



ELSEVIER

## RESEARCH

# Investigating duration of nocturnal ingestive and sleep behaviors of horses bedded on straw versus shavings

Linda Greening, Victoria Shenton, Kate Wilcockson, James Swanson

Centre for Performance in Equestrian Sports, UWE Hartpury, Gloucester, Gloucestershire, United Kingdom.

**KEYWORDS:**

equine;  
 nocturnal;  
 recumbent;  
 ingestion;  
 behavior;  
 bedding

**Abstract** Horses are stabled overnight for a number of practical reasons; however, there is little research quantifying nocturnal equine behavioral patterns or the extent to which different environments influence nocturnal behavior. The aim of this study was to establish whether differences in duration of sleep and ingestive behaviors were apparent for horses bedded on straw (group 1) or shavings (group 2). Ten geldings of mixed breed (mean age:  $7.3 \pm 3.53$  years) bedded on either shavings ( $n = 5$ ) or straw ( $n = 5$ ) were observed between 7 PM and 7 AM. Duration of behaviors according to a predefined ethogram was recorded in minutes using a video recorder and continuous focal sampling. Mann–Whitney *U* tests were used to identify whether any significant differences in duration of ingestion and sleep behaviors occurred for horses bedded on straw compared with shavings. Of the total observation period, group 1 spent, on average, 29.3% of their time budget engaged in recumbent behaviors, compared with 12.2% for group 2. However, no significant differences in duration were established between horses bedded on straw or shavings for standing sleep, sternal recumbency, and lateral recumbency behaviors ( $P > 0.05$ ). Ingestive behaviors occupied approximately one-third of the time budget, with no significant difference ( $P > 0.05$ ) observed between groups. On average, group 1 spent a longer proportion of the observation period ingesting bedding (8.1%) compared with group 2 (1%). Duration of bedding ingestion appeared to peak between 1 AM and 7 AM for both groups. Although not quantified, general observations revealed horses were motivated to alternate between eating hay and bedding in both groups, owing to the prevalence of bedding ingestion. The results indicate that straw bedding facilitates the display of ingestive and sleep behaviors, whereas horses bedded on shavings spent a greater proportion of their nocturnal time budget engaged in “other” behaviors. Further research is required to investigate the extent to which different types of bedding material enrich the environment of horses that are stabled overnight. © 2012 Elsevier Inc. All rights reserved.

## Introduction

The domestic environment within which the horse is kept and managed can present challenges to instinctive and innate

behavioral patterns. Research indicates that within this environment, stabling and associated practices are often the most challenging aspects that the horse is expected to cope with (e.g., McGreevy et al., 1995; Henderson & Waran, 2001; Piccione et al., 2008). Intense stabling practices, involving long periods of confinement with little access to (free) exercise, have been associated with increased restlessness and aggression (Werhahn et al., 2011). Extended periods of confinement can also be associated with increased risk of abnormal behavior development (McGreevy et al., 1995).

---

Address for reprint requests and correspondence: Linda M. Greening, MSc, Centre for Performance in Equestrian Sports, Hartpury House, UWE Hartpury, Gloucester, Gloucestershire, GL193BE, United Kingdom; Tel: +44 (0)1452 702349; Fax: +44 (0)1452 700629.

