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Day-time time budgets of pregnant mares housed in tie stalls: a comparison of draft versus light mares

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Abstract

Day-time (08.30–05.30 h) time budgets were generated from 55 light and 55 draft late pregnancy mares housed in tie stalls from ten pregnant mares' urine (PMU) farms using continuous video recording. Equal numbers of light and draft mares were filmed on each farm during the months of February and early March. The actions recorded included eating, drinking, resting (standing and recumbent), standing active, and interactions between horses (aggressive and non-aggressive). In addition, the presence and duration of stereotypic behaviours such as cribbing, head bobbing, weaving, and wood/bar chewing were recorded. Light mares spent significantly more time feeding and significantly less time standing active and standing resting ($P < 0.05$, Rank Sum Two Sample Test). However, the time budget of both groups fell within the range of previously published activity budgets of feral horses. Therefore, the differences noted may not be clinically relevant. Three light and two draft mares performed repetitive behaviours at a level that is considered stereotypic (at >5% of their daily time budget). There was no significant difference in the number of horses performing stereotypies between light and draft mares. When the time budgets of both light and draft mares who performed stereotypies were pooled, the activities did not differ significantly from their counterparts who did not perform stereotypies. Because of the overall low prevalence of stereotypies and the fact that time budgets were similar to free-range horses, we believe that the management practice of keeping large numbers of pregnant mares in tie stalls is rational and that the welfare of mares is sound. Furthermore, we did not see a behavioural justification for a bias in the weight class of horses used within this management system.

Keywords: Horse; Time budget; Stereotypies; Housing

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1. Introduction

Large differences in the amount of time a confined animal engages in behavioural activities (time budget) compared to feral or wild conspecifics has been used as a measure of poor welfare (Kiley-Worthington, 1989; Marsden, 1993; Waran, 1997). Theoretically, an animal should be able to perform its full compliment of behaviours at levels similar to its free-living relatives. However, an animal need not show all behaviours within its repertoire for its welfare to be maximised. Wild animals have considerable flexibility in their expression of behaviours (Veasy et al., 1996) and alter these behaviours to suit environmental conditions (Kaseda, 1983; Duncan, 1985; Dawkins, 1990). Many of the needs of captive animals can be met by the management system, and thus, some of the motivation to perform certain behaviours would be decreased (Dawkins, 1990). Therefore, the time budget of captive or domestic species may be quite different from that of their wild counterparts without representing a decrease in their welfare. However, time budgets of wild or feral animals can be useful as a starting point in determining the welfare of captive animals because they act as a baseline for comparison if there is evidence that the absence of certain behaviours results in poor welfare (Winskill et al., 1995).

Compared to their feral relatives, the diversity of behaviours observed in stabled horses has been dramatically altered due to the confining nature of the husbandry system. Time budget analysis of feral and pasture-kept horses has uncovered the importance of interspecific social contact, exercise and lengthy grazing times (Crowell-Davis et al., 1985; Houpt et al., 1986; van Dierendonck et al., 1996). When given ad-lib hay and the opportunity to see and touch adjacent horses, the time budget of stabled horses is very similar to free-range horses in regard to time spent eating and resting (Sweeting et al., 1985; Sweeting and Houpt, 1987; Houpt and Houpt, 1989; Kiley-Worthington, 1990).

The sequences of behaviours in stereotypies can be simple or complex but they are relatively invariant, repeated over and over, and have no apparent goal or function (Ödberg, 1978). It is generally accepted that husbandry practices have the greatest effect on the development of stereotypies in stabled horses (Houpt and McDonnell, 1993; Simpson, 1998) and that management changes that allow a horse to perform actions within their behavioural repertoire will lead to a reduction in stereotypic expression (Winskill et al., 1996; Waran and Henderson, 1998; Cooper et al., 2000). To date, only one time budget of a horse performing stereoptypies has been published in a peer reviewed journal (Houpt and McDonnell, 1993). A few studies have reported success at decreasing stereotypic expression in horses by manipulating diet (Gillham et al., 1994; Johnson et al., 1998), levels of exercise (Krzak et al., 1991), and levels of social contact (Cooper et al., 2000), though the stereotypic behaviour was not completely extinguished. In essence, the change in management factors attempted to give horses the opportunity to closely match the activity budget of a free-range horse.

Some research has been published in scientific journals on behaviour of the draft horse. Previous studies have shown that the maternal (Smith-Funk and Crowell-Davis, 1992; Barber and Crowell-Davis, 1994) and social (Ellard and Crowell-Davis, 1989; Estep et al., 1993) behaviour of draft mares does not differ from other breeds of horses. There is no published data on the stabled behaviour of draft horses. McDonnell et al. (1999) reported the time budget of pregnant stalled mares (slightly less than half were draft mares) but

failed to distinguish between the mare types in their activity budgets. As a result, it is not known if draft horses are more or less prone to the development of stereotypies.

In the present study, we calculated the time budgets of both light and draft pregnant mares housed in tie stalls via time lapse video recording. The study was designed to estimate whether one class of horses was better suited to this management system. In addition, we looked at the time budgets of horses which performed stereotypies and compared them to unaffected horses within the same management system. Such a comparison could determine the underlying motivation for the expression of stereotypies under this management practice.

