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Effect of housing on rubber slat mats during pregnancy on the behaviour and welfare of sows in farrowing crates

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The aim of this study was to evaluate the effect of flooring type during gestation, lameness and limb lesion scores on welfare and behaviour of sows in farrowing crates. Sixty sows group-housed during gestation in pens with solid concrete floored feeding stalls and a concrete, fully slatted group area either uncovered (CON; n = 30) or covered with 10 mm thick rubber slat mats (RUB; n = 30) were transferred to the farrowing crate at 110d of gestation (-5d). Lameness was scored on -5d and at weaning (28 d post-farrowing). Limb lesions were scored on -5d, 24 h later (-4d), 3 to 5 days post farrowing and at weaning (i.e., day 28 post farrowing). Sows were video recorded for 24 h on -5d, after the last piglet was born (FARROW) and prior to weaning. Videos were sampled every 10 min and an index of the proportion of time spent in different postures (standing [S], ventral [VL] and lateral lying [LL] and total lying) and number of postural changes was calculated. Median scores were calculated for limb lesions and classified as \leq median or $>$ median. Postural data were tested for normality and analysed using mixed model equations methodology. Flooring during gestation did not affect any of the variables recorded in this study. However, RUB sows tended to make more postural changes than CON sows ($P = 0.10$). Sows with swelling scores $>$ median spent more time LL (68.9 vs. $63.1 \pm 2.19\%$; $P < 0.05$) and less time VL (19.9 vs. $25.8 \pm 2.27\%$; $P < 0.05$) than sows with swelling scores \leq median. Time spent S and VL decreased and LL increased at FARROW compared to -5d and prior to weaning ($P < 0.01$). We found no effect of flooring type during gestation on welfare and behaviour in the farrowing crate. Factors such as limb lesions and adaptation to confinement (i.e., time spent inside the

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farrowing crate) appeared to have a greater influence on sow welfare and behaviour in farrowing crates than the flooring on which they were housed during gestation.

Keywords: farrowing crate; rubber mats; sow behaviour; sows; welfare

Introduction

Since January 2013 individual gestation stalls are banned in the European Union from 28 days after service until one week before farrowing as per EU legislation (EU Council Directive 2008/120/EC). Group housing during gestation has several welfare benefits for sows including greater freedom of movement (Marchant and Broom 1996a). However, sows are more prone to lameness and limb injuries in group systems compared to gestation stalls where bedding is not provided (Calderón Díaz, Fahey and Boyle 2014). Nevertheless, the negative effects of group housing of sows on concrete slats can be ameliorated by the use of rubber slat mats (Tuytens *et al.* 2008; Elmore *et al.* 2010; Calderón Díaz *et al.* 2013; Calderón Díaz and Boyle 2014). These authors reported benefits associated with rubber flooring including reduced lameness scores, greater ease of changing posture and less severe limb injuries in gestating sows. Indeed rubber slat mats could be a useful alternative to straw bedding which is often incompatible with liquid manure systems. Rubber is more yielding and has a lower thermal conductivity than bare concrete (Bøe *et al.* 2007).

In spite of the partial ban on total confinement systems for pregnant sows, the practice of confining sows in farrowing crates during the lactation period is still widespread (Weng, Edwards and Hsia, 2009). Boyle *et al.* (2000, 2002a) reported that gilts and sows housed in groups during gestation have more difficulty adapting to farrowing crates compared to animals coming from stalls because of their lack of experience of close confinement. However, although Boyle *et al.* (2000) suggested that

gilts which were kept in groups on bedding during pregnancy were more stressed during the first hour in the farrowing crate than gilts which were kept in groups on bare concrete, the implications of the flooring used for gestating sows on their behaviour and welfare in farrowing crates has not been well investigated. It could be postulated that reduced lameness and limb lesion scores arising from housing on rubber flooring during pregnancy might be reflected in better posture, changing behaviour and lower limb lesion scores for sows in farrowing crates. The aim of this study was to evaluate the impact of flooring type during gestation on the behaviour and welfare of sows in farrowing crates and to determine how lameness and limb lesions influence sow behaviour in the farrowing crate.

Materials and Methods

Animals

The farm on which this experimental work was conducted was in compliance with Statutory Instrument S.I. No. 311 of 2010 European Communities (Welfare of Farmed Animals) Regulations 2000. No invasive measures were used, thus the experiment did not require licensing under the European Communities (Amendment of Cruelty to Animals Act 1876) Regulations 2005. The study was conducted on the experimental pig farm of the Pig Development Department, Teagasc Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland from March 2011 to August 2012. A total of 64 Large

White × Landrace sows (range parity 1 to 8; parity average 3.36; s.d. 2.56) housed in groups of four were used in the study.

