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Measurements of body composition during late gestation and lactation in first and second parity sows and its relationship to piglet production and post-weaning reproductive performance ☆

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ABSTRACT

The objective of this study was to characterize multiple body condition traits in a white crossbred composite population of first- and second-parity sows and, determine if these traits relate to litter production and reproductive parameters. Differences between parity or time were determined using a mixed model and reported as LSM ± SE. As expected, parity 2 dams were heavier ($P < 0.0001$; 202.5 ± 1.57 kg versus 174.1 ± 1.35 kg) than parity 1 dams. Of interest however, parity 2 dams lost more ($P=0.0340$) loin eye area from late gestation to weaning (−4.1 ± 0.78 cm^2 versus −2.5 ± 0.60 cm^2) but had a greater ($P=0.0026$) recovery in loin eye area from weaning to post-weaning (2.8 ± 0.76 cm^2 versus 0.6 ± 0.59 cm^2) versus primiparous females. However the period between weaning measurements and post-weaning measurements tended ($P=0.0978$) to favor parity 1 dams (16.0 ± 0.35 d) versus parity 2 dams (15.4 ± 0.43 d). Parity 2 dams also had a greater ($P \leq 0.05$) ovulation rate following weaning than parity 1 dams. Regression analyses indicated body weight of dams at several time points had a positive ($P \leq 0.05$) relationship to ovulation rate (range 0.03 ± 0.012 to 0.05 ± 0.013 corpora lutea kg^{-1}). Piglet ADG was positively ($P \leq 0.05$) associated with dam body weight (range 0.30 ± 0.103 g kg^{-1} to 0.49 ± 0.106 g kg^{-1}) and dam backfat thickness (range 0.93 ± 0.363 g mm^{-1} to 1.14 ± 0.378 g mm^{-1}) regardless of parity. Regression analyses indicated interactions ($P \leq 0.05$) between parity and backfat thickness at weaning (−0.11 ± 0.023 piglets mm^{-1}) and post-weaning backfat thickness (−0.12 ± 0.025 piglets mm^{-1}) were negatively associated with number of nursed piglets weaned among parity 1 dams. Furthermore, loin eye area at weaning (−0.06 ± 0.024 piglets $cm^{2\ -1}$) and loss of loin eye area from late gestation to weaning (−0.05 ± 0.020 piglets $cm^{2\ -1}$) were negatively ($P \leq 0.05$) associated with number of nursed piglets weaned but were not influenced by parity in regression analyses. In conclusion, these data provide knowledge on differences in body composition before and after the lactation period in young dams under similar conditions. Of interest, second parity dams appear to have greater lean tissue elasticity versus primiparous females. Future studies will further refine the relationship among body composition in primiparous females and subsequent impact on sow longevity.

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1. Introduction

Though improvements in management and selection of gilts has occurred in the modern swine industry, a vast amount of early parity dams fail to remain in the herd primarily due to reproductive failure (Arango et al., 2005). For removal rates in parity 0 through parity 9+ females, reproduction was cited as the most common reason for culling at 33% (Lucia et al., 2000). Total removal rates following parities 1 and 2 were 15% and 12%, respectively, of which approximately 40% and 30% were attributed to reproductive failures that included lack of observed estrus, conception failure, and failure to farrow (Lucia et al., 2000). In another study, removal rates in early parity dams (1–3) were predominantly attributed to reproduction (not pregnant, weak or no estrus, discharge, prolonged return to estrus, abortions, metritis, long intervals between farrowings, mummification, dystocia, and vaginal- and rectum prolapse) whereas dams removed after parities 4–6 were culled mostly due to udder/milk production problems (Engblom et al., 2007).

Traits affiliated with body condition are related to reproduction. For instance, adjusted loin muscle area in young gilts prior to

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entering the breeding herd was positively associated with the probability of remaining in the herd longer and total number of piglets born (Stalder et al., 2005; Nikkilä et al., 2013). Energy intake and output contribute to an animal's body condition. Lactation, in and of itself, is a very energy demanding period for a sow. Primiparous animals have a greater energy demand during lactation as many are still growing while also supplying needed nutrients to their offspring. Inadequate feed intake during lactation has been associated with increased risk of removal from the herd before the next farrowing season (Anil et al., 2006; Knauer et al., 2010). Inadequate feed intake and/or excessive weight loss during lactation were indicators of tissue catabolism in exchange for meeting metabolic demands of the mammary gland and had adverse effects on reproductive parameters, such as increased weaning-to-estrus interval (Svajgr et al., 1972; Reese et al., 1984; Baidoo et al., 1992). Bergsma et al. (2009) estimated that 65% of a sow's metabolizable energy from either feed intake or body stores was redirected to piglet growth during lactation. Studies have shown that increased energy intake during lactation decreased backfat loss in primiparous sows and increased piglet weights at weaning (Nelssen et al., 1985). Nelssen et al. (1985) also reported an inverse relationship between energy intake and serum urea concentrations indicating that sows with lower energy intake had greater deamination of body tissue. Energy balance and tissue mobilization have important effects on reproduction, and first and second parity sows are more likely to be culled for reproductive failure. A greater understanding of how body condition and composition changes before, during, and following lactation affect reproduction in primiparous sows is needed to create methods or techniques to improve retention.