2. Materials and methods

2.1. Animals

One hundred and ten (55 light and 55 draft) pregnant mares were observed while in production at 10 pregnant mares' urine (PMU) farms during daylight hours (08.30–17.30 h) by continuous video-recording. PMU contains estrogens used in the manufacture of hormone replacement therapy for post-menopausal women. Five farms in Alberta, one farm in Saskatchewan, and four farms in Manitoba were included in the study. Based on information provided on a 1996 survey of the PMU industry (Flannigan and Stookey, 1998), farms were selected from the industry at random with the provision that both light and draft mares were present on each farm and the following inclusion criteria were met:

(a) The producer was willing to be included in the observational study.
(b) The farm had a minimum of 20 light and 20 draft on-line, production mares.
(c) The farm had a combined population of at least 50 on-line, production mares.

The draft and light mares observed were from a variety of recognised breeds or crossbreds. Draft crossbreds were at least two-thirds draft breeds and >650 kg while light crossbreds weighed <500 kg based on producer estimates. Equal numbers of light and draft mares were observed on each of the 10 farms (Table 1). Each draft mare had a corresponding light mare on the same farm and, thus, both were exposed to identical housing management. Any horse which displayed a stereotypy developed the condition on the farm under study as no horse was included if it was affected prior to being acquired by the producer. In other words, we were not interested in collecting data on horses that may have developed stereotypies due to previous housing conditions or experience. Otherwise, horses that were filmed were selected at random.

2.2. Housing

All mares were housed in accordance with the described recommendations in the PMU Code of Practice (Anonymous, 1990). Each mare was tethered to the front of its individual stall by either a rope or a chain, and attached to a urine collection harness during the filming period. The urine collection harness is a non-invasive, flexible pouch suspended from the ceiling by rubber tubbing. While maintained for the collection of urine, horses could stand

Table 1
Number of horses and management factors of farms observed for time budgets in pregnant mares' urine (PMU) production mares, winter 1997

Farm no.	Number observed			Management factors							
	Light	Heavy	Total	No. of production mares[a]	No. of barns	Grain		Hay (no. of times fed per day)	Water		Exercise (no. of days between periods[b])
						No. of times fed per day	Method of delivery[c]		No. of times per day	Method of delivery[c]	
1	6	6	12	120	1	3	By hand	4	11	Auto	8
2	3	3	6	128	1	3	By hand	4	12	Auto	6
3	3	3	6	88	1	2	By hand	4	14	Auto	4
4	7	7	14	98	2	2	By hand	3	2	Auto	14
5	9	9	18	110	1	3	By hand	3	23	Auto	4
6	7	7	14	50	1	3	Auto	2	15	Auto	7
7	6	6	12	105	1	2	By hand	4	14	Auto	As required
8	7	7	14	135	1	2	By hand	4	3	Covered bowl	As required
9	4	4	8	185	3	2	Auto	3	12	Auto	No exercise
10	3	3	6	115	2	2	By hand	3	12	Auto	No exercise
Total	55	55	110	$\bar{x} = 115.4 \pm 11.2$							

[a] Based on survey results from 1996. Farms 1–9 had mares oriented face to face, while mares from farm 10 were oriented back to back.

[b] The farms which exercised mares "as required" were unable to estimate how many days a mare was in the barn between exercise periods.

[c] Automatic systems delivered either grain or water directly to the mare using an adjustable timer. The covered bowl is opened by the producer for 10 min and contained 41 l (nine imperial gallons) of water.

or lie down and easily move backward or forward. Stalls were aligned side by side in rows and each was approximately 1.25 m wide by 2.5 m in length. In all cases, mares could touch adjacent mares and had access to forage for the majority of the day.

2.3. Observations

Observations took place during the months of February and early March of 1997. On each farm, four video cameras (CCTV Model WV-BP130) were attached directly in front of mares such that three to four mares could be observed simultaneously per camera. The video cameras were connected to time lapse video recorders (Panasonic AG6730 Time Lapse Video Recorder) set to record continuously for 24 h. Although video recordings were made for a consecutive 24 h period, the 9 h observation interval (08.30–17.30 h) was chosen because it was the duration of time that light was available across all farms. Every attempt was taken to maintain the normal management practices on each farm, so as not to affect the outcome of the time budget or to influence the expression of stereotypies. Therefore, since some of the farms kept overhead lights off while the producer was not in the barn, the amount of time horses could be viewed was consistent with ambient light for the season in the areas of the farm.

We attempted to film six light and six draft mares on each farm. Unfortunately, equipment failures and the physical restrictions of the barn (due to barn layout) prevented the filming of the desired number of mares on some farms. Ultimately, a balanced number of light and draft mares were filmed on each farm, but some farms had more or less than 12 horses that contributed to the data set (see Table 1). Horses were not moved to other portions of the barn to make observations easier for the investigators.