E-mail: linda.greening@hartpury.ac.uk

Barriers within traditional and conventional stabling systems therefore appear to reduce the opportunity for the horse to display normal behavior and increase the likelihood of abnormal behavior display (Cooper and Albentosa, 2005; Rose-Meirhöfer et al., 2010). However, the role of the horse in modern society seems to necessitate stabling (Henderson, 2007), and as a result, research exists to investigate methods to enrich the stable environment using feed-balls (Henderson and Waran, 2001), increased opportunities to forage (Thorne et al., 2005), and increased visual horizons, such as mirrors (Cooper et al., 2000; Mills and Davenport, 2002). The use of bedding in the stable is a traditional practice that is receiving increased attention as a stimulus that is reported to exert variable positive and negative influences (Werhahn et al., 2010). However, previous studies investigating bedding report contradictory evidence, possibly owing to noncomparable sample populations or aspects of the study design. For example, some studies included female populations exclusively (Haupt et al., 1986; Werhahn et al., 2010), used relatively small stalls (Pedersen et al., 2004), and used crossover designs using different bedding materials (Werhahn et al., 2010). During preference tests, horses have been observed to choose straw bedding when given the choice (Mills et al., 2000), but some have also demonstrated no significant preference (Hunter and Haupt, 1989). Some of the negative conclusions from bedding research suggest that bedding material has little significant influence on behavior (Thompson, 1995) and is linked with colic (Greet and Rosedale, 1987). More recently, research has shown that straw bedding encourages more bedding-directed behaviors, less standing behavior, and longer-duration recumbent behavior (Pedersen et al., 2004; Werhahn et al., 2010). The current study therefore aimed to establish whether significant differences existed for a sample population of mixed-breed/age geldings, bedded on either straw or shavings, looking at the duration of nocturnal ingestive and sleep behaviors.

## Methods and materials

### Materials

Ten geldings of mixed breed and age (average age:  $7.3 \pm 3.53$  years; range: 4-13 years) were allocated to either group 1 (straw;  $n = 5$ ) or group 2 (shavings;  $n = 5$ ) based on the bedding material that appeared in their stable. Each horse had been bedded on the material for at least 5 months previously. Each stable measured 12 feet by 12 feet, the design of which prevented physical contact between neighboring horses owing to solid walls separating each horse; they were able to see each other from the stable door. No deep litter systems or rubber matting was present in any of the stables. The bedding that appeared in the stable was either wheat straw or pinewood shavings that were not entirely new and varied in depth according to owner preference (minimum: 10 cm).

Each horse was provided with access to pasture for between 6 and 10 hours during the day and given its normal feed and/or individual ration of hay at 6.30 PM. All horses were individually stabled on the same yard and underwent light-to-medium work but were privately owned and therefore subject to different daily regimens.

### Experimental design

Each horse was filmed once for a period of 12 hours between 7 PM and 7 AM. The light was left on during the study, and horses were habituated to this for a period of 2 nights before data collection. A Sony Handycam DCR-SX15E (Sony, Tokyo, Japan) with a NP-FV100 battery was secured in the stable rafters in the top corner above the stable door and set on a wide-angle lens so that the entire stable was visible to facilitate data collection. Duration of ingestion and recumbent behaviors according to a predetermined ethogram (Table 1) were recorded using continuous focal sampling. Sleep was recorded where the behavior lasted for longer than 1 minute. Ethical approval was granted by Hartpury College.

### Statistical analysis

To establish whether differences in frequency or duration of ingestive and recumbent behaviors existed for horses bedded on straw or shavings, Mann-Whitney  $U$  tests were used ( $n_1 = n_2 = 5$ ). Significance levels were set at  $P < 0.05$ . Total mean duration of individual behaviors was calculated from the sum of the total time spent engaging in that behavior by each horse, divided by the size of the sample population in each group. Mean duration data were also used to calculate the proportion of the total observation period (720 minutes) that each behavior was displayed for.

## Results

### Sleep behavior

No significant differences between group 1 or 2 were observed for average total duration sleep standing ( $z = -0.104$ ;  $P > 0.05$ ), sternal recumbency ( $z = 0.301$ ;  $P > 0.05$ ), and lateral recumbency ( $z = 1.985$ ;  $P > 0.05$ ) (Table 2). During the total observation period, horses bedded on straw spent, on average, 29.3% of their time budget engaged in recumbent behaviors, compared with 12.2% for those bedded on shavings. Overall, horses bedded on straw spent, on average, 56.9% engaged in sleep behaviors compared with 49.2% for horses bedded on shavings.