The objectives of the current study were to (1) establish comprehensive measurements of body condition in parity 1 and 2 pre-, peri-, and post-parturient sows and (2) relate these components to the important traits of piglet production and post-weaning reproductive performance, which influence sow retention.

2. Materials and methods

All experimental procedures and techniques were reviewed and approved by the U.S. Meat Animal Research Center (USMARC) Animal Care and Use Committee. Procedures for handling animals complied with the Guide for the Care and Use of Agricultural Animals in Research and Teaching (FASS, 2010).

2.1. Animal population and sampling

A four breed composite line (Maternal Landrace–High-lean Landrace–Duroc–Yorkshire) maintained at USMARC for at least seven generations was used for the collection of data in this project as previously described (Rempel et al., 2011). Briefly, founder animals were generated from Yorkshire × maternal Landrace (YL) then mated with unrelated commercially available semen from Duroc or high-lean Landrace boars. Offspring (Duroc × YL and High-lean Landrace × YL) were reciprocally bred to create the four-line composite. Inter se matings were continued maintaining 12 sire family lines. Females were artificially inseminated twice with single-sire semen, 24 h apart, following estrus detection. Batch farrowing groups were coordinated to occur every two months (January, May, July, September, and November identified as 1–5 for statistical purposes, respectively).

Upon entering the farrowing facility at approximately day 110 gestation (d110G), females were fed a standard 19% CP lactation diet (Table 1) of 2.0 kg per day. Upon farrowing all dams were fed 1.8 kg of the lactation diet per day and incrementally adjusted daily to achieve the equivalent of 1.8 kg + 0.45 kg per piglet nursed by day 7 of lactation continuing through weaning. At d10 of lactation, creep feed was provided to piglets through weaning (0.23 kg daily/litter). Following weaning, sows were group penned ($n=20$) and fed 2.3 kg per head per day of a 13% CP corn-soybean meal based diet.

Table 1
Composition of as-fed lactation diet.

Item	
Ingredients, % as is	
Ground corn	70.1
Soybean meal	25.0
Dicalcium phosphate	1.5
Limestone	0.95
Soybean oil	1.0
Salt	0.5
Vitamin premix	0.2
Trace mineral	0.2
Choline	0.2
Lysine HCl	0.1
Tylan-40	0.13
Phytase 600	0.09
Calculated analyses, DM basis[a]	
ME, MJ/kg	14.01
CP, g/kg	19.0
TID lysine, g/kg	9.7
Ca, g/kg	7.8
Available P, g/kg	3.4

[a] Calculated analysis based on standard feed tables (NRC, 1998).

Data were collected in 2009 from either parity 1 ($n=257$) or parity 2 ($n=127$) females, no repeated measures were collected. Dams were excluded from the analyses if they failed to lactate or were incapable of successfully completing lactation ($n=11$). Ten first parity females were removed from the study for one of the following reasons: death of sow post-farrowing ($n=4$), unfit to nurse ($n=4$), or destruction of litter ($n=2$). An 11th first parity sow was removed from the study as a litter of 7-d old piglets were transferred on following the death of their dam. Crossfostering of piglets occurred within 48 h of farrowing when necessary: if a dam had more than 13 live piglets, if functional teat number was insufficient to support number of offspring, or if the dam had health issues that may be detrimental to piglets.

All females were weighed at d110G, day 1 post-farrowing (d1PF), weaning (WN), and post-weaning (post-WN). Tenth-rib backfat thickness (BFT) and loin eye area (LEA) were imaged using an Aloka 500 SD (Aloka, Wallingford, CT) at d110G, WN, and post-WN. Measurements of BFT (mm) and LEA (cm^2) were conducted in duplicate using the BioQuant Nova Prime Image system (v. 6.9.1, BIOQUANT Image Analysis Corp.; Nashville, TN) and the average values were used in analyses. Changes in body weight, BFT, and LEA were defined as differences between the sampling time point measurements.

Weaning to estrus interval (WEI) was measured as the duration of days following weaning until estrus detection. Estrus was detected using once daily fenceline exposure with mature boars while herdsmen applied back pressure to determine receptivity. Estrus detection was conducted for 30 d following weaning. Females were weighed and body condition measures were performed within 72 h of estrus detection or at the conclusion of the 30 d period if no estrus was detected. Following the first or second parity post-weaning period, sows were slaughtered and ovulation rate (OR) was determined as the number of corpora lutea present on the ovary.

Piglet performance is presented as number of weaned piglets nursed by the dam (NUM_NUR; Mean ± SD; 9.1 ± 1.64 piglets), which was correlated (0.6053; $P<0.0001$) with number of piglets