Data were transcribed during playback of the videotapes using The Observer (Noldus Information Technology, Version 3.0 for Windows, Wagenigen, The Netherlands) computer software. Behaviours performed by horses were transcribed continuously for the 9 h observation period for all horses. However, to reduce observer bias, each 9 h tape was divided into three, 3 h time blocks for analysis, which resulted in 96 'farm-time' block combinations. Farm-time blocks were analysed in random order. Horses were observed individually in each block from left to right as they appeared on the screen; the initial horse to be observed differed with each successive observation block (for example: time block 1—observed as left mare, middle mare, right mare; time block 2—observed as middle, right, then left; and so on).

The behaviours recorded included the behavioural activity, frequency of interaction and types of stereotypies, if observed. These behaviours were categorised as actions or stereotypies on two separate channels within The Observer computer software. Tables 2 and 3 define the behaviours within the two categories evaluated. Interactions between mares were counted as frequency data only. Stereotypies, when present, were included in the standing active portion of the time budget. The amount of time involved in a stereotypy was also recorded using a separate channel within The Observer software. Where stereotypies were represented as a percentage of observed time, the remainder of the time was recorded as absent from stereotypies within this channel. In anticipation of being fed, most horses became more active and performed repetitive behaviours as the producers forked hay or administered grain into bunkers elsewhere in the barn. These

Table 2
Definition of actions recorded during time budget analysis

Eating	Head in bunker or on the floor, chewing motions; head could be elevated if chewing motions were obvious
Drinking	Head in water bowl for continuously >5 s; therefore, splashing water was not recorded as drinking
Rest	
Standing	Standing motionless, eyes partially closed, drooping head and ears; head bobs and ear twitches excepted
Recumbent	Lying in the stall
Standing active	Standing with eyes open, head movement, interacting with herd mates, grooming, or moving about stall
Interaction[a]	Mare must initiate action toward a neighbour, contact is not necessary
Aggressive	Overt aggression characterised by biting, kicking, or threats; threats were distinguished by a quick motion toward a neighbouring horse and often included a retreat by the neighbour
Non-aggressive	Non-aggression characterised by nuzzling, sniffing, or other

[a] Events not characterised in time budget but included for frequency.

actions were considered to be redirected behaviours and, as a result, were not included in the analysis.

In addition to being rigid in form and without goal or function, some authors believe that a stereotypy must occur at a level that interferes with the normal functioning of an animal before its welfare is considered compromised (Broom and Kennedy, 1993; Moon-Fanelli and Dodman, 1998). Broom and Johnson (1993) set this cut-off at 5% of an animal's active time. Although all repetitive behaviours were included in the data entry, for the purpose of this study, repetitive behaviours expressed for <5% of the overall observed time were

Table 3
Definition of equine stereotypies[a] recorded during time budget analysis[b,c]

Absent	No stereotypies present; default setting that accumulated the time a horse was not engaged in stereotypic behaviour
Cribbing	A behaviour where the horse grasps a fixed object with its incisors and sucks air; obvious on the video image by flexion of the neck muscles
Head bobbing	A continuous, repetitive nodding of the head
Weaving	A side-to-side swaying motion involving the head, forequarters and occasionally may include the hindquarters
Wood/bar chewing	A behaviour where the horse attempts to actively chew sites in its enclosure
Striking	Continuous, repetitive kicking of the front of the stall
Other	
Oral	Other oral stereotypies not included above such as windsucking, self mutilation, lip snapping/licking, or bar licking
Movement	Other movement stereotypies not included above

[a] Repetitive, invariant behaviours which have no apparent function (Ödberg, 1978).

[b] These behaviours were scored if they were performed >10 continuous times at a speed subjectively quicker than normal motions of the horse.

[c] Definitions adapted from Houpt and McDonnell (1993).

considered either vacuum activities, or redirected behaviours as described by other authors (Houpt and McDonnell, 1993).

2.4. Time budget generation and statistical analysis

The Observer computer software was also employed to develop time budgets for each mare through time-event tables and via the elementary features within the software. Average time budgets for light and draft breeds were generated by compiling individual data analysed within Statistics (Statistics Analytical Software, 1994, Version 4.1, Tallhasse, FL, USA) computer statistical program. The amount of time spent in each activity, the number of observations, and the number of activity changes over the 9 h observation interval (a total of 540 min) were compared between light and draft mares and between stereotypic and non-stereotypic mares using Rank Sum Two Sample (Mann–Whitney) Tests. The number of mares showing stereotypies in each mare category was compared by Pearson's Chi-square tests.

3. Results

3.1. Farms

Although management practices were different on each farm, collectively the management practices were consistent with the industry as a whole (Table 1) based on survey data collected at the same time from the previous year (unpublished data). The average number of production mares for farms in the observational study was 115.4 ± 11.2.

3.2. Time budgets

The overall time budgets of light and draft tethered pregnant mares were very similar; however, light mares spent significantly more time feeding and significantly less time standing active and standing resting (Table 4). Time spent resting in a recumbent position, the total time spent resting and the amount of time spent drinking were not significantly different between light and draft mares. Likewise, the number of activity changes and interactions with neighbouring mares were not significantly different between the two breed types (Table 5). The majority of mares took the opportunity to interact with neighbouring mares (87.2% of light mares versus 89.1% of draft mares).

