Sexual Dimorphism in Growth of Sucking and Growing Pigs

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ABSTRACT : Three studies were conducted to determine the effect of sex on pre- and post-weaning performance of pigs. These studies were conducted in response to observations that female pigs appear to grow faster than male pigs after weaning. In addition, female pigs have been found to grow faster than male pigs when supplied with supplemental milk before weaning. The aims of the present work were to further characterise the ontogeny of sex differences growth of nursing and growing pigs. In the first study, piglets sucking 32 sows were crossfostered to produce litters of 10 boars (n=9), 10 gilts (n=11) or 5 boars and 5 gilts (n=12). Liveweight of the sucking pigs was then measured weekly until weaning at 4 weeks of age. In the second study, 80 boars and 80 gilts were weaned at 26 days of age and growth performance measured until 21 days post-weaning. In the third experiment, 40 boars and 40 gilts were weaned into groups of 5 pigs at either 17 or 25 days of age and pigs were weighed until they were approximately 90 kg liveweight. All-boar litters grew more slowly than the all-gilt and mixed litters such that by 14 days of age the all-boar litters were 10% lighter than the all-gilt or mixed litters (39 vs. 43.8 kg, p=0.050). The proportional difference in litter weight appeared to be maintained at 21 days of age (53.9 vs. 59.4 kg, p=0.063) but was diminished by 28 days of age (66.5 vs. 70.8 kg, p=0.28). In the second study, gilts grew more quickly than boars over the first 7 and 21 days post-weaning and as a consequence were 10% heavier than boars at 21 days after weaning (13.7 vs 12.48 kg, p=0.001). In the third study, gilts grew more quickly than boars in the immediate 7 days post-weaning (40 vs. 5 g/day, p=0.014) whereas from 7 until 35 days post-weaning there was no significant difference in growth rate (381 vs. 360 g/day, p=0.19). Gilts also grew more quickly than boars over the 14 days after being moved into the grower (631 vs. 570 g/day, p=0.013) and finisher (749 vs. 688 g/day, p=0.038) sheds. However, these differences were not maintained over the entire period in each shed. These data support the hypotheses that gilts handle the stresses of weaning and other transitions better than boars. ***(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 11 : 1610-1615)***

Key Words : Pig, Lactation, Sex, Growth, Weaning, Stress

INTRODUCTION

During the finisher phase, intact male pigs (boars) grow faster and more efficiently than female pigs (gilts) (Dunshea et al., 1993, 1998). While it has generally been accepted that up until about 50 kg of weight there is little difference in the growth performance of the two sexes (Campbell et al., 1988), recent data suggest that the neonatal gilt appears to perform better than the boar. For example, Power et al. (1996) reported that boars, particularly those that were small-for-age, eat less and grow more slowly in the immediate post-weaning period than their female contemporaries. The reasons for this sexual dimorphism are unknown but may be related to greater visceral organ weight and digestive function in gilts (Pluske et al., 1997).

Recently, it has been shown that female pigs grow more quickly over the last 14 days of a 28 day lactation when provided *ad libitum* with supplemental milk from 4 days of age (King et al., 1998). This raises the possibility that young gilts are more hungry or seek out feed more effectively than young boars. Gilts suckle sooner than boars immediately after parturition and exogenous oestradiol administration decreases the interval between birth and first suckle (Bate and Hacker, 1982). These findings suggest that gilt piglets may be necessary in a litter to maximally stimulate milk production of the sow.

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The process of weaning itself can introduce a number of stressors such as the psychological stress of being moved from the sow and relocated to a new shed with new pen mates (Bryant and Ewbanks, 1972; Arnone and Dantzer, 1980; Dantzer and Mormède, 1981) and thermal stress associated with movement into an environment often outside the pigs zone of thermoneutrality and subject to draughts (LeDividich et al., 1980; Funderburke and Seerley, 1990). In addition, there is a nutritional stress associated with the change from a readily digested, simple liquid diet to a more indigestible, complex solid diet (Lecce et al., 1979; Pluske et al., 1996). This transition often occurs at a time when the digestive and ingestive capacity of the piglet still limits feed intake and digestion (Pluske et al., 1996).

