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Risk factors for stillbirths in two swine farms in the south of Brazil

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Abstract

We evaluated stillbirth risk factors in two commercial swine farms of the Rio Grande do Sul State (south of Brazil). The study was conducted during 1 month in Farm A and during 2 months in Farm B, both during 1999. Data for all farrowings that occurred during the study period were recorded (101 for Farm A and 373 for Farm B), without interference in the farm management. In Farm A, 39% of all litters born during the period of interest had stillborn piglets and the stillborn risk for piglets was 12%. In Farm B, 25% of all litters had stillborn piglets whereas the stillborn risk was 2%. Variables considered as potential risk factors for stillbirths were: parity (1, 2–3, 4+); breed (purebred or crossbred); sow body-condition (normal or fat); use of oxytocin during parturition (yes or no); obstetric intervention through vaginal palpation (yes or no); farrowing duration (<4 or $\geq$4 h); mummified fetuses (yes or no); total litter size (<12 or $\geq$12 piglets); and litter birth weight (<11 or $\geq$11 kg). All stillborn piglets had their classification validated by necropsy. In multivariable logistic-regressions, the cases were the litters having at least one stillborn piglet. In Farm A, litters having at least 12 pigs and in which oxytocin was used during the parturition had 20.8-times-higher odds of stillborn occurrence. In Farm B, litters from sows having parity $\geq$4 had 2.2-times-higher odds of stillborn occurrence than litters from parity 2 to 3 females, litters having $\geq$12 pigs had 2.0-times-higher odds of a stillborn piglet than smaller litters and farrowings in which vaginal palpation was performed had 8.0-times-higher odds. Farrowing room management to minimize stillborn risk should target higher-parity females, large litters and optimization of practices of obstetric interventions.

Keywords: Stillborn piglets; Litter size; Parity; Farrowing; Oxytocin; Vaginal palpation

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1. Introduction

Stillborn piglets are those that are apparently normal but die shortly before or during the parturition (Christianson, 1992; Dial et al., 1992). The main cause of stillbirths is anoxia (English and Wilkinson, 1982; Christianson, 1992; Herpin et al., 2001), which is common in cases of dystocia. Additionally, stillbirths can be related to environment, nutrition and to sire and dam factors (Christianson, 1992).

Stillborn risks are highly variable in different countries (English and Wilkinson, 1982; Marsh et al., 1992; King and Xue, 1996), which commonly reflects differences in the sow:personnel ratio attributed to differences in labor costs (Holyoake et al., 1995). High stillborn risks are related negatively to breeding-herd efficiency, because they are associated with reduction in both the number of pigs weaned per litter and the number of pigs weaned per female per year (Wilson et al., 1986; Dial et al., 1992). Thus, identification of risk factors associated with stillbirths could help to optimize reproductive efficiency. However, risk factors for stillbirths have not been characterized clearly. Our objectives were to describe the distribution of litters having stillborn piglets and to characterize stillbirth risk factors in two commercial swine farms in Brazil.

2. Material and methods

This study was conducted in two different commercial swine farms located in the Rio Grande do Sul State, in the southern region of Brazil. In the first farm (Farm A, which had an average breeding-herd inventory of 400 females), the study was conducted during March 1999. In the second farm (Farm B, with an average breeding-herd inventory of 1050 females), the study period was September and October 1999. The difference between the study periods was because the same technicians were used in both farms and it was not possible to conduct the study in both places simultaneously. Those technicians were in charge of recording data concerning all farrowings that occurred during the period of interest, without interference in the routine farrowing room management.

Sows were transferred to farrowing rooms approximately 1 week prior to the predicted farrowing date and were housed in individual farrowing crates having plastic floors. Farrowing groups were made of 10 sows in Farm A and 16 sows in Farm B. Sows were fed (twice daily) a lactation diet having 18% crude protein, but received no feed as soon as signs of parturition were identified. All females that entered the farrowing rooms were recorded in individual cards, which included the following data: breed; parity; and body-condition score prior to farrowing (coded from 1 to 5, where 1 represents the thinnest female) (Patience and Tacker, 1989). At farrowing, additional data were recorded: time of beginning and end of parturition; use of oxytocin; occurrence of obstetric intervention through vaginal palpation; litter size (total, stillborns and mummified fetuses); and litter birth weight (including all piglets born, stillborns and mummified fetuses).

