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The relationship between activity level, litter performance and motion symmetry in adult sows

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HIGHLIGHTS

- The study recorded activity in sows before and after farrowing using accelerometers.
- High activity in total was associated with a higher total piglet mortality.
- The distribution of load between the legs was not affected by recording before or after farrowing.
- There was no relationship between activity and gait asymmetry.

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ABSTRACT

Lameness and poor limb quality of the sow is, apart from being painful and causing discomfort to the sow, also associated with an increased risk of crushing of piglets. Records of sow activity, as a potential indicator for increased risk of crushing, or increased risk of limb problems, were studied. Records of activity were collected using accelerometers attached to a collar around the neck of the sow. Data was collected on 63 sows at Research centre Lövsta, Uppsala, before and after farrowing. The accelerometers recorded movements over a period of 2.5 days per recording period. Sows were housed individually in farrowing pens with access to straw. Litter size at birth, number of dead piglet and cause of death was recorded by the staff in the stable. A pressure mat was used to investigate how sow gait was affected before and after farrowing. Differences in sow gait parameters were small before and after farrowing. The results show a significant difference in stride velocity between the left and right forelimbs. Further differences were recorded for the stride length of hind limbs. No significant changes were recorded for the weight load distribution between limbs. Activity levels varied over the day with highest activity during the day and lowest at night and in the early morning. Sows with higher levels of activity had a larger proportion of dead piglets, and high levels of activity in total after farrowing was associated with a higher proportion of crushed piglets. However, sows with higher activity levels during the night before farrowing had a lower proportion of crushed piglets. There was no association between activity levels and signs of lameness. In conclusion, activity may serve as an indicator of risk of piglet mortality, but activity in the farrowing pen does not seem to be a useful indicator of lameness.

1. Introduction

Lameness and poor limb quality display serious welfare problems in pig production. Limb weakness is, after reproduction failure, the most common reason for involuntary culling. It can be assumed that lameness is associated with pain and reduced well-being. Approximately 50 % of the sows are replaced every year on Swedish pig farms (Engblom et al., 2007; Bonde et al., 2004). The short life of sows in commercial herds displays a welfare issue, an ethical issue and also has an economic impact for the farmer. It has previously been shown that good overall movement and good limb conformation are favorably genetically correlated with a higher piglet survival at birth, shorter weaning to service interval and improved sow longevity (Le et al., 2015a; Le et al., 2016; Le et al., 2015b).

Around 18 % of the live born piglets in Sweden die during their 5 week nursing period. Crushing is one of the most common causes of pre-weaning mortality (Grandinson et al., 2002). Lame sows have problems in changing posture between standing and lying, and display a higher

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frequency of uncontrolled led lying-down behavior (Bonde et al., 2004) which is associated with a higher risk of crushing of piglets (Wechsler and Hegglin, 1997). Anil et al. (2009) found that lame sows had a lower number of piglets born alive. Therefore, it is of great importance to enable objective ways of assessing pain and physical function in sows.

Pain assessment in animals is complex, partly because the etiology of pain varies, and partly because there is no direct way to grade pain. Therefore, indirect assessment of pain is used, such as palpation, behavioral studies, as well as visual movement assessment (Ison et al., 2016). Additional methods, especially in orthopedic pain, are to record the animal's level of physical activity and how the distribution of the weight load between limbs. Studies have shown high reliability for recording physical activity using activity monitors, an accelerometer technique that measures acceleration in two or three directions of movement and the position of the sensor (Yin et al., 2024). It provides data of how the animal has moved in time and distance, as well as the intensity of the activity. It is likely that the level of physical activity is linked to the level of animal welfare, as animals in pain generally move less (Chapa et al., 2020). Further, a good validation study has been reported (Chapa et al., 2020; Oczak et al., 2022). Thus, monitoring of physical activity in sows suggests that there is an association between lameness, physical activity and pain behaviour (Ala-Kurikka et al., 2017), but it is unclear how physical activity changes in connection with farrowing.

