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Mutual Relationship between Litter Size and Weaning to First Service Interval in the Sow

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ABSTRACT

The present study aimed to investigate the mutual relationship between litter size (LS) and weaning to the first service interval (WSI) in the sow. Retrospective data was collected from 313 farrowings born from 121 Landrace x Yorkshire sows on a farm. The effect of the LS on the subsequent WSI and the effect of the WSI on the subsequent LS were analyzed with one-way ANOVA. Results showed that, on one hand, LS was negatively associated with the WSI. WSI of sows with an LS of 11-13 piglets was longer than that of the sows with an LS of >13, and shorter than that of the sows with an LS of <11. On the other hand, WSI had a quadratic effect on the subsequent LS. Accordingly, sows with a WSI of 6-10 days had a smaller subsequent LS when compared with sows with a WSI shorter than 6 days. When the WSI surpassed 10 days, the subsequent LS tended to increase. The present study indicated that LS and WSI had a mutual relationship. The results suggested that the selection of a large LS may result in a short WSI and the selection of a short WSI may result in a large LS, and both of these will result in an increase in reproductive performance.

Key words: Litter size, Reproductive performance, Sows, Weaning, First service.

INTRODUCTION

The profit of swine breeding farms relies largely on the reproductive performance of the sows (Mills et al. 2020; Guan et al. 2021). In recent decades, the swine reproductive performance has increased substantially (Ward et al. 2020; Ju et al. 2022) by elevating the number of pigs weaned per sow per year from 20 to 30 and the future figure may reach 40 (Koketsu et al. 2017). The number of pigs weaned per sow per year depends on many factors such as litter size (LS), lactation length, and weaning to the first service interval (WSI). A short WSI will reduce nonproductive days and increase the number of litter per sow per year. Also, a reduction in WSI resulted in an increased farrowing rate and a higher number of piglets born alive (Hoshino and Koketsu 2008; Tummaruk et al. 2010). Therefore, short WSI sows have been selected to increase reproductive performance (Kemp et al. 2018).

The effect of WSI on LS was quite well described (Dewey et al. 1994; Marois et al. 2000; Tantasuparuk et al. 2000; Tummaruk et al. 2000; Segura-Correa et al. 2014) and most authors found that WSI had a quadratic effect on the subsequent LS in which a WSI of about 6-10 days was most deleterious (Dewey et al. 1994; Marois et al. 2000; Tantasuparuk et al. 2000; Tummaruk et al. 2000). By contrast, Segura-Correa et al. (2014) reported that WSI was positively and linearly associated with subsequent LS.

Several factors influenced the WSI such as lactation length (Koketsu and Dial 1997; Mabry et al. 1996; Koketsu et al. 1997; Bertoldo et al. 2009), parity (Vesseur et al. 1994; Karvelienė et al. 2008), weight loss during lactation (Tantasuparuk et al. 2001), follicle size during lactation (Lopes et al. 2020), and LS at weaning (Vesseur et al. 1994). However, how LS at birth affects WSI has not been reported. Because both LS and WSI depend on ovarian activities. We hypothesized that LS at birth might have some effect on WSI. Therefore, the present study aimed to explore whether a mutual relationship between LS and WSI existed.

MATERIALS AND METHODS

Ethical Approval

This retrospective study did not interfere with animals, therefore, it was waived from the ethical approval by the Committee on Animal Research and Ethics, Faculty of Veterinary Medicine, Vietnam National University of Agriculture, Vietnam.

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Animals

This study used the information collected from 121 Landrace x Yorkshire sows on a farm in Hoa Binh province in Northern Vietnam. This swine farm had a capacity of 200 reproductive sows. Sows were kept in individual gestation and farrowing crates. During the pregnancy period, sows were daily fed 2-3.5kg industrialized feed with the minimum metabolizable energy of 3000-3200kcal/kg and crude protein levels of 14 and 16.5% depending on gestation phases. Sows were vaccinated against porcine reproductive and respiratory syndrome, foot and mouth disease, classical swine fever, pseudorabies disease, and circovirus. Deworming was conducted twice per year. The temperature of the gestation and farrowing rooms was controlled by using fans and a water sprinkler system. A week before farrowing, pregnant sows were moved to farrowing rooms where they were allocated in individual crates. After farrowing, sows were fed increasingly to an *ad libitum* level at day 6 postpartum. Sows were administered with amoxicillin trihydrate every 48h at least 3 times postpartum (15mg/kg). Oxytocin (20 IU per time per sow) was daily used to enhance the discharge of the fetal membrane remnants and inflammatory exudate until the vaginal discharge clearance. Cross-fostering was practiced and each sow nursed about 10-12 piglets. Lactation length ranged from 21-25 days. On the weaning day, no feed was given to the sows. From day one post-weaning, sows were fed 2.5-3.0kg per day. At weaning, sows were injected with vitamin ADE (1.500.000IU vitamin A palmitate, 500,000IU vitamin D3, 25mg dl-a-tocopherol acetate) and moved to pregnant crates. About 3 days postweaning, boars were used to stimulate sows' estrus. Post-weaning estrus was detected, and sows were inseminated with fresh diluted semen twice at an interval of about 12 hours.

