

Late gestation hemoglobin concentrations in sows: Predictor for stillborn piglets

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Summary

This study examined the association between hemoglobin (Hb) concentrations in sows and the number of stillborn pigs. Based on late gestation Hb concentrations, the number of prepartum and intrapartum stillborn pigs was greater ($P < .001$) in the anemic sows than in the nonanemic sows.

Keywords: swine, sow, hemoglobin, stillbirths

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Resumen - Concentraciones de hemoglobina en gestación tardía en cerdas: Predictor de lechones nacidos muertos

Este estudio examinó la asociación entre las concentraciones de hemoglobina (Hb) en cerdas y el número de lechones nacidos muertos. Con base en las concentraciones de Hb en gestación tardía, el número de lechones nacidos muertos antes del parto e intraparto fue mayor ($P < .001$) en las cerdas anémicas que en las no anémicas.

Résumé - Concentrations d'hémoglobine en fin de gestation chez les truies: Prédicteur pour les porcelets mort-nés

Cette étude a examiné l'association entre les concentrations d'hémoglobine (Hb) chez les truies et le nombre de porcs mort-nés. Sur la base des concentrations de Hb en fin de gestation, le nombre de porcs mort-nés prépartum et intrapartum était plus élevé ($P < .001$) chez les truies anémiques que chez les truies non anémiques.

Measurements of hemoglobin (Hb) concentrations are used to determine if sows are anemic. The normal Hb range in sows is 10 to 16 g/dL and less than 10 g/dL is indicative of anemia.¹ Anemia is prevalent during early lactation and Hb levels begin to trend upwards in late lactation.² Furthermore, parity also contributes to the occurrence of anemic sows; anemia is more common as parity increases.³ A recent study demonstrated that the probability of stillbirths was negatively associated with sow Hb concentrations.⁴ A stillborn piglet refers to a fetus that dies in utero prior to or during farrowing. Piglets that die after the birth process are simply dead piglets. This association between Hb concentrations and the number of stillborn piglets required further investigation in commercial sow farms. Therefore, the primary objective of this study was to determine the

relationship between sow Hb concentrations and the number of stillborn piglets and postpartum dead piglets.

Materials and methods

Five sow farms (3000-4000 sows/farm) were included in this study. Each farm was Pork Quality Assurance Plus certified and an Institutional Animal Care and Use Committee protocol was not required. Sows ($n = 390$, 45-128 sows/farm) from varying parities were selected on each farm. Blood samples were collected in late gestation (> 112 days) and within 12 h after farrowing for Hb determinations. Blood was obtained from an ear vein with a 20-gauge needle, loaded into a 10 μ L microcuvette, and processed in a HemoCue Hb 201.^{2,5} This instrument was factory calibrated against the International Council for Standardization in Haematology reference method for Hb concentration and did not need further

calibration. Litter demographics (number of live born, stillborn, and mummies) also were recorded for each sow. Deceased piglets were dissected and lung flotation tests were performed.⁶

The Hb concentrations and litter characteristics were analyzed with an analysis of variance with the main effect being anemia. The effect of farm and parity category were analyzed in a similar fashion. Means were compared with Tukey's test (Statistix, Version 10, Analytical Software). A generalized linear model with negative binomial distribution (to account for over dispersion of data) was fitted in SAS 9.4 (SAS Institute Inc) to analyze the effect of late gestation Hb (LGHB) concentrations on number of stillborn piglets. The other variables of interest were parity, farm, piglets born alive, and number of mummified fetuses.

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Results

Although one study used values less than 10.0 g/dL to classify anemia,¹ the study used sows in mid gestation. Using 10.3 g/dL as the Hb reference value for anemia in sows prior to farrowing as previously described,⁴ 210 sows were classified as anemic in late gestation. The remaining 180 sows were considered nonanemic. The descriptive statistics for these two groups of sows are shown in Table 1. The number of prepartum and intrapartum stillborn piglets was greater ($P < .001$) in the anemic sows than in the nonanemic sows. The number of postpartum dead pigs and mummies per litter did not differ between the two classifications of sows.

The post farrowing Hb (PFHB) concentrations and number of pigs born alive, stillborn pigs, and postpartum dead pigs differed among farms (Table 2). In contrast, the LGHB concentrations were similar among farms. The LGHB concentrations were less ($P = .008$) in parity ≥ 3 sows than in parity 1 or 2 sows (Table 3). Over 79% of older parity (> 4) sows were anemic following farrowing.

The multivariate analysis (Table 4) showed that LGHB concentrations, farm, and number of mummies were significant factors in the number of stillborn pigs. The estimate for the LGHB concentration was -0.30 and the exponential was 0.74. Thus, if a sow with 10 g/dL has two prepartum and intrapartum stillborn pigs, and if one could increase the LGHB concentration to 11 g/dL, the sow would be expected to have $2 \times 0.74 = 1.48$ stillborn piglets.