Since bone health in sows is important for animal welfare topic (Heinonen et al., 2013) and poor bone health is associated with pain and reduced physical activity, it is utterly important to enable objective measurements of physical activity and motion symmetry. Clinically, bone health is assessed by visual movement examination, behaviour assessment and palpation (Conte et al., 2014; Ala-Kurikka et al., 2017). Visual movement assessment is a relatively subjective examination method and in companion animals and horses, it is supplemented with more objective kinetic methods such as recording with force plate and pressure measurement mat (Pairis-Garcia et al., 2014; Fahie et al., 2018; Stadig et al., 2016; Stadig and Bergh, 2015). Initial studies have been conducted in pigs, and the results are promising regarding its validity and implication in pig research (von Wachenfelt, 2009; Stavrakakis et al., 2014; Meijer et al., 2014; Meijer, 2016).

Further, gait scoring and limb conformation is routinely recorded on young animals in nucleus herds to be used in genetic evaluation. However, there is a need for an easy access technique to collect information also from older animals on farm, both to learn more about limb health in adult sows and to aid farmers in identifying animals that may be in pain or at risk of performing more harmful behavior around their litter. The aim of this study was to investigate if activity data recorded with accelerometers can be used as an indicator of physical activity in sows and if it is related to litter performance. Further, it was to compare gait parameters in sows before and after farrowing, assessed with a pressure measurement mat.

2. Material and methods

2.1. Animals

The study was performed at Research Centre Lövsta, the research farm at the Swedish University of Agricultural Sciences. The study included data from 63 litters from 59 individual pure-bred Yorkshire sows, farrowing between June 2020 and May 2023. Parity number ranged from 1 to 8 with an average of 2.4. All sows were loose-housed in groups during gestation and moved to individual farrowing pens without crates approximately one week before expected farrowing. The pens measured 6.5 m2 with 2/3 concrete floor and the remaining 1/3 slatted floor. Sows were fed a standard sow feed according to Swedish norm and distributed twice a day with an automated feeding system. Creep feed was offered to the piglets from the second or third week after farrowing. Each pen had a separate corner for the piglets with extra cover and a heat lamp. Straw was provided two-three times a day with approximately 2 kg long straw and 1 kg chopped straw per day. Cross-fostering is not routinely practiced in the research herd. All piglets were weighed individually at birth and at weaning. Stillborn piglets were weighed if they were fully developed at birth. All piglets that died before 10 weeks of age were weighed and the farm staff determined the cause of death by visual inspection. Sows were weighed within 1 day of parturition and at weaning.

2.2. Activity records

Activity was recorded using HOBO Pendant® G data loggers (Onset Computer Corporation, Pocasset, MA, USA). The data loggers were waterproof, weighed 18 g and had dimensions of 58 × 33 × 23 mm (length × width × height). The data loggers were attached to cow collars using plastic cable ties, and elastic bandage and duct tape were used to protect the unit. The collars were fitted around the neck of the sows and the loggers were programmed to start recording at 4–5 pm, at least a couple of hours after the collar was put on the sow. Staff was present in the stable approximately between 7 am and 4 pm. The memory capacity allowed the logger to record activity every 10th second for 2,5 days and the collar was removed from the sow on the morning of the third day. In the event that a collar came off, stable staff was instructed to put it back on the sow again. A log book was kept in each farrowing unit and staff wrote down the day and time when a collar was found on the floor and put back on again. If a collar came off an individual sow more than three times during one period of recording, the sow was excluded from that recording session and staff was instructed to not attempt to put the collar back on again. Records were collected on the first or second day after the sow entered the farrowing pen and again after farrowing. In the beginning of the study the repeated measures of activity after farrowing were collected the days before weaning ($n = 16$) but a lot of data was lost because the piglets pulled on the collars and chewed on the accelerometers. For the later part repeated records were collected approximately one week after farrowing ($n = 23$) when the piglets were younger and less active.

