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RELATIONSHIP OF BACKFAT THICKNESS AND BODY WEIGHT ON SOW HEALTH AND REPRODUCTIVE PERFORMANCE

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ABSTRACT

The study was performed to investigate the relationship of backfat thickness (BFT) and body weight (BW) of sows of different breeds and parities to their health and reproductive performance. Data analyzed included 346 sow individual records from a commercial farm in Balayan, Batangas, Philippines. BFT had weak negative correlations with respiratory-related clinical signs (RRCS, r= - 0.140) and weaning-to-service interval (WSI, r= - 0.164) overall set of clinical signs (CS, r= - 0.231) and number of mummified (MM, r= 0.310) fetuses. There was significant moderate negative relationship between BFT and total born (TB, r= - 0.439) and born alive (BA,r= - 0.405) piglets. Moderate positive correlations between BFT and average piglet weight at birth (APWT, r= 0.411) in parity 4, and with weaning-to-conception interval (WCI, r= 0.310) and farrowing interval (FI, r= 0.360) in parity 1. BW had a weak to moderate positive relationships with number of stillborn (SB, r= 0.117), lactation-related clinical signs (Lact-CS, r= 0.204),TB (r= 0.334), BA (r= 0.334)and litter weight (LWT, r= 0.318)across breeds and evidently seen in parity 3(TB, r= 0.486; BA, r= 0.501;LWT, r= 0.422). In parity 5 > BW had positive correlations to the overall set of CS (r= 0.449), Lact-CS (r= 0.346), Systemic clinical signs (SCS, r= 0.326) and RRCS (r= 0.360). BW had negative correlations with WSI (r= - 0.273) and WCI (r= - 0.214) for F1 sowsand with FI (r= -0.480) at parity 5 >. Hence, with the observed association of BFT and BW to sow health and reproductive performance, they can be used as tools in the implementation of a more efficient breeding management program.

Key words: animal health, backfat, body weight, reproductive performance, sows

INTRODUCTION

Reproduction performance is a key to profitability in pig production. To improve swine reproduction performance, breeding management must be given attention. Monitoring of sow condition is an important management consideration. Majority of the piggery farms use body condition scoring (BCS) which is the traditional method for sow condition evaluation (Roongsitthichai *et al.*, 2010). Using BCS may have several disadvantages as it is a subjective and inaccurate method that largely depends upon the scoring skills of the person. It is likely that less attention will be paid to deviations from the optimal condition due to herd blindness. Further, a sow that appears to be thin can still have a fairly high amount of back fat (Muirhead and Alexander, 1997).

Backfat thickness measurement is a practical and relatively inexpensive means of monitoring sow condition. In a study of high-producing pig herds, BFT measurement served as a valuable tool to monitor and improve the farm productivity and efficiency (Maes *et al.*, 2004). Moreover, BFT helps in monitoring health and in diagnosing underlying metabolic diseases since it is a good indicator of fat and the metabolic status of a sow (Morris *et al.*, 1998; Barnett *et al.*, 2001). Fat reserves act as buffer in times of nutritional inadequacy and protects the animal in poor environmental circumstances (Close, 2003).

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Body weight is found to be a good indicator of proper timing for breeding (Kummer *et al*., 2006) and is also a good trait to estimate the energy requirements for maintenance (Ramaekers, 2012). The findings of Rozeboom *et al*. (1996), Tummaruk *et al*. (2009), Amaral Filha *et al*. (2010) and Schenkel *et al*. (2010) showed that breeding sows with high BW resulted to higher litter size. In addition, higher BW was also reported to shorten the WSI and weaning to conception interval (WCI) as demonstrated by the studies of Tantasuparuk *et al*. (2001) and Tummaruk *et al*. (2007, 2009).

Nowadays, very few pig producers in the Philippines measure and control the BFT and BW of their sows at breeding and farrowing to increase their reproductive performance. These parameters may be considered by pig raisers as part of their standard breeding management program. The present study aimed to determine the relationship of BFT and BW of sows with different breeds and parities on their health and reproductive performance.

MATERIALS AND METHODS

Data Source and Collection

Three hundred forty-six individual sow records of Landrace, Large White, and Landrace-Large White crosses (F1) from a commercial breeder farm in Balayan, Batangas, Philippines were collected and analyzed. Sows had parities ranging from 1 to 5 $\geq$.

