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Observations on cubicle utilisation on ten dairy farms

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Cubicle utilisation is considered an important indicator of animal welfare in cows. However, there are still unanswered questions about lying positions and gaps in research regarding standing behaviour. For this reason, this study used wildlife cameras to observe cubicle utilisation on a total of ten dairy farms. The study found that the cubicles were occupied on average 45% of the time, with 5% of this time spent standing. Standing utilisation of the cubicles increased during the afternoon. The study found no correlation between the space available in the barn and cubicle utilisation. The analysis of the type of standing utilisation on four farms showed that the cows were predominantly standing incompletely in the cubicles. Furthermore, it was observed that cows were lying with their outstretched front legs on average 18% of the time, with a higher proportion of this occurring in the afternoon than in the morning. If these findings are corroborated by further studies, the diurnal differences in cubicle utilisation could justify a different evaluation of the results, for example in the context of animal welfare audits.

Keywords

cubicle, standing comfort, lying comfort, cow comfort indices

It is acknowledged that adequate lying times are an indicator of animal welfare for dairy cows. However, it is important to consider the influence of housing conditions and management when interpreting these results (Tucker et al. 2021). There are still open questions in some areas. For instance, the comparison of lying positions on pasture and in the barn raises questions regarding animal health and welfare when lying positions of cows are restricted (Van Erp-van der Kooij et al. 2019). Additionally, there are gaps in research on the standing behaviour of cows, which Tucker et al. (2021) believe deserves just as much attention as lying behaviour.

Lying and standing behaviour in the cubicle

To identify potential areas for improvement in stall management, Dahlhoff (2014) suggests that the analysis of reference value deviations in the quality and quantity of different lying positions may be a useful approach. Lateral lying positions with outstretched hind limbs are generally categorised as "wide" lying positions (Van Erp-van der Kooij et al. 2019). No distinction is made between one or two outstretched forelimbs (Hörning et al. 2001, Van Erp-van der Kooij et al. 2019). Pelzer et al. (2011) provide reference values for the recumbent position "outstretched forelimb". The target value is 21%, the guideline value is >15%, and the limit value is 10-15% of lying cows. In the "Management aid for the assessment and improvement of animal welfare in dairy farming", a proportion of >10% is considered optimal, 5-10% suboptimal, and <5% is considered unacceptable (Benz et al. 2021). In a field study conducted in 55 cubicle barns, Pelzer et al. (2007) identified the influence of a 20 cm

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high front sill or a front board, which hindered the possibility of stretching out the front legs, as the cause of low proportions of lying positions with outstretched front legs. In their observations of lying positions on pasture and in barns, Van Erp-van der Kooij et al. (2019) identified differences between herds in Uruguay (one herd with year-round full grazing) and the Netherlands (25 herds with summer grazing). The authors concluded that further research into restrictive factors on lying positions is necessary.

In studies by Tucker et al. (2006), cubicles without a threshold were found to be favoured by cows, with the animals spending 1.2 hours longer in these areas each day (Tucker et al. 2006). In contrast, in humid cubicles, cows lie for shorter periods (Fregonesi et al. 2007, Chen et al. 2017). To compensate for this reduction in lying behaviour, they spend longer periods of incompletely (perching) and completely standing in the cubicles (Fregonesi et al. 2007). Furthermore, the positioning of the neck control exerts a significant influence on the standing behaviour of cows in the cubicle. The occurrence of perching is observed to decrease with more restrictive perching, while complete standing increases with less restrictive, rigid neck control positioned further away from the faeces edge (Tucker et al. 2005, Bernardi et al. 2009, Fregonesi et al. 2009). However, udder and cubicle cleanliness deteriorate if the neck control is mounted at a greater distance from the edge of the cubicle (Fregonesi et al. 2009). In contrast, lameness occurs more frequently with a restrictive neck control (Bernardi et al. 2009). The hooves of cows that are incompletely positioned in the cubicle are increasingly exposed to the negative influence of faeces and urine, which damages the hoof horn (Mülling and Budras 1998). Soiling of the limbs is a risk factor for udder diseases (Schreiner et al. 2003). Benz et al. (2020) recorded a higher probability of completely standing in the cubicle with a flexible neck control compared to a rigid neck tube and also describe that standing increases overall in the afternoon. Abade et al. (2015) also observed longer periods of completely standing in the cubicles with an alternative cubicle design without a divider and neck control. Dahlhoff (2014) states a maximum of 3% for completely standing in the cubicle and a maximum of 4% for incompletely standing of all animals in a herd when recording the location three hours after feeding.