2.3. Gait analysis

The gait analysis was performed with a pressure measurement mat (Strideway 4 High resolution; Tekscan Inc., Northwood, MA, USA) and software "Walkway Research ver. 7.60–31″ (Tekscan Inc., Norwood, MA, USA) was used to collect the kinetic data. The mat was regularly calibrated based on the weights of the sows. Records were made of the distribution of weight load between the four limbs, and gait parameters such as stride length and time. The pressure measurement mat was placed in a specially built wooden structure that enabled the pigs to walk in a straight line, and the mat was covered by a 1 mm-thick non-slip plastic mat (see Figs. 1 and Fig. 2). The non-slip plastic mat was longer than the pressure measurement mat and reached approximately 100 cm before the start of the pressure measurement mat and 100 cm after the end of the pressure mat. The sows were recorded at one occasion before farrowing and one after, in connection with collection of activity data. Cameras filmed the sows from a lateral aspect. The sows walked over the pressure mat at a comfortable individual pace and were enticed to walk over the mat with the help of fruit rewards. The sow's correct behaviour over the mat was defined as walking at a constant pace in a straight line, looking straight ahead. It was subjectively assessed by the authors and noted in the data collection protocol. Further, a visual evaluation of the gait symmetry was conducted during the trials.

2.4. Statistical analysis

Data from the activity loggers and litter performance was edited, and associations between activity data, asymmetry index and litter performance was analyzed using the analysis software SAS (release 9.4) and

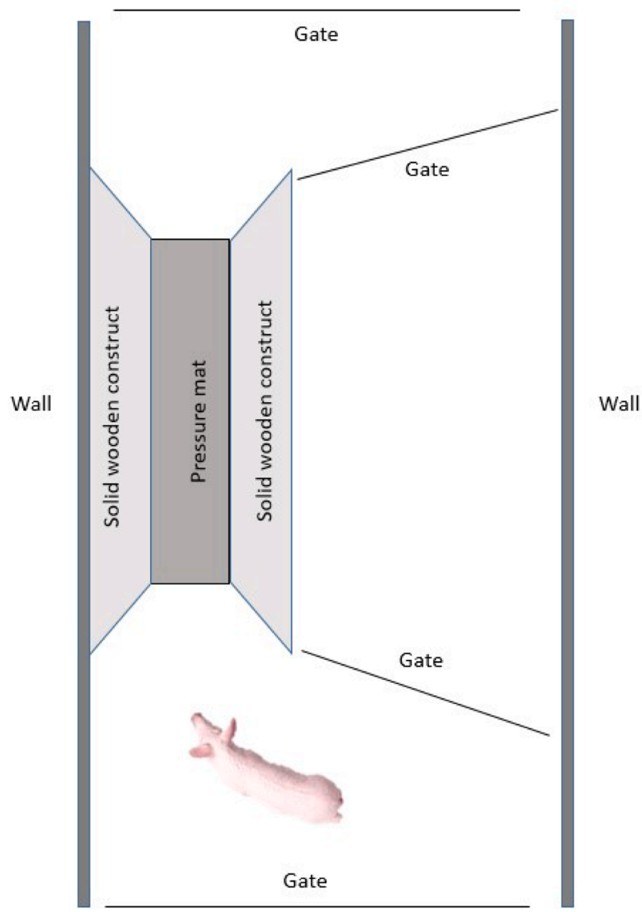

Fig. 1. Illustrating the set-up of the pressure mat. Part of the main aisle in the farrowing stable was closed off using portable bar gates. The pressure mat was placed close to one wall, within a solid wooden construct used to guide sows in a straight line across the mat. The wooden construct was bolted to the concrete floor so that it could not be moved by the sows, and the walls leaned outwards at an angle so that they would not touch the sows and disturb their gate. The sows could cross the mat from both directions. One person was present in the closed off area with the sow during the recordings, to encourage the sow to walk across the mat by providing a food reward.

proc GLM.