3.3. Stereotypies

Table 6 is a list of all of the horses that displayed some type of repetitive behaviour. Repetitive behaviours were observed in some horses on all but two of the farms. Three light horses (horse identification numbers 62, 84 and 108) and two draft horses (horse identification numbers 5 and 14) out of the 55 horses in each group showed repetitive behaviours at a level to be considered a stereotypy (at >5% of the observed time). There was no significant difference in the number of horses performing stereotypies between light

Table 4
Average time budgets of pregnant mares' urine (PMU) production mares of the two breed types during late production season, 1997[a,b]

Activity	Breed type	
	Light	Draft
Percent of time ($\bar{x} \pm$ S.E.)		
Feeding	57.88 ± 2.19 (312.5 ± 11.9) a	50.19 ± 2.21 (270.7 ± 12.0) b
Standing active	19.00 ± 1.34 (102.3 ± 7.2) a	22.48 ± 1.33 (121.3 ± 7.2) b
Standing resting	20.15 ± 1.40 (108.6 ± 7.5) a	24.23 ± 1.45 (130.6 ± 7.8) b
Recumbent resting	1.02 ± 0.35 (5.5 ± 1.9)	1.22 ± 0.38 (6.9 ± 2.2)
Total resting	21.16 ± 1.42 (114.1 ± 7.7)	25.45 ± 1.56 (134.2 ± 8.6)
Drinking	1.98 ± 0.21 (10.7 ± 1.1)	1.89 ± 0.19 (10.2 ± 1.0)
Activity changes ($\bar{x} \pm$ S.E.)	94.33 ± 4.47	87.91 ± 3.90

Means across the corresponding row with different letters (a, b) are significantly different ($P < 0.05$, Rank Sum Two Sample (Mann–Whitney) Tests).

[a] Values based on 55 horses in each group over the daylight hours (08.30–17.30 h).

[b] Numbers in parentheses are the amount of time in minutes ($\bar{x} \pm$ S.E.) that the activity was performed over the 9 h (540 min) observation period.

and draft mares. Using this 5% criteria, three farms had mares within the group that showed stereoptypic behaviour (farm #4, one light mare; farm #5, one draft mare; farm #8, one draft and two light mares). This sample of farms is too small to make statistical inferences concerning the management factors associated with the identification of stereotypies but an interesting pattern emerges when compared to farms which do not have horses expressing stereotypies. The three farms which had horses that showed stereotypies were at the extremes of the number of times horses were offered water each day (farm 4: 2 times per day, farm 5: 23 times per day, and farm 8: 3 times per day). The seven farms that did not have horses that displayed stereotypies offered water to their mares ranging from 11 to 15 times per day (Table 1).

Because there was such wide variation in the time budgets of mares who performed stereotypies (Tables 7 and 8, and Figs. 1 and 2), no significant differences were apparent from the analysis of the two classes of mares found within the PMU industry. As a result, the data from the mares who performed stereotypies were pooled for comparison with their

Table 5
Frequency of aggressive and non-aggressive interactions among observed neighbouring production mares at PMU farms during the 9 h observation period, winter 1997[a]

Activity	Breed type	
	Light	Draft
Interactions ($\bar{x} \pm$ S.E.)		
Non-aggressive	2.27 ± 0.55	1.69 ± 0.36
Aggressive	11.53 ± 2.08	7.36 ± 1.62
Total	13.80 ± 2.36	9.04 ± 1.70

[a] Values based on 55 horses in each group over the daylight hours (08.30–17.30 h).

Table 6
Repetitive behaviours performed by observed individual horses[a] during 9 h of continuous, daylight observation (08.30–17.30 h)

Horse identification no.	Farm no.	Behaviour seen	Total duration (s)	Percent of the day	Bouts			
					Frequency[b]	Mean duration[c] (s)	Minimum duration (s)	Maximum duration (s)
Light								
106	1	Head bob	204.9	0.63	4	51.22 ± 12.92	28.5	88.2
101	2	Weaving	148.5	0.46	3	49.50 ± 8.04	36.0	63.8
98	4	Wood/bar	51.8	0.16	2	25.90 ± 18.40	7.5	44.3
		Oral[d]	109.9	0.34	1	109.9 ± 0	–	–
Total			161.7	0.50	3			
84[e]	5	Weaving	2833.2	8.74	24	118.05 ± 31.65	9.4	551.1
67	6	Weaving	315.4	0.97	10	31.54 ± 7.60	6.1	89.0
		Oral[f]	963.1	2.97	13	74.08 ± 23.38	21.9	345.3
Total			1278.5	3.94	23			
108[e]	8	Oral[f]	1794.9	5.69	8	224.36 ± 87.24	51.2	751.0
62[e]	8	Weaving	4556.7	14.06	19	239.83 ± 57.05	27.0	941.8
Draft								
32	3	Weaving	74.8	0.23	2	37.40 ± 13.00	24.4	50.4
1	4	Weaving	433.6	1.34	6	72.27 ± 26.40	11.1	154.8
14[e]	4	Head bob	55.4	0.17	2	27.70 ± 5.00	22.7	32.7
		Weaving	2227.5	6.88	38	58.62 ± 15.76	10.0	541.8
Total			2282.9	7.05	40			
5[e]	8	Weaving	8196.6	25.3	16	512.29 ± 21.45	38.8	2769.5
21	9	Weaving	74.8	0.23	2	37.4 ± 18.38	24.4	50.4