Methods for investigating lying behaviour

Lying behaviour

Automated methods for recording behavioural parameters in the form of transponders with acceleration and position sensors are widely used in practice and research (Darr and Epperson 2009, Ledgerwood et al. 2010, Mattachini et al. 2013). These techniques offer the possibility of recording lying, standing and activity, thus enabling quantitative analyses. Additionally, systems have been developed to automatically recognise cows in their individual cubicles (Porto et al. 2013, Enders et al. 2006) or to track their location within the barn using artificial intelligence (Fuentes et al. 2023). These tracking systems are capable of recording the localisation of individual animals in real time (Wolfger et al. 2017). According to Mattachini et al. (2011), images evaluated in hourly time intervals allow for the correct interpretation of lying, standing and feeding behaviour in the analysis period 7 am to 2 pm and 7 pm to 10 pm. However, additional night hours do not improve the quality of the information, and a strong management influence is observed one to two hours after milking times.

Direct observation enables a differentiated qualitative assessment of animal behaviour, but is very time-consuming. For instance, the observation of partial or complete lying outside a lying area within

the Welfare Quality® Protocol for dairy cattle requires a total of 120 minutes. Alternative procedures are proposed so that it is possible to observe more segments (at least 12) and reduce the individual observation time. However, the replacement of individual parameters with prediction models to save time did not prove successful in studies by DeVries et al. (2021).

One-off observations, or snapshots, are employed in animal welfare audits, with indices calculated from these observations. Cook et al. (2005) recommend using the Stall Standing Index (SSI = percentage of standing cows out of all cows in contact with the cubicle) two hours before morning or evening milking. Should the SSI value exceed 0.20, a more comprehensive investigation into the prevalence of lameness within the herd is recommended, including an assessment of the cubicle design. Zapf et al. (2015) propose the recording of the proportion of animals not lying completely on the cubicle twice a year, at the midpoint of the summer and winter half-year, three hours after feed presentation. The KTBL special publication "Tierschutzindikatoren – Leitfaden für die Praxis" ("Animal welfare indicators – practical guidelines") specifies that the manner in which cubicles are utilised provides more detailed information regarding potential deficiencies. For instance, an elevated proportion of dairy cows not lying down may signify a deficiency in the number of feeding places. Cows standing incompletely in the cubicle may indicate an incorrectly positioned neck control. Furthermore, cows standing with four legs in the cubicle and lying down with a delay may indicate potential shortcomings in the quality of the lying area (Brinkmann et al. 2016).

Material and method

A total of ten farms were included in the analyses. All farms had a new or converted dairy barn between 2018 and 2021, with an animal to lying place ratio of 1 to 1 and an animal to feeding place ratio of at least 1.2 to 1. All farms had either feed pusher robots or feed belts, which is why the present study did not record the feeding times on the farms in detail. Innovative measures to reduce ammonia emissions and optimise animal welfare were integrated into the barn concepts, including walking surface designs with urine drainage, raised feeding stalls, and structured exercise yards. The herd sizes ranged from 58 to 206 animals, and the annual milk yield in the 2021 test year ranged from 4,300 to 11,300 kg of milk. All but one farm had deep stalls, which, with the exception of farms A and E (slurry solids), were bedded with straw. Four farms had automatic bedding. Farms A and E used a rail-mounted bedding robot (JH Agro, Denmark) and farms G and I used an auger conveyor system (Schauer, Austria). All cubicles were between 1.20 and 1.25 cm wide and 2.60 to 2.70 m long. With the exception of farm H (Cow Welfare model), the neck controls were flexible and mounted at a height of approximately 0.9 metres. Eight farms milked automatically, while farm G had a tandem milking parlour and farm I had a rotary milking parlour (Table 1).

Table 1: Key figures and structural and technical design details of the dairy cattle barns on the study farms

Farm	Dairy cow herd	Breed	Milk yield in 2021	Milking system	Cublicle type	Bedding technology	Flooring system	Walking area per cow (sqm)[1]	Rubber flooring in %	Number of cubicles analysed
A	148	SBT, FL, XFM	9500	AMS	Deep bedded stall	automated	paved floor	11.8	87	10
B	180	SBT, XFM, FL	9700	AMS	Elevated stall	mechanised	slatted floor	7.0	93	10
C	165	FV, XFM	11200	AMS	Deep bedded stall	mechanised	paved floor	5.9	55	10
D	146	SBT, RBT	10300	AMS	Deep bedded stall	mechanised	paved floor	9.4	100	10
E	150	SBT, XFM	9900	AMS	Deep bedded stall	automated	paved floor	5.2	80	10
F	193	SBT, FM, RBT, FL, BV	6900	AMS	Deep bedded stall	mechanised	paved floor	5.9	51	8
G	58	FL	4300	Milking parlour	Deep bedded stallx	automated	paved floor	9.3	without[2]	10
H	72	RBT, XMM, SBT	7500	AMS	Deep bedded stall	mechanised	slatted floor	4.2	79	7
I	236	FL, XFM	8300	Milking carousel	Deep bedded stall	automated	paved floor	6.0	76	10
J	145	FL	11300	AMS	Deep bedded stall	mechanised	paved floor	7.4	86	6

[1)] Walking area without cubicles and raised feeding stalls, if necessary incl. exercise yard