Experimental design and husbandry

Sows were grouped according to parity (32 gilts, and 32 sows parity ≥ 4; there were no second or third parity sows in the herd at the time of the study). Sows were housed in pens with four free access feeding stalls (each 1.71 m Length × 0.65 m Width × 1.02 m Height) with solid concrete flooring. Behind the feeding stalls there was a group area (3.20 m Length × 2.68 m Width) with concrete slatted (slat width 14.5 cm, gap width 2 cm; void area = 8.2%) floor either uncovered (CON, n = 32) or covered with rubber slat mats (RUB, n = 32) (EasyFix™ Rubber Products, Ballinasloe, Co. Galway, Ireland) that could be used for exercise and dunging. Allocation of sows to the experimental treatments is further described by Calderón Díaz and Boyle (2014). The sows were not confined in the stalls and they were free to move about the pen at all times. Two sows (1 CON and 1 RUB) died during gestation. The CON sow had to be euthanised because of an injury to her back which caused paralysis. The RUB sow became trapped under the feeder trough. Additionally, two sows (1 CON and 1 RUB) were removed from the experiment because they were not pregnant and needed to be transferred to the breeding barn. The RUB pens were identical to the CON pens except that the group area was covered with rubber slat mats (1.60 m Length × 0.29 m Width × 0.01 m Height; void area = 8.2%). The rubber mats consisted of a 10 mm thick two-strip system with circular-shaped patterns on the surface and wedges underneath. Each mat covered two slats and one gap. The rubber slat mats were attached to the concrete slats by hammering the wedges underneath into the underlying gaps. No additional means of fixation was required.

The gestation house had four pens (two CON and two RUB); each pen was occupied four times during the 16 month period of the trial. Sows remained in the groups from 4 weeks after service until day 110 of pregnancy when they were transferred to the farrowing facilities. Sixty sows were transferred to the farrowing facilities on day 110 of gestation. The farrowing facilities consisted of eight mechanically ventilated, thermostatically controlled rooms, each with 10 farrowing pens. Room temperature was maintained at 20 °C before farrowing, at 24 °C for the first two weeks of lactation and thereafter at 20 °C. Pens (2.3 m Length × 1.65 m Width) were fitted with a centrally positioned farrowing crate (2.3 m Length × 0.5 m Width). Each pen had a fully slatted cast iron floor (void area = 32%). Heat pads (1.51 m Length × 0.40 m Width) for the piglets were located on either side of the farrowing crate and maintained at 36 °C. Lighting was manually operated. Day time lighting (8 h30 to 17 h00) was provided by overhead fluorescent strips with an intensity of 40 lux. If needed, night time lighting was provided by energy saving bulbs with an intensity of 3 lux.

Throughout gestation and lactation, sows were fed a wet diet (water-to-meal ratio 3.5:1; 13.1MJ digestive energy/kg and 4.5:1; 13.2MJ digestive energy/kg, respectively) consisting mainly of wheat, barley and soya meal from a computerised feeding system (Big Dutchman, Pig Equipment GmbH, Vechta, Germany). Sows had *ad libitum* access to water via a nipple drinker in the feed trough in the farrowing crate. Weaning occurred approximately 28 days after farrowing.

Scoring methodology – timing of inspections/ observations

Sows' locomotory ability was recorded on transfer from the gestation accommodation to the farrowing facilities (-5d) and

at weaning; limb lesions were recorded on -5d, 24 h after entering the farrowing crate (-4d), 3 to 5 days post-farrowing (POSTF) and at weaning. Behavioural observations were made on -5d, after the last piglet was born (FARROW) and at weaning.

Locomotory ability

Locomotory ability was assessed using aspects of the procedure of Main *et al.* (2000) and included the evaluation of the sow's standing posture and gait. Sows were given a score of 0 (not lame) to 5 (severely lame, cannot stand). Sows were removed from the gestation accommodation and walked on a solid concrete floored alleyway connecting the gestation accommodation with the farrowing facilities to assess locomotory ability.