Therefore, a study was conducted to investigate the performance of all-boar, all-gilt and mixed (boar plus gilt) litters on the sow to determine whether sex of the litter had any effect upon pre-weaning growth performance of pigs. In addition, two studies were conducted to confirm whether there were any differences in post-weaning growth performance of boars and gilts and whether there were any differences between the sexes in their growth response to dietary and environmental changes at later stages of growth.

MATERIALS AND METHODS

Animals and housing

All studies used crossbred (Large White × Landrace) pigs sourced from the Pig Research and Training Centre in

Werribee. Sows were housed in farrowing crates in an insulated building with blinds that were raised and lowered to control temperature. Sows were offered 2.0 kg/day of a lactation diet containing 14.3 MJ DE, 160 g crude protein and 9.3 g available lysine/kg prior to farrowing. After farrowing, daily feed allowance was increased by 0.5 kg until 5 kg/day in Experiment 1 or *ad libitum* feed intakes were reached for Experiments 2 and 3. Piglets were denied access to both solid creep feed and water while on the sow. Pigs were weaned into groups (as indicated for respective experiments) and were housed in an insulated weaner shed maintained at 26°C and they were allowed *ad libitum* access to a protein adequate diet containing 14.5 MJ DE, 210 g CP and 11.9 g lysine/kg (table 1).

Experiment 1

This experiment was designed to measure the pre-weaning performance of all-gilt, all-boar and mixed-sex litters of 32 (first parity) that were allowed to farrow naturally. Sows were fed 5 kg of a lactation diet per day throughout the lactation. Within 24 h of farrowing, after piglets had suckled and received colostrum, the piglets were cross-fostered to produce litters of 10 boars, 10 gilts, or 5 boars and 5 gilts. It was envisaged that equal replicates of each sex could be obtained but a paucity of boars and an abundance of gilts being born resulted in 9, 11 and 12 sows nursing all-boar, all-gilt and mixed litters, respectively. Piglets were weighed at birth and at weekly intervals until 4 weeks of age.

Table 1. Composition of weaner diet

Component	g/kg
Ingredient	
Wheat	676.1
Tallow	20.6
Blood meal	22.9
Meat and bone meal	75.0
Soyabean meal	150.0
Peas	50.0
L-lysine·HCl	0.56
DL-Methionine	0.78
Salt	2.00
Vitamin and mineral premix[A]	3.00
Estimated composition[B]	
Digestible energy (MJ DE/kg)	14.5
Crude protein (g/kg)	210.3
Total lysine (g/kg)	11.9

[A] Vitamin mineral premix provided the following nutrients per kilogram of air-dry diet (mg); retinol, 6.4; cholecalciferol, 0.083; tocopherol, 22; menadione, 0.60; riboflavin, 3.3; nicotinic acid, 16.5; pantothenic acid, 5.5; pyrodoxine, 1.1; biotin, 0.56; choline, 1.100; cyanocobalamin, 0.017; Fe, 88; Zn, 55; Mn, 22; Cu, 6.6; I, 0.22; Se, 0.1.

[B] Estimated from ingredients.

Experiments 2 and 3

Experiment 2 involved 80 boars and 80 gilts from mixed sex litters weaned at an average of 26 days of age into groups of 20 of each sex. Therefore, as the pen was treated as the experimental unit, there were four replicates of each treatment in Experiment 2. The pigs were weighed at birth, weaning, and at 7 and 21 days post-weaning. The third experiment involved 40 male and 40 female pigs from mixed-sex litters weaned into groups of 5 pigs at either 17 or 25 days of age. Since the pen was the experimental unit, Experiment 3 was a 2 × 2 factorial with 4 replicates of each treatment. The pigs were weighed at weaning and weekly thereafter until slaughter at approximately 90 kg liveweight. They were moved from the weaner to the grower shed at an average weight of 23 kg and from the grower to the finisher shed at an average weight of 55 kg. As a consequence, pigs weaned early (ie. 17 d of age) were in the weaner shed an additional 2 weeks. The pigs remained in their established groups throughout the study. There were also dietary changes with the transition from weaner to grower and grower to finisher accommodation.