### Ingestion behaviors

Only 1 horse bedded on shavings was observed not to display any type of bedding ingestion behavior. No

**Table 1** Ethogram of ingestive and sleeping/recumbent behaviors

Category	Description of activities
Ingest hay	Masticating, prehending or swallowing hay
Ingest concentrates	Masticating, prehending or swallowing concentrates
Ingest bedding substrate	Masticating, prehending or swallowing bedding substrate
Sleep while standing	Standing immobile, no or limited ear movement, relaxed tail, limited leg movement, eyes closed or half shut
Sternal recumbency	Recumbent, with sternum in contact with the ground, legs folded beneath the body, no or limited ear movement
Lateral recumbency	Recumbent, either lateral thoracic area parallel to and in contact with the ground, head immobile and in contact with the ground, legs extended

Adapted from Dierendonck et al., 1996; Winkill et al., 1996; Flannigan and Stookey, 2002; Souris et al., 2007.

significant differences were observed for median total duration of hay ingestion ( $z = -0.940$ ;  $P > 0.05$ ) or bedding ingestion ( $z = 1.776$ ;  $P > 0.05$ ) (Table 3). Of the total observation period, horses bedded on straw spent, on average, 36.2% of their time engaged in ingestion behaviors, compared with 33.1% displayed by horses bedded on shavings.

General observations recorded peak duration of hay ingestion occurring between 7 PM and 10 PM, followed by a general decrease until 4 AM and 7 AM. Around this time, bedding ingestion was seen to increase. Additionally, horses with hay nets were observed to have some hay left in the morning, which may be explained in some cases by the prevalence of bedding ingestion.

## Nocturnal time budget

Distinct differences were observed in nocturnal time budgets for lateral recumbency and ingesting bedding behaviors, when comparing the shavings (Figure 1) and

straw (Figure 2) bedding groups. Overall, the average proportion of time spent on other activities was greater for horses bedded on shavings (17.7%) compared with straw (7%). This equates to 127.44 minutes and 50.40 minutes, respectively, where horses were not engaged in sleep, recumbent, or ingestive behaviors.

## Discussion

The results of the current study, although nonsignificant, reinforce previous research findings that straw bedding encourages increased bedding ingestion and recumbent behaviors and reduced standing-related behaviors (Pedersen et al., 2004; Werhahn et al., 2010). No standardization of bed size or condition was made, thus representing “normal” bedding conditions observed in the general population. Motivation to engage in bedding ingestion behaviors may have been influenced by bedding condition, where horses have been observed to display antiparasite strategies when grazing at pasture (Fleurance et al., 2007). Further exploration of this theory in the stable may be useful to establish whether bedding condition influences nocturnal behavior.

On average, the horses bedded on straw were observed to ingest their bed for longer than those bedded on shavings, although it is important to note that the latter still engaged in bedding ingestion behaviors to some extent. Research has shown that horses provided with multiple forage opportunities were observed to perform foraging behavior more frequently and for longer (Thorne et al., 2005). In the current study, however, there was little difference in total average duration of ingestion behavior between shavings and straw beds, suggesting that although straw offers variation in palatability, it does not significantly influence the amount of time that horses spend eating in the stable overnight. Although not quantified, general observations noted that horses moved between ingestion of hay to bedding ingestion, supporting the idea that some motivation exists to introduce variation into the diet. However, the ethogram used in the current study incorporated prehension of bedding under the heading “bedding ingestion,” which may have included hay that was mixed in with the bed, although the observer attempted to discern between hay and bedding ingestion.