Limb lesions

Limb lesions (environmentally induced/arising from pressure or traumatic contact with fixtures and fittings) on the front fetlock, carpal joint, humerus, elbow, carpus, hock, tarsus-metatarsus joint, hind fetlock and metatarsus (Figure 1) were scored according to their severity using a 'weighted scoring system' adapted by Boyle *et al.*

(2000) from de Koning (1985). The lesions were classified under the following categories: i) score 0 = normal; ii) score 1 = callus (thickening of the epidermis and atrophy of glands) or alopecia (hair loss); iii) score 2 = swelling (abnormal enlargement of a part of the body, typically as a result of an accumulation of fluid); iv) score 3 = wound (where the epidermis is interrupted but not ulcerated and there is no evidence of secondary infection); v) score 3 = bursitis (acquired fluid-filled sac that develops in the subcutaneous connective tissue; usually occurs on the hind legs below the point of the hock or on the lateral sides of the elbow); vi) score 4 = severe wounds (these ulcerated lesions may or may not be accompanied by infection or vii) or severe swellings (characterised by redness and swelling accompanied by heat and pain) and viii) score 6 = severe wounds plus severe swellings. The sum of scores across all sites for each lesion type yielded a total score for each sow for each lesion type/inspection time.

Behavioural observations

Observations of lying-down behaviour were as per Boyle *et al.* (2002a). On

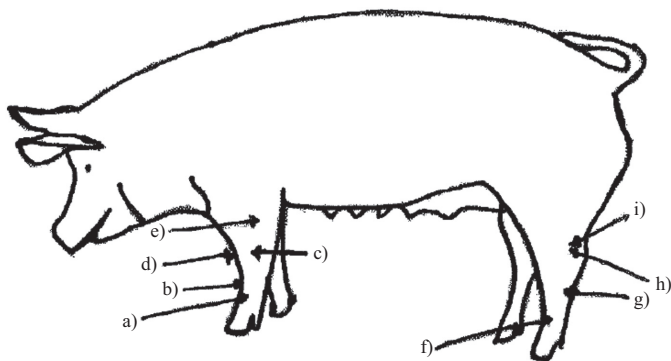


Figure 1. Topographical representation of locations on right and left, front and rear limbs of sows inspected for limb lesions. a) Front fetlock; b) carpal joint; c) humerus; d) carpus; e) elbow; f) hind fetlock; g) metatarsus; h) tarsus-metatarsal joint; and, i) hock.

-5d, sows were recorded continuously in real time for 3 h using a maximum of six black and white cameras (Sony CCTV camera WV-BP130/B) installed on the ceiling of the farrowing rooms and the output was recorded using a time-elapased VCR (Mitsubishi HS-1024) operated in the 3 h mode and a video multiplexer (Panasonic WJ-FS 216). The videotapes (TDK TV180) were analysed in real time mode and information for latency (minutes) to lie-down after entering the crate, number of lying-down attempts required and time (seconds) taken to lie-down were recorded. Once the 3 h video recording finished, sows were time lapse recorded continuously for 24 h. The videotapes were analysed by instantaneous scan sampling every 10 min. An index of the time spent in five different postures [dog sitting, standing (S), lateral lying (LL), ventral lying (VL) and lying (i.e., lateral and ventral lying combined together - L)] and of the number of postural changes made per observation day were calculated. The same procedure was performed at FARROW and prior to weaning. Additionally, lying-down behaviour following the morning feeding was recorded on each of these observation days as per -5d.

Statistical analysis

For this study, sow was considered the experimental unit as they were housed individually. All the observations were done once the sows were removed from their gestation accommodation and each sow was scored individually. For locomotory ability, body and limb lesions, scores on -5d were used as covariates in the model. Parity was classified as first and ≥ 4 . Sows were categorised as non-lame (score ≤ 1) or lame (score ≥ 2). Medians (M_e) were calculated for limb lesions

and values were classified as \leq median or $>$ median lesion scores. Severe swellings were not included as there were very few records of this lesion. Locomotory ability and limb lesions were analysed using logistic binomial regression analysis by the use of Wald statistics to investigate their association with the predictor variables. Predictor variables with a $P \leq 0.35$ (Niranjan *et al.* 2005) were included in the final model. Flooring type during gestation was included in the model irrespective of its P value. Data were analysed using Proc GENMOD (SAS 2011). Statistical differences were reported when $P < 0.05$ and statistical trends were reported when $P > 0.05$ and < 0.10 . Results are reported as odd ratios (OR) with the associated 95% confidence intervals (CI).

The effects of flooring type during gestation and lameness scores on latency, time and number of attempts to lie-down were analysed using non-parametric tests. Data from each observation day were analysed separately. Latency and time to lie-down were analysed using the Kruskal-Wallis test in Proc NPAR1WAY (SAS 2011). Number of attempts to lie-down (1 or ≥ 2 attempts) was analysed using a chi-square test in Proc FREQ (SAS 2011). On -5d, the number of sows that lay-down before the video recording started was analysed using a chi-square test in Proc FREQ (SAS 2011).