Activity was calculated by calculating the difference between acceleration in each time point and the acceleration in the previous time point, for each respective dimension x, y and z.

$$x_2 - x_1 = x_{21}$$
$$y_2 - y_1 = y_{21}$$
$$z_2 - z_1 = z_{21}$$

Absolute values of these differences were summed to give the total activity for each time point as follows: $\text{activity}_{21} = |x_{21}| + |y_{21}| + |z_{21}|$

Activity records were defined as sum of all activity scores over the entire collection period, but also divided as activity during daytime (7 am – 4 pm), nighttime (10 pm – 5 am), morning (5 am – 7 am) and evening (4 pm – 10 pm). Data was analyzed using Pearson correlation coefficients and proc glm in SAS.

The data from the pressure mat were evaluated for normal distribution using normal probability plots for the residuals. Unpaired and paired *t*-tests were performed in Excel (Microsoft Excel 2016) and compared the data before and after farrowing. Significance level was set to $p < 0.0\ 5$.

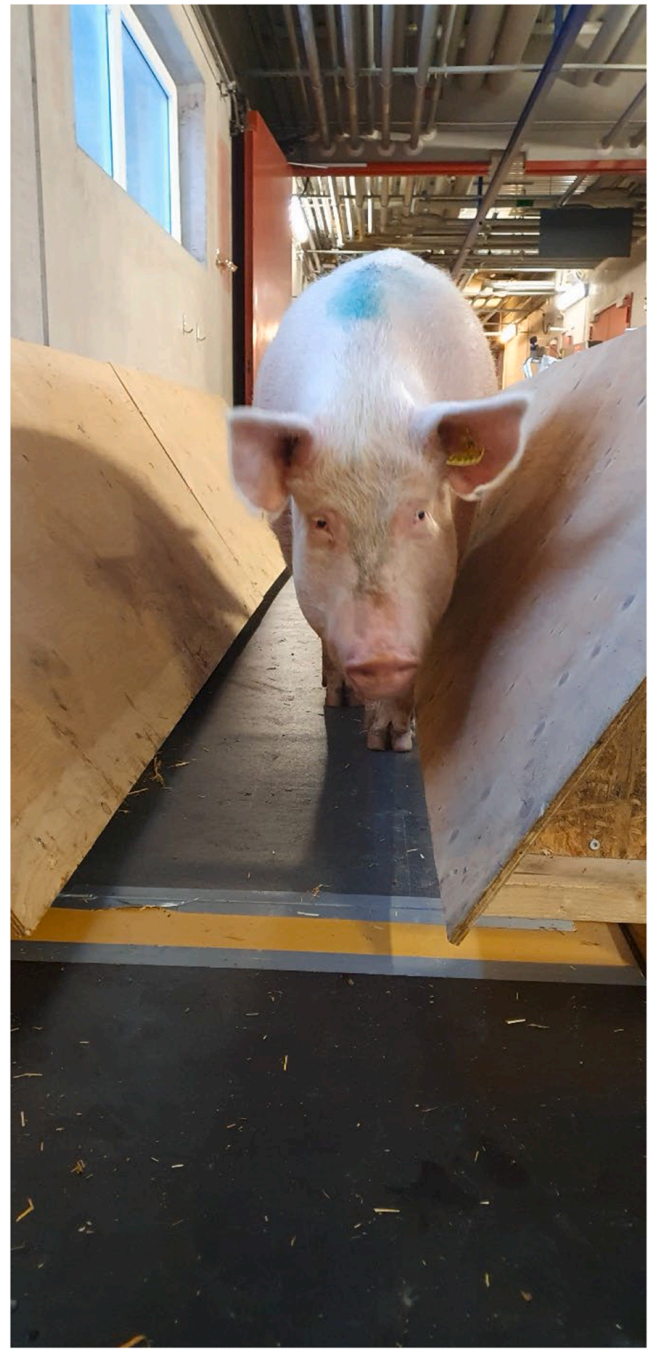

Fig. 2. The wooden construct used to guide sows in a straight line across the pressure mat. The pressure mat was covered in a 1 mm plastic mat and sows were given a fruit reward after each time they crossed over the mat.

