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Bite and kick injuries in horses: Prevalence, risk factors and prevention

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Summary

Reasons for performing study: **Studies on the prevalence and predisposing factors of bite and kick injuries in horses have not been reported in a population-based data sample.**

Objectives: **To investigate the prevalence of bite and kick injuries in horses and associated risk factors in a representative sample of horses in Switzerland.**

Methods: **A questionnaire on the incidence of disease and injury, which included the frequency of bite and kick injuries and their association with breed, housing, use and feeding regime, was sent to 2559 horse owners randomly selected throughout Switzerland.**

Results: **The data of 2912 horses with 897 disorders diagnosed by a veterinarian were analysed. There were 231 injuries, 50 (21.6%) caused by a bite or kick from another horse; this number corresponded to 5.6% of all diseases and injuries and concerned only 1.7% of all the horses evaluated. Warmblood, Thoroughbred and Arabian horses had a 4.3 times higher risk of bite or kick injuries than horses of other breeds. Eighteen per cent of injuries were associated with a change in housing management and occurred regardless of whether horses were kept in groups permanently or sporadically.**

Conclusions and potential relevance: **A stable group hierarchy and a housing system that provides adequate space and is adapted to horse-specific behaviour are important factors in prevention and kick and bite injuries.**

Introduction

In addition to exercise-associated injuries, kick and bite injuries occur frequently in horses (J.M. Knubben, unpublished data). In a retrospective study of 1181 injuries, Derungs *et al.* (2004) determined that a kick from another horse was the most common cause. Of 256 horses with kick injuries, 120 (47.2%) had a bone fracture, which necessitated euthanasia in 34 (13.3%) of cases (Derungs *et al.* 2004). In another study, the cause of radius or tibial fracture was a kick from another horse in 17 of 23 injured horses (Derungs *et al.* 2001). Although bite and kick injuries can occur at any time with potential horse-to-horse contact, pasture was found to be the most common situation for this type of injury (Derungs *et al.* 2004); there was no information on whether the horses were kept permanently on pasture as a group or during the day only. In addition to chasing, rearing and mounting, kicking and biting are signs of normal equine behaviour and are part of aggressive, threatening, submissive and avoidance behaviour in order to maintain a long-lasting dominance (van Dierendonck *et al.* 1995; McDonnell and Haviland 1995; McGreevy 2004). Not all kick injuries are due to aggression: some occur accidentally with exuberant behaviour.

Horses are herd animals and react to threat with flight. Alert, alarm and flight may occur simultaneously (Waring 2003), and life in a herd is regulated by a complex social hierarchy and variety of behaviours. This social organisation and the ability to flee immediately at high speed are survival strategies that ensure long-term survival with respect to reproduction, finding food and safety from predators (Miller 2001).

Whenever possible, horses try to avoid direct conflict by establishing a long-lasting dominance hierarchy; behavioural signals, such as threatening gestures, are ritualised behaviour that ensures safe communication from a distance. On the other hand, aggressive confrontations deplete energy reserves, pose health risks and separate individuals from the safety of the herd. They are often attributable to insecurity and poorly established relationships (Mills and Nankervis 1999). Aggressive injurious behaviour seldom occurs in herds of free-ranging horses because the potential victim usually has ample space to avoid the aggressor (Mills and Nankervis 1999; Waring 2003). In free-ranging Przewalski horses, threatening behaviour occurred more often than physical fighting; when fighting did occur, biting was seen more often than kicking (Keiper and Receveur 1992).

Biting is associated mainly with offensive behaviour, whereas kicking with the hindlimbs was used predominantly for defence (Wells and von Goldschmidt-Rothschild 1979; Waring 2003). Aggressive behaviour is commonly associated with competitive situations during foraging and reproductive activities, and its frequency and intensity depend on herd stability (Arnold and Grassia 1982; Houpt and Keiper 1982; Houpt 1991; van Dierendonck *et al.* 2004; Grogan and McDonnell 2005). In free-ranging herds, kicks often result in no or minimal injury, because horses are unshod. The physical properties of hoof horn are greatly different from those of a steel horseshoe, which produces

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much higher peak forces and, therefore, poses a greater risk of injury (Piskoty *et al.* 2005).