Observations of on-line mares during the winter 1997.
[a] A total of 55 light and 55 heavy horses were observed across 10 farms.
[b] Frequency of observed repetitive behaviours during 9 h observation period.
[c] $\bar{x} \pm$ S.E.
[d] Licking or nibbling over the front bar of the manger.
[e] Horses identified as performing stereotypies based on 5% or greater of observed time.
[f] Lip snapping or licking.

non-stereotypic counterparts (Tables 7 and 8). No significant differences between the time budgets of these two groups of horses were evident. The averages of behavioural activities and activity changes by mares who performed stereotypies from pooled data were similar to time budgets of the non-stereotypic mares within this study. Although significance was lost due to the small sample size of horses which performed stereotypies and high variability within this group, there were some trends noted on close inspection of the data.

Table 7
Average time budget of stereotypic and non-stereotypic pregnant mares' urine (PMU) production mares during late production season, 1997[a]

Activity	Stereotypic[b]			Unaffected[c]
	Light breeds	Draft breeds	Overall average	
Percent of time ($\bar{x}$ ± S.E.)				
Feeding	60.22 ± 14.19 (323.5 ± 78.1)	43.10 ± 4.28 (232.7 ± 60.9)	53.37 ± 9.53 (287.2 ± 51.9)	54.07 ± 1.62 (291.8 ± 8.8)
Standing active	24.83 ± 8.70 (133.0 ± 45.3)	29.12 ± 9.56 (157.3 ± 51.6)	26.54 ± 5.74 (142.2 ± 30.3)	20.46 ± 3.85 (110.3 ± 5.2)
Standing resting	12.55 ± 5.35 (66.8 ± 28.3)	26.10 ± 1.8 (140.9 ± 9.7)	17.97 ± 4.47 (96.5 ± 24.1)	22.39 ± 1.05 (120.7 ± 5.6)
Recumbent resting	1.10 ± 1.10 (5.8 ± 5.8)	0.46 ± 0.46 (2.5 ± 2.5)	0.86 ± 0.64 (4.5 ± 3.4)	1.13 ± 0.27 (6.2 ± 1.5)
Total resting	13.65 ± 6.18 (72.6 ± 32.5)	26.56 ± 2.26 (143.4 ± 100.9)	18.81 ± 4.68 (100.9 ± 25.2)	23.52 ± 1.10 (125.3 ± 6.0)
Drinking	1.29 ± 0.65 (7.0 ± 3.5)	1.35 ± 0.48 (6.6 ± 3.0)	1.35 ± 0.48 (6.8 ± 2.2)	1.97 ± 0.15 (10.6 ± 0.8)
Activity changes ($\bar{x}$ ± S.E.)	85.50 ± 8.50	88.67 ± 14.19	87.40 ± 8.62	91.30 ± 3.10

[a] Numbers in parentheses are the amount of time in minutes ($\bar{x}$ ± S.E.) that the activity was performed over the 9 h (540 min) observation period.
[b] Averages based on three light horses and two heavy horses over the daylight hours (08.30–17.30 h).
[c] Averages based on 105 horses (52 light horses and 53 heavy horses) over the daylight hours (08.30–17.30 h).

Table 8
Frequency of interactions among stereotypic and non-stereotypic observed neighbouring production mares at PMU farms during the 9 h observation period, winter 1997

Activity	Stereotypic[a]			Unaffected[b]
	Light breeds	Draft breeds	Overall average	
Interactions ($\bar{x} \pm$ S.E.)				
Non-aggressive	1.0 ± 0.58	1.0 ± 1.0	1.0 ± 0.45	2.03 ± 0.34
Aggressive	2.67 ± 0.88	5.50 ± 5.5	3.80 ± 1.93	9.71 ± 1.48
Total	3.67 ± 1.20	6.50 ± 6.5	4.80 ± 2.67	11.73 ± 1.53

[a] Averages based on three light horses and two heavy horses over the daylight hours (08.30–17.30 h).
[b] Averages based on 105 horses (52 light horses and 53 heavy horses) over the daylight hours (08.30–17.30 h).

Horses which performed stereotypies tended to stand actively for more of their time with a corresponding lower level of resting in a standing position. In addition, mares who performed stereotypies appeared to interact with their neighbouring horses much less than mares that did not show stereotypies.

4. Discussion

This is the first study that has directly compared the behaviour and time budget of draft type mares to light mares under analogous management conditions. The time budgets of both light and draft breeds housed in tie stalls within the industry compare quite favourably to the time budgets of free-range and Przewalski horses (Tables 9 and 10). The significant differences in behaviour evident between the two classes of horses were not clinically relevant because the amount of time spent on these behaviours in both groups fall within the range generally found in the time budgets of free-range horses if time spent eating hay and grazing times are considered analogous.

