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THE EFFECTS OF THREE TYPES OF DRY SOW HOUSING ON SOW WELFARE

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ABSTRACT

Pregnant pigs housed in stalls, three groups of five with individual feeders, and a large group with access to an electronic sow feeder were studied in order to evaluate the welfare consequences of these systems. Behaviour, pituitary-adrenal function, immune system function and reproduction were measured during the first and fourth pregnancies. Behaviour and pituitary-adrenal function data are presented here. The levels of salivary cortisol during dexamethasone and adrenocorticotrophic hormone tests of pituitary-adrenal function were no different in pigs from each system soon after introduction to the housing conditions. The behaviour data suggest that the procedure of mixing these pigs together for the first time was probably stressful due to the occurrence of vigorous fighting. At the fourth pregnancy, no differences in pituitary-adrenal function were detected. At this stage, pigs housed socially had developed stable social hierarchies, while the stall-housed pigs continued to experience relatively high levels of unresolved aggressive encounters with their neighbours and had developed high levels of oral stereotypies which are indicative of a frustrating environment. In the long-term, therefore, housing pregnant pigs in groups would appear to be no more stressful than housing them in stalls. In fact, the behaviour data point to considerably more long-term problems for stall-housed sows. The data also emphasise the need for research into ways of mixing pregnant pigs together to avoid undue social stress.
KEYWORDS: Pig, Welfare, Stress, Behaviour, Pituitary-adrenal function, Sow housing

INTRODUCTION

On many modern farms, pregnant pigs are housed singly in a space of about 2m x 0.6m. They are either enclosed in this space by a metal cage (stall), or they are restrained in this area by a tethering chain attached to a collar around their neck or girth. Tethered and stall-housed pigs cannot turn around and are generally prevented from performing many of the behaviour patterns that pigs perform in less restricted conditions (e.g. rooting, complex social behaviour). Consequently, there is public concern about the welfare of animals kept in these conditions (e.g. Harrison, 1964). The UK government has recently announced that it is to ban the use of these housing systems from 1998 onwards. As a result, group-housing systems for pregnant pigs will have to replace stalls and tethers.

The objective of this study was to examine the effects of two indoor group-housing systems on measures of the welfare of pregnant pigs, and to compare pigs housed in these systems with pigs housed in stalls. The study followed 63 female pigs from early life until their fourth pregnancy. A longitudinal experimental design was used to obtain information on how the pigs

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responded to their initial introduction to the three housing systems (during the first pregnancy), and how they adjusted to the systems over time. A variety of measures, which can be used as indicators of animal welfare (Broom, 1988), were collected during the first and fourth pregnancies. These included measures of behaviour and responsiveness, pituitary-adrenal function, immune system function, growth rate and reproductive success. This paper will focus on measures of behaviour and pituitary-adrenal function during the first and fourth pregnancies.

METHODS

Procedure

The 63 Large White x Landrace (Masterbreeders, Tring, UK) pigs were introduced into the three housing systems when they were about 9 months old and in the seventh week of their first pregnancy. Eleven pigs were housed in conventional stalls (2m x 0.6m). Three groups of five pigs were housed in identical pens comprising a strawed lying area (3m x 2.2m), a dunging area (2m x 2.2m) and five individual feeding stalls. Pigs in these two systems were fed once a day at about 0730h. The remaining 37 pigs were housed in a large pen divided into a strawed lying area (11.4m x 5.5m) and a dunging area (5.1m x 5.5m). Part of the dunging area was occupied by an electronic sow feeder unit (crate manufactured by Quality Equipment, Bury St Edmunds, UK and electronics by Nedap Poiesz, Hengelo, Netherlands) in which the sows were fed one at a time. The feeding cycle started at 1500h. All pigs were fed 2.2kg per day throughout observation periods, and water was available ad libitum. The behaviour of the pigs was observed for five days during the first three weeks following introduction to the housing systems. During the fifth week, pituitary-adrenal function of each pig was assessed. All pigs remained in the same housing systems and, during their fourth pregnancy, their behaviour was once more observed for five days, and their pituitary-adrenal function was assessed again at the 10th-11th week of pregnancy.