3. Results

Average litter size, mortality and growth in the 63 litters included in the study are presented in Table 1 together with sow weights at farrowing and at weaning. Due to an error in the data base, 12 litters had missing weights at birth and therefore growth data until weaning could not be calculated for these litters. Parity number was on average 2.3 and ranged between 1 and 8.

None of the sows responded negatively to the collars with the data loggers. Only first farrowing sows required a few minutes to get used to the collar. This was done by placing the collar loosely on the neck or back of the sow and leaving it there for approximately five minutes

Table 1
Average piglet weights, growth rate and proportion of dead piglets in the litter, and average sow weights at farrowing and weaning for the 63 litters included in the study.

Trait	N	Mean	Std
Piglets			
Birth weight (kg)	51	1.39	0.28
Growth birth-weaning (kg/day)	49	0.25	0.08
Total number born	63	16.7	4.12
Dead, total (%)	63	23.5	15.9
Crushed (%)	63	7.1	9.3
Dead, weak (%)	63	5.6	7.1
Sows			
Weight at farrowing (kg)	62	299.5	26.6
Weight at weaning (kg)	63	285.7	28.4

before closing it around the neck. After five minutes none of the sows seemed to react to wearing it.

In total 94 periods of activity were recorded with 4 sows having repeated records over more than one parity (Table 2). Of those with complete activity records both before and after farrowing within the same lactation a total of 18 individual sows had records on gait analysis from the pressure mat. Highest activity was observed in the daytime during staff working hours and lowest during the night and early morning. There were no significant differences in activity between sows and gilts or between different seasons or farrowing years.

Pearson correlation coefficients between total activity and litter performance are shown in Table 3. There were significant correlations estimated between activity and total proportion of dead piglets, and between total activity after farrowing and proportion of crushed piglets. The correlation between total activity after farrowing and crushed piglets was mainly explained by activity after farrowing in the early morning (0.51 ± 0.00), whereas the correlation between activity and proportion of dead piglets was mainly explained by activity levels during the night (0.45 ± 0.00 and 0.51 ± 0.00 before and after farrowing respectively). There was also a significant negative correlation estimated between nightly activity levels before farrowing and number of crushed piglets of -0.25 ± 0.06.

The results from the pressure measurement mat are presented as mean values ± standard deviation in Table 4 (load parameters) and Table 5 (gait parameters). The data is based on three trials for each registration occasion, and a minimum of 12 stances per trial. The data were normally distributed. An unpaired *t*-test between the group before ($n = 15$) and after farrowing ($n = 18$) showed statistical significance for the gait parameters stride length left/right ($p = 0.00$), stride velocity left/right ($p = 0.01$), stride velocity left front/right front ($p = 0.03$) and stride length left hind/right hind ($p = 0.00$). No significant changes were seen in load distribution between limbs. The results presented as symmetry indices can be seen in Tables 4 and 5.

A paired *t*-test between before and after farrowing ($n = 14$) showed a statistical difference for stride length left/right ($p = 0.03$), stride velocity left/right ($p = 0.02$), stride velocity left front/right front ($p = 0.02$) and stride length left hind/right hind ($p = 0.03$) (Tables 6 and 7). No significant changes were seen in load distribution between limbs.

Table 2
Sum of activity (g) of sows recorded with the data loggers over different periods of time of day. First recording at approximately one week before expected farrowing and second recording at approximately one week after farrowing or at weaning.

Time of day	N	Before farrowing (g)	N	After farrowing (g)
Morning (5 am – 7 am)	57	251.87	34	238.59
Daytime (7 am – 4 pm)	57	1112.13	37	1293.38
Evening (4 pm – 10 pm)	57	1080.99	36	1042.19
Night (10 pm – 5 am)	57	382.51	36	406.94
Total	57	2827.51	37	2923.04

Table 3
Pearson correlation coefficients between litter performance traits and total activity levels. Values in bold were significant ($p < 0.05$).