Other researchers, who looked at day-time time budgets of feral horses (Salter and Hudson, 1979; Crowell-Davis et al., 1985; Berger, 1986), reported foraging times that were slightly higher than we found in this study (60–75 versus 50–58% in the present study). Mares within this study had foraging times that were more similar to pasture/zoo studies of the horse's closest living wild relative, the Przewalski horse (Boyd, 1988; Hogan et al., 1988). Likewise, compared to Przewalski horses, tethered pregnant mares stood alert and rested for a similar percentage of their day (both at approximately 20%). Houpt et al. (1986) compared stabled versus pasture night-time (19.00–07.00 h) time budgets of peri-parturient pony mares. In that study, the investigators found that the biggest difference between the two management approaches was in the amount of time spent feeding. The stalled mares spent 15% of their time eating forage while the pasture mares grazed for 55% of their observed time. In our study of stabled, late pregnancy mares, time spent eating more closely resembled the findings for pregnant mares kept on pasture (Houpt et al., 1986). Sweeting et al. (1985) found that social facilitation was crucial to preserve the feeding portion of the time budget in stabled Shetland ponies. A possible reason that the

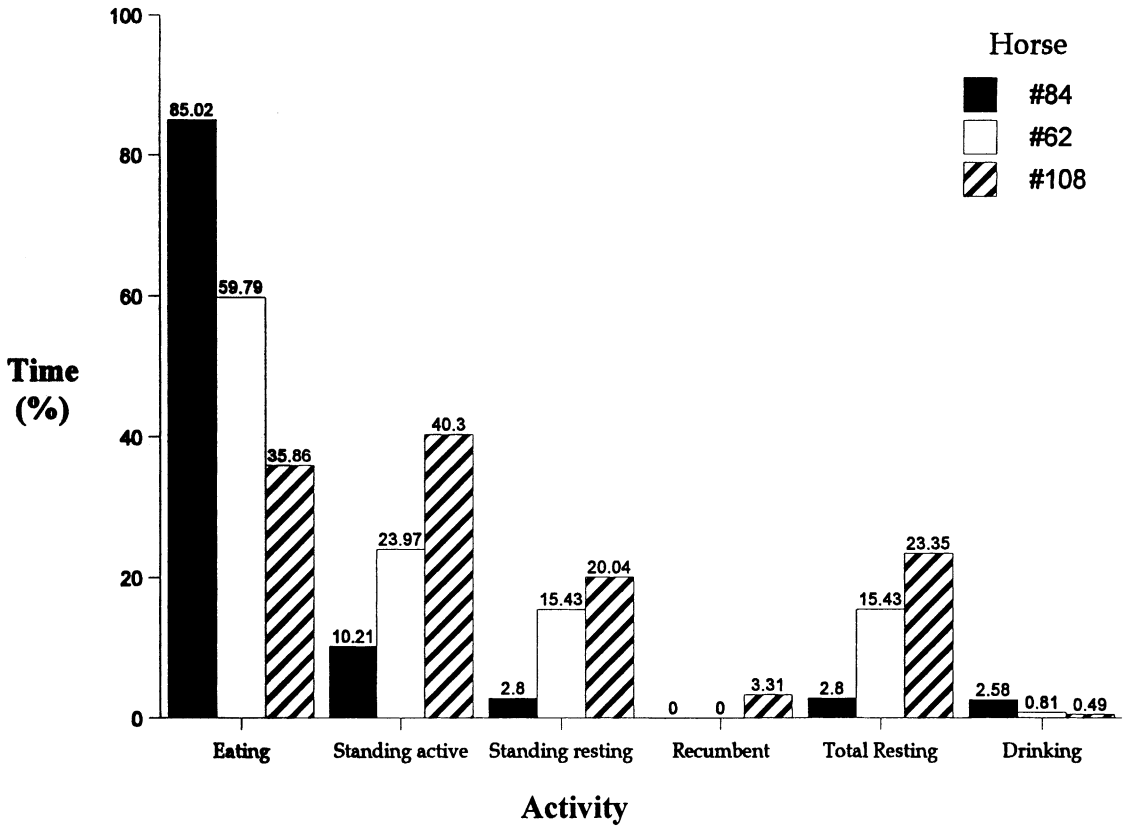

Fig. 1. Time budgets for light pregnant mares' urine (PMU) on-line, production stereotypic mares during daylight hours (08.30–17.30 h) for winter 1997. Horse #84: stereotypic for 8.75% of observed time; horse #62: stereotypic for 14.06% of observed time; horse #108: stereotypic for 5.69% of observed time.