Data Collection and Definition

Data including parity, LS (total born), and WSI from investigated sows were collected. In total, information from 121 sows and 313 litters reproduced from these sows was collected. All these sows were in production during the study period. Data were collected from the hand-written sow cards. Usually, information included the date of birth of sows, name of sows' parents, ear tag number, sow identification, parity, date of inseminations, boars' names, (estimated) dates of farrowing, dates of weaning, LS (total born), number born with deformities, number of stillbirths, number of mummified fetuses, and weaning weight. However, only sow identification, parity, LS, lactation length (calculated from dates of farrowing and weaning), and WSI were collected in this study. Table 1 shows the number of sows at each parity with information on LS(n), WSI(n), LS(n+1) in which LS(n) and WSI(n) were the reproductive criteria in the parity n, LS(n+1) was a reproductive criterion in the parity n+1.

Statistical Analysis

In this study, the effects of LS in the parity n on the WSI in the parity n, and the effect of WSI in the parity n on the LS in the parity n+1 were investigated. The LS was partitioned into 3 groups including LS <11, LS =11-13, and LS >13 piglets. WSI was divided into 5 groups including 1-3, 4, 5, 6-10 and >10 days. The effects of LS on WSI and vice versa were analyzed using analysis of variance (one-way ANOVA) in the Statistical Package for the Social Sciences Version 22 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp). The least significant difference was used as the post hoc test for pair comparison. The significance level was at a P<0.05.

Table 1: Number of sows with investigated criteria in each paired parity

Parity	LS(n) - WSI(n) - LS(n+1)
1-2	LS1-WSI1 - LS2 (n=121)
2-3	LS2 - WSI2 - LS3 (n=86)
3-4	LS3 - WSI3 - LS4 (n=48)
4-5	LS4 - WSI4 - LS5 (n=26)
5-6	LS5 - WSI5 - LS6 (n=16)
6-7	LS6 - WSI6 - LS7 (n=12)
7-8	LS7 - WSI7 - LS8 (n=4)

LS (n): litter size in the parity n; WSI (n): weaning to the first service interval at the parity n.

Table 2: Effect of birth litter size on weaning to the first service interval in the same parity

Litter size	Number of litters	Weaning to the first service interval (day)
<11 piglets	22	9.6±7.3^{a}
11-13 piglets	99	6.9±5.6^{b}
>13 piglets	192	5.4±3.7^{c}
Average	313	6.2±4.8

The data are presented as Mean±SD. Different superscripts in the same column mean significant difference.

Table 3: Effect of weaning to the first service interval on litter size of the subsequent farrowing

Weaning to the first service interval	Number of litters	Litter size
1-3 days	17	14.6±2.4^{a}
4 days	104	14.3±2.3^{a}
5 days	138	14.4±2.1^{a}
6-10 days	22	13.0±2.2^{b}
>10 days	32	13.9±1.8^{ab}
Average	313	14.2±2.2

The data are presented as Mean±SD. Different superscripts in the same column mean significant difference.

RESULTS

WSI in 313 investigated reproductive cycles was 6.2±4.8 days, varying between 1 and 21. The average LS of 313 farrowings was 14.2±2.2. LS at birth had negative effects on WSI. Sows with an LS of 11-13 had a longer WSI than that of the sows with an LS larger than 13 piglets (P<0.05) (Table 2). Sows with an LS of <11 piglets had the longest WSI. About 77.3% of the sows were inseminated on days 4 and 5 post weaning in which the sows served on day 5 accounted for about 44.0%. Only small proportions of sows were served during days 1-3 and after day 5 post-weaning, i.e., 5.4 and 17.3%, respectively. WSI significantly influenced the subsequent LS. Sows with a WSI of 6-10 days had a smaller subsequent LS in comparison with sows with a WSI of <6 days (P<0.05).