[2)] Littered walking area

BV=Braunvieh, FL=Fleckvieh, SBT=Holstein-Schwarzbunt, RBT=Holstein-Rotbunt, XFM=Crossbreed beef cattle x dairy cattle, XMM=Crossbreed dairy cattle x dairy cattle

The data collection period spanned from 15 January 2021 to 5 April 2022. The data was collected over a period of eight to ten hours during the day on days without heat stress. The temperature-humidity index (THI) was calculated according to the methodology outlined by Zimbelman et al. (2009). The THI was calculated using the following formula: The THI was calculated using the following formula: THI = (0.8 x air temperature) + [(relative humidity / 100) x (air temperature - 14.4)] + 46.4. This was done in order to exclude the known influence on the behaviour of dairy cows, as reported by Cook et al. (2007) and Hut et al. (2022). The morning period was defined as the period before 12:00, while the afternoon period was defined as the period after 13:00.

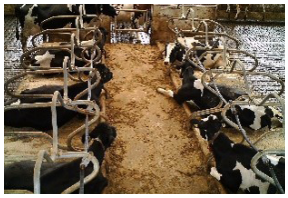
The data set comprised minute-by-minute image recordings, which were subjected to systematic analysis on a personal computer. The observations were summarised as mean values on an hourly basis. To assess cubicle utilisation, a stable segment comprising 6 to 10 cubicles was recorded on each farm. Marginal cubicles, which are expected to have a lower occupancy rate (Enders et al. 2006), were not included. A total of ten parameters were defined for the purposes of both quantitative and qualitative cubicle utilisation (Table 2).

Table 2: Definition of the study parameters for cubicle utilisation and lying positions lying positions

Parameter	Definition
Box utilisation BN_{total} (%)	Percentage of cubicles used out of all cubicles observed
Property utilisation LN_{total} (%)	Proportion of cubicles used for lying down out of all cubicles observed
Property utilisation LN_{rel} (%)	Proportion of cubicles used for lying down out of all cubicles used
Standing utilisation SN_{total} (%)	Proportion of cubicles used for standing out of all cubicles observed
Standing utilisation SN_{rel} (%)	Proportion of cubicles used for standing out of all cubicles used
Completely standing in the cubicle	Standing with all four limbs inside the cubicle
Incompletely standing in the cubicle	Standing with the front feet in the cubicle and with the hind limbs in the walkway (perching)
Outstretched front leg front leg (%)	Proportion of lying positions with at least one front leg stretched out for all lying cows in the cubicles observed

In the four automatic milking farms designated as B, D, E, and F, the cameras were positioned in a manner that enabled the assessment of both standing behavior (completely or incompletely in the cubicle) and lying positions with outstretched front leg (Figure 1).

Parameter outstretched front leg, example image from farm F



Parameter outstreched front leg and incomplete stance S2, example image from farm B

Parameter outstretched front leg and incomplete stance S2, example image from farm D

Parameter completely standing S4, example image from farm E

Figure 1: Example images for the parameters outstretched front leg, incompletely (S2) and completely standing (S4) from the four farms B, D, E, F

The data set is therefore divided into two sections: a general section on cubicle utilisation (A) and a section on cubicle utilisation including lying positions (B) (Table 3).

Table 3: Survey of the test parameters within the two test sections (A) and (B)

Examination section	Number of farms	Number of overservation days	Examination time	Numer of oberservations	Parameter						
					Box utilisation BN_{total} (%)	Property utilisation LN_{total} (%)	Property utilisation LN_{rel} (%)	Standing utilisation SN_{total} (%)	Standing utilisation SN_{rel} (%)	Completely/incompletely standing in the cubicle	Outstretched front leg (%)
(A)	10	5	8:00 to 16:00	23132	x	x	x	x	x		
(B)	4	3	7:00 to 17:00	6675	x		x		x	x	x

The wildlife cameras utilised for animal observation were manufactured by Dörr GmbH (SnapShot Limited 5.0s), Campark Electronics Co. LTD (T150) and Boly Media Communications Co., LTD (BG662-W4K). The study presented provided descriptive data based on the practical conditions, which were

validated by simple statistical tests. The data for the parameters BN_{total}, LN_{total}, LN_{rel}, SN_{total} and SN_{rel} were not normally distributed, necessitating the use of a non-parametric test for the pairwise comparisons (Wilcoxon test). For multiple pairwise comparisons, the α-error correction according to Bonferroni was performed to adjust the significance level. The data for the parameter "outstretched front leg" were normally distributed, allowing for the pairwise mean comparisons to be carried out using a t-test. The Kendall's tau test was employed to assess the correlation between variables. The distribution of frequencies was analysed for binomial data sets using the binomial test. The statistical analyses were conducted using the R programming language, version 4.2.1, and the R Commander package. The threshold for statistical significance was set at $p < 0.05$.