The aim of this study was to determine the frequency of bite and kick injuries in a horse population and to identify the associated risk factors; and thereby to identify measures of prevention to minimise such injuries.

Materials and methods

Data collection

Of 16,067 Swiss horse farms with a total of 72,394 horses (Anon 2003), 2559 farms with 11,631 horses (horses, ponies, donkeys, mules and hinnies) were chosen at random. The farms were distributed evenly throughout the cantons and language regions of Switzerland. Questionnaires (Table 1; www.evj.co.uk/suppinfo) were sent to horse owners or managers between December 2003 and March 2004. A questionnaire was completed for each horse and included questions about breed, age, gender, stabling, socialisation with other horses, use, exercise and feeding regimes, health status, preventive health management programs and ongoing diseases. Some owners had died or had sold their horses, which left a total of 2456 farms with 10,073 equids. There were 3117 completed questionnaires, which yielded a compliance rate of 30.9%. After exclusion of questionnaires completed for donkeys, mules and hinnies, the data from 2912 horses and ponies were analysed.

Owners were asked to report only on diseases and injuries that had occurred in the previous 12 months and had been diagnosed by a veterinarian. For horses with injuries, owners were asked to describe how and why the injury occurred. More emphasis was placed on bite and kick injuries than on injuries incurred during training, competition or transport, or after running into a fence or self-mutilation.

Definitions

For the analyses, the husbandry systems under which the horses were kept were grouped into 2 main housing systems, similar to other studies (Bachmann and Stauffacher 2002; Bachmann *et al.* 2003). Tie stalls, individual box stalls and individual box stalls with access to a paddock were classified as *individual housing*. Group housing in both, subdivided (*structured*) and open stalls (*unstructured*), was classified as *group housing*. In many cases, horses were kept in an individual box stall for some of the time, mostly at night, but at other times had access to pasture or paddock with other horses. However, only horses kept permanently in a group with at least one other horse were classified as belonging to *permanent group housing*. *Change in housing system* up to 4 weeks before injury included change in herd composition or in housing management.

Individually-housed animals could be kicked or bitten if they had access to a pasture or paddock with other horses some of the time or were placed in situations in which their personal space was invaded, such as in a trailer, barn alleyway or warm-up area.

Competition horses included those that competed in events such as jumping, dressage, driving, 3-day eventing, racing, roping, reining, barrel racing, gaited classes and vaulting. *Pleasure horses* were not used in competitive events or at most in pleasure events.

TABLE 1: Questionnaire sent to horse farms

Refer to www.evj.co.uk/suppinfo for details.

Statistical analysis

Logistic regression was used to identify factors relating to husbandry, use of the horses, treatment of wounds and treatment success in association with bite and kick injuries.

Selection of potential risk factors for the outcome variable was based on their known or suspected causal relationship, supported by literature or by biological reasoning. The exponentials of β-coefficients presented were interpreted as odds ratios (OR), for which a 95% confidence interval (95% CI) was given. An OR>1 is predisposing and implies a positive association, while an OR<1 is preventive and implies an inverse association.

A backward stepwise method was used in the models to eliminate potential risk factors. The outcome variable in the first model consisted of whether or not a horse had been seen by a veterinarian because of a bite or kick injury. The following variables and 2-way interactions between them were tested as potential risk factors: breed (Warmblood, Thoroughbred and Arabian vs. other breeds), housing of horses (individual vs. permanent group housing) and use of horse (competition vs. pleasure).

In the second model, the occurrence of kick and bite injuries was analysed in relation to other injuries seen by a veterinarian. The following explanatory variables were tested: changes in housing during the 4 weeks preceding the injury (yes/no), did the injury require surgical treatment (yes/no) and complete healing of injury (yes/no).

Microsoft Access 2002[1] was used for data processing, and the SPSS for Windows 13.0[2] for statistical analysis.

