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Increasing the piglets' use of the creep area – A battle against biology?

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Abstract

Indoor farrowing systems are based upon the assumption that the newborn piglets will leave their mother after suckling and enter a heated creep area, but newborn piglets are motivated to remain close to the sow. Several creep area features attractive to piglets were used to attempt to maximise time spent in the creep area the first two days after birth and to find out whether increased time spent in the creep area would affect early piglet mortality in farrowing pens. Forty-six loose-housed sows and their litters kept in individual farrowing pens were subjected to one of three creep area treatments; control (CON); concrete floor, bedding (BED); an insulated and soft bedding and HUT; an insulated and soft bedding in addition to an extra wall to increase the heat conserving capacity in the creep area. The pens were video-recorded from 0-72h after birth and analysis was conducted from 08:00 - 14:00 and from 20:00 - 02:00 on each day. The attempts to make the creep area attractive did not increase the use of the creep area; piglets in the HUT treatment spent less time in the creep area and more time resting near the sow than piglets in the CON and BED treatment. Offering a heated creep area with soft bedding did not increase time spent away from the sow, nor did it reduce piglet mortality. Quality of the creep area thus appears to have little impact on piglet survival.

Keywords: pig welfare, piglet mortality, creep area, farrowing pens

1. Introduction

The domestic sow shows maternal behaviour similar to that of the wild boar (e.g. Jensen, 1986; Gustavsson et al., 1999), and under semi-natural conditions, domestic sows will leave the group to search for a suitable nest site 1-2 days prior to farrowing (e.g. Jensen, 1988). When a suitable nest site has been located, she excavates a hollow and collects suitable material to build a nest in it, spending typically 5-10 hours on the construction (e.g. Wood-Gush and Stolba, 1982; Jensen, 1993). During the first two days after birth, the sow will spend 90 % of her time in the nest, only leaving the nest for brief foraging trips (Stangel and Jensen, 1991). The piglets spend these first days after birth resting in close contact with the sow and littermates, leaving the nest only to defecate (Stangel and Jensen, 1991). Remaining in the nest after birth serves several adaptive functions for the piglets: it facilitates the development of the mother-young bond (Jensen and Redbo, 1987), it reduces the chance of becoming separated from the sow or being detected by predators, and perhaps more importantly, gaining heat (Fiala and Hurnik, 1983) and food from the udder. Unlike most mammals, piglets are born without fur or brown adipose tissue so their thermoregulatory capacity is poorly developed during the first days after birth (e.g. Berthon et al, 1994; Herpin et al., 2002). Although hypothermia is rarely recorded as cause of death in commercial herds, it might often be the primary cause of starvation and crushing (reviewed by Edwards, 2002), as hypothermia renders the piglet less able to find a teat or avoid overlying by the sow (English, 1993). Heat from the udder will reduce the amount of energy needed to maintain body temperature and the intake of colostrum provides a valuable energy source for thermoregulation (Herpin et al., 1994), which in turn may increase the piglets' chances of survival. Piglets in semi-natural conditions start following the sow on small foraging trips from 4

days after birth, and the sow and litter rejoin the group around 10 days after farrowing (Newberry and Wood-Gush, 1988; Jensen, 1988).

Unlike the sow-piglet interactions observed in semi-natural conditions, where the sow leaves the piglets in the nest, modern farrowing systems are based on the principle that newborn piglets will leave the sow and enter a heated creep area. In this system, room temperature in the farrowing unit is kept within the sows' thermal comfort zone, around 20 °C, while a suitable microclimate (30-34°C) to avoid hypothermia in piglets is provided in the creep area. However, numerous studies have found that young piglets prefer to huddle near both sow and littermates, even if there are unfavourable thermal conditions in the sow area, instead of staying in the creep area during the first days after birth (e.g. Hrupka et al., 1998; Andersen et al., 2007; Moutsen et al., 2007; Vasdal et al., 2009). In fact, Hrupka et al. (2000) found that piglets were more attracted to an anesthetized piglet in a cold chamber than to an empty warm chamber, suggesting that the attraction to physical contact is stronger than the attraction to ambient heat. The piglets only start using the creep area to a substantial extent from day 3 after birth (e.g. Hrupka et al., 1998; Berg et al., 2006; Vasdal et al., 2009), which is the age when they would naturally start exploring the nest surroundings together with the sow (e.g. Stangel and Jensen, 1991).