	Total activity	
Litter trait	Before farrow.	After farrow.
Piglet growth	−0.08 ± 0.60	0.16 ± 0.39
Total dead (%)	**0.38 ± 0.00**	**0.48 ± 0.00**
Crushed (%)	−0.07 ± 0.78	**0.28 ± 0.10**
Weak (%)	0.07 ± 0.59	0.15 ± 0.36

Table 4
Load parameters reported as symmetry indices, in two independent groups of sows.

Load parameter (symmetry index)	Sows before farrowing ($n = 15$)	Sows after farrowing ($n = 18$)
Peak Vertical Force Front/Hind	1.30 ± 0.12	1.40 ± 0.26
Peak Vertical Force Left/Right	1.05 ± 0.12	1.03 ± 0.06
Peak Vertical Force Left Front / Right Front	1.04 ± 0.17	1.03 ± 0.10
Peak Vertical Force Left Hind / Right Hind	1.07 ± 0.15	1.04 ± 0.14

Table 5
Gait parameters reported as symmetry indices, in two independent groups of sows. Bold values indicate significant differences between the groups.

Gait parameter (symmetry index)	Sows before farrowing ($n = 15$)	Sows after farrowing ($n = 18$)	Significance
Stance Time Front/ Hind	1.00 ± 0.06	1.06 ± 0.13	NS
Stride Time Front/ Hind	1.20 ± 0.49	1.12 ± 0.25	NS
Stride Length Front/ Hind	1.05 ± 0.04	1.08 ± 0.15	NS
Stride Velocity Front/ Hind	1.00 ± 0.09	0.99 ± 0.1	NS
Stance Time Left/Right	1.00 ± 0.11	1.00 ± 0.08	NS
Stride Time Left/Right	1.15 ± 0.44	0.98 ± 0.05	NS
Stride Length Left/ Right	**0.98 ± 0.03**	**1.02 ± 0.04**	**0.00**
Stride Velocity Left/ Right	**0.97 ± 0.07**	**1.04 ± 0.08**	**0.01**
Stance Time Left Front / Right Front	1.02 ± 0.17	1.02 ± 0.13	NS
Stride Time Left Front / Right Front	1.31 ± 0.88	0.97 ± 0.07	NS
Stride Length Left Front / Right Front	1.00 ± 0.06	1.01 ± 0.05	NS
Stride Velocity Left Front / Right Front	**0.94 ± 0.13**	**1.07 ± 0.23**	**0.03**
Stance Time Left Hind /Right Hind	1.00 ± 0.10	0.99 ± 0.10	NS
Stride Time Left Hind /Right Hind	0.99 ± 0.08	1.00 ± 0.06	NS
Stride Length Left Hind /Right Hind	**0.98 ± 0.06**	**1.04 ± 0.06**	**0.00**
Stride Velocity Left Hind / Right Hind	1.03 ± 0.08	1.03 ± 0.07	NS

Based on analysis of peak vertical force symmetry, 20 sows were classified as presenting an asymmetrical gait, indicative of lameness. There was no significant difference in activity between lame sows and those without asymmetry, but the lame group displayed a larger variation in activity.

4. Discussion

This project aimed at investigating the relationship between individual variation in activity levels in sows with litter performance and limb health. The use of data loggers allowed us to record activity during

Table 6
Load parameters reported as symmetry indices, in two dependent groups of sows.

Load parameter (symmetry index)	Sows before farrowing ($n = 13$)	Sows after farrowing ($n = 13$)
Peak Vertical Force Front/Hind	1.30 ± 0.12	1.34 ± 0.20
Peak Vertical Force Left/Right	1.04 ± 0.13	1.02 ± 0.07
Peak Vertical Force Left Front / Right Front	1.04 ± 0.18	1.00 ± 0.08
Peak Vertical Force Left Hind / Right Hind	1.07 ± 0.17	1.05 ± 0.14

Table 7
Gait parameters reported as symmetry indices, in two dependent groups of sows. Bold values indicate significant differences between the groups.