DISCUSSION

The effects of WSI on the subsequent LS were in line with several previous studies. Dewey et al. (1994) found that the sows with a WSI of 5-10 days produced the smallest LS in comparison with sows with a WSI of 2-4 days and more than 10 days. Similarly, Marois et al. (2000) also reported that LS bottomed when WSI fell into the range of 7-10 days. Furthermore, Tantasuparuk et al. (2000) found that an LS decreased by about 0.5 piglets when the WSI increased from 1-5 to 6-7 days. Another study also substantiated that when WSI increased from 4-10 days, the LS was decreased by one piglet (Tummaruk et al. 2000). Although most studies found a quadratic effect of WSI on the subsequent LS, Segura-Correa et al. (2014) reported a positive and linear effect. Findings by Segura-Correa et al. (2014) might be attributable to the nature of data analysis where WSI was treated as a continuous variable rather than being partitioned into ranges.

The smaller LS in sows with a WSI of 6-10 days could be attributable to some reasons. These sows might have a shorter estrus duration and a shorter interval from estrus to ovulation in comparison with sows with a shorter WSI (Kemp and Soede 1996). A short estrus duration and a short estrus to ovulation interval might result in insemination at a suboptimal time relative to ovulation (Kemp and Soede 1996; Tantasuparuk et al. 2000; Tummaruk et al. 2000). Another reason that might cause the suboptimal time of insemination in the sows with a long WSI was a highly variable interval of estrus to ovulation (Lopes et al. 2020). Moreover, sows with a WSI of 6-8 days also had a lower ovulation rate in comparison with sows with a WSI of 4-5 days (Deckert et al. 1997). A negative association between the WSI and ovulation rate was also reported by Patterson et al. (2001). Suboptimal insemination time and lower ovulation rate might cause a decreased subsequent LS in sows with a WSI of 6-10 days in the present study. The restoration of subsequent LS in sows with a WSI >10 days might be the result of a longer recovery duration after a catabolic lactation interval (Tantasuparuk et al. 2000). However, this mechanism could not explain why sows with a WSI of 1-5 days had a larger subsequent LS in comparison with that in sows with a WSI of 6-10 days. If the mechanism had been true in this case, the latter group should have had a larger subsequent LS because they had a longer recovery time. Therefore, there might be other mechanisms that explain the quadratic effect of the WSI on the subsequent LS. It is suggested that the time of follicle recruitment, the intervals from follicle recruitment to estrus/ovulation may also contribute to the effect of the WSI on the subsequent LS, and future research may address this issue to further explore the relationship between these two criteria.

Reports on the correlation between the LS and the WSI at the same parity are scarce. Vesseur et al. (1994) found a positive association between the LS at weaning with the WSI. That relationship was explained by a lower sucking intensity and a lower degree of inhibition on the hypothalamic and hypophyseal hormones resulting in an earlier restoration and development of follicles, and a shorter WSI in sows with a smaller LS at weaning. However, in the present study, the number of piglets nursed by a sow was quite similar (10-12 piglets), and the lactation length varied a little (21-25 days). Therefore, such effects were not likely to exist in the present study. In this study, we found that LS had a negative association with WSI at the same parity. A large LS is the result of many factors such as high-quality sperm, an optimal time of insemination, proper nutrition, high uterine nurturing capacity, high quality of follicles, and a large number of ovulated oocytes (Mallmann et al. 2020; Savic et al. 2022; Theil et al. 2022). LS is genetically inherited (Ma et al. 2018; Sell-Kubiak 2021; Lee et al. 2022; Sell-Kubiak et al. 2022). Therefore, in comparison with a sow with a small LS, a sow with a large LS at parity n is more likely to have a large LS at parity n+1. The sows with a large LS at parity n+1 must have an increased number of recruited and developed follicles post-weaning at parity n. An increased number of follicles present on the ovary postweaning may result in a higher amount of estrogen which caused earlier estrus in these sows. This may be the explanation for the negative association between birth LS and WSI at the same parity in the present study.

Conclusion

The present study indicated that birth LS and WSI had a negative mutual relationship. A large birth LS shortened the WSI at the same parity and a short WSI increased the LS in the subsequent litter. The results of this study suggested that the genetic selection of hyperprolific sows could be based on the selection of both LS and WSI.

Author Contributions

NH Nam contributed to study concept, data acquisition, management, and analysis, interpretation of results, and manuscript writing. P Sukon contributed to study concept, data analysis, interpretation of results, and manuscript writing.

Conflict of Interest

None

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