Discussion

An early study found that sows in herds with a high rate of stillbirths were found to have 25% to 50% reduction in Hb concentrations.⁷ Similarly, a recent study reported that the probability of stillbirths was negatively associated with the sow Hb concentrations.⁴ Therefore, the results of the present study support findings in earlier reports that LGHB concentrations were associated with the occurrence of stillborn piglets. The precise mechanism to explain the relationship between sow anemia and stillbirths is speculative; however, iron deficiency

may contribute to impaired uterine contractions at farrowing.⁴ The low LGHB concentrations are likely due to the increase in plasma volume in sows, and at least in part, to the transfer of iron from the dam to the fetuses through the maternal uteroferrin-transferrin-ferritin pathway.^{8,9}

Considering the relationship between LGHB concentrations and their ability to be used as a predictor for stillborn pigs, intervention with iron supplementation could be considered at this time. If sows were not anemic, it was apparent that iron treatment of pregnant sows did not improve sow and piglet hematology or stillbirth rate.¹⁰ Additional studies are warranted to determine the time and concentration of iron that would be needed to counteract the deficiency. Based on the present results, this would vary with parity, farm, and from sow to sow. It should be noted that the present study demonstrated farm-to-farm variability, and this must be considered when interpreting the results or recommending corrective actions. Thus, the severity of the anemia and farm

Table 1: Mean (SEM) hemoglobin (Hb) concentrations and litter parameters for anemic (n = 210) and nonanemic (n = 180) sows*

Variable	Anemic sows	Nonanemic sows
Late gestation Hb, g/dL	9.3 (0.05) ^a	11.1 (0.05) ^b
Post farrowing Hb, g/dL	9.5 (0.09) ^a	9.9 (0.09) ^b
Pigs born alive, No.	13.7 (0.2) ^a	12.9 (0.24) ^b
Prepartum and intrapartum stillborn/litter	0.8 (0.1) ^a	0.4 (0.07) ^b
Postpartum dead/litter	0.2 (0.03)	0.3 (0.06)
Mummies/litter	0.4 (0.06)	0.3 (0.04)

* Anemia classification is based on Hb concentrations in late gestation.

^{a,b} Within row, differing superscripts denote values that differ by $P < .01$.

Table 2: Mean (SEM) hemoglobin concentrations, number born alive, and stillbirths in five farms

Farm	Sows, No.	LGHB, g/dL	PFHB, g/dL	Prepartum/ intrapartum stillborns, No.	Postpartum dead pigs, No.	Pigs born alive, No.
1	81	10.2 (0.12)	9.0 (0.11) ^c	0.43 (0.12) ^{ab}	0.07 (0.03) ^b	14.0 (0.33) ^{ab}
2	70	9.9 (0.13)	9.6 (0.16) ^b	0.86 (0.14) ^a	0.10 (0.04) ^b	12.8 (0.28) ^b
3	128	10.1 (0.11)	10.2 (0.12) ^a	0.87 (0.13) ^a	0.27 (0.08) ^{ab}	12.9 (0.27) ^b
4	66	10.2 (0.12)	9.4 (0.14) ^{bc}	0.29 (0.10) ^b	0.12 (0.05) ^b	14.5 (0.23) ^a
5	45	10.3 (0.14)	9.9 (0.15) ^{ab}	0.49 (0.16) ^{ab}	0.56 (0.15) ^a	12.5 (0.69) ^b

^{a,b,c} Within column, values with different superscripts differ $P < .05$.

LGHB = Late gestation hemoglobin concentrations; PFHB = Post farrowing hemoglobin concentrations.

Table 3: Percentage of anemic sows and mean (SEM) hemoglobin concentrations in various parities of sows

Parity category*	Sows, No.	LGHB, g/dL	Anemic sows, %	PFHB, g/dL	Anemic sows, %
1	52	10.8 (0.14) ^a	25.0	10.0 (0.17) ^a	57.7
2	80	10.5 (0.11) ^a	46.3	9.8 (0.15) ^a	68.8
3	171	9.9 (0.09) ^b	62.0	9.7 (0.11) ^{ab}	70.2
4	87	9.9 (0.11) ^b	62.1	9.3 (0.11) ^b	79.3

* Category 1 = parity 1; Category 2 = parity 2; Category 3 = parities 3 and 4; Category 4 = greater than 4th parity.

^{a,b} Within column, values with different superscripts differ $P < .01$

LGHB = Late gestation hemoglobin concentrations; PFHB = Post farrowing hemoglobin concentrations.

Table 4: Multivariate analysis of the late gestation Hb (LGHB) concentrations and other variables that contribute to stillborn pigs*

Analysis of maximum likelihood parameter estimates							
Parameter	df	Estimate	Standard error	Wald 95% confidence limits		Wald chi-square	Pr > ChiSq
Intercept	1	1.87	0.93	0.05	3.70	4.04	0.04
LGHB	1	-0.31	0.09	-0.46	-0.14	12.85	0.00
Farm 1	1	0.21	0.39	-0.56	0.98	0.29	0.59
Farm 2	1	0.76	0.38	0.01	1.50	3.93	0.05
Farm 3	1	0.89	0.36	0.18	1.61	6.01	0.01
Farm 4	1	-0.09	0.44	-0.94	0.77	0.04	0.84
Farm 5	0	0.00	0.00	0.00	0.00	.	.
Mummies	1	0.38	0.12	0.14	0.62	9.27	0.00
Dispersion	1	1.63	0.33	1.09	2.43	.	.

LR statistics for type 3 analysis

Source	df	Chi-Square	Pr > ChiSq
LGHB	1	12.87	0.0003
Farm	4	16.22	0.0027
Mummies	1	10.16	0.0014

* The estimate for LGHB = -0.30 and the exponential = 0.74. The negative binomial dispersion parameter was estimated by maximum likelihood.

differences likely would dictate the timing and treatment of sows. In our modern sow facilities, it is unlikely that individual sows would be tested, and thus, alternative approaches must be considered.

Implications

Under the conditions of this study:

- Anemia in late gestation predisposes sows to increased pre- and intrapartum stillborn pigs.
- Sows with parity ≥ 3 tend to have lower Hb concentrations than younger sows.
- Treatment, prevention, and assessment of late gestation anemia require additional studies.

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Conflict of Interest

None reported.

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