Data on time spent in different postures and postural changes were tested for normality before analysis by the Shapiro-Wilk test and examination of the normal plot. Data were analysed using Proc MIXED (SAS 2011). Dog sitting was not included in the analysis as there were very few observations of this behaviour. Flooring type during gestation was included in the model irrespective of its

P value. A Tukey-Kramer adjustment was used to account for multiple comparisons. Statistical differences were reported when $P < 0.05$ and statistical trends were reported when $P > 0.05$ and < 0.10 . Results are reported as least-square means \pm standard error of the mean.

Results

Factors associated with locomotory ability and limb lesions

The percentage of lame sows (i.e., score ≥ 2) did not differ between flooring treatments on transfer to the farrowing crate (33.9% CON sows vs. 28.8% RUB sows; $P > 0.05$) or at weaning (17.5% of sows in each flooring treatment were classified as lame). There was no association between flooring type during gestation and any of the limb lesions studied ($P > 0.05$). There was a tendency for a decreased risk of wound ($M_e = 3$; OR = 0.65, CI = 0.27–1.57; $P = 0.06$) scores greater than the median at weaning compared with -4d. Additionally, there was an increased risk of callus ($M_e = 6$; OR = 8.28, CI = 3.33–20.60; $P < 0.01$) scores greater than the median at weaning compared with -4d. Sows of parity ≥ 4 had an increased risk of callus (OR = 2.84, CI = 1.28–6.27; $P < 0.01$) and bursitis ($M_e = 3$; OR = 2.12, CI = 1.05–4.29; $P < 0.05$) and a decreased risk of wound (OR = 0.41, CI = 0.18–0.89; $P < 0.05$) scores greater than the median compared with first parity sows. Sows with alopecia (OR = 4.10; CI = 1.96–8.58; $P < 0.01$), swelling (OR = 2.84; CI = 1.42–5.69; $P < 0.01$) and wound (OR = 2.63; CI = 1.25–5.54; $P < 0.01$) scores greater than the median later in lactation were more likely to have had higher scores on -5d compared with sows with lesion scores less than or equal to the median when entering the farrowing accommodation.

Behavioural observations

Lying-down behaviour. Twenty-one sows (9 CON and 12 RUB sows) lay down before the video recording started (i.e., < 10 min after entering the farrowing crate). Neither flooring type during gestation nor lameness score were related to the number of sows that lay down before the video recording started ($P > 0.05$). Additionally, there was no association between flooring type during gestation or lameness score and the latency, time and number of attempts to lie down on any of the observation days ($P > 0.05$).

Postural behaviour. There was no association between the time spent in the different postures inside the farrowing crate and flooring type during gestation. Time spent S ($P < 0.01$) and VL ($P < 0.01$) increased and LL ($P < 0.01$) and L ($P < 0.01$) decreased on -5d and prior to weaning compared to FARROW (Figure 2). First parity sows spent less time S (6.4 vs. $10.6 \pm 0.78\%$; $P < 0.01$) and LL (60.2 vs. $71.8 \pm 2.42\%$; $P < 0.01$) and spent more time VL (31.8 vs. $13.9 \pm 2.56\%$; $P < 0.01$) and L (92.2 vs. $85.8 \pm 0.89\%$; $P < 0.01$) than older parity sows. Sows with swelling scores greater than the median spent more time LL (68.9 vs. $63.1 \pm 2.19\%$; $P < 0.05$) and less time VL (19.9 vs. $25.8 \pm 2.27\%$; $P < 0.05$) than sows with swelling scores less than or equal to the median. Lameness score did not affect the postural behaviour ($P > 0.05$).

Number of postural changes. Sows housed on rubber flooring during gestation tended to make more postural changes (33.1 vs. $30.1 \pm 1.31\%$; $P = 0.10$) compared to CON sows. Sows made more postural changes on -5d and at weaning ($34.2 \pm 1.42\%$ and $39.6 \pm 1.69\%$ respectively; $P < 0.01$) than on FARROW ($20.9 \pm 1.81\%$).

