Evaluation of the relationship between injuries and size of gestation stalls relative to size of sows

Leena Anil, BVSc, MVSc, PhD; Sukumarannair S. Anil, BVSc, MVSc, PhD; John Deen, DVM, PhD

Objective—To determine whether there is a relationship between sow injuries and size of gestation stalls relative to sow size.

Design—Prospective study.

Animals—267 pregnant sows.

Procedure—Sows were randomly selected from 4 swine farms. Sow and stall measurements were obtained, and injuries were scored on the basis of location, number, and depth. Ratios of stall length to sow length and stall width to sow height were calculated.

Results—High injury scores were associated with low ratios of stall length to sow length and stall width to sow height.

Conclusions and Clinical Relevance—A small increase in stall dimensions could reduce injuries and improve well-being of sows considerably. (*J Am Vet Med Assoc* 2002;221:834–836)

In the United States, pregnant sows are generally housed singly in stalls. The chances of injuries due to aggression from other sows are low in stalls, but improper stall design and small dimensions can cause injuries. Most gestation-stall designs are based on the static space requirements of the sow without allowance for the dynamic space requirements associated with the sow standing up or lying down,[1] during which the body moves beyond the boundaries of the static space requirements because of sideways, forward, and backward movements. The problem of spatial restriction increases as the size of the sow increases during pregnancy. The main alternative to stall housing, group housing, also has shortcomings, such as loss of control over individual feed intake and aggression between sows, which affect sows' well-being. Although there are various indicators to assess well-being of sows in any housing system, the most direct and undisputable indicators at the farm level are injuries and mortality rate. Physical injuries cause pain and suffering. The extent of lesions on the skin reflects the quality of the sow's physical and social environment. Although there are a few studies[2-4] on injuries in sows, none have considered stall measurements in relation to sow measurements in evaluating injury scores. Most commercially available stalls provide the minimum space required for typical-sized sows and have similar designs and dimensions. However, sow size varies considerably depending on age, genetics, feeding level, and stage of pregnancy. This means that the effective space available to a sow can be inadequate. When a sow moves within a restricted space, injuries may be more likely. Therefore, the purpose of the study reported here was to determine whether there is a relationship between sow injuries and size of gestation stalls relative to sow size.

From the Department of Clinical and Population Sciences, College of Veterinary Medicine, University of Minnesota, St Paul, MN 55108.

Drs. L. Anil and S. S. Anil's present address is Souparnika, TC-46/32, Puthurkara, Ayyanthole, PO, Thrissur, Kerala, India-680003.

Address correspondence to Dr. Deen.

Materials and Methods

Data were collected from 267 sows with various durations of pregnancy, which were randomly selected from 4 swine farms in Minnesota. The number of sows from each farm (farm 1, 31 sows; farm 2, 68 sows; farm 3, 89 sows; farm 4, 79 sows) was limited to one-tenth of the number of pregnant sows in gestation stalls. A systematic random sample of sows in gestation stalls was taken by measuring every tenth sow to estimate the prevalence of injuries. On all farms, the pregnant sows were housed in stalls with partial- to full-slatted floors. Stall measurements, including length (excluding feeder), height, and width, were taken. The stalls were prefabricated and uniform in size within each farm. From each farm, 2 randomly selected stalls were measured individually to ensure uniformity. There were some differences among farms related to the length of slatted or solid floors in each stall because of the manner of attaching the prefabricated stalls on the floors to permit passages of sufficient width between rows of stalls. The type of bars on the stalls and the types and positions of the feeders were also different among the 4 farms. Sow measurements were made on the basis of the procedure adopted[4] for assessing the allometric space requirement for pigs. These measurements were length (tail to scapula), height at the shoulders, and breadth at the shoulders.

An injury score was calculated by use of a scoring pattern based on those suggested in previous studies.[3,5] The same observer performed the injury scoring on all farms. Injuries on various body parts, such as ear (right and left); face, snout, and forehead; shoulders, forelimbs, neck, and thorax (right and left sides); flank (right and left sides); top of the back (dorsum); udder; hind quarters, croup, and hind limb (right and left); tail; and vulva were recorded as partial injuries. A total injury score was calculated by adding all partial injury scores. If the depth of a wound was > 0.5 cm, it was considered a deep wound. A score of zero was given for no injury, 1 for slight injury (< 5 superficial wounds), 2 for obvious injury (5 to 10 superficial wounds, ≤ 3 deep wounds, or both), and 3 for severe injury (> 10 superficial wounds, > 3 deep wounds, or both).

Statistical analyses—Frequencies of partial injury scores, total injury scores, and stall measurements in relation to sow measurements (the ratios of **stall length to**

animal length [SLAL] and **stall width to animal height [SWAH]**) were analyzed. For comparison between injury scores and stall-animal ratios, SLAL and SWAH were each divided into 2 classes—1 class of ratios that were less than the mean ratio, and 1 class of ratios that were greater than the mean ratio. Variation among farms was assessed by use of ANOVA, with total and partial injury scores as dependent variables. Similarly, variation among farms was analyzed by use of ANOVA with sow dimensions and stall-animal ratios as dependent variables. Pair-wise comparison of farms was done by use of least significant difference analysis. A linear regression equation was computed with combined data from all farms to determine relationships among total injury scores, SLAL, and SWAH. All analyses were performed with statistical software.[a] For all comparisons, differences were considered significant if $P < 0.05$.