All pigs classified as stillborns at the farm were necropsied (to validate their diagnosis). For each piglet, the lungs were extracted and submerged into a receptacle with water. Only those having lungs that did not float in the water were classified as stillborns, because this indicated that they had not breathed (Christianson, 1992). The dead fetuses were not

Table 1
Parity distribution in two commercial swine farms in Brazil (1999)

Parity	Farm A			Farm B		
	Litters		Stillborns (% yes)	Litters		Stillborns (% yes)
	No.	%		No.	%	
1	16	16	25	68	18	13
2	18	18	22	60	16	20
3	14	14	57	46	12	15
4	5	5	20	35	9	23
5	4	4	50	33	9	30
6	22	22	32	44	12	23
7	8	8	5	55	15	42
8	11	11	91	32	9	37
9	2	2	0	0	–	–
10	1	1	100	0	–	–
Total No.	101			373		

checked for the presence of pathogens. That can be justified by the fact that both farms had high health status, as indicated by yearly serological evaluations that identified no problems related to infectious diseases. Furthermore, vaccination against leptospirosis and parvovirus was routinely conducted in both farms.

Frequency distributions and descriptive statistics were generated to characterize stillborn occurrence and potential risk factors, in both farms. For further analysis, all potential risk factors were categorized: parity (1, 2–3 and 4+); breed (purebred or crossbred); body-condition score, as recorded by the same person in both farms (normal = 3, fat = 4 or 5, because no female had a score <3); use of oxytocin during the parturition (yes or no); obstetric intervention through vaginal palpation during the parturition (yes or no); duration of parturition ($\leq$4 or >4 h); occurrence of mummified fetuses (yes or no); total born litter size (<12 or $\geq$12 piglets); and litter birth weight (<11 or $\geq$11 kg). The response variable was defined as the prevalence of at least one stillborn piglet in a given litter (yes or no). Initially, the association among stillbirth occurrence in a litter and individual risk factors was evaluated through an univariable analysis, in which statistical significance was

Table 2
Descriptive statistics for performance parameters in two commercial swine farms in Brazil (1999)

Parameter	Farm A				Farm B			
	Litters	Mean	SD	Median	Litters	Mean	SD	Median
Parity	101	4.3	2.5	4	373	4.1	2.4	4
Farrowing duration (h)	101	4.5	1.8	4.2	367	4.2	1.7	4.1
Total born litter size	101	10.8	3.7	11	373	10.7	2.7	11
Stillborn piglets	39	1.9	1.0	2	92	1.0	0.2	1
Mummified fetuses	14	1.5	1.2	1	40	1.1	0.4	1
Litter birth weight (kg)	101	14.1	4.1	14.7	370	15.3	3.8	15.3

assessed by Yates' corrected chi-square tests. The factors that had $P \leq 0.25$ in the univariable analysis were included in multivariable logistic-regression models, in which having at least one stillborn piglet in the litter was the outcome. Models were run separately for each farm, to prevent confounding due to herd-specific management differences. Such models also included interaction terms represented by dummy variables to asses the joint effect of two different factors. For instance, the interaction between total litter size and use of oxytocin was categorized in four levels representing the four possible combinations among the two levels of each of those factors. Odds ratio (OR) and 95% confidence

Table 3
Description of farm-specific risk factors for litters having ≥1 stillborn piglets (Brazil, 1999)

Parameter	Stillborns (Farm A: 101 litters)				Stillborns (Farm B: 373 litters)			
	Yes		No		Yes		No	
	n	%	*n*	%	*n*	%	*n*	%
Parity[a,b]								
1	4	25	12	75	9	13	59	87
2–3	10	31	22	69	19	18	87	82
≥4	25	53	28	47	64	32	135	68
Breed								
Purebred	6	40	9	60	34	24	105	76
Crossbred	33	38	53	62	58	25	176	75
Body-condition								
Normal	12	44	15	56	71	24	228	76
Fat	27	36	47	64	20	29	48	71
Use of oxytocin[a,b]								
No	14	25	42	75	70	22	245	78
Yes	25	56	20	44	21	37	36	63
Vaginal palpation[a,b]								
No	28	33	56	67	83	23	276	77
Yes	11	65	6	35	7	64	4	36
Farrowing duration (h)[b]								
<4	14	38	23	62	33	21	125	79
≥4	25	39	39	61	57	27	152	73
Mummified fetuses[b]								
No	34	39	53	61	77	23	256	77
Yes	5	36	9	64	15	38	25	63
Total litter size[a,b]								
<12	10	20	41	80	35	16	179	84
≥12	29	58	21	42	57	36	102	64
Litter birth weight (kg)[a,b]								
<11	6	27	16	73	47	23	156	77
≥11	33	42	46	58	44	26	123	74