Interestingly, when the researcher asked the owners about each horse before the start of data collection and

**Table 2** Average duration (minutes) of sleep and sternal behaviors, also showing total duration as a proportion of the total observation period (%)

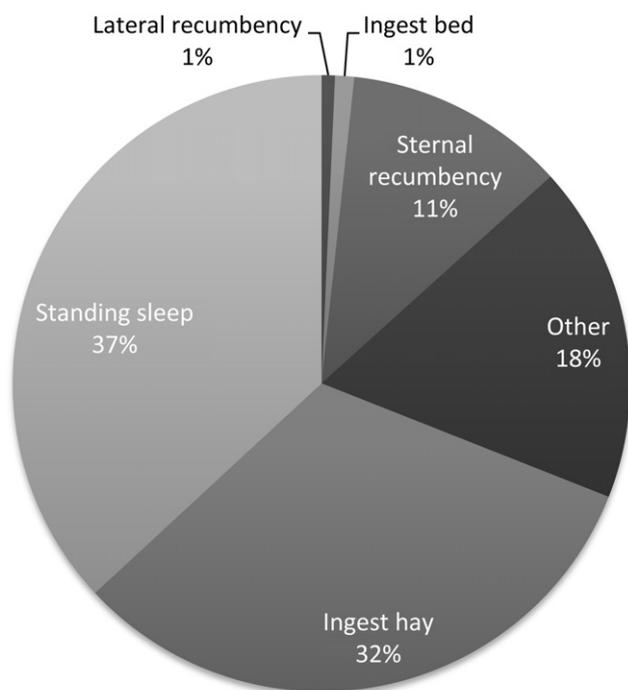
Measurements of duration of behavior	Sleep standing		Sternal recumbency		Lateral recumbency	
	Shavings	Straw	Shavings	Straw	Shavings	Straw
Median duration (minutes)	263	273	113	148	6	45
Mean duration (minutes)	266	199	83	162	5	49
Proportion of total observation period (%)	37	28	12	23	1	7

**Table 3** Average duration (minutes) of ingestion behaviors, also showing total duration as a proportion of the total observation period (%)

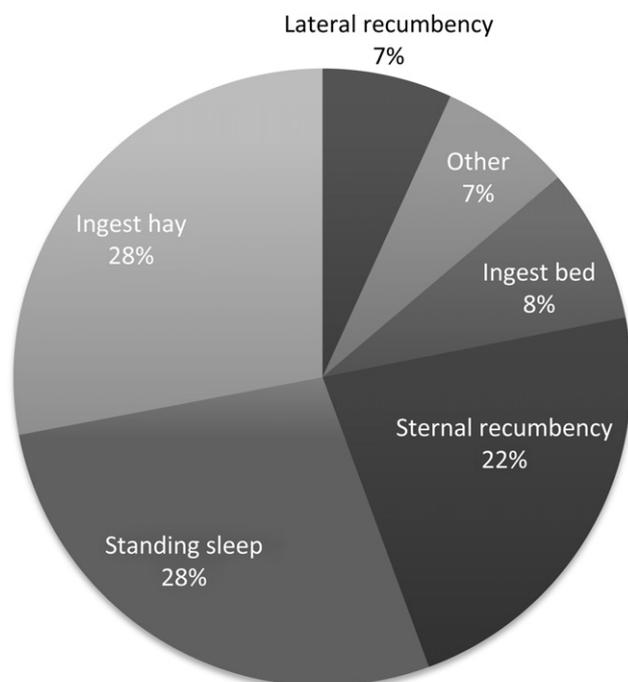
	Ingestion of hay		Ingestion of bedding	
	Shavings	Straw	Shavings	Straw
Median duration (minutes)	248	228	8	17
Mean duration (minutes)	231	202	7	58
Proportion of total observation period (%)	32	28	1	8

whether their horse had colicked in the past 5 months, all owners replied no. Although straw ingestion has been linked with colic in the past (Greet and Rossdale, 1987), the anecdotal reports from owners in the current study do not support this. Some horses engaged in bedding ingestion more than others, suggesting different individual motivation to do so. Increasing access to different types of forage within the stable has also been shown to decrease straw bed forage behavior (Thorne et al., 2005), which may offer a practical solution for owners of horses that have experienced colic associated with the use of a straw bed.