Statistical analyses

Data from Experiment 1 were analysed by ANOVA with the main effect being sex of the litter and with the sow as the experimental unit. Since the hypothesis was that all-boar litters would perform more poorly than either mixed or all-gilt litters, a separate analysis was performed comparing all-boar litters with pooled data from the mixed and all-gilt litters. Pre-weaning data from Experiment 2 were analysed using a split-plot design with sow as the blocking factor and sex as the subplot. Post-weaning data from Experiment 2 were analysed using a simple ANOVA with the pen of pigs as the experimental unit. Data from Experiment 3 were analysed by two-way ANOVA suitable for a factorial design with sex and weaning age as the main effects and the pen of pigs as the experimental unit. All analyses were performed using GENSTAT (Payne et al., 1993).

RESULTS

Data from the first experiment are given in table 2. There was no effect of sex on birthweight of individual pigs or the established litters. However, over the first 2 weeks of lactation the all-boar litters tended to grow more slowly than the all-gilt and mixed litters (1.78 vs. 2.07 kg/d, $p=0.063$). Consequently, at 14 days of age, the all-boar litters were 10% lighter than the all-gilt or mixed litters (39.0 vs. 43.8 kg, $p=0.050$). While the proportional difference in litter weight was maintained at 21 days of age (53.9 vs. 59.4 kg, $p=0.063$), it was diminished by 28 days of age (66.5 vs. 70.8 kg, $p=0.28$). The improvement in growth in the mixed litters was not confined to just the gilts since the growth rate of the boars in

Table 2. Effect of litter composition on piglet and litter liveweight data are from Experiment 1

	Litter composition (L)					Significance	
	Boar	Gilt	Mixed	SED[A]	SED[B]	L[A]	B[B]
Piglet weight (kg)							
Birth	1.42	1.46	1.50	0.06	0.06	0.44	0.28
7 days of age	2.62	2.85	2.78	0.16	0.14	0.37	0.18
14 days of age	4.18	4.57	4.53	0.23	0.20	0.22	0.080
21 days of age	5.76	6.10	6.27	0.32	0.28	0.27	0.13
28 days of age	7.11	7.17	7.58	0.44	0.39	0.49	0.49
Litter weight (kg)							
Birth	14.2	14.6	15.0	0.63	0.55	0.44	0.28
7 days of age	24.8	27.7	26.9	1.70	1.49	0.25	0.10
14 days of age	39.2	44.5	43.1	2.54	2.24	0.13	0.050
21 days of age	53.9	59.3	59.5	3.25	2.85	0.18	0.063
28 days of age	66.5	69.8	71.8	4.46	3.92	0.50	0.28

[A] Boar vs. Gilt vs. Mixed, [B] Boar vs. (Gilt+Mixed).

the mixed litters was similarly enhanced. For example, at 14 days of age the boars from all-boar litters were lighter than boars from mixed litters (4.18 vs. 4.53 kg, p=0.043) which in turn were not different than gilts from both mixed litters (4.54 kg) and all-gilt litters (4.57 kg).

Data from the second study are given in table 3. There was no significant effect of sex on birthweight, growth rate until weaning or weaning weight (table 3). However, gilts grew more quickly over the first 7 and 21 days post-weaning and, as a consequence, were 10% heavier (p<0.001) than boars at 21 days after weaning.