Despite the piglets' motivation to lie close to the sow, many farmers' constructions and scientific studies have been aimed at increasing the attractiveness of the creep area whilst the use of the creep area in farrowing crates has been increased by: reducing temperature in the sow area (Zhou and Xin 1999; Schormann and Hoy, 2006; Burri et al. 2009), adding a warm water bed in the creep area (Ziron and Hoy, 2003) or providing a simulated udder in the creep area (Lay et al.,

1999; Toscano and Lay, 2005). Piglets in farrowing crates spend more time in the creep area than piglets in farrowing pens, possibly because the sow area is made less attractive by slatted floors, horizontal bars around the sow and reduced space (Blackshaw et al., 1994; Vasdal et al., 2009). Another reason for this difference might be the extra attraction of the sow area to piglets resulting from higher maternal motivation displayed by sows in farrowing pens showing more piglet-directed behaviour, higher responsiveness to piglet screams and increased nursing behaviour (e.g. Cronin et al., 1996; Arey et al., 1996; Jarvis et al., 2005). Vasdal et al. (in press) found that 24-hour-old piglets preferred 42 ºC to other, lower infrared temperatures, and a thick layer of sawdust to both a foam mattress and a water mattress. Thus, it might be possible to increase the use of the creep area in loose-housed sows by combining a thick layer of sawdust with high infrared temperatures. However, although previous studies have shown that piglets in farrowing crates spend more time in the creep area than piglets in farrowing pens, a relationship between increased time spent in the creep area and piglet mortality has not yet been documented. This information would be important to the ongoing work of reducing piglet mortality in loose-housed sows.

The aim of this study was to investigate, firstly, whether improving the thermal comfort and softness of the creep area would increase time spent in the creep area during the first three days after birth, and secondly, whether this would affect early piglet mortality in loose-housed sows.

2. Material and methods

2.1. Experimental design

Loose-housed sows and their litters kept in individual farrowing pens were subjected to one of three creep area treatments during the first three days after farrowing (0-72h); Control (CON); concrete floor, bedding (BED); an insulated and soft bedding and HUT; an insulated and soft bedding in addition to an extra wall, to increase the heat conserving capacity in the creep area. During four farrowing batches, a total of 46 sows were randomly allotted to one of the treatment pens: CON (n=17), BED (n=15) and HUT (n=14) six days before expected farrowing.

2.2. Animals and housing

This experiment was conducted at the Pig Research Unit at the Norwegian University of Life Sciences. All sows were Yorkshire x Norwegian Landrace with parities ranging from 1 to 8 (mean ± S.E: 2.7 ± 0.2) and inseminated with Duroc x Landrace boars. The sows were moved from the group housing gestation unit to the farrowing unit at day 110 post-insemination. The farrowing unit where the farrowing pens were located was insulated and mechanically ventilated and the air temperature was kept at 20 ºC until farrowing, and then reduced to 16 ºC.

Each farrowing pen measured 8.9 m² in total, and the sow area (part of the pen accessible to the sow) measured 7.0 m² with 3.7 m² slatted plastic floor (Figure 1). The creep area measured 1.9 m², of which 1.0 m² was covered with a wooden ceiling. The creep area was separated from the sow area by a diagonal wall (2 x1 m) with a 20 cm gap along the bottom for piglets to enter. This diagonal wall was located 30 cm from the wooden ceiling in the creep area (Figure 1). The solid floor in the sow area was covered by a 2 cm layer of sawdust in all three treatments, and all pens were cleaned out twice a day. The creep areas were maintained according to the treatment requirements.

The sows were fed to appetite with a standard lactation concentrate at 0800 h and 1400 h, in addition to 0.5 kg of roughage twice a day. From day 113 until farrowing the sows got 2.0 kg of straw daily for nest building. Lights were kept on for 24 hours to allow video-recording.

Figure 1 here.

To avoid interference with the treatments, no aid was given to newborn piglets at the time of farrowing. During the first day after farrowing the piglets were individually weighed, ear marked, given iron injection and teeth grinded. Male piglets were castrated around day 5. Piglets in the largest litters were cross-fostered to the smaller litters between 12 and 24 hours after birth, so that no sow had more piglets than the number of functional teats. Piglets were cross-fostered equally within and between the treatments. Litter size in this study is thus number of live-born piglets fostered off + piglets fostered on from other sows.