Table 1—Sow and stall dimensions and stall-animal ratios (mean ± SD) on 4 farms

Dimensions (in) and stall-animal ratios	Farm 1 (31 sows)	Farm 2 (68 sows)	Farm 3 (89 sows)	Farm 4 (79 sows)
Sow dimensions				
Length	47.74 ± 3.27^{a}	49.27 ± 2.91^{b}	46.54 ± 3.26^{c}	43.12 ± 2.21^{d}
Breadth	14.77 ± 1.47^{ab}	15.24 ± 1.44^{a}	16.39 ± 1.40^{c}	14.72 ± 0.97^{b}
Height	30.76 ± 2.40^{a}	31.54 ± 1.66^{b}	28.36 ± 1.77^{c}	28.83 ± 1.39^{c}
Stall dimensions*				
Length (excluding feeder)	69.29	69.29	69.29	78.74
Width	23.62	23.62	22.05	23.23
Length of solid area	33.85	18.11	35.82	0
Length of slatted area	35.43	51.81	33.46	78.74
Height	42.13	42.13	39.76	38.19
Stall-animal ratios				
Stall length to animal length	1.458 ± 0.10^{a}	1.412 ± 0.09^{b}	1.496 ± 0.11^{a}	1.83 ± 0.09^{c}
Stall width to animal height	0.772 ± 0.06^{a}	0.751 ± 0.04^{b}	0.781 ± 0.05^{a}	0.807 ± 0.04^{c}

^{a,b,c,d}Within each row, values with different superscripts are significantly ($P < 0.001$) different.
*Stalls were prefabricated and uniform in size within each farm.

Results

A significant ($P < 0.001$) difference was detected among sow lengths on the 4 farms, with the smallest animals on farm 4 (**Table 1**). Significant differences in sow length, breadth, and height were detected among the farms in various combinations. Overall, mean ± SD sow length was 46.36 ± 3.71 in, sow breadth was 15.41 ± 1.48 in, and sow height was 29.59 ± 2.18 in. Mean stall length on the 4 farms ranged from 69.29 to 78.74 in (overall mean, 72.09 in), mean stall width ranged from 22.05 to 23.62 in (overall mean, 22.98 in), mean length of solid stall floor ranged from 0 to 35.82 in (overall mean, 20.49 in), mean length of slatted floor ranged from 33.46 in to 78.74 in (overall mean, 51.6 in), and mean stall height ranged from 38.19 in to 42.13 in (overall mean, 40.17 in). Mean ± SD SLAL for all farms was 1.569 ± 0.199 (range, 1.412 to 1.830) and mean SWAH was 0.780 ± 0.05 (range, 0.751 to 0.807). In general, frequencies of high partial injury scores and total injury scores were much greater with low SLAL and SWAH (**Table 2**); that is, larger sows, relative to stall length or width, had greater injury scores. Significant ($P < 0.001$) differences among farms were detected for total injury scores and for all partial injury scores, except those involving the vulva (**Table 3**). The highest partial injury scores were those for the head region and the hind limbs.

The linear regression equation computed to predict the total injury score from the SLAL and SWAH was total injury score = 8.7885 − 2.054(SLAL) 5.14683(SWAH) ($R^2 = 0.238$; $P < 0.001$). The SLAL and SWAH explained 24% of the variability of TIS.

Table 2—Frequency of injury scores corresponding to 2 ranges of ratios between stall length and animal length (SLAL) and stall width and animal height (SWAH) in 267 pregnant sows in gestation stalls

	Frequency			
	SLAL range		SWAH range	
Injury location	≤ 1.569	> 1.569	≤ 0.780	> 0.780
Total injury				
0–1	64	77	66	75
2–3	76	31	66	41
4–5	18	1	18	1
Head				
0–1	147	102	143	106
2–3	11	7	7	11
Forelimb				
0–1	152	108	143	117
2–3	6	1	7	0
Hind limb				
0–1	143	104	135	112
2–3	15	5	15	5
Top of the back				
0–1	154	109	146	117
≥ 2	4	0	4	0
Tail base				
0–1	158	109	150	117
≥ 2	0	0	0	0
Vulva				
0–1	158	109	150	117
≥ 2	0	0	0	0

For SLAL and SWAH, ranges were calculated as ≤ mean and > mean.