Results

Information on housing was available for 2843 of 2912 horses analysed. A total of 1993 (70.1%) horses were housed in individual box stalls and 1639 (83.2%) of these were turned out on pasture or in a paddock with other horses during the day on an irregular basis and depending on the season. It was common for the members of these groups and the number within a group to change. The remaining 850 (29.9%) were kept in groups permanently. Data of 2912 horses with 897 disorders diagnosed by a veterinarian were analysed. The frequency of kick and bite injuries was summarised in Table 2.

Fifty injuries were attributable to a kick (n = 44) or bite (n = 6) from another horse. Twenty-five (56.8% of 44) kick injuries and one bite injury (16.7% of 6) resulted in lameness.

Of the 231 injuries, 181 (78.4%) were associated with factors other than biting or kicking, such as poor footing or a fence (n = 88) (38%), the box stall (n = 18) (8%), terrain and hacking (n = 30) (13%), training (n = 8) (3.5%), competition (n = 8) (3.5%), transportation (n = 7) (3.0%) or other circumstances, such as a pitchfork injury or unknown events (n = 21) (9.1%).

The breed was known in 49 horses with kick or bite injuries: There were 32 Warmbloods, 2 Thoroughbreds, 2 Arabians and 13 others (e.g. Swiss Franches-Montagnes and different pony breeds, see Table 3). In 2493 horses, without kick or bite injuries,

TABLE 2: Number and percentage of kick and bite injuries

	Horses (n = 2912)	Cases (n = 897)
Health disorder	718 (24.7%)	897
Injury	223 (7.7%)	231 (25.8%)
Kick or bite	50 (1.7%)	50 (5.6%)

data about breed were available. There were 948 (38.0%) Warmbloods, Thoroughbreds or Arabians and 1545 (62.0%) others.

Information about housing was available in 48 of 50 cases: 35 of 48 kick or bite injuries were sustained by horses kept in individual box stalls (Table 3); 30 of these were kept at least part of the time on pasture or in a paddock together with other horses. The other 13 injured horses were from permanent group housing, and 9 of these horses had free access to forage at all times, while 11 were fed grain, and all but one were fed separately for this. Housing was known in 2494 horses without a kick or bite injury: There were 1783 (71.5%) horses from individual stalls and 711 (28.5%) from permanent group housing.

Nineteen of 46 horses with kick or bite injuries were used for competition and 27 for pleasure (Table 3); no relevant information was available for the remaining 4 cases. In 2496 horses without kick or bite injuries, information about use was available; 704 (28.2%) horses were used in competition and 1792 (71.8%) were used for pleasure.

The risk of a kick or bite injury was not significantly affected by the type of housing (individual or permanent group housing) or use (competition or pleasure) of the horse. The risk of a kick or bite injury was more than 4 times higher in Warmblood, Thoroughbred or Arabian horses than in other breeds (Table 3).

In 9 of 50 cases, the kick or bite injury was associated with a change in the housing system (Table 4). Compared with other injuries, the risk of a kick or bite injury was higher after a change in housing (χ^2_1 = 10.3, P = 0.001, OR = 6.3, 95% CI 2.0–19.8). Surgical repair was required in 7 of the kick and bite injuries. In 43 cases, the injuries healed completely. Comparison of bite and kick injuries with other injuries revealed no differences in the proportion of injuries that required surgical repair (χ^2_1 = 0.5, P = 0.478, OR = 0.7, 95% CI 0.3–1.9) and in response to treatment (χ^2_1 = 1.2, P = 0.269, OR = 1.6, 95% CI 0.7–4.1, Table 4).

Discussion

The proportion of bite and kick injuries was low in comparison to other diseases (e.g. colic, respiratory disease, J.M. Knubben, unpublished data).

In 2004, when the data for this study were collected, a relatively large proportion of horses (29.9%) were kept permanently in groups in Switzerland (J.M. Knubben, unpublished data). This was almost twice the number of 16.5% in a previous study in 1997, carried out with a similar questionnaire (Bachmann and Stauffacher 2002). However, approximately 66% of the horses were still kept in individual box or tie stalls in 2004. The relatively high proportion of horses kept permanently in groups in both studies may have been attributable to confounding factors; for example, owners willing to complete a questionnaire may be more supportive of an animal-friendly housing system and interested in the health and well-being of their horses and, therefore, more inclined to use a group housing system. Moreover, the differentiation between the terms individual and group housing may be misleading because, in the former, more than 85% of the horses had restricted access to pasture or a paddock with other horses. Therefore, kick and bite injuries were also a problem in many individual housing systems.