Data in sow cards from December 22, 2009 to December 25, 2012 included sow identification number, breed, date of birth, date bred, expected date of farrowing, actual date of farrowing, parity, BW and BFT before farrowing, litter size and weight at birth weight, average piglet weight at birth, WSI, WCI, FI, and the observed CS of diseases.

Specifically, CS observed were reproduction-related (number of SB, number of MM fetuses, repeat breedings, vaginal discharges, prolapses and abortions), lactation-related (agalactia and hypogalactia), systemic (inappetence and hyperthermia), respiratory-related (coughing and thumping), and mobility-related problems (lameness, weak legs and splay legs).

BFT and BW were measured on the 100th day of gestation. Measurement of BFT (in millimeters) was performed using Amplitude mode (A-mode) ultrasonography (Renco Lean-Meter®, Renco Corporation, Minneapolis, MN, USA). The BW (in kilograms) of sows was taken individually using a digital weighing scale (Armstrong®, China).

Statistical Analysis

Statistical analysis was carried out using the Statistical Packages for Social Sciences or SPSS version 17 (SPSS Inc. Polar Engineering and Consulting, Chicago, U.S.A.). Descriptive statistics were used to describe BFT, BW, health and reproductive parameters across parities and breed. Correlation analyses were conducted particularly point biserial correlation for the CS observed and Pearson product moment correlation for the other variables.

RESULTS

Results shown on Table 1 show that health variables in general showed very weak negative relationship to BFT except for the Lact-CS. Very weak positive correlations to BFT was noted in SB for Landrace sows, ReproCS in Large White sows and Lact-CS in F1 sows. Results revealed a weak significant negative relationship between BFT and RRCS (r= -0.140) among breeds. The negative relationship between BFT with the overall set of CS and RRCS was significant only in Landrace sows with correlation values of r= -0.231, r= -0.235, respectively.

The correlations of BFT to reproductive parameters per breed and across sow groups are shown in Table 2. Majority of the results for reproductive performance parameters measured had weak negative relationship to BFT but significant correlation was seen only in WSI in all sows (r= -0.164) as exemplified in F1 sows (r= -0.242).

The results on Table 3 show significant negative correlations of BFT with health parameters in parity 1 and parity 2. BFT was negatively correlated with overall CS observed (r= - 0.229), RRCS in parity 1 (r= - 0.264) and with MM (r= - 0.233) in parity 2.

Table 1. Correlation coefficient of backfat thickness with the sow health parameters per breed and across sow groups.

Health Parameters	BREED			
	All (N=346)	**Landrace (N = 87)**	**Large White (N = 59)**	**F1 (N = 200)**
CS	-0.077	-0.231*	-0.041	-0.031
ReproCS	-0.032	-0.091	0.125	-0.006
SB	-0.023	0.033	-0.183	-0.100
MM	-0.019	-0.106	-0.055	-0.115
LactCS	0.029	-0.008	0.081	0.028
SCS	-0.014	-0.053	-0.129	-0.010
RRCS	-0.140	-0.235*	-0.084	-0.077
MCS	-0.073	-0.114	-0.119	-0.043

CS - Clinical Sign; ReproCS-Reproduction-related clinical signs; Lact-CS- Lactation-related clinical signs; SCS – Systemic clinical signs; RRCS-Respiratory-related clinical signs; MCS-Mobility-related clinical signs; *Correlation is significant at the P<0.05 (2-tailed).

As presented in Table 4, BFT was positively related with WCI (r= 0.310) and FI (r= 0.360) in parity 1. Significant moderate negative relationshipswere found between BFT and TB (r= -0.439), BA (r= -0.405) and WSI (r= -0.345) in Parity 4. On the other hand, BFT was positively related with APWT in the same parity (r= 0.411).

Based on the results presented in Table 5, BW had a positive relationship with the number of SB (r= 0.117) across sow groups. Lact-CS positively correlated with BW (r= 0.204). RRCS (r= - 0.122) and observed ReproCS were negatively correlated with BW (r= - 0.204).

The number of SB had a positive relationship with BW (r= 0.150) in F1 sows. Lact-CS positively correlated with BW in Large White (r= 0.276) and F1 sows (r= 0.214). F1 sows showed negative correlations of ReproCS with BW (r= -0.288).

It can be seen on Table 6 that the BW of sows had significant positive relationship with TB and BA (r= 0.334) and LWT (r= 0.318) across breeds. Specifically, the TB, BA and LWT of Large White (r= 0.413); (r= 0.376); (r= 0.467), F1 sows (r= 0.375); (r= 0.374); (r= 0.330) and only with LWT for Landrace sows (r= 0.260). BW was negatively correlated with WSI (r= -0.273) and WCI (r= -0.214) in F1 sows.