Table 3—Injury scores (mean ± SD) in 267 pregnant sows in gestation stalls on 4 farms

Injury location	Farm 1	Farm 2	Farm 3	Farm 4	All farms
Total injury	1.871 ± 1.20^{a}	2.456 ± 1.16^{b}	1.202 ± 1.01^{c}	1.038 ± 0.98^{d}	1.551 ± 1.21
Head	0.581 ± 0.50^{abc}	0.456 ± 0.61^{ac}	0.719 ± 0.72^{b}	0.392 ± 0.59^{c}	0.539 ± 0.64
Forelimbs	0.387 ± 0.49^{ab}	0.5 ± 0.68^{a}	0.169 ± 0.41^{cd}	0.189 ± 0.43^{bd}	0.285 ± 0.52
Hind limbs	0.484 ± 0.77^{ab}	0.632 ± 0.81^{a}	0.214 ± 0.46^{cd}	0.392 ± 0.65^{bd}	0.405 ± 0.67
Top of the back	0.29 ± 0.52^{a}	0.57 ± 0.58^{b}	0.01 ± 0.10^{cd}	0.025 ± 0.15^{d}	0.191 ± 0.43
Tail base	0.097 ± 0.30^{abc}	0.19 ± 0.39^{a}	0.034 ± 0.18^{bd}	0.013 ± 0.11^{cd}	0.075 ± 0.26
Vulva	0^{a}	0.047 ± 0.12^{a}	0.022 ± 0.15^{a}	0^{a}	0.011 ± 0.11

^{a,b,c,d}Within a row, values with different superscripts are significantly ($P < 0.001$) different.

Discussion

It was evident that when SLAL or SWAH were in their respective higher ranges, corresponding frequencies of injury scores were low. Sows on farm 4 were smaller than sows on the other 3 farms and had lower injury scores. Our findings are supported by results of another study[1] in which sows with larger body dimensions had a higher prevalence of external injuries in close confinement housing because of reduced maneuverability, compared with smaller sows. Although high injury scores were noticed for the head region in our study, the head has a great degree of maneuverability, and such injuries are not necessarily due to lack of space. It was also observed that most of the head injuries were in the snout region, and this might result from interaction between the sow and the feeder and attempts to obtain food from adjacent stalls; head injuries were more likely related to this behavior than to the length or width of the stall.

When forelimbs and hind limbs were considered together, the combined injury scores were greater than scores for the head region. Limb injuries were caused mainly by slatted floors, because the slats had sharp edges.[6] The hind limbs were on the slatted portion of the floors on all farms and had higher mean injury scores than did the forelimbs. This finding is similar to that reported in an Irish study[7] of pregnant sows housed in stalls that were 2 × 0.6 m. While standing up and in the act of lying down, sows slip more on their hind limbs,[8] causing injuries. Furthermore, because of inadequate stall width, sows often had to place their limbs in the adjacent stall when in lateral recumbency, and the sow in the adjacent stall may have stepped on their outstretched limbs. Mean height of the sows was 29.59 in, whereas mean stall width was only 22.98 in. This may explain the high limb injury scores on farm 2, where SWAH was low. On farm 4, although the floor was fully slatted, limb injury scores were lower, compared with those on farm 2, because SWAH was greater.

Injuries on the top of the back (dorsum) were not due to contact with the top of the stall, because in most instances there was adequate space between them—mean stall height was 40.17 in, whereas mean sow height was only 29.59 in. Furthermore, during normal movements (ie, forward, backward, sideways, standing up, and lying down) the sow's back did not appear to come in contact with the top of the stall. This suggests that these injuries occurred when the back was pressed forcefully against the bars on the sides of the stall during lateral recumbency because of inadequate stall width in relation to the height of the sow. These injuries appeared worse if the bars did not have smooth, round edges, as on farm 2 where mean injury score for this region was higher than that of the other farms.

The lowest injury scores were detected for the vulva. Vulva injuries in swine are mainly caused by biting by other sows and are more common in group-housing systems. In our study, it was found that when the sow moved backward in the stall, the tail base and back of the thigh came in contact with the bars of the stall before the vulva did, reducing injuries to the vulva even if SLAL was low. The tail also had low injury scores, and this might be attributable to high maneuverability of the tail.

The significant differences in total and partial injury scores among the 4 farms may have been attributable to the size variation among the sows and to a lesser extent to differences in stall construction among farms. Differences in stall construction were related to the length of slatted and solid areas and the type of sidebars.

The relationship between SLAL and SWAH was responsible for approximately one-fourth of the injuries sustained by sows in the gestation stalls. Other factors could include type and materials of the floor, sharp edges on the stall and feeder, and aggression between adjacent sows. Increasing the width of stalls may provide a better effect in preventing sow injuries, compared with increasing stall length.

At present, neither use of pens nor stalls is foolproof in ensuring the well-being of pregnant sows. Our results suggest that provision of extra space can considerably reduce injury scores and improve the well-being of large pregnant sows in stalls. There is a limit in increasing stall size, as this will offset the advantages of the stall housing system. Other possible means of improving sow welfare in stalls, without large costs, include making the edges of feeders, water troughs, and the iron bars smooth and round.

[a] SAS Software, version 8.1, SAS Institute Inc, Cary, NC.

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SWINE/ RUMINANTS