Approximately 25% of all the reported diseases were attributable to injuries, although the cause of the trauma was not known in all cases. Injuries not caused by a kick or a bite from another horse were associated mainly with running into fences or obstacles, poor footing, uncontrolled exuberance and self-trauma.

However, the causes of these injuries were not always identified and, therefore, kick or bite injuries cannot be ruled out. More than half of the kick and bite injuries were associated with lameness, although the anatomical location of the lesion was rarely reported. In a study of a semi-feral pony herd, the rump and barrel were the regions most commonly injured by kicks and bites (Grogan and McDonnell 2005).

Circumstances of injuries

Based on our data, the circumstances for bite and kick injuries can be divided into 3 categories:

1) *Horses kept in individual box stalls but allowed access to pasture:* Commingling with other horses often does not follow a strict schedule and may be seasonal. Furthermore, the group composition often changes. Establishment of dominance is frequently less pronounced than in permanent group housing and needs to be re-established each time a horse is removed from or added to the group. The group composition is often determined by human decisions and horses are placed in a barn and not by the compatibility of the horses in the group, which makes establishment of a stable hierarchy difficult (Fürst *et al.* 2006). A well-established dominance hierarchy within a herd is considered a prerequisite for a low incidence of injuries (Mills and Nankervis 1999; McGreevy 2004).

TABLE 3: Potential risk factors for kick or bite injuries in horses

		No injury	Kick, bite	Total	OR	95% CI	χ^2_1	P value
Breed	Warmblood, Thoroughbred, Arabian	948 (96.3%)	36 (3.7%)	984	4.3	2.2–8.5	21.3	P<0.001
	Other	1545 (99.2%)	13 (0.8%)	1558	Reference			
Housing	Individual	1783 (98.1%)	35 (1.9%)	1818	1.5	0.8–3.1	1.304	P = 0.239
System	Permanent group	711 (98.2%)	13 (1.8%)	724	Reference			
Use	Competition	704 (97.4%)	19 (2.6%)	723	1.2	0.6–2.7	0.251	P = 0.616
	Pleasure	1792 (98.5%)	27 (1.5%)	1819	Reference			

TABLE 4: Number and percentage of kick and bite injuries (n = 50) and other injuries (n = 181) in relation to housing changes, surgical repair and outcome

Cause of injury	Change in housing system up to 4 weeks before injury	Surgical repair	Complete healing of injury
Kick or bite	9 (18.0%)	7 (14.0%)	43 (86.0%)
Other	5 (2.8%)	29 (16.0%)	118 (65.2%)

2) *Horses kept permanently in groups:* Although there is usually an established dominance hierarchy, it may be difficult for individual herd members to distance themselves from others because of limited space. So-called social partners are tolerated within an individual 'flight zone', whereas close herd mates are allowed within the 'personal space' (Mills and Nankervis 1999). In a herd of Highland ponies with well defined threat hierarchies, most dominant herd members threatened certain individual ponies more often than others (Clutton-Brock *et al.* 1976; Roberts and Browning 1998). Most horses also spent more time next to particular individuals, which they also tended to groom more frequently. There was no apparent association (or disassociation) between threat and proximity relations.

Because subdominant horses may not be able to respond to body signals displayed by more dominant horses, both parties may resort to kicking and biting. Many horse owners are unaware of the dangers of *cul-de-sacs*, corners and narrow passageways and a lack of choice for entry into different areas of the stable.

3) *Horses kept mostly in individual box stalls:* These are less accustomed to contact with other horses or are placed in situations in which their personal space is invaded, for example in a trailer, barn alleyway or warm-up area. In a study at 2 Texas slaughter plants, Grandin *et al.* (1999) described kick and bite injuries that resulted from fighting during transport of the horses. A minimum of 30% of all horses examined had visible bite marks on their bodies. Damage caused by kicking was often not visible on horses, but was apparent as bruises on the carcasses. Twenty-five percent of all carcasses had bruises, and kicks or bites were responsible for 51% of these.