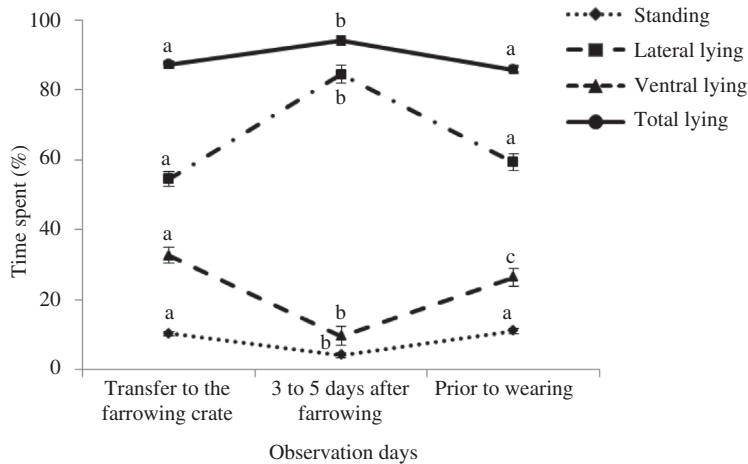


Figure 2. Time (LS Means \pm SE %) spent standing, lateral and ventral lying and total time lying by lactating sows housed on concrete slats either uncovered or covered by rubber slats mats during gestation on the different observation days. a b c represent significant differences between days within each posture; $P < 0.05$.

Discussion

In disagreement with our hypothesis, benefits arising from housing sows on rubber flooring during pregnancy in terms of lameness and limb lesions (Calderón Díaz *et al.* 2013; Calderón Díaz and Boyle 2014) did not translate into welfare improvements for sows in farrowing crates. Indeed the benefits in terms of reduced lameness reported by Calderón Díaz *et al.* (2013) were not realised when the sows in the current study were observed/inspected during pregnancy (see Calderón Díaz and Boyle 2014 for further discussion). This explains why no differences in respect of lameness were seen when the sows were moved into the farrowing crates. There was a beneficial effect of housing on rubber on limb lesions of the sows used in this study when inspected during gestation as reported by Calderón Díaz and Boyle (2014). It is possible that the lesions recorded in the farrowing crate developed during the lactation period rather than during gestation. Indeed the flooring used in farrowing

crates can be highly injurious (KilBride, Gillman and Green 2009; Calderón Díaz, Fahey and Boyle 2014).

We hypothesised that the reduced risk of lameness and limb lesions arising from housing on rubber flooring during pregnancy would be manifest in better agility in the farrowing crate. As these variables did not differ between treatments during gestation, it is unsurprising that we did not find any beneficial effect of housing on rubber floor during gestation on lying and postural behaviour in the farrowing crate on any of the observation days. However, it is possible that the tendency of RUB sows to make more postural changes was due to better postural changing ability arising from fewer strains on the locomotory system arising from housing on rubber during pregnancy. However, further research (i.e., use of x-rays, post-mortem examinations) is needed to establish if this was the case. Additionally, there was no effect of flooring type during gestation or lameness score on the number of sows

that lay down before the video recording started after entering the farrowing crate (i.e., in < 10 min after entering the crate). The latter is contrary to the results reported by (Calderón Díaz, Fahey and Boyle 2014) where more lame sows tended to lie-down in the first 10 min inside the farrowing crate. However, the number of lame sows in that study was higher and almost half of the lame sows that lay-down before the video recording started were severely lame. Thus, it is possible that the degree of lameness presented in this study was not severe enough to affect the sows lying down behaviour. This was confirmed by the fact that we did not find any difference in the latency, time and number of attempts to lie-down between lame and non-lame sows on any of the observation days.

On -5d, sows most probably were feeling distress due to confinement because animals that cannot perform normal movements or that face movement difficulties experience poorer welfare (Marchant and Broom 1996b; Boyle *et al.* 2000, 2002a,b). Lateral lying is reported as the preferred resting position in pigs (Eckel *et al.* 2003). The explanation for the higher proportion of time spent ventral lying by first parity sows is unclear. It could be possible that first parity sows experienced more frustration as it was the first time they experienced close confinement. The presence of higher swelling scores on the limbs affected the lying posture of sows. Sows with swelling scores greater than the median spent more time lateral lying where the limbs are fully extended perhaps to reduce the pressure applied to the lesions by their body weight.

Conclusion

We found no beneficial effect of housing sows on rubber slat mats during gestation

on welfare and behaviour in the farrowing crate. Under the conditions of this study, factors such as limb lesions and adaptation to confinement had a greater influence on sow behaviour than the flooring they were kept on during gestation. The tendency for sows which were kept on rubber flooring during gestation to make more postural changes may be an indicator of better joint health and less discomfort while changing postures.

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