Results

Investigation section (A)

The observation period of eight hours revealed that the cubicles were used on average 40% of the time for lying (LN_{total}, SD 24%) and 5% for standing (SN_{total}, SD 8%), with 55% of the time they were unoccupied. There was no significant difference in pit utilisation (BN_{total}) between the morning and afternoon (Wilcoxon test, p-value = 0.322). The proportion of occupied cubicles used for standing (SN_{rel}) was 11% (SD 3%) on average across the farms, with the proportion in the afternoon averaging 12% (SD 1.1%), 26% higher than in the morning (10%, SD 1.7%). The difference between morning and afternoon was 21% on average for the eight automatic milking farms, while the difference for the two conventional milking farms was significantly higher at 85% (binomial test, p-value < 0.001). Over the course of the observation period from 8 a.m. to 4 p.m., the proportion of standing use in relation to cubicle use increased significantly on the ten farms. This indicates a positive correlation between SN_{rel} and time of day (Kendall tau test, p-value = 0.032, tau = 0.643) (Figure 2).

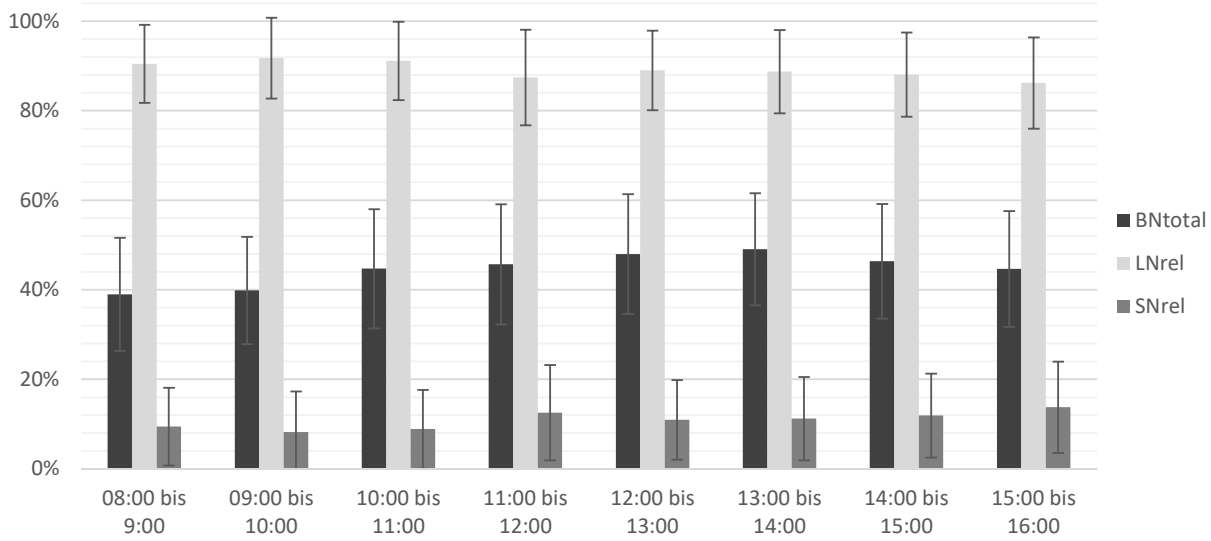


Figure 2: Type of box use (box use BN_{total}, relative lying use LN_{rel}, relative standing use SN_{rel}) over eight hours between 8:00 and 16:00, data basis ten farms, five days/farm, hourly averages based on minute-by-minute observations (23133 observations in total)

The analysis of multiple pairwise comparisons revealed significant differences between the ten farms with regard to the parameter of cubicle utilisation. In terms of relative lying and standing utilisation, farm B in particular exhibited significant differences to six of the nine other farms (Wilcoxon test, p-value > 0.006 after Bonferroni correction), as detailed in Tables 4 and 5.

Table 4: Comparison of box utilisation BNtotal , lying utilisation LN_{rel} and standing utilisation SN_{rel} over eight hours between 8:00 and 16:00, data basis ten farms, five days/farm, hourly averages based on minute-by-minute observations (23133 observations in total)

Farm	BN_{total}			LN_{rel}			SN_{rel}		
	Median	Min	Max	Median	Min	Max	Median	Min	Max
A	34%	4%	75%	94%	58%	100%	6%	0%	42%
B	38%	14%	62%	82%	37%	100%	18%	0%	63%
C	64%	30%	97%	92%	67%	100%	8%	0%	33%
D	52%	10%	81%	90%	40%	100%	10%	0%	60%
E	51%	10%	83%	91%	47%	100%	9%	0%	53%
F	76%	9%	100%	88%	50%	100%	12%	0%	50%
G	44%	0%	80%	94%	73%	100%	6%	0%	27%
H	20%	0%	50%	92%	0%	100%	8%	0%	100%
I	40%	0%	91%	93%	33%	100%	7%	0%	67%
J	32%	0%	72%	92%	0%	100%	8%	0%	100%

Table 5: Significance when analysing the multiple pair comparisons for box use BN_{total}, lying down use LN_{rel} and standing use SN_{rel} in ten farms, Wilcoxon test with p-value > 0.006 after Bonferroni correction

Box Utilisation BN_{total}									
Farm	B	C	D	E	F	G	H	I	J
A	n.s.	*	*	*	*	n.s.	*	n.s.	*
B		*	*	*	*	n.s.	*	n.s.	n.s.
C			*	*	n.s.	*	*	*	*
D				n.s.	*	n.s.	*	*	*
E					*	*	*	*	*
F						*	*	*	*
G							*	n.s.	n.s.
H								*	n.s.
I									n.s.