Feeding management

The effect of feeding management, such as the feeding of hay or grain to horses in permanent group housing separately or as a group could not be assessed because of the low number of horses. However, it is well known that fighting among herd members is often associated with limited food and water (Arnold and Grassia 1982; Houpt and Keiper 1982; Houpt 1991). In addition to group make-up and the design of the housing system, the method of feeding plays a substantial role in the risk of bite and kick injuries (Fürst *et al.* 2006).

Housing and breed

In the present study, the type of housing system (individual or group) and the use of the horse (pleasure or competition) did not greatly influence the risk of a kick or bite injury. The breed factor, on the other hand, constituted a significant risk as Thoroughbred and Warmblood horses were 4.3 times more likely to suffer a kick or bite injury than other breeds. Thoroughbreds and Arabians have been previously identified as more common victims of kick and bite injuries than horses of other breeds (Derungs *et al.* 2004). Warmbloods, Arabians and Thoroughbreds are the most common horses in Switzerland (38.5%) followed by different pony breeds (26%), Swiss Franches-Montagnes horses (26%) and others (9% e.g. American Quarterhorse, Standardbred, Lusitano, Andalusian, J.M. Knubben, unpublished data). Breed-specific differences with respect to certain behaviours, aggressiveness and personal space have been described by several authors (Schäfer 1991; Fraser 1992; Burger *et al.* 2003).

In comparison with other injuries, bites and kicks were more often preceded by changes in the housing environment, such as changes in the group composition or structural changes. Therefore, group housing may not always be the best option for boarding stables or sales barns with frequent changes in group composition. Introduction of a new horse into a stable group must be done gradually and cautiously (Kurtz *et al.* 2000). Stability of herd structure, housing management and design of the housing facilities appear to play an important role in the prevention of bite and kick injuries.

In conclusion, bite and kick injuries are greatly affected by housing management regimes. This is true for individual housing systems with temporary group housing but also for permanent group housing. Preventive measures include establishment of a consistent group of horses, large turn-out area and large enough barns or sheds with designs that provide individual feeding spaces and allow subdominant horses to avoid dominant herd mates. Sudden changes in housing and pasture management should be avoided, and differences in character and temperament between individual horses or horses of different breeds considered.

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Manufacturers' addresses

[1]Microsoft Corporation, Redmond, Washington, USA.
[2]SPSS, Chicago, Illinois, USA.

References

Anon (2003) *Landwirtschaftliche Betriebsstruktuerhebung*, Swiss Federal Statistics Office, Neuchâtel.

Arnold, G.W. and Grassia, A. (1982) Ethogram of agonistic behavior for Thoroughbred horses. *Appl. Anim. Ethol.* **8**, 5-25.

Bachmann, I. and Stauffacher, M. (2002) Haltung und Nutzung von Pferden in der Schweiz: Eine repräsentative Erfassung des Status quo. *Schweiz. Arch. Tierheilk.* **144**, 331-347.

Bachmann, I., Audigé L. and Stauffacher M. (2003) Risk factors associated with behavioural disorders of crib-biting, weaving and box-walking in Swiss horses. *Equine vet. J.* **35**, 158-163.

Burger, D., Imboden, I., Jallon, L., Ionita, J.C., Rapin, V., Doherr, M. and Poncet, P.A. (2003) Introduction of a behavioural test for Franches-Montagnes horses. In: *Proceedings of the European Association for Animal Production.* p 387.

Clutton-Brock, T.H., Greenwood, P.J. and Powell, R.P. (1976) Ranks and relationships in Highland Ponies and Highland Cows. *Z. Tierpsychol.* **41**, 202-216.

Derungs, S., Fürst, A., Haas, C., Geissbuehler, U. and Auer, J. (2001) Fissure fractures of the radius and tibia in 23 horses: a retrospective study. *Equine vet. Educ.* **13**, 313-318.