Piglets not able to survive because of injuries or starvation were humanely euthanized by the staff and all dead piglets were subjected to a post mortem to determine cause of death. The dead piglets were categorized as stillborn (lungs sink in water), dead without milk in the stomach (lungs float, no milk in stomach), dead with milk in their stomach (lungs float, milk in stomach), crushed without milk in the stomach (physical signs of crushing, no milk in stomach) and crushed with milk (physical sign of crushing, milk in stomach). A physical sign of crushing included bruising to the body, cranial bone fractures, haemorrhagesor crushed internal organs. In addition to the physical signs, the video recordings were used to document crushings.

2.3 The creep areas

All three creep area treatments had floors made of standard concrete, and a ceiling made of solid wood 65 cm over the floor. The creep areas were heated by a red infrared 250 W heat-lamp mounted in the wooden ceiling. The infrared temperature was regulated by an infrared (IR) temperature controller (Model VE122S IR Controller, Veng Systems®, Roslev, Denmark) using an IR temperature sensor (Model VE181-50, Veng Systems®). The set-point infrared temperature in the creep area was 34 ºC; however as the heat lamp was unable to reach this temperature, the infrared temperature in the creep area remained at around 30 ºC.

The different creep areas treatments were as follows:

CON: the concrete floor in the creep area was sprinkled with <100 g of sawdust, a similar amount to that used in commercial herds.

BED: Insulated and soft bedding: i.e. a thick layer of sawdust (7-10 cm) covered the entire concrete floor in the creep area.

HUT: In addition to a thick layer of sawdust (7-10 cm) on the concrete floor, an extra diagonal wall (65 cm x 160 cm) with an entrance (20cm x 40 cm) was put up under the wooden ceiling in the creep area to provide a better covered area without draught, with a more stable, higher infrared temperature. The infrared temperature in HUT was around 2 ºC higher than in CON and BED.

2.4. Behavioural observations

The sows were continuously video-recorded from 2 days before farrowing until 3 days after farrowing. A video camera was suspended over each pen and connected to a computer using the MSH video system (M.Shafro & Co, www.guard.lv). The behaviour of the piglets and their location in the pen was scored using instantaneous sampling every 10 minutes from 0800 - 1400 (6 hours) and from 2000 - 0200 (6 hours) at day 0 (0-24 hours), day 1 (25-48 hours) and day 2 (49-72 hours), adding up to a total of 216 observations per litter. The video analysis of each litter began at 0800 on the morning after the farrowing was finished. These two periods were chosen due to the presumed high activity at 0800-1400, and presumed low activity at 2000 – 0200. In order to score the location of the piglets, the farrowing pen was divided into two zones: the creep area and the sow area (the rest of the pen).

The behaviour and location of piglets was scored using the following categories:

Number of piglets:

1. In the creep area.
2. Suckling (actively sucking on a teat).
3. Active in sow area (standing/walking/running/exploring etc).
4. Piglet resting alone in sow area without body contact with sow or littermates.
5. Resting in contact with the sow or littermates.

2.5. Statistical methods

In the analysis, the litter was used as the statistical unit. The differences in piglet behaviour and location between treatments and days were analysed using a Glimmix model procedure in SAS software with Poisson distribution, including the following class variables: treatment (CON, BED, HUT), batch (1, 2, 3 and 4), days after farrowing (0, 1, 2) and sow parity (1-8). The interactions between treatment*batch and treatment*day were also included in the model. Sow was included as a random effect, and litter size was included as a continuous variable in the model. Piglet mortality and causes of mortality were analysed using a Genmod procedure in SAS with Poisson distribution including the following class variables and their interactions: treatment (CON, BED, HUT), batch (1, 2, 3, 4), days after farrowing (0, 1, 2) and sow parity (1-8), with litter size included as a continuous variable. Due to the lack of normal distribution, relationships between piglet location and piglet mortality were analysed by a Spearman Rank correlation analysis.

3. Results

3.1. Piglet location in the pen

Piglets in the HUT treatment spent less time (% of observations) in the creep area than piglets in the CON and BED treatments ($F_{2.88}$=10.8, P<0.001), while there was no difference in time spent (% of obs) in the creep area between the CON and BED treatment (Table 1). The number of piglets lying in the creep area increased in the first two days after farrowing ($F_{4.88}$=6.8; P<0.01), and this increase was highest in the BED treatment ($F_{4.88}$=2.7; P<0.05) (Figure 2). There were large differences between litters with the same treatment in how much time they spent (% of obs) in the creep area; the litters ranged from 2% to 72 % of the observations in all three treatments.