Lying Utilisation LN_{rel}									
Farm	B	C	D	E	F	G	H	I	J
A	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
B		*	*	*	*	*	n.s.	*	n.s.
C			n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
D				n.s.	n.s.	*	n.s.	n.s.	n.s.
E					n.s.	n.s.	n.s.	n.s.	n.s.
F						*	n.s.	n.s.	n.s.
G							n.s.	n.s.	n.s.
H								n.s.	n.s.
I									n.s.

Standing Utilisation SN_{rel}									
Farm	B	C	D	E	F	G	H	I	J
A	*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
B		*	*	*	*	*	n.s.	*	n.s.
C			n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
D				n.s.	n.s.	*	n.s.	n.s.	n.s.
E					n.s.	n.s.	n.s.	n.s.	n.s.
F						*	n.s.	n.s.	n.s.
G							n.s.	n.s.	n.s.
H								n.s.	n.s.
I									n.s.

Correlation between BN_{total}, SN_{rel} and available space or proportion of rubber flooring in the barn

There was no correlation between the space available in the barn and the utilisation of cubicles (BN_{total}). This indicates that cubicles were not used more frequently on farms with less floor space per cow (Kendall's tau test, p-value = 0.601, tau = -0.156). Furthermore, the available space did not correlate with the standing utilisation SN_{rel} (Kendall's tau test, p-value = 0.291, tau = -0.289) and the proportion of rubber flooring also showed no correlation with SN_{rel} (Kendall's tau test, p-value = 0.381, tau = 0.244).

Investigation section (B)

The cubicles on the four farms B, D, E and F were utilised by an average of 55% during the observation period (BN_{total}, SD 20%). The average cubicle utilisation was 86% (LN_{rel}, SD 18%) (Figure 3).

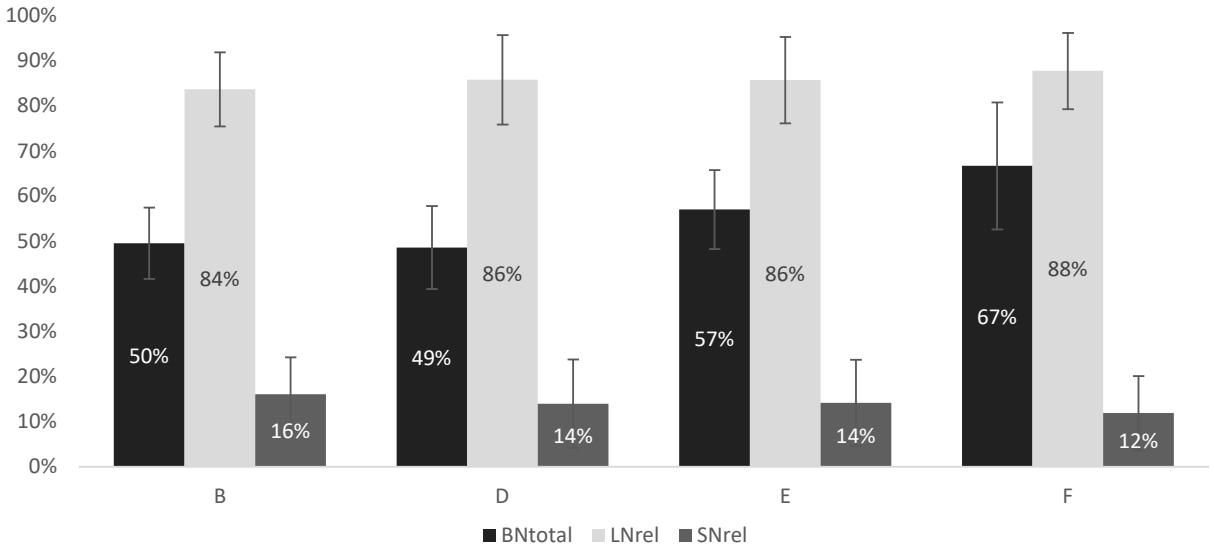


Figure 3: Average box utilisation over 10 hours between 7:00 and 17:00, data basis four farms with AMS, three days/farm, hourly averages based on minute-by-minute observations (6675 observations in total)

The mean percentage of standing time spent in an incomplete (S2) posture in the cubicle was 92% (SD 1.8%). The cows exhibited a mean of 8% of their standing periods in a complete posture with all four limbs in the cubicle (S4). This is illustrated in Figure 4.