Derungs, S., Fürst, A., Hässig, M. and Auer, J.A. (2004) Frequency, consequences and clinical outcome of kick injuries in horses: 256 cases (1992-2000). *Wien. Tierärztl. Mschr.* **91**, 114-119.

Fraser, A.F. (1992) Maintenance behaviour. In: *The Behaviour of the Horse*, Ed: A.F. Fraser, CAB International, Wallingford. pp 58-116.

Fürst, A., Knubben, J., Kurtz, A., Auer, J. and Stauffacher, M. (2006) Pferde in Gruppenhaltung: Eine Betrachtung aus tierärztlicher Sicht unter besonderer Berücksichtigung des Verletzungsrisikos. *Pferdeheilkunde* **22**, 254-258.

Grandin, T., McGee, K. and Lanier, J.L. (1999) Prevalence of severe welfare problems in horses that arrive at slaughter plants. *J. Am. vet. med. Ass.* **214**, 1531-1533.

Grogan, E.H. and McDonnell, S.M. (2005) Injuries and blemishes in a semi-feral herd of ponies. *J. equine vet. Sci.* **25**, 26-30.

Houpt, K.A. (1991) Investigating equine ingestive, maternal, and sexual behavior in the field and in the laboratory. *J. anim. Sci.* **69**, 4161-4166.

Houpt, K.A. and Keiper, R. (1982) The position of the stallion in the equine dominance hierarchy of feral and domestic ponies. *J. anim. Sci.* **54**, 945-950.

Keiper, R. and Receveur, H. (1992) Social interactions of free-ranging Przewalski horses in semi-reserves in the Netherlands. *Appl. anim. behav. Sci.* **33**, 303-318.

Kurtz, A., Pollmann, U., Schnitzer, U. and Zeeb K. (2000) *Gruppenhaltung von Pferden. Eingliederung fremder Pferde in bestehende Gruppen*. Schweizerischer Tierschutz STS, Basel.

McDonnell, S.M. and Haviland, J.C.S. (1995) Agonistic ethogram of the equid bachelor band. *Appl. anim. behav. Sci.* **43**, 147-188.

McGreevy, P. (2004) Social behavior. In: *Equine Behavior: A Guide for Veterinarians and Equine Scientists.* Ed: P. McGreevy, W.B. Saunders Co., Edinburgh. pp 119-150.

Miller, R.M. (2001) Behavior and misbehavior of the horse. *Vet. Clin. N. Am.: Equine Pract.* **17**, 379-387.

Mills, D. and Nankervis, K. (1999) *Equine Behaviour: Principles & Practice,* Eds: D. Mills and K. Nankervis, Blackwell Science, Oxford. pp 110-137.

Piskoty, G., Jäggin, S., Michel, S.A. and Fürst, A. (2005) Experimental study of fractures of long bones due to impact loading. In: *First International Conference on Mechanics of Micromaterials & Tissues*, Rob O. Ritchie, Waikoloa, Hawaii. p O21.

Roberts, J.M. and Browning, B.A. (1998) Proximity and threats in highland ponies. *Soc. Networks* **20**, 227-238.

Schäfer, M. (1991) Grundfunktionstypen. In: *Pferdehaltung*, Ed: H. Pirkelmann, Ulmer, Stuttgart. pp 45-53.

van Dierendonck, M.C., Devries, H. and Schilder, M.B.H. (1995) An analysis of dominance, its behavioural parameters and possible determinants in a herd of Icelandic horses in captivity. *Neth. J. Zool.* **45**, 362-385.

van Dierendonck, M.C., Sigurjónsdóttir, H., Colenbrander, B. and Thorhallsdóttir, A.G. (2004) Differences in social behaviour between late pregnant, post-partum and barren mares in a herd of Icelandic horses. *Appl. anim. behav. Sci.* **89**, 283-297.

Waring, G.H. (2003) Agonistic behavior. In: *Horse Behavior*, 2nd edn., Ed: G.H. Waring, Noyes Publications/William Andrew Publishing, Norwich, New York. pp 253-269.

Wells, S.M. and von Goldschmidt-Rothschild, B. (1979) Social behaviour and relationships in a herd of Camargue horses. *Z. Tierpsychol.* **49**, 363-380.

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