Gait parameter (symmetry index)	Sows before farrowing ($n = 13$)	Sows after farrowing ($n = 13$)	Significance
Stance Time Front/ Hind	1.00 ± 0.06	1.05 ± 0.11	NS
Stride Time Front/ Hind	1.23 ± 0.53	1.12 ± 0.28	NS
Stride Length Front/ Hind	1.05 ± 0.04	1.09 ± 0.15	NS
Stride Velocity Front/ Hind	1.00 ± 0.10	1.00 ± 0.09	NS
Stance Time Left/Right	1.00 ± 0.12	1.00 ± 0.07	NS
Stride Time Left/Right	1.17 ± 0.47	0.99 ± 0.04	NS
Stride Length Left/ Right	**0.98 ± 0.03**	**1.02 ± 0.04**	**0.03**
Stride Velocity Left/ Right	**0.97 ± 0.07**	**1.02 ± 0.05**	**0.02**
Stance Time Left Front / Right Front	1.02 ± 0.18	1.01 ± 0.08	NS
Stride Time Left Front / Right Front	1.36 ± 0.93	0.99 ± 0.06	NS
Stride Length Left Front / Right Front	**0.99 ± 0.06**	**1.01 ± 0.05**	**0.02**
Stride Velocity Left Front / Right Front	**0.93 ± 0.14**	**1.02 ± 0.05**	**0.03**
Stance Time Left Hind /Right Hind	0.99 ± 0.10	0.99 ± 0.11	NS
Stride Time Left Hind /Right Hind	0.98 ± 0.08	1.00 ± 0.06	NS
Stride Length Left Hind /Right Hind	0.98 ± 0.06	1.04 ± 0.06	NS
Stride Velocity Left Hind / Right Hind	1.01 ± 0.08	1.04 ± 0.07	NS

a long period of time without having to manually score behavioural data. However, it was not without problems to attach the data loggers to the sows. Previous studies have fastened the data logger around the limb of the sow (Ringgenberg et al., 2010). This also allows for determining body posture if the alignment of the logger can be fixed relative its dimensions. One aim of this study was to determine if there is a different in motion symmetry before and after farrowing, and therefore repeated records after farrowing were needed. To avoid curious piglets chewing on the sow's limb and potentially wounding the skin so instead it was opted for attaching it to a collar and not directly to the sow's limbs. The first attempts to record activity around weaning resulted in many cases of lost data due to piglets pulling the collar off the sow and chewing on the data logger. Around weaning the collars also got exposed to a much wetter and dirtier environment in the pen which caused the battery to short circuit in several cases even if the logger is generally water proof. To avoid this the second recording after farrowing was instead moved to about a week after farrowing when piglets are smaller and not as active. This improved the success rate in retrieving data from the accelerometers.

A higher level of activity was generally associated with a higher proportion of total number of dead piglets. This association was not observed when looking at the main causes of death among live born piglets, crushing and death of small and weak piglets. The results suggest that active sows may have a higher risk of stillbirth, which is the third major cause of death in the pre-weaning period. This is in agreement with previous findings (Anil et al., 2009). One explanation could be if active sows show more restless behavior during parturition and in that way may prolong the farrowing duration. Further research is needed to verify if sows that show more activity also have a prolonged expulsion stage of parturition. Higher activity levels during the night before farrowing was associated with a lower proportion of crushed piglets. Previous studies have suggested that sows that display more nesting behavior have lower piglet mortality (Ocepek and Andersen, 2017), and nightly activity in the days before farrowing could reflect nesting behavior. However, further research is needed to verify if nesting behavior is the explanation to higher nightly activity.