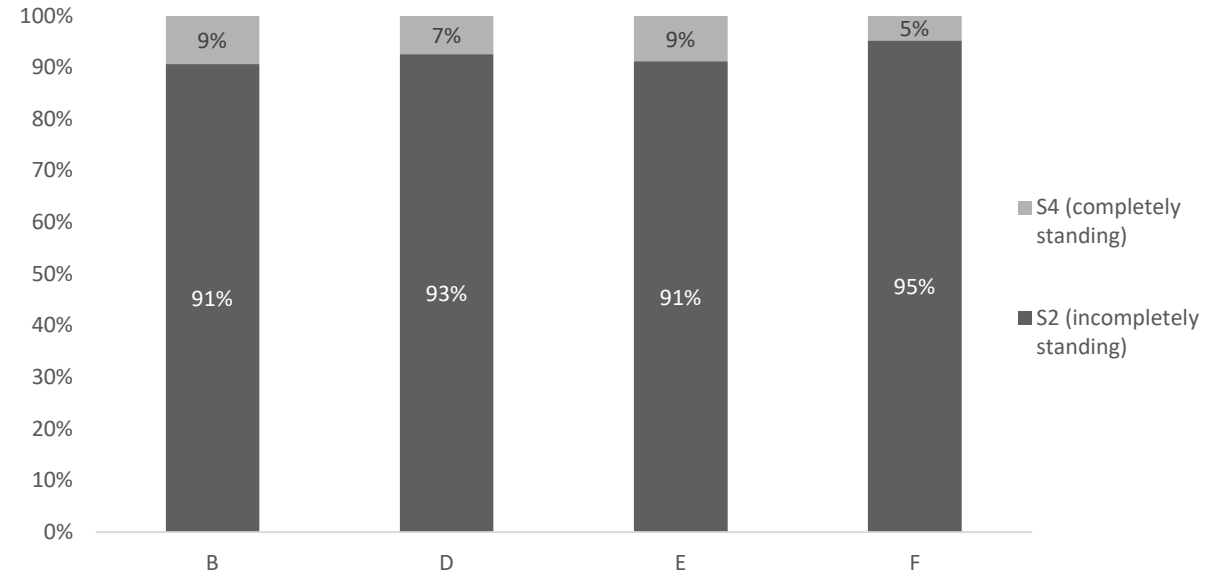


Figure 4: Proportion of completely and incompletely standing within the standing utilisation of the cubicle in four farms with AMS, data basis: hourly mean values based on minute observations between 7:00 and 17:00 over three days per farm, a total of 6675 observations

The proportion of time spent standing in the cubicle (S2) remained unchanged throughout the day (Kendall's tau test, p-value = 0.445). However, the proportion of time spent standing completely (S4) increased in line with the time of day (Kendall's tau test, p-value = 0.010).

The utilisation of the stalls differed only between farms B and F. No differences were found with regard to the parameters lying use LN_{rel} and standing use SN_{rel}. Incompletely standing in the cubicle (S2) was comparable on all farms, while completely standing (S4) was observed significantly more frequently on farm B (Tables 6 and 7).

Table 6: Comparison of box utilisation BN_{total} , lying utilisation LN_{rel} , standing utilisation SN_{rel} and the proportions of completely and incompletely standing on four farms B, D, E and F

Farm	BN_{total}			LN_{rel}			SN_{rel}			Proportion of S2			Proportion of S4		
	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max
B	53%	23%	74%	87%	38%	97%	13%	3%	62%	11%	1%	62%	1,3%	0,0%	5,8%
D	48%	11%	81%	88%	0%	100%	12%	19%	100%	10%	0%	100%	0,4%	0,0%	6,1%
E	56%	24%	83%	88%	40%	99%	12%	13%	60%	11%	1%	60%	0,5%	0,0%	8,2%
F	79%	11%	99%	89%	67%	97%	10%	7%	33%	9%	3%	33%	0,4%	0,0%	3,0%

Table 7: Significance when analysing the multiple pair comparisons for cubicle use BN_{total} , cubicle use LN_{rel} , standing use SN_{rel} and the proportions of incompletely standing S2 and completely standing S4 in the cubicle on four automatic milking farms, Wilcoxon test with p-value > 0.017 after Bonferroni correction

Box Utilisation BN_{total}				Lying Utilisation LN_{rel}				Standing Utilisation SN_{rel}				Proportion of S2				Proportion of S4			
Farm	D	E	F	Farm	D	E	F	Farm	D	E	F	Farm	D	E	F	Farm	D	E	F
B	n.s.	n.s.	*	B	n.s.	n.s.	n.s.	B	n.s.	n.s.	n.s.	B	n.s.	n.s.	n.s.	B	*	*	*
D		n.s.	n.s.	D		n.s.	n.s.	D		n.s.	n.s.	D		n.s.	n.s.	D		n.s.	n.s.
E			n.s.	E			n.s.	E			n.s.	E			n.s.	E			n.s.