Straw beds have been reported to facilitate more sternal recumbency (Werhahn et al., 2010) and lateral recumbency (Pedersen et al., 2004). In the current study, a straw bed



**Figure 1** Time budgets of average total duration of nocturnal behavior shown as a proportion for the entire observation period for horses bedded on shavings.



**Figure 2** Time budgets of average total duration of nocturnal behavior shown as a proportion for the entire observation period for horses bedded on straw.

appeared to encourage horses to spend a greater proportion of the observation period engaged in both lateral and sternal recumbency compared with horses bedded on shavings, suggesting that straw facilitates sleep, and more importantly paradoxical sleep, highlighting the potential for improved welfare. However, it is recognized that the exact amount of exercise each horse undertook was not standardized, which may have influenced the amount of rest that individual horses were motivated to undertake during the study (Caanitz et al., 1991). Similarly, the study could afford to be conducted over a longer period to gain more data for each individual, and the size of the horse relative to the dimensions of the stable should also be considered in future, as horses have been found to engage in more recumbent behavior in large boxes (Raabymagle & Ladewig, 2006).

Overall, the average proportion of time spent on other activities was greater for horses bedded on shavings (17.7%) compared with straw (7%). Further research may help to verify the following suppositions: that this time may have been spent in standing alert, moving, rolling, engaging in stereotypic behavior, or defecation. Generally, it is accepted that environmental enrichment aims to improve the biological functioning of an animal by making adjustments to the artificial environment, although measuring the success of such improvements quantitatively has proven to be challenging (Newbury, 1995). Where it is possible to account for biologically relevant behaviors within time budgets, it could be suggested that a straw bed encourages the display of more beneficial or functional behaviors from horses compared with shavings, although further

research would be required to account specifically for the type and prevalence of these.

## Conclusion

No statistically significant differences were observed for time spent engaged in ingestion or sleep behaviors when horses were bedded on shavings compared with straw. The proportion of time not spent engaged in sleep- or ingestion-related behaviors was greater for horses bedded on shavings, suggesting straw enables more functional behavior to be displayed in the stable overnight. Although no episodes of colic were recorded during or before the study, owners are recommended to approach the requirements of individual horses with care. Future research should focus on quantifying the occurrence of other nocturnal behaviors, whereas a greater understanding of individual horse bedding preferences, including factors affecting motivation behind bedding-directed and recumbent behaviors, is still required.

## Acknowledgments

The authors extend their thanks to Fernando de Mata for proofreading this article.