In the third study gilts tended to be heavier at weaning than boars (7.62 vs. 7.27 kg, p=0.095) and grew more quickly in the 7 days after post-weaning (40 vs. 5 g/day, p=0.014) (table 4). From 7 until 35 days post-weaning there was no significant difference in growth rate between gilts and boars (381 vs. 360 g/day, p=0.19). There was no significant effect of weaning age on growth rate over the first 7 d post weaning (17 vs. 29 g/day for pigs weaned early and late respectively, p=0.39). On the other hand, early-weaned pigs grew more slowly than the older weaned pigs from 7 until 35 days post-weaning (296 vs. 445 g/day, p<0.001). The cumulative effects over the first 35 days post-weaning were that gilts tended to grow more quickly than boars (313 vs. 289 g/day, p=0.095), and that pigs weaned early grew more slowly than those weaned later (240 vs. 361 g/day, p<0.001). After the pigs were moved into the grower shed the gilts grew more quickly over the first 2 weeks than the boars (631 vs. 570 g/day, p=0.013), and the early-weaned pigs grew more slowly than the late-weaned pigs (493 vs. 708 g/day, p<0.001). Over the entire grower phase there was no difference in rate of gain of gilts and boars (761 vs. 767 g/day, p=0.73), while early-weaned pigs grew more slowly than later-weaned pigs (739 vs. 789 g/day, p=0.008). When the pigs were moved into the finisher shed the gilts grew more quickly than the boars (582 vs. 421 g/day) over the first 7 days and, for the only period of the study, the early-weaned pigs grew more quickly than the pigs weaned later (588 vs. 417 g/day, p<0.001). This was particularly so for the gilts as indicated by the interaction (p=0.088). Over the entire finisher phase there was no effect of either sex (860 vs. 875 g/day, p=0.48) or weaning age (857 vs. 877 g/day, p=0.33) on growth rate. However, over the final 4 weeks of the finisher period gilts tended to grow more slowly than boars (938 vs. 977 g/day, p=0.086), and the early-weaned pigs grew more slowly than the pigs weaned later (925 vs. 990 g/day, p=0.005). While there was no effect of sex on growth rate from weaning until slaughter (607 vs. 606 g/day, p=0.97), the early-weaned pigs grew more slowly than the later-weaned pigs over the same period (595 vs. 618 g/day, p=0.020).

Table 3. Effect of sex on pre- and post-weaning growth of piglets. Data are from Experiment 2 where pigs were weaned at an average of 26 d

	Boar	Gilt	SED	Significance
Piglet weight (kg)				
Birth	1.58	1.53	0.05	0.29
Weaning	7.71	7.91	0.22	0.36
7 days post-weaning	8.14	8.63	0.26	0.054
21 days post-weaning	12.35	13.67	0.40	0.001
Daily gain (g/day)				
Birth-weaning	241	243	7.4	0.79
0-7 days post-weaning	47	96	23.4	0.036
7-21 days post-weaning	301	360	16.8	<0.001
0-21 days post-weaning	221	274	15.2	<0.001

Table 4. Effect of sex and weaning age on post-weaning rate of gain (g/day) of pigs data are from Experiment 3

Sex (S)	Boar		Gilt		SED	Significance		
Weaning age (W) (days)	17	25	17	25		S	W	S × W
Weaner phase								
0-7 days	1	9	32	48	19	0.014	0.39	0.78
0-14 days	65	143	58	172	17	0.38	<0.001	0.13
0-35 days	233	344	247	378	20	0.095	<0.001	0.50
Weaner-grower	367	344	363	378	18	0.25	0.79	0.14
Grower phase								
0-7 days	186	725	297	692	54	0.31	<0.001	0.064
0-14 days	473	666	512	750	34	0.013	<0.001	0.36
Grower-finisher	749	785	729	793	26	0.73	0.008	0.45
Finisher phase								
0-7 days	468	374	708	456	64	<0.001	<0.001	0.088
0-14 days	705	670	815	682	45	0.038	0.005	0.094
Finisher-slaughter	868	881	846	874	29	0.48	0.33	0.73