Lying position with outstretched front leg

The proportion of observations in which the animal was in a lying position with one or both front legs stretched out was recorded at an average of 18% (SD 5.4%), with an average of 14% (SD 4.4%) occurring in the morning between 8:00 and 12. The number of observations in which the lying position was recorded was significantly lower in the afternoon between 13:00 and 18:00, with an average of 21% (SD 3.4%) (t-test, p-value = 0.007) (Figure 5).

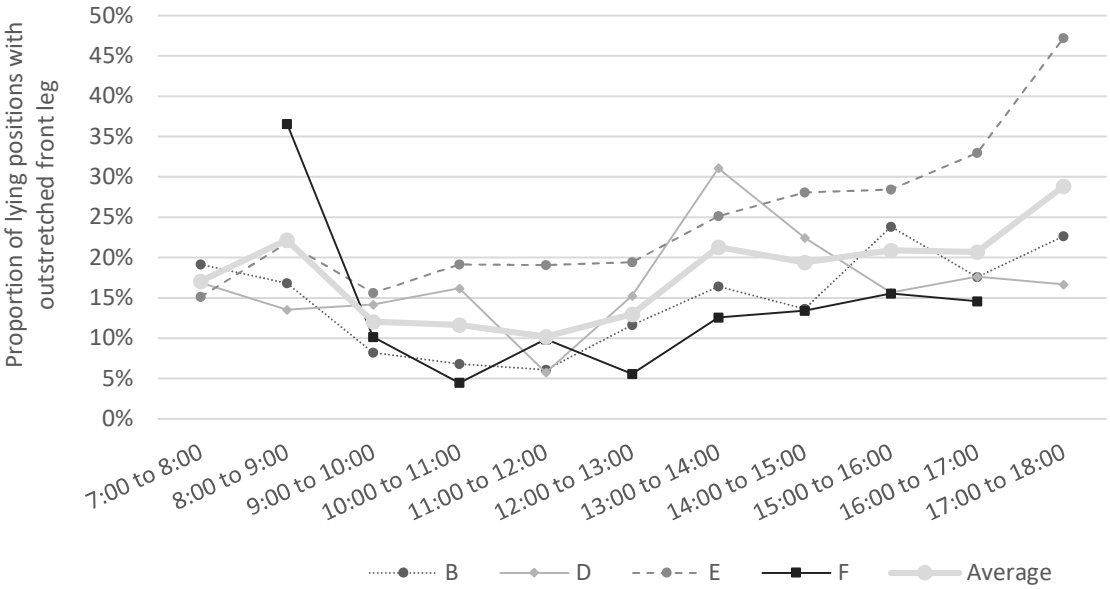


Figure 5: Daily course of the proportion of lying positions with outstretched front leg in four farms with AMS, data basis: minute-by-minute observations between 7:00 and 18:00 over three days per farm, a total of 6675 observations

However, no correlation was found between the lying position with the front leg outstretched and the time of day (Kendall's tau test, p-value = 0.218).

The frequency of lying with the front leg stretched out differed between individual farms. Only farm E exhibited a significant difference from all other farms (T-test, 27 to 33 hourly values per farm, significance level after Bonferroni correction p-value < 0.017). The mean proportion of lying positions with outstretched front leg observed on the farm was 25% (SD 12%), compared to 15% (SD 11%) on farm B, 17% (SD 13%) on farm D and 13% (SD 14%) on farm F (Fig. 6).

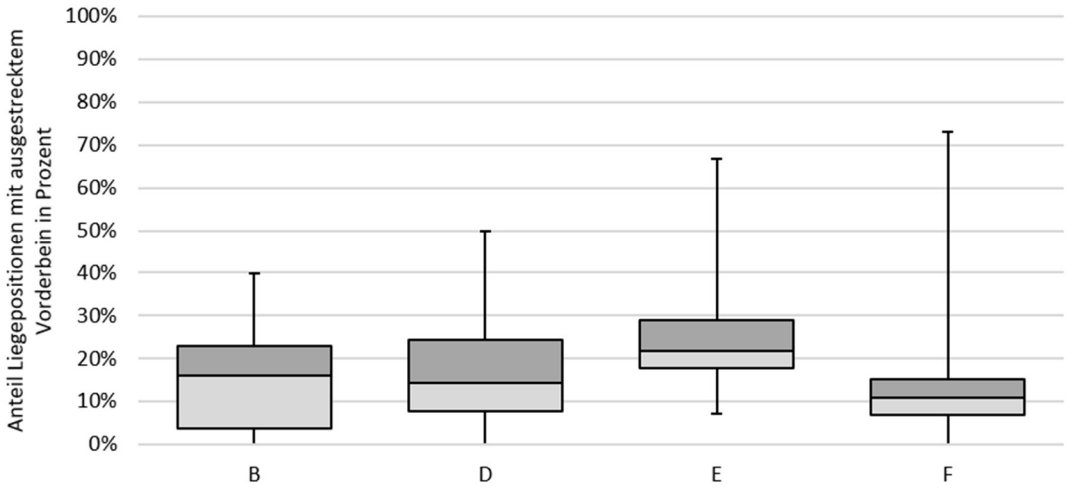


Figure 6: Illustration of the proportion of lying positions with outstretched front leg in four farms with AMS, data basis: minute-by-minute observations between 7:00 and 18:00 over three days per farm, a total of 6675 observations, farm E differs significantly from all other farms (paired mean comparisons, t-test, significance level after Bonferroni correction p-value < 0.017)

