies, the donkeys in this study all had at least one dental or oral disorder, and the prevalence of dental disorders (100%) was much higher than that in other clinical surveys. For example, only 53.6% of the working donkeys (<15 years) in Mexico were diagnosed with dental disorders (Du Toit *et al*., 2008a). Among the donkeys over 20 years in the UK, a higher prevalence of dental disorders (73% and 93%) was observed in 357 donkeys (Du Toit *et al*., 2009) and

donkeys, post-mortem (Du Toit *et al.*, 2008b), respectively. In the current study, the high prevalence of dental disorders in young donkeys may result from a lack of dental care and examinations, as the owners do not commonly realize the importance of dental health.

The prevalence of incisor disorders was recorded in 93.1%, which was much higher than that in Zamorano-Leonés and Mirandês Donkeys >25 years (90.3%) (Rodrigues *et al.*, 2013a), although the prevalence of incisor disorders in Zamorano-Leonés and Mirandês Donkeys increased with age. Incisor diastemata (90.1%) significantly increased the prevalence of incisor disorders, while only 15.5% of the Zamorano-Leonés and Mirandês donkeys (<10 years) were diagnosed with incisor diastemata (Rodrigues *et al.*, 2013a). The incisor diastemata of the jennies in our study was even higher than that (16.13%) of the Zamorano-Leonés and Mirandês donkeys > 20 years (Rodrigues *et al.*, 2013a). CA was recorded as the second most common incisor disorder in our study with a prevalence of 17.8%, which was lower than that in the clinical survey of Zamorano-Leonés and Mirandês donkeys (Rodrigues *et al.*, 2013a). The Zamorano-Leonés and Mirandês donkeys are endangered breeds, therefore, inbreeding might cause a higher prevalence of CA in both breeds.

Compared to the studies of donkeys in the UK, Portugal and Spain (Du Toit *et al.*, 2009; Rodrigues *et al.*, 2013a), there was a lower prevalence of VC in our study, at about 9.90% (10 of 101). Three donkeys were diagnosed as mild VC. By contrast, 40% of the donkeys in the studies performed in Portugal and Spain were diagnosed with VC, while the prevalence was only 3.3% in the young age groups (<10 years) and the prevalence of VC increased from 29.3% to 70.9% with age (>10 years) (Rodrigues *et al.*, 2013a). A study in the UK revealed that VC was observed in 97% of the donkeys, claiming that it was considered as the normal appearance in donkeys, unless VC was extremely obvious or inhibiting normal mastication (Du Toit *et al.*, 2009). However, all the donkeys with VC were diagnosed as abnormal in this study.

In horses, the most common incisor disorders were complicated factures (1.0%) resulting from trauma to the rostral aspect of the face (McGorum and Railton, 1999); however, all the incisor fractures in our study were non-complicated fractures and the prevalence was higher (14.9%), possibly caused by biting hard objects.

SEPs (100%) were the most frequent changes in cheek teeth and both the maxillary and mandibular cheek teeth were affected by severe SEPs in our study. The prevalence of SEPs in this study (100%) was much higher than that observed in Zamorano-Leonés and Mirandês donkeys under 10 years (59.7%) (Rodrigues *et al.*, 2013b), while it was similar to the prevalence of 98% in Mexican donkeys (Du Toit *et al.*, 2008a). SEPs might be seen as the physical change related to the hypsodont masticatory action and the diagnosis was subjective, especially without ulcers. In addition, native coarse crop residue was the main constituent of the jennies' diet, which would result in greater lateral masticatory movement. Therefore, the prevalence of SEPs was supposed to be lower. However, SEPs in these 101 jennies were really severe and nearly half of the donkeys had buccal or lingual ulcers as well. The severe SEPs were considered to be the major reason for the ulcers, as the location of ulcers was consistent with the SEPs. The head collars commonly used for the donkeys were made of rope, which was less likely to cause soft tissue injury in the mouth. The donkeys in this study had never received a dental examination or treatment before this study and this might be the reason for the high prevalence of SEPs and other related abnormalities like ulcers.

The severe SEPs might be closely related to the high prevalence of buccal (54.5%) and lingual ulcers (33.7%). In a retrospective study of horses, it was suggested that buccal SEPs could result in oral pain and buccal ulceration, while lingual SEPs rarely cause lingual ulceration (Duncanson, 2015). In our study, it was hard to evaluate the association between ulcers and SEPs as all the donkeys had severe SEPs. The prevalence of buccal ulcers (54.5%) observed in the jennies was slightly higher than that of lingual ulcers (33.7%), which may support the conclusion in the retrospective study of horses (Duncanson, 2015).

Focal overgrowths were found in 72.3% of the jennies and commonly affected the 106 and 107, or the 311 and 411. The prevalence of focal overgrowths in this study was even higher than 40.32%-51.6% of >20 years population in Zamorano-Leonés and Mirandês donkeys, and Mexican working donkeys, although it was recorded that the prevalence of focal overgrowths increased with advancing age (Du Toit *et al.*, 2008a, Rodrigues *et al.*, 2013b).

Cheek teeth diastemata was commonly found in geriatric donkeys in other studies but it was observed in 37.6% of these 101 jennies which were all under 15 years of age. The prevalence of diastemata ranged from 3.8%- 7.7% in donkeys < 10 years in Mexico, UK, Spain and Portugal (Du Toit *et al.*, 2008a; Du Toit *et al.*, 2009; Rodrigues *et al.*, 2013b).