[a] Variables included in multivariable logistic-regression model for Farm A ($P < 0.25$).
[b] Variables included in multivariable logistic-regression model for Farm B ($P < 0.25$).

intervals (CIs) were calculated (Schlesselman, 1982; Kelsey et al., 1986; Martin et al., 1987). Model building used backwards elimination to determine which factors could be excluded from the multivariable model and estimation of the likelihood-ratio chi-square statistic at $P < 0.05$ at each step. Additionally, single chi-square tests (2-tailed) were used to determine whether there was collinearity among variables dropped from the logistic-regression models and those remaining in the final models. Analysis were conducted through the FREQ and CATMOD procedures (SAS®, 1991).

3. Results

Farm-specific parity and stillborn distributions are in Table 1 and descriptive statistics are shown in Table 2. In Farm A, 39% of the litters farrowed during the period of interest had stillborn piglets and 12% of a total of 1565 piglets born were stillborns. In Farm B, 25% of all litters farrowed had stillborn piglets and 2% of the 3997 piglets born during that period were stillborns.

Table 3 shows farm-specific frequency distributions of individual risk factors. Factors offered to the multivariable models for both farms included parity, use of oxytocin, vaginal palpation, total litter size and litter birth weight. Additionally, the multivariable model for Farm B also included farrowing duration and occurrence of mummified fetuses.

Odds of litters having stillbirths were higher in Farm B with total litter size ≥12 piglets (Table 4). In Farm A, there was an interaction between total litter size and use of oxytocin. So, stillbirth occurrence in Farm A had 21-times-higher odds for females farrowing litters

Table 4
Farm-specific multivariable logistic models of litters having ≥1 stillborn piglets (Brazil, 1999)

Parameter	Farm A (101 litters)[a]			Farm B (373 litters)[b]		
	OR	95% CI	*P*	OR	95% CI	*P*
Parity						
1	–	–	–	0.7	0.3, 1.6	0.41
2–3	–	–	–	1.0	–	–
4+	–	–	–	2.2	1.2, 3.9	0.008
Vaginal palpation						
No	–	–	–	1.0	–	–
Yes	–	–	–	8.0	1.9, 32.6	0.004
Total litter size						
<12	–	–	–	1.0	–	–
≥12	–	–	–	2.0	1.5, 2.8	<0.0001
Oxytocin/total litter size						
No, ≤11	1.00	–	–	–	–	–
No, ≥12	2.93	0.8, 10.3	0.09	–	–	–
Yes, ≤11	1.73	0.4, 7.0	0.49	–	–	–
Yes, ≥12	20.8	5.3, 81.8	<0.0001	–	–	–

[a] Constant: −1.76; model deviance: 114.48; model d.f.: 99; Model P: 0.14.
[b] Constant: −3.56; model deviance: 373.67; model d.f.: 366; model P: 0.38.

of at least 12 piglets and that received oxytocin during parturition. In Farm B, stillborn piglets were more likely also for females of parity $\geq$4 and for those that received vaginal palpation, but oxytocin use was not a risk factor (Table 4).

Significant collinearity was identified among some factors excluded from the logistic-regression and some of those remaining in the final models. In both Farms A and B, higher total litter size was associated with higher litter birth weight, and higher frequency of oxytocin use was associated with higher frequency of vaginal palpation (both $P < 0.001$). Furthermore, in Farm B, higher-parity was associated with higher litter birth weight and higher frequency of fat sows (both $P < 0.001$).

In Farm A, occurrence of more than one stillborn per litter was observed in 19 farrowings. Two stillborns occurred in nine litters, 3–4 stillborns occurred in nine litters and five stillborns in one litter. Those 19 sows generally seemed to be older and fat.

In Farm B, only four litters had more than one stillborn piglet; all four of them had two stillborns. Those four sows were younger and none was fat.

4. Discussion

The stratification by farm was justified by the difference of almost 10% points between the stillborn risks observed in the two analyzed farms. According to industry benchmarks (King and Xue, 1996), the risk observed for Farm A (12%) would be considered extremely high. Stillborn risks commonly observed in Brazil are lower than those observed in other countries such as USA, Canada and Japan (King and Xue, 1996) probably as a function of the lower labor cost in Brazil.