DISCUSSION

The data from the lactation study suggest that litters containing gilts grow more quickly than those that contain only boars. Bate and Hacker (1982) found that gilts suckle sooner than boars immediately after parturition and that the interval between birth and first suckle can be reduced by oestradial injection. Also, gilts are more likely to survive the first few days after parturition than boars, particularly if they have a low birthweight (Bereskin et al., 1973; Pettigrew et al., 1986). Therefore, it may be possible that circulating oestrogen or related steroids may stimulate appetite or cause hyperactivity in neonatal gilts. As well as increasing survival of the individual pigs, it is likely that having gilts in the litter would improve the overall growth of the entire litter as observed in the present study, since the increased activity of the gilts could stimulate suckling pressure and milk yield. Interestingly, we have shown that female pigs grow more quickly over the last 14 days of a 28 day lactation when provided *ad libitum* with supplemental milk from 4 days of age (King et al., 1998). Likewise, gilts grew faster than boars when offered supplemental skim milk between days 10 and 20 of age (Dunshea et al., 1999). These data raise the possibility that young gilts are hungrier or seek feed out more effectively than young boars.

The effect of having gilts in the litter diminished over the final week of lactation, primarily due to a decrease in growth of the litters containing gilts rather than to an increase in gain of the all-boar litters. A decrease in litter growth often occurs after 3 weeks of lactation (Cranwell et al., 1995), particularly in large litters (Dunshea and Walton, 1995). Therefore, it is perhaps not surprising that the growth of the heavier litters containing gilts decreased over the latter stages of lactation.

The data from experiments 2 and 3 confirm that gilts grow faster than boars in the immediate post-weaning period, although the length of time for which this persists is variable. Although feed intake was not measured, the increased growth of gilts was most likely due to an increase in feed consumption. Previously, we have shown that gilts eat more and grow more quickly than boars during the first week after weaning (Power et al., 1996; Dunshea et al., 1999). In a retrospective analysis of 58 studies conducted at the University of Kentucky, Cromwell et al. (1996) demonstrated that although barrows were heavier at weaning, gilts grew more rapidly over the subsequent 4 weeks. Given that the post weaning performance of gilts is superior to both barrows and boars it appears that the factor(s) responsible are intrinsic to the gilt. Others have found that neonatal male rats were more susceptible than female rats to early dietary deficiencies, retardation and handling stresses (Crutchfield and Dratman, 1980). In addition to the possibility that the hormonal milieu stimulates the appetite and (or) reduces stress of the gilt, it is also possible that there is further sexual dimorphism with respect to gastrointestinal size and function. In this context, gilts appear to have a more developed gastrointestinal system and pancreatic enzymic capacity than boars when weaned at either 14 or 28 days of age (Cranwell et al., 1997; Pluske et al., 1997).

Another important finding from this study was that gilts grew better than boars after transition between sheds and/or changes in feed composition across the different stages of growth investigated. These responses occurred despite the pigs remaining in their established groups when moving from weaner to grower and grower to finisher accommodation. Recently, we have also shown that young gilts (35 d old) handle the transition from an early-weaner, pelleted diet to a late-weaner, mash diet more readily than contemporary boars (Dunshea et al., 2000). Schleitzer et al.

(1990) and Pfeiffer et al. (1991) found pigs that were re-housed a number of times between weaning and slaughter grew more slowly than pigs that were not re-housed. Likewise, Mardarowicz (1985) found that the pigs were moved once or twice between birth and slaughter had a lower growth rate and a higher incidence of pneumonia than pigs that were not moved to a new environment. Therefore, it appears that growth performance can be compromised when pigs are moved to new surroundings. The present data suggest that gilts may not suffer as great a growth check as boars after this transition.

In conclusion, litters that contain at least half gilts grow faster than those that contain only boars. Therefore, for optimal pre-weaning performance it is important to ensure that some gilts are present in each litter. In addition, gilts appear to grow faster than boars after transitions and management practices that reduce stress should be investigated for boars.

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