Table 2. Correlation coefficients of backfat thickness with reproductive parameters per breed and across sow groups.

Repro. Parameters	BREED			
	All (N=346)	**Landrace (n = 87)**	**Large White (n = 59)**	**(L x Y) F1 (n= 200)**
TB	-0.090	-0.173	0.234	-0.047
BA	-0.058	-0.157	-0.073	-0.011
LWT	-0.028	-0.128	-0.140	-0.038
APWT	0.077	0.077	-0.075	0.028
WSI	-0.164*	-0.117	-0.208	-0.242*
WCI	-0.007	0.009	-0.002	-0.115
FI	0.020	0.037	0.041	-0.149

LW- Litter weight; APW-Average piglet weight; WSI- Weaning-to-service interval; WCI-Weaning-to-conception interval; FI-Farrowing interval. *Correlation is significant at P<0.05 level (2-tailed).

Table 3. Correlation coefficients of backfat thickness with the sow health parameters per parity.

Health Parameters	PARITY				
	Parity 1 (n=92)	**Parity 2 (n=74)**	**Parity 3 (n=74)**	**Parity 4 (n=49)**	**Parity 5≥ (n=57)**
CS	-0.229*	-0.054	-0.184	-0.104	0.108
ReproCS	0.016	0.028	-0.115	0.069	0.038
SB	-0.055	-0.068	-0.108	-0.184	-0.069
MM	-0.026	-0.233*	-0.155	-0.010	0.090
LactCS	-0.131	0.073	0.048	0.012	0.034
SCS	-0.146	-0.028	-0.104	0.056	0.231
RRCS	-0.264*	-0.081	-0.138	0.021	0.100
MCS	-0.021	-0.080	-0.182	0.124	-0.105

CS - Clinical Sign; ReproCS-Reproduction-related clinical signs; Lact-CS- Lactation-related clinical signs; SCS – Systemic clinical signs; MCS-Mobility-related clinical signs; *Correlation is significant at P<0.05 level (2-tailed).

Based on the results shown on Table 7, only the number of SB was positively related with BW in parity 1 (r=0.223) and absence of significant correlations of BW with health parameters in parities 2, 3, and 4. BW had moderate positive association with the overall set of CS (*r*=0.449), Lact-CS (r=0.346), SCS (r=0.326), and RRCS (r=0.360) in parity 5 ≥.

Significant correlations of BW were observed in reproductive performance parameters of parities 3 and 5 ≥ (Table 8). In parity 3, BW had a moderate positive relationship with TB (r=0.486), BA (r=0.501) and with LWT (r=0.422). In parity 5 ≥, BW was found to be negatively associated with FI (r= -0.480).

Table 4. Correlation coefficients of backfat thickness with reproductive parameters per parity.

Repro. Parameters	PARITY				
	Parity 1 (n=92)	Parity 2 (n=74)	Parity 3 (n=74)	Parity 4 (n=49)	Parity 5≥ (n=57)
TB	-0.184	-0.046	-0.022	-0.439**	-0.078
BA	-0.171	0.004	0.014	-0.405**	-0.046
LWT	-0.124	-0.001	-0.02	-0.074	-0.113
APWT	0.138	-0.050	0.039	0.411**	0.198
WSI	-0.117	-0.031	-0.276	-0.345*	-0.054
WCI	0.310*	-0.060	-0.143	0.027	-0.041
FI	0.360*	-0.055	-0.041	0.037	-0.114

LWT-Litter weight; APWT- Average piglet weight; WSI-Weaning-to-service interval; WCI-Weaning-to-conception interval; FI- Farrowing interval. **Correlation is significant at the 0.01 level (2-tailed).*Correlation is significant at the 0.05 level (2-tailed).

Table 5. Correlation coefficients of body weight with the health parameters per breed and across sow groups.

Health parameters	BREED			
	All (N=346)	Landrace (n = 87)	Large White (n = 59)	F1 (n = 200)
CS	-0.049	-0.069	0.130	-0.086
ReproCS	-0.204**	-0.073	-0.005	-0.288**
SB	0.117*	-0.024	0.181	0.150*
MM	-0.040	-0.143	-0.035	-0.006
LactCS	0.204**	0.005	0.276*	0.214**
SCS	0.020	0.081	-0.051	0.017
RRCS	-0.122*	-0.093	-0.161	-0.121
MCS	-0.017	-0.126	0.203	-0.003

CS - Clinical Sign; ReproCS-Reproduction-related clinical signs; Lact-CS- Lactation-related clinical signs; SCS – Systemic clinical signs; MCS-Mobility-related clinical signs; **Correlation is significant at P< 0.01 level (2-tailed). *Correlation is significant at P< 0.05 level (2-tailed).