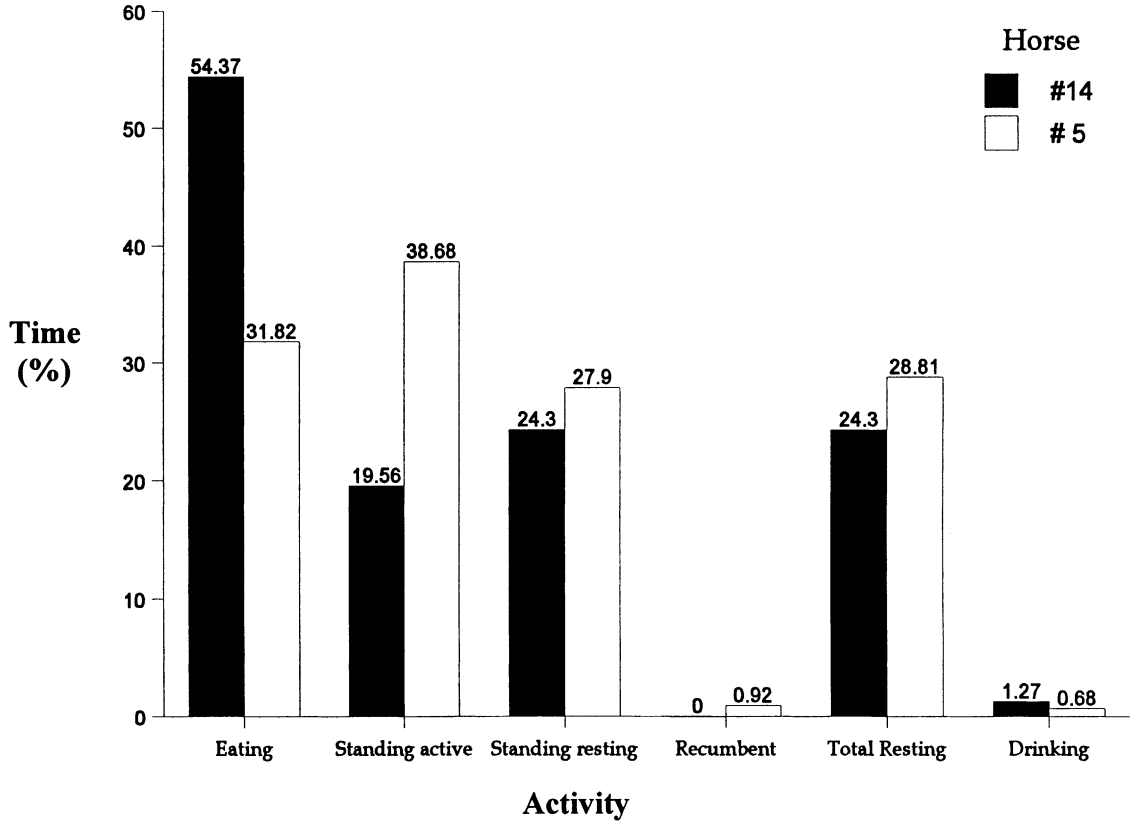

Fig. 2. Time budgets for draft pregnant mares' urine (PMU) on-line, production stereotypic mares during daylight hours (08.30–17.30 h) for winter 1997. Horse #14: stereotypic for 7.05% of observed time; horse #5: stereotypic for 25.3% of observed time.

Table 9
Characteristics and time budgets from domestic and feral horse (*Equus caballus*) studies

Group	No. of animals	Herd type	Observation period	Time budget (%)						Source
				Foraging	Standing: alert	Standing: resting	Lying: sternal	Lying: lateral	Moving	
Great basin wild horses	NR	Feral	Day-time	60	NR	NR	NR	NR	NR	Berger (1986)
Western Alberta	NR	Feral	Day-time (6 a.m. to 8 p.m. non-continuous)	75	NR	~20	~5		NR	Salter and Hudson (1979)
Welsh ponies	11	Pasture	Day-time	70	NR	NR	NR	NR	NR	Crowell-Davis et al. (1985)
Shetland ponies	26	Pasture	Night-time (6 p.m. to 6 a.m.)	55–69	22	33	4.2	0.2	2.7–4.7	Houpt et al. (1986)
Assateague island ponies	NR	Feral	Night-time (7 p.m. to 5 a.m.)	54.6	NR	23.5	~16.5		4.5	Keiper and Keenan (1980)
Masaki Japanese horses	12	Feral	24 h	71–76	NR	20–27			NR	Kaseda (1983)
Camargue horses	20–28	Feral	24 h (2 days per month)	60	4	18	1.5	5	9.5	Boy and Duncan (1979)
Camargue horses	9–15	Feral	24 h	54–63	6–14	16–23	1.0–4.7	0.2–4.8	8–11	Duncan (1980)
Camargue horses	8	Feral	24 h	55–63	5.5–8.5	11–21	0.2–1.8	3.5–9.3	5.2–12.7	Duncan (1985)

NR: not recorded.

Table 10
Characteristics and time budgets from Przewalski horse (*Equus przewalskii*) studies

Group	No. of animals	Herd type	Observation period	Time budget (%)						Source
				Foraging	Standing: alert	Standing: resting	Lying: sternal	Lying: lateral	Moving	
Mares	5	Zoo/pasture	Day-time (8 a.m. to 5 p.m. non-continuous)	66	19.4				12.4	Hogan et al. (1988)
Twenty-seven mares, fifteen stallions	52	Zoo/pasture (several zoos)	Day-time (8 a.m. to 6 p.m.)	48–59	21–24	9.6–10.4	0.4		8.5–14.1	Boyd (1988)
One stallion, five females, two sub-adult females	8	Zoo/pasture	24 h (non-continuous)	46.4	20.6	15.7	4.1	1.2	7.4	Boyd et al. (1988)
Five stallions, nine mares	14	Mongolian reserve	Day-time (8 a.m. to 8 p.m.)	30–68	NR	20–65			10	van Dierendonck et al. (1996)

NR: not recorded.

tethered mares in our study have time budgets typical of free-range horses is because they are kept in close proximity to other mares (with the ability to interact freely) and have the opportunity to eat hay for most of their day. The similarity we found in the time budgets of the two classes of horses is important because it has implications about the horses that are best suited to the management practice of tethering mares.