When looking at the litters with high and low use of the creep area, there were no significant differences in sow parity, birth weight or litter size.

Table 1 here

A higher percentage of piglets were resting near the sow in the HUT treatment than in the CON and BED treatment ($F_{2.88}$=3.0, P=0.05) (Table 1). The percentage of piglets suckling, being active near the sow or resting alone was not affected by the treatments. During the first three days after birth the piglets decreased the time spent (% of obs) suckling ($F_{2.88}$=50.8; P<0.001) and the time spent (% of obs) active in the sow area ($F_{2.88}$=13.6; P<0.01). Overall, the piglets spent less than a third of their time in the creep area during the first three days after birth, while they spent more than half their time resting near the sow or suckling (Table 1).

Figure 2 here

Increased litter size reduced both the time the piglets spent (% of obs) resting alone ($F_{1.88}$=5.1, P<0.05) and the time they spent (% of obs) resting near the sow ($F_{1.88}$=5.5, P<0.05). Piglet location in the pen was affected by sow parity; litters of sows with parity 6 used the creep area more than any other parity ($F_{7.88}$=2.4, P<0.05), while piglets of sows with parity 7 spent more time (% of obs) active near the sow ($F_{7.88}$=2.7, P<0.05) than in the other parities. Sow had a significant effect on time spent (% of obs) in the creep area (t=2.4, P<0.05), time spent (% of obs) nursing (t=-5.8, P<0.001) and time spent (% of obs) active in the sow area (t=-2.4, P<0.05).

The percentage of piglets resting alone were higher in batch 1 than in the other batches ($F_{3.88}$=6.4, P<0.05), while the percentage of piglets resting together with the sow were higher in batch 2 than in the other batches ($F_{3.88}$=5.5, P<0.01). There was a significant interaction between batch and treatment on time spent (% of obs) active in the sow area ($F_{6.88}$=2.7, P<0.05), and there tended to be an interaction between batch and treatment on time spent (% of obs) in the creep area ($F_{6.88}$=2.0, P<0.1). However there were no clear trends in the direction of these effects.

3.2. Piglet mortality

There were no significant differences in piglet mortality among the three treatments (Table 2). Neither sow parity, number of live-born piglets or piglet birth-weight varied significantly between the treatments. There were no significant differences between the treatments in the percentage of piglets being crushed by the sow (Table 2). Fewer piglets died of causes other than crushing in the BED treatment than in the CON and HUT treatment ($\chi^2_{2, 29}$=31.0, P<0.01) (Table 2). In the CON treatment, piglets were crushed in 37% of the litters, while piglets died of other causes in 68% of the litters. These values were 50% of the litters (crushed) and 37% of the litters (other causes) in the BED treatment, and 31% of the litters (crushed) and 50% of the litters (other causes) in the HUT treatment, respectively. Piglet mortality was reduced from 9.5±1.9% of the live born on day 0, to 6.5±1.7% on day 1 and to 3±0.7% on day 2 (Figure 3). Litter size had no effect on piglet mortality in this study.

Table 2 here

The four batches did not differ in sow parity, litter size or birth weight. Batch 1 had a higher mortality rate ($\chi^2_{3, 29}$=17.7, P<0.01), a higher percentage of stillborn piglets ($\chi^2_{3, 29}$=9.5, P<0.05) and most piglets were crushed ($\chi^2_{3, 29}$=4.8, P<0.01). There was no significant interaction between batch and treatment on piglet mortality. Piglet mortality was affected by sow parity; parity 3 and 5 had the highest piglet mortality, while parity 1 and 6 had the lowest piglet mortality ($\chi^2_{7, 29}$=56.7, P<0.001).

Figure 3 here.

The total time spent (% of obs) in the creep area was not significantly related to piglet mortality in any of the treatments on day 0, day 1 or day 2. There was no relationship between mortality and time spent (% of obs) resting near the sow, resting alone or being active near the sow.