DISCUSSION

Significant weak negative relationship between BFT and respiratory related problems implies that lower BFT is correlated with the higher occurrence of coughing and thumping. Sows with CS of coughing and thumping will have diminished appetite causing growth reduction due to inadequate feed intake (Lawhorn, 1998), providing an explanation for the negative relationship of BFT and RRCS. As Close (2003) points out, fat reserves have a buffering effect in times of inadequate nutrient intake and also protect the

Table 6. Correlation coefficients of body weight with reproductive parameters per breed.

Repro. Parameters	BREED			
	All (N=346)	Landrace (n = 87)	Large White (n= 59)	(L x Y) F1 (n = 200)
TB	0.334**	0.156	0.413**	0.375**
BA	0.334**	0.192	0.376**	0.374**
LWT	0.318**	0.260*	0.467**	0.330**
APWT	0.087	0.125	0.136	-0.101
WSI	-0.102	0.176	0.090	-0.273**
WCI	-0.126	0.022	-0.103	-0.214*
FI	-0.109	0.009	0.023	-0.197

LWT-Litter weight; APW- Average piglet weight; WSI- Weaning-to-service interval; WCI-Weaning-to-conception interval; FI- Farrowing interval. **Correlation is significant at P< 0.01 level (2-tailed).*Correlation is significant at P< 0.05 level (2-tailed).

animal from poor environmental influences. The BFT was not associated with litter size and litter weight. This is consistent with the findings of Lopez-Serrano *et al*. (2000),Yazdi *et al*. (2000), and Knauer (2006) who reported unfavorable or no relationship between BFT and sow reproductive lifetime measures.

The findings of the present study also suggest that F1 sows with thicker backfat may have shorter WSI. This confirms the findings of Roongsitthichai *et al*. (2010) and

Table 7. Correlation coefficients of body weight with health parameters per parity.

Health Parameters	PARITY				
	Parity 1 (n=92)	Parity 2 (n=74)	Parity 3 (n=74)	Parity 4 (n=49)	Parity 5 ≥ (n=57)
CS	-0.122	-0.117	-0.004	0.240	0.449**
ReproCS	-0.125	-0.057	0.060	0.067	-0.105
SB	0.223*	0.176	0.224	0.068	0.112
MM	-0.088	-0.028	-0.046	0.018	-0.042
LactCS	0.050	0.097	-0.01	0.140	0.346**
SCS	-0.028	-0.071	0.003	0.209	0.326**
RRCS	-0.158	-0.131	-0.026	-0.001	0.360**
MCS	0.089	-0.055	-0.041	0.148	0.259

CS - Clinical Sign; ReproCS-Reproduction-related clinical signs; Lact-CS- Lactation-related clinical signs; SCS – Systemic clinical signs; MCS-Mobility-related clinical signs; **Correlation is significant at P<0.01 level (2-tailed).*Correlation is significant at P< 0.05 level (2-tailed).

Tummaruk *et al.* (2001) that gilts with high BFT (14-18 mm) had shorter WSI and higher farrowing rate compared with sows of low BFT (< 14 mm). Further, Tantasuparuk *et al.* (2001) showed that F1 sows had shorter WSI (i.e., where proportion of sows mated after weaning within 5 days was higher in crossbred sows compared with purebred sows).

Table 8. Correlation coefficients of body weight with reproductive parameters per parity.

Repro. Parameters	PARITY				
	Parity 1 (n=92)	Parity 2 (n=74)	Parity 3 (n=74)	Parity 4 (n=49)	Parity 5 ≥ (n=57)
TB	0.095	0.198	0.486**	0.063	0.094
BA	0.073	0.153	0.501**	0.043	0.091
LWT	0.100	0.167	0.422**	0.086	0.092
APW	0.018	0.007	0.072	0.003	0.205
WSI	-0.238	0.281	-0.218	-0.224	-0.155
WCI	-0.168	0.199	-0.082	0.056	-0.330
FI	-0.154	0.147	-0.042	0.002	-0.480**

LWT- Litter weight; APWT- Average piglet weight; WSI-Weaning-to-service interval; WCI-Weaning-to-conception interval; FI- Farrowing interval.