In review papers of equine stereotypies, it is commonly stated that draft horses show fewer vices than lighter, warm-blooded breeds (Kiley-Worthington, 1983; Houpt and McDonnell, 1993). The authors speculated that they see a lower incidence of stereotypies in draft breeds because either this class of horses is less prone to them or draft horses are rarely housed in the intensive conditions found in other equine industries. Our study demonstrates that there is not much difference in the level of stereotypies between the two classes of horses when kept under identical management conditions indicating that the behaviour of draft horses does not differ significantly from their lighter counterparts.

Results from a survey of the PMU industry found a statistical association between drinking water management and the presence of stereotypies on the farm (Flannigan and Stookey, 1998). Although the association was not identical to those found in this study, a relationship between the presence of horses which perform stereotypies on farms and water management (i.e. intermittent access of 2–3 times per day or 23 times per day) uncovered by our study may be valid. However, other studies on tethered horses within the PMU industry (Freeman et al., 1999; McDonnell et al., 1999) did not find behavioural or physiological abnormalities when they compared horses exposed to intermittent versus continuous access to drinking water. In fact, they saw stereotypic behaviour only in horses who had continuous access to water. There could be three possible explanations for these conflicting results. Perhaps the observed relationship is a coincidence because the farms with stereotypic horses also had a greater number of observed horses than other farms within our study (Table 1). A second possibility is that these farms may have some other management factors not taken into consideration that impacted on the presence of stereotypies in mares. Finally, it is possible that there is an association between intermittent watering and increased stereotypies.

The number of times a horse drinks and the amount of water ingested are dependent on diet, water availability, environmental temperature and other physiological requirements, such as lactation (Hinton, 1978; Crowell-Davis et al., 1985; Sweeting and Houpt, 1987). Feral horses are reported to drink only once or twice in a 24 h period (Fraser, 1992), but it is recommended that stabled horses be watered three to four times daily allowing at least 5 min of continuous drinking per bout (Hinton, 1978). Although some feral horses drink relatively few times within a day, they have the option of moving to watering areas and drinking to satiety when thirsty. Frustration is a common theoretical concept in the motivation underlying stereotypic development (Wemelsfelder, 1993). Food restriction leading to frustration through anticipation of the next meal has been implicated as the major cause in the development of stereotypies in the pig (Lawrence and Terlouw, 1993). Stabled ponies drank an average of three times per hour when given continuous access to water (Sweeting and Houpt, 1987). Perhaps the farms which are offering water less than four times daily are not offering water when the horses are thirsty, leading to frustration. Also, at the other extreme, offering small amounts of water multiple times per day may cause frustration in the horse if not enough water is furnished to satisfy thirst at any one bout.

The time budgets of stereotypic horses within this study differed from the other published time budget of a stereotypic horse. Houpt and McDonnell (1993) found that the time budget of a weaving mare (who spent 20.8% of her time weaving) differed from a non-stereotypic mare housed under identical conditions in two important areas. The weaving mare lay in a sternal position for a larger part of her day (24.3%) when compared to a non-affected mare (1.4%) and ate for one third of the time. In contrast, our study found that the time budgets of mares who perform stereotypies (as a group) were very similar to the time budgets of non-stereotypic mares. The number of activity changes was also similar.

Although not significant, there were some differences in the number of interactions with neighbouring mares in the stereotypic horses compared to non-stereotypic horses. These differences may be due to the small sample size of stereotypic horses within this study. Alternatively, since lack of social contact between horses has been cited as one of the major causes of equine stereotypies (Luescher et al., 1991; McGreevy et al., 1995; Simpson, 1998), perhaps the stereotypies arose because the mares were unable to interact with their neighbours. We do not know why these horses interacted less often with neighbouring mares as proximity to other horses was similar for all mares. Also, we do not know if the stereotypic pattern developed because of the inability to interact or if the mares interacted less because they were absorbed in stereotypic activity. Stereotypies may be a way of coping with an overly aggressive, dominant neighbour when the mare is too fearful to reciprocate aggressively. In addition, the trend toward increased active standing (versus resting in a standing position) may be an attempt to be alert to the actions of their neighbours. Since the number of interactions with neighbours was the only relative difference in the mares who performed stereotypies, this factor should be examined in a larger population of similar mares under analogous management conditions.

Prior to starting this study, we believed that draft type horses may be more suited to the life of a tethered mare because they were reported to have a calmer demeanour. Although there were differences in the time budgets of the two classes of mares on farms within this study, there was not a practical difference in the time budgets between peri-parturient light and draft mares housed in adjacent tie stalls. The management and housing practices of keeping large numbers of pregnant mares in tie stalls is probably a better simulation of the behavioural needs of the horse than other systems that may not give horses access to adequate forage and may deprive them of social contact. The similarities between the time budgets of tethered mares and free-range horses, and the low level of stereotypies demonstrates that the welfare of horses within this management system is good. In addition, there is no behavioural justification for a bias in the class of horses used within this management system.

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