## References

- Caanitz, H., O'Leary, L., Houpt, K.A., Petersson, K., Hintz, H., 1991. Effect of exercise on equine behavior. *Appl. Anim. Behav. Sci.* 31, 1-12.
- Cooper, J.J., Albertosa, M.J., 2005. Behavioral adaptation in the domestic horse: potential role of apparently abnormal responses including stereotypic behavior. *Livest. Prod. Sci.* 92, 177-182.
- Cooper, J.J., McDonald, L., Mills, D.S., 2000. The effect of increasing visual horizons on stereotypic weaving: implications for the social housing of stabled horses. *Appl. Anim. Behav. Sci.* 69, 67-83.
- Dierendonck, M.C., Bandi, N., Batdorj, D., Dürgerlham, S., Munkhtsog, B., 1996. Behavioral observations of reintroduced Takhi or Przewalski horses (*Equus ferus przewalski*) in Mongolia. *Appl. Anim. Behav. Sci.* 50, 95-114.
- Flannigan, G., Stookey, J.M., 2002. Day-time time budgets of pregnant mares housed in tie stalls: a comparison of draft versus light mares. *Appl. Anim. Behav. Sci.* 78, 125-143.
- Fleurance, G., Duncan, P., Fritz, H., Cabaret, J., Cortet, J., Gordon, I.J., 2007. Selection of feeding sites by horses at pasture: testing the anti-parasite theory. *Appl. Anim. Behav. Sci.* 108, 288-301.
- Greet, T.R.C., Rossdale, P.D., 1987. The digestive system. In: Rossdale, P.D. (Ed.), *Veterinary Notes for Horse Owners*. Stanley Paul and Co. Ltd., London, UK, pp. 5-24.
- Henderson, A.J.Z., 2007. Don't fence me in: managing psychological well-being for elite performance horses. *J. Appl. Anim. Welf. Sci.* 10, 309-329.
- Henderson, J.V., Waran, N.K., 2001. Reducing equine stereotypies using an equiball. *Anim. Welf.* 10, 73-80.
- Houpt, K.A., O'Connell, M.F., Houpt, T.A., Carbonaro, D.A., 1986. Night-time behavior of stabled and pastured peri-parturient ponies. *Appl. Anim. Behav. Sci.* 15, 103-111.
- Hunter, L., Houpt, K.A., 1989. Bedding material preferences of ponies. *J. Anim. Sci.* 67, 1986-1991.
- McGreevy, P.D., Cripps, P.J., French, N.P., Green, L.E., Nicol, C.J., 1995. Management factors associated with stereotypic and redetected behaviors in the Thoroughbred horse environments. *Appl. Anim. Behav. Sci.* 44, 270-271.
- Mills, D.S., Davenport, K., 2002. The effect of a neighbouring conspecific versus the use of a mirror for the control of stereotypic weaving behavior in the stabled horse. *Anim. Sci.* 74, 95-101.
- Mills, D.S., Eckley, S., Cooper, J.J., 2000. Thoroughbred bedding preferences, associated behavior differences and their implications for equine welfare. *Anim. Sci.* 70, 95-106.
- Newbury, R.C., 1995. Environmental enrichment: increasing the biological relevance of captive environments. *Appl. Anim. Behav. Sci.* 44, 229-243.
- Pedersen, G.R., Søndergaard, E., Ladewig, J., 2004. The influence of bedding on the time horses spend recumbent. *J. Eq. Vet. Sci.* 24, 153-158.
- Piccione, G., Costa, A., Giannetto, C., Caola, G., 2008. Daily rhythms of activity in horses housed in different stabling conditions. *Bio. Rhyth. Res.* 39, 79-84.
- Raabymagle, P., Ladewig, J., 2006. Lying behavior in horses in relation to box size. *J. Eq. Vet. Sci.* 26, 11-17.
- Rose-Meierhöfer, S., Klaer, S., Ammon, C., Brunsch, R., Hoffmann, G., 2010. Activity behavior of horses housed in different open barn systems. *J. Eq. Vet. Sci.* 30, 624-634.
- Souris, A.C., Kaczensky, P., Julliard, R., Walzer, C., 2007. Time budget-, behavioral synchrony- and body score development of newly released Przewalski's horse group of *Equus ferus przewalski*, in the Great Gobi B strictly protected area in SW Mongolia. *Appl. Anim. Behav. Sci.* 107, 307-321.
- Thorne, J.B., Goodwin, D., Kennedy, M.J., Davidson, H.P.B., Harris, P., 2005. Foraging enrichment for individually housed horses: practicality and effects on behavior. *Appl. Anim. Behav. Sci.* 94, 149-164.
- Thompson, K.N., 1995. Alternate bedding materials for horses. *Eq. Prac* 17, 20-23.
- Werhahn, H., Hessel, E.F., Bachhausen, I., Van den Weghe, H.F.A., 2010. Effects of different bedding materials on the behavior of horses housed in single stalls. *J. Eq. Vet. Sci.* 30, 425-431.
- Werhahn, H., Hessel, E.F., Schulze, H., Van den Weghe, H.F.A., 2011. Temporary turnout for free exercise in groups: effects on the behavior of competition horses housed in single stalls. *J. Eq. Vet. Sci.* 31, 417-425.
- Winskill, L.C., Waran, N.K., Young, R.J., 1996. The effect of a foraging device (a modified 'Edinburgh Foodball') on the behavior of the stabled horse. *Appl. Anim. Behav. Sci.* 48, 25-35.