**Correlation is significant at the 0.01 level (2-tailed).

There are negative relationships observed between BFT thickness with occurrence of RRCS and overall CS in parity 1 and mummification (MM) of fetuses in parity 2. RRCs may affect animal health and reduce appetite, thereby contributing to reduced growth rate (Lawhorn, 1998). The observation of CS in first parity sows may be linked to the oxidative stress among younger sows, thus reducing the immune response of the animal. MM fetuses are usually seen higher in earlier and older parities of sows due to the low placental production index (Borges *et al.* 2005).

In parity 1, the results suggest that as BFT decreases, WCI and FI decrease. In parity 4, it was found that lower BFT is associated with lower APWT. Meanwhile, litter size increased and WSI was longer in parity 4. Based from the descriptive statistics of parity distribution, parity 4 had the highest mean litter size (TB and BA). A related study conducted by Prendergast and Jensen (2012) using laboratory animals observed that the reduction in body fat is associated with the increased number of embryos which resulted to greater reproductive effort leading to utilization of body fat.

The finding that higher BW of sows is correlated with the number of SB may be explained by obstruction of the birth canal which may prolong the farrowing process and lead to fetal asphyxia during parturition (Alonso-Spilsbury *et al.*, 2007). This was evidently seen among F1 sows. A large litter and a high-parity (Borges *et al.*, 2005) coupled with reduced muscle tone of the uterus are also factors that increases the risk of stillbirths.

Lactation-related CS (Lact-CS) such as hypogalactia and agalactia are positively correlated with BW in Large White sows and F1 sows. This finding agrees with the report of Young *et al.* (2004) where the number of secreting alveolar cells in fattened sows is decreased and causes low production of colostrum and milk. The number of mammary epithelial cells is correlated with milk production as mentioned by Kim *et al.* (2000). Excess body condition or over fatness can affect the gilts and sows' ability to produce adequate milk to nurse their piglets. The study of Revell *et al.* (1998) demonstrated that over-fattened sows produced less milk by 15% as compared to lean animals and differences become more evident at the beginning of lactation. A study by Weldon *et al.* (1991) demonstrated that excessive energy intake can compromise mammary development during gestation and may reduce milk production in the subsequent lactation.

Sows that have higher BW were found to have less reproductive disordersas observed in the present study. BW had a moderate relationship with litter size (TB and BA) and litter weight which affirms the results from previous studies (Tummaruk *et al.*, 2000; 2001; 2007; Kummer *et al.*, 2006) that sows with greater growth rate, and corresponding higher BW, have greater total piglets born. The result further supported the finding of Schenkel *et al* (2010) where sows with high BW had higher litter size. Matysiak *et al.* (2010) in their study explained that the increase in the BW of gilts increases the number of ovulating egg cells and systematic development of the reproductive system, thus, contributing to the increase in litter size.

The finding that the number of SB piglets decreases with low BW in parity 1 can be attributed to their innately smaller appetite. Excess fats in sows can lead to reproductive performance disorders and farrowing difficulties resulting to more SB piglets (Zaleski and Hacker, 1993).

The positive relationship found between BW and Lact-CS in older parities is consistent with the findings of Maes *et al.* (2004), Borges *et al.* (2005) and Amaral Filha *et al.* (2010). Occurrences of CS, systemic CS (inappetence and hyperthermia), Lact-CS and RRCS in sows with higher BW in last parities can be attributed to decreased immunity of the animals due to old age thus lowering overall performance. The studies of Flowers and Day (1990) and Zhao *et al.* (2011) attributed the lower performance of sow to increased oxidative stress.

The findings on the positive relationship of BW before farrowing with litter size and litter weight during parity 3 suggest that as BW increases, litter size and litter weight also increase. These results were consistent with Rozeboom *et al.* (1996) and Tummaruk *et al.* (2009) where sows bred with high BW have higher litter size. Furthermore, this is consistent with reports that litter size increases with parity, where the highest number are reached from parity 3 to 5 (Koketsu *et al.* 1999; Hoving *et al.*, 2010). As mentioned previously (Tantasuparuk *et al.*, 2000), litter size is caused by an increase in fertilization rate and embryonic survival with the age of the sow and/or by an increase in uterine dimension. BW was found to be negatively correlated with FI in last parities and similar to previous reports (Tantasuparuk *et al.* 2000; Schwarz *et al.* 2009).

The present study showed that monitoring BFT thickness can be a useful tool to assess the sows' health while BW is an important indicator of the reproductive performance of the sows.

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