Our hypothesis before the study was that activity level could serve as an indicator of lameness in that sows in pain will be less willing to move. There were no clear relationship between activity, in total or anytime during the day, and deviances in symmetry index from the pressure mat. Sows classified as lame, showing a motion asymmetry, did however display a larger variation in activity compared with sows not classified as lame, indicating that some show more activity and others less. Previous studies have shown that lame sows walk less (Ala-Kurikka et al., 2017). It is possible that sows in pain may walk less but they might also shift position more often if becoming uncomfortable. Because activity was recorded in the farrowing pen there is little opportunity for the sow to move in the same way as in a group housing system. Newer techniques with video cameras and computer vision may help achieving accurate records of activity in group housing systems. In this study accelerometers were not deemed possible to use for the risk of other sows chewing on the equipment and potentially injuring the sow wearing the data logger.

Further, the project investigated sows walking over a pressure measurement mat, before and after farrowing. The results are presented as symmetry indices, since absolute values of peak vertical force is highly influenced by the registration velocity (Meijer et al., 2014). The results show that there was a significant difference in stride velocity of the symmetry between the left and right forelimbs, between sows before and after farrowing. Further differences were recorded for the symmetry indices between the hind limbs stride lengths. There was no difference in peak vertical forces, thus how the sows distributed their weight between the four limbs. The results indicate that there are few and small changes between recordings before and after farrowing. To the best of our knowledge, there is not previous documentation on gait parameters and load distribution in sows around farrowing. Further, there is no consensus on cut-off values for registered gait parameters, which complicates the analysis of the results in regard of its clinical significance. The symmetry values for pigs have been suggested to 1.5 for the weight distribution between fore- and hind limbs (Meijer et al., 2014). It is in accordance with suggested values for cats and dogs, that are approximately 1.0 for the symmetry indices for left verses right side (Lascelles et al., 2007; Schnabl and Bockstahler, 2015). Values for weight distribution between fore- and hind limbs suggested between approximately 1.2 and 1.6 for peak vertical forces, depending on breed- especially in dogs (Moreau et al., 2013; Corbee et al., 2014; Schnabl and Bockstahler, 2015). Regardless of the lack of clinically validated values to distinguish between lame and sound, the techniques has been validated for sows, showing a fair to excellent intra-class correlation between runs on the same day with a ICC of 0.80 for peak vertical force and 0.86 for peak vertical pressure (Meijer et al., 2014). Further, studies have shown that sows with a clinical lameness show a reduction in maximum pressure and stance time (Karriker et al., 2013).

The possible explanation for the non-excising differences from the actual study may be an actual non-difference. The results may also be due to study limitations, such as a limited study population, although the changes were small and thus would probably not be larger with a larger study group. Further, one limitation using the pressure measurement mat is the influence of gait velocity on the values of peak vertical force. It is known that the velocity affects the gait parameters, thus the results in the present study are presented as symmetry indices that are less influenced by the pigśvelocity walking over the mat. One strength of the present study is the use of objective outcome techniques, such as the pressure measurement mat and activity monitors, especially since the clinical use of visual lameness examination of pigs has limited reliability. A weakness in recording of activity and the use of collars was that the accelerometer was not secured in a specific position in relation to the sow. When the collar was attached around the sow's neck, the accelerometer was placed under the chin, but it could shift position if the collar rotated. Therefore, we could not determine the body position of the sow. This could have added valuable information and should be considered in future studies. Using video cameras in combination with computer vision and AI would provide a way of recording activity without having to fit equipment on the animal itself.

5. Conclusion

In conclusion, the indications are that the current time between recordings before and after farrowing does not affect the distribution of load between the limbs. It is unclear whether the measured significant differences in gait parameters have any clinical significance. However, the pressure measurement mat is a validated objective technique for assessing gait parameters and weight distribution in sows and its use should be encouraged in future studies. Activity levels in the farrowing pen does not seem to be a good indicator of lameness, but may indicate sows that are at risk of having higher piglet mortality. Some data was lost due to sows losing their collars. It would be desirable to use techniques that do not require equipment fitted on the sow, for example video recordings combined with computer vision and AI. Further research is needed to verify these results.

CRediT authorship contribution statement

Katja Nilsson: Writing – original draft, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Anna Bergh:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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