Total litter size was the only risk factor associated with stillbirth in both farms. However, such an association was characteristic only in Farm B, where litters having 12 or more piglets had 2-times-higher odds of stillborns, because in Farm A the stillborn risk associated with litter size interacted with oxytocin use. It is important to consider that, although it is a risk factor for stillborns, total litter size is unknown before farrowing. Therefore, constant farrowing supervision is an important management tool to help to reduce stillborn risk, even though its use may be limited due to high labor costs (Holyoake et al., 1995).

The stillborn risk for sows in the parity reference level (2–3) was higher in Farm A than in Farm B (31 and 18%, respectively). Thus, the lack of stillborn risk associated with parity in Farm A may have been a consequence of a lower discrepancy between females having parity $\geq$4 and those in the reference level; indicating that stillborn risk in Farm A was uniformly higher across all parities. Nevertheless, it is important to consider that the higher odds of stillborns associated with parity $\geq$4 in Farm B has a lower limit of the 95% CI very close to 1. The results observed for Farm B agree with the assumption that, in farms having low stillborn risk, such risk is generally higher in higher-parity females, who usually farrow larger litters as well (Dial et al., 1992).

The association between parity and stillborn risk is commonly attributed to prolonged parturition and higher weight variability for individual pigs in higher-parity females (Christianson, 1992; Dial et al., 1992). However, although farrowing duration and litter birth weight were individually associated with stillborn risk, no association was observed in the multivariable analysis. On the other hand, the effect of litter birth weight cannot be ruled out due to its collinearity with both litter size and parity, indicating that larger litters are heavier and that heavier litters are more frequent at higher-parities. The investigation of the assumption that piglets that are either too light or too heavy would be more likely to be stillborns (Christianson, 1992) was limited because piglets could not be individually weighted in the analyzed farms because of labor constraints.

Because means for parity and total litter size were similar in the two analyzed farms, the higher stillborn risk observed in Farm A is possibly related to specific characteristics of its farrowing room management—especially the high frequency of oxytocin use and vaginal palpation. In Farm A, oxytocin was used in 44% of all farrowings, but it was a risk factor for stillbirth only on those litters having at least 12 piglets (55% of all farrowings with oxytocin use), in which the odds of stillborns were 21-times-higher. Vaginal palpation was associated with stillborn risk only in Farm B, where such an intervention was less frequent than in Farm A (3 and 17%, respectively). Both oxytocin use and vaginal palpation are practices recommended to minimize stillborn occurrence in cases of dystocia (Runnels and Clark, 1992). Oxytocin would be indicated in cases of uterine inertia, whereas obstetric intervention would be advised when the female has uterine contractions but is unable to deliver the piglets. Nevertheless, the higher odds of stillborn associated with such interventions suggests that they may be conducted incorrectly in the farms, or in extreme situations of dystocia when there is no possibility of success, as implied by the positive collinearity between oxytocin use and vaginal palpation. Those results indicate that obstetric interventions should be optimized to reduce stillborn risk, reinforcing the need of intensive training of the farrowing room labor force to provide qualified farrowing supervision.

Any study dealing with stillborn risk is potentially prone to confounding due to the imprecision commonly observed in the classification of stillborns and preweaning mortality (Dial et al., 1992). In a study by Vaillancourt et al. (1990), nearly 9% of the piglets classified as stillborns by farmers were born alive. We minimized this misclassification because we confirmed stillbirths by necropsy. Generally, there is an expectation that stillborn risk would be higher in longer parturitions and for fat females (Christianson, 1992; Dial et al., 1992). However, our results disagree. In Farm A, more than 70% of the females were classified as "Fat", but stillbirth occurrence distributed evenly across categories; in contrast, in Farm B, a relatively low proportion of females were classified as "Fat" and there was a positive collinearity between body-condition and parity. Also, we should consider that body-condition scores are sensitive to inconsistencies, because they are subjectively defined and follow an arbitrary scale. The lack of a significant effect of farrowing duration could have been a consequence of the criterion to categorize this variable based on its frequency distribution.

5. Conclusions

High-parity females and litters having ≥ 12 piglets require special attention in the farrowing room due to higher stillborn risk. Practices aimed to reduce stillborn risk, such as use of oxytocin and obstetric intervention through vaginal palpation, should be conducted carefully because they can be associated with higher stillbirth risk, if used incorrectly.

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