Discussion

The cubicles were utilised at a similar frequency in the morning and afternoon, with no discernible difference in BN_{total} between the two periods. However, the manner and type of utilisation differed, with a higher proportion of cows standing in the cubicles in the afternoon than in the morning. A comparison of the relative standing use parameter SN_{rel} with the Stall Using Index SSI (Cook et al. 2005) can be used as a guide for orientation purposes. However, it should be noted that the SSI is measured once two hours after milking in all cubicles in the barn on conventionally milking farms, rather than over several hours. Therefore, the standing behaviour can be assessed as unremarkable. The average SN_{rel} was found to be 11%, which was below the postulated threshold value of 20% for the SSI on all ten farms studied. This would necessitate a more detailed analysis of lameness prevalence and cubicle design (Cook et al. 2020). However, since diurnal differences were observed, a correlation with the cubicle settings and management of the farms studied is unlikely. Benz et al. (2020) also observed increased standing in the afternoon. The authors hypothesised that udder filling before the evening milking time could be responsible for this behaviour. Of the ten farms studied, eight had automatic milking systems and, with a relative standing utilisation of +21%, showed a smaller difference than the two conventionally milking farms with a relative standing utilisation of +85%. This assumption can therefore be partially supported. Although the precise causes remain uncertain, it can be agreed with Cook (2005) that there are differences in the standing utilisation of cubicles between the times of day, which must be taken into account in observations and evaluations.

The way cows stand in cubicles is relevant for claw and udder health (Bernardi et al. 2009, Fregonesi et al. 2009). In the present study, the cows were observed to stand incompletely in the cubicles. However, only the influence of the neck control on incompletely standing in cubicles (perching) has been investigated so far, with no investigation of the influence of the tread design. Should the motivation of the cows to stand completely inside the cubicle be attributed to the deformable surface of the cubicle, it would be reasonable to hypothesise that fewer cows would stand completely inside the cubicles in barns with deformable tread surfaces. This could explain why the cows in this study were predominantly incompletely in the cubicles, given that a high proportion of the farms had installed rubber running surfaces. This hypothesis would require further testing under controlled conditions, which was not feasible within the scope of this study. However, it is worth considering whether there are general differences in terms of standing utilisation between high and low stalls. In the present study, only one farm had high stalls. This farm exhibited a unique pattern of standing and lying utilisation, with the highest proportion of animals standing completely in the cubicle.

Despite the limitations of the study design, no correlation could be established between the amount of space available and the utilisation of stalls (BN_{total}). This question was investigated because it would be plausible that cubicles are more frequently used as a place of retreat if less space is available overall. This situation occurs regularly in rebuilds. However, the sample size of ten farms was relatively small, so further studies could revisit this aspect.

Lying positions with the front leg stretched out are adopted by 20% of cows in the pasture (Pelzer et al. 2007), which was also approximately achieved on the four farms studied. The reason for the cows' greater tendency to adopt this lying position in the afternoon remains unclear. As the duration of the total lying time is linked to this lying position (Tucker et al. 2006), it would be interesting to consider additional lying times in further studies on lying positions with the front leg stretched out. The pairwise analysis of the proportion of lying positions with the front leg stretched out showed that

these were observed more frequently on farm E than on the other farms, which also did not differ from each other. Farm E thus achieved the target value of 21% postulated by Pelzer et al. (2011). Farms B and D were within the target value of 15%, with farm F falling slightly short of this. However, the values on all farms were higher than the threshold value of 10% specified in the "Management aid for the assessment and improvement of animal welfare in dairy farming" (Benz et al. 2021). It can be concluded that no negative deviations were observed in any of the four farms with regard to lying positions with the front leg outstretched.

Conclusions

The present study addresses some aspects of cubicle utilisation that have been little studied to date and should be given greater attention in future studies. For example, it was observed that cows increasingly used cubicles for standing in the afternoon. The highest proportion of standing use was observed on a farm with raised cubicles. However, if the cubicles were used for lying down, the proportion of lying positions with the front leg stretched out was higher in the afternoon than in the morning. In conclusion, it can be stated that different observation times should be considered for parameters of cubicle use in the context of animal welfare audits via adjusted target values. Should further examination of the results presented here reveal the necessity, a correction factor (e.g. -25%) could be introduced for the standing utilisation of cubicles for observations in the afternoon.

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