4. Discussion

Improving the thermal comfort and softness in the creep area did not increase the use of the creep area, nor did increased use of the creep area reduce piglet mortality. The hut was least used of the three creep areas, opposite to what was predicted based on previous findings that piglets prefer warm and soft areas (e.g. Zhou and Xin 1999; Schormann and Hoy, 2006; Burri et al. 2009; Vasdal et al., in press). In total, the piglets spent less than a third of their time in the creep area, thus none of the three creep area treatments in the present study were able to attract the piglets away from the sow to a greater extent than in reported in other studies (e.g. Berg et al., 2006; Vasdal et al., 2009). This fits well with previous findings; piglets are strongly motivated to lie close to the sow and litter mates early after birth regardless of the presence of a heated creep

area (Hrupka et al., 1998; Andersen et al., 2007; Moutsen et al., 2007). Lying close to the sow after birth is a highly adaptive behaviour as it increases the piglets' chance of survival, and it can therefore be considered as a battle against the biology to aim at attracting newborn piglets away from the sow. Being based on a more natural principle, several farrowing pen designs such as the Werribee pen (Cronin et al., 2000), family group systems (e.g. Bøe, 1993) and the freedom farrowing system (Baxter, 1991) allow the sow to leave the piglets, and production results in such systems are similar to crates (e.g. Cronin et al., 2000).

Heat has previously been shown to attract young piglets, but with higher infrared temperatures than in this study, and more importantly, without a sow present (Hrupka et al., 2000; Vasdal et al, in press). To our knowledge, no studies have managed to attract newborn piglets away from the sow in loose housed pens to a great extent. Piglets in pens use the creep area less than piglets in crates (e.g. Vasdal et al., 2009), not only due to differences in the physical layout of the pen, but perhaps more importantly due to the higher maternal motivation displayed by sows in pens (e.g. Arey et al., 1996; Jarvis et al., 2005). Sows with increased maternal motivation are generally known to be more responsive to piglet vocalizations (e.g. Wechsler and Heggelin, 1996), have more nose contact with the piglets (e.g. Andersen et al., 2005), and show reduced activity around farrowing and early stages of lactation (e.g. Jarvis et al., 1999; Andersen et al., 2005; Burri et al., 2009). Earlier studies have suggested that variations in the sows' maternal behaviour may explain differences in the piglets' behaviour (e.g. Berg et al., 2006), but it is not clear if and how the sow encourages the piglets to use the creep area. From a biological point of view, improved maternal behaviour should in fact increase the piglets' attraction to the sow and would thus increase the time spent together with the sow, rather than the opposite.

In accordance with previous findings (e.g. Berg et al., 2006), there were large differences between litters in use of the creep area. However, there was no relationship between time spent in the creep area and piglet mortality. The creep area has long been considered an important part of the farrowing environment, providing the piglets with a suitable microclimate, and physical protection from the sow. However, if increased use of the creep area was positive for piglet survival, differences in mortality should be expected between litters with high and low use of creep area. Vasdal et al. (2009) found that piglets in crates spent significantly more time in the creep area during the first three days after birth than piglets in pens, however there were no differences in mortality between these environments (Pedersen et al., in prep). These results suggest that the creep area is less important for piglet survival than previous thought.

In the present study, there was no relationship between time spent resting near the sow and piglet mortality. Other studies have found that presence of more piglets in the sow area increased the risk of crushing, but the piglets that spend more time in the sow area when the sow is not nursing are often the weak and hungry piglets in the litter (e.g. Weary et al., 1996). Thus it might be other factors, such as the physical state of the piglets that explains early piglet mortality. A majority of the piglets in the present study died before receiving milk, suggesting that starvation was a major predisposing factor for the mortality. Surprisingly, litter size had no clear effect on mortality in this study, contrary to previous findings (e.g. Weber et al., 2009; Pedersen et al., in prep). The negative effects of large litter sizes might have been camouflaged by the cross fostering, as the sows never had more piglets than functional teats.

Knowing that hypothermia is a major contributor to early piglet mortality (English, 1993) it could be expected that piglets in treatments with an improved thermal quality had a lower mortality due to the reduced heat loss. However this was not the case in this study, as piglet mortality was similar in the three treatments. This result is supported by earlier finds; heat conserving capacity of the creep area does not affect piglet mortality in commercial loose-housed sow herds (Andersen et al., 2007). In order to reduce early piglet mortality by improving the thermal quality of the creep area, the piglets need to actually spend time in the creep area, which is not the case the first three days after birth. Although the piglets were resting close to the sow most of the time, there were still large differences in the use of the creep area between litters within the same treatment. There are no obvious characteristics of the litters that spent more time in the creep area, as neither sow parity, litter size nor did birth weight varied between litters with high and low use of the creep area.

In conclusion, offering a heated creep area with soft bedding did not increase time spent away from the sow, nor did it reduce piglet mortality. Quality of the creep area thus appears to have little impact on piglet survival.

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