Some severe dental disorders were observed in this study, including step mouth (10.8%), wave mouth (5.9%) and shear mouth (7.8%). Although the jennies were much younger, the prevalence of these severe dental disorders was higher than that of donkeys < 10 years in the clinical studies of the UK, Mexico, Portugal and Spain (Du Toit *et al.*, 2008a; Du Toit *et al.*, 2008b; Du Toit *et al.*, 2009; Du Toit *et al.*, 2010; Rodrigues *et al.*, 2013a; Rodrigues *et al.*, 2013b). The extent of dental care and the roughness of their food content could have contributed to these findings.

Shear mouth was found to be significantly (P <0.01, Cramer's V> 0.5) associated with age. Focal overgrowths, wave mouth, shear mouth and canine calculus accumulation were moderately (P <0.05, 0.3 <Cramer's V <0.5) associated with age. As the jennies in this study were generally young, we might have missed some relationships between dental disorders and age groups. Besides, age estimation is less accurate in donkeys over 12 years because various factors can influence the occlusal wear patterns. The BCSs of the jennies were generally low and all the donkeys were evaluated to be no higher than 2.5. The association of dental disorders with BCS was also accessed in this study; however, there was not any statistically significant association. The median BCSs of donkeys

with and without severe dental disorders were the same (1.5). Generally low BCSs may result from various factors, for instance, nutrition, dental abnormalities and housing.

The prevalence of dental disorders in this study was quite high, especially SEPs, focal overgrowths and diastemata, which may accounted for by the rough daily diet and a lack of regular dental treatment. Although the jennies investigated were under 15 years old, there was a high prevalence of severe dental disorders, resulting from ignorance of dental care. Our study reflected and highlighted the importance of dental health in Chinese donkeys. It is suggested that regular dental care should be introduced to owners, which may help improve donkeys' dental condition and overall welfare.

In conclusion, dental health is of significant importance in the Chinese donkey population. Sharp enamel points, incisor diastemata and focal overgrowths are the most common dental disorders. While shear mouth was the only one found to be significantly associated with age, age was associated with the presence of incisors calculus accumulation, VC, focal overgrowths, wave mouth and canine calculus accumulation to some degree. Therefore, the welfare of the donkeys in China must be improved and proper dental care should be introduced to the production protocol for donkeys' well-being.

Conflicts of interest: *All authors declare that they have no conflict of interest.*

Acknowledgements

The authors would like to thank Dr. G. Reed Holyoak and Dr. Joao Rodrigues, for their suggestions on this study.

References

Deng L, Shi S, Li J, Tang C, Liao Q, Xie P 2020. A cross-sectional survey of foaling-related parameters of jennies (*Equus asinus*) under smallholder farm conditions in Northeast China. J Equine Vet Sci. 87:102928.

Dixon PM, Dacre I 2005. A review of equine dental disorders. Vet J.169:165-187.

Du Toit N, Burden FA, Dixon PM 2008a. Clinical dental findings in 203 working donkeys in Mexico. Vet J. 178:380-386.

Du Toit N, Gallagher J, Burden FA, Dixon PM 2008b. Post mortem survey of dental disorders in 349 donkeys from an aged population (2005–2006). Part 2: Epidemiological studies. Equine Vet J. 40:209-213.

The modified Triadan system: nomenclature for veterinary dentistry. Floyd MR. J Vet Dent. 1991 Dec;8(4):18-9.

Du Toit N, Burden FA, Dixon PM 2009. Clinical dental examinations of 357 donkeys in the UK. Part 1: Prevalence of dental disorders. Equine Vet J. 41:390-394.

Du Toit N, Burden FA, Dixon PM 2010. Clinical dental examinations of 357 donkeys in the UK: Part 2 – epidemiological studies on the potential relationships between different dental disorders, and between dental disease and systemic disorders. Equine Vet J. 41: 395-400.

Du Toit N, Dixon PM 2012. Common dental disorders in the donkey. Equine Vet Educ. 24:45-51.

Duncanson G 2015. A Retrospective Dental Study on 5334 Horses in General Practice. Equine Vet J. S48(47):10.

Easley J, Tremaine H 2011. Dental and oral examination. In: Equine dentistry, 3rd ed. Easley J, Dixon PM, Schumacher J. (eds.). Elsevier, Philadelphia. 185-198.

McGorum B, Railton DI 1999. Brammer S. Equine dental disease part 1: a long-term study of 400 cases: disorders of incisor, canine and first premolar teeth. Equine Vet J. 31:369-377.

McGorum B, Railton DI, Brammer S 2018. Can scientists influence donkey welfare? Historical perspective and contemporary view. J Equine Vet Sci. 65: 25–32.

Michael RF 1991. The modified Triadan system: nomenclature for veterinary dentistry. J Vet Dent. 4:18-19.

Muylle S 2011. Aging. In: Equine dentistry, 3rd ed. Easley J, Dixon PM, Schumacher J. (eds.). Elsevier, Philadelphia. 85-95.

Evans L, Crane M 2018. Body Condition Score. In: The Clinical Companion of the Donkey, 1st ed. Evans L, Crane M. (eds.). The Donkey Sanctuary. 232.

Rodrigues JB, Araújo S, Sanroman-Llorens F, Bastos E, San Roman F, Viegas C 2013a. A Clinical Survey Evaluating the Prevalence of Incisor Disorders in Zamorano-Leonés and Mirandês Donkeys (*Equus asinus*). J Equine Vet Sci. 33:710-718.

Rodrigues JB, Dixon PM, Bastos E, San Roman F, Viegas C 2013b. A clinical survey on the prevalence and types of cheek teeth disorders present in 400 Zamorano-Leonés and 400 Mirandês donkeys (*Equus asinus*). Vet Rec. 173:581.

Wu C 2017. Status of Chinese donkey industry. Proceedings of 1st International Symposium on Donkey Science. Dong'E, Shandong, P.R. China. August 14th–17th.