Behavioural observations

On each observation day, the pigs were watched four times, once in each of the following time periods: 0830-1000h, 1130-1300h, 1400-1530h, 1600-1730h. A combination of focal, instantaneous and behaviour sampling techniques was used (Martin & Bateson, 1986), as described in detail in Mendl et al. (1992). The instantaneous sampling technique provided information about how much time each pig spent in specific behavioural states. These included inactive (lying still with eyes open or closed), performing oral behaviour (rooting/chewing at straw/objects, sham-chewing), performing social behaviour, performing maintenance behaviour (scratching, urinating, defaecating), or sitting/standing/moving. The focal and behaviour sampling techniques provided information about the duration and frequency of specific behavioural events including the occurrence of stereotypies such as sham-chewing, bar-biting and trough-biting behaviour, and the occurrence of agonistic social interactions (involving aggressive physical contact or active avoidance without contact), non-agonistic interactions (involving nosing or chewing behaviour) and fights (agonistic behaviour involving repeated physical contact and lasting longer than 5 seconds). It was also possible to determine the percentage of agonistic interactions which had a clear outcome (successful displacement of one pig by another) and which escalated beyond a simple initiation and response. Full details of recording methods are given in Mendl et al. (1992).

Tests of pituitary-adrenal function

Pituitary-adrenal function was assessed using dexamethasone (DXM) suppression and adrenocorticotrophic hormone (ACTH) challenge tests. These tests are of use in assessing the functional state of the system which may, in turn, reflect the psychological state and experiences of the individual during the preceeding few weeks. Decreased sensitivity to the suppressive effects of DXM (a synthetic glucocorticoid) on ACTH and corticosteroid production is often seen in depressed or stressed individuals (e.g. Meunier-Salaun et al., 1987; Haracz et al., 1988). A high maximal response to ACTH is often seen in individuals who have

recently been exposed to certain types of chronic stress (Dantzer et al., 1983; von Borell & Ladewig, 1989). These tests were carried out in situ in the pens and started at about 1330h. The tests differed slightly in the first and fourth pregnancies, but followed the same basic protocol. A baseline sample was collected prior to the first injection of DXM (Merck, Sharp & Dohme, Hoddesdon, UK. 1st parity: 0.02mg/kg intra-venous. 4th parity: 0.1mg/kg intra-venous). Two hours later, the ACTH injection ("Synacthen", CIBA, Horsham, UK) was given (1st parity: 4µg/kg intra-muscular. 4th parity: 5µg/kg intra-venous). Samples were collected for four hours from the DXM injection (1st parity: 1 per h. 4th parity: 1 per 20min.). At both pregnancies, saliva samples were collected. Salivary cortisol was measured using an enzyme-linked immunosorbent assay (Cooper et al., 1989). In the fourth pregnancy, plasma samples were also collected from some sows (stalls, N=6; small groups, N=6; large group, N=13) using temporary ear catheters (Zanella & Mendl, 1992), and plasma cortisol was measured using a radioimmunoassay technique. Further details are given in Mendl et al. (1992).

RESULTS

Behaviour data and pituitary-adrenal function data are considered in turn for each pregnancy. The experimental groups are referred to as stalls, small group (groups of five) and large group.

Behaviour

First pregnancy

The housing systems had clear effects on the way animals used their time. During the first three weeks in the housing systems, gilts in the small groups were least inactive and spent most time sitting/standing/moving and performing oral behaviour. Gilts in the large group were involved in most social behaviour, while gilts in the stalls spent most time performing maintenance behaviour (see Table 1).

Table 1. General Activity of Pigs

Behaviour (% obs. time)		Stall mean	(sem)	Small group mean	(sem)	Large group mean	(sem)	ANOVA F-ratio	p-value
Inactive	1st	77.37	(2.38) a	62.74	(2.57) b	78.42	(0.96) a	24.86	<0.001
	4th	30.04	(9.02) c	46.31	(4.30) b	70.67	(2.72) a	20.34	<0.001
Sit/Stand/ Move	1st	6.74	(1.15) b	9.44	(0.80) a	7.14	(0.48) b	3.35	0.042
	4th	11.44	(4.02)	11.82	(1.79)	9.57	(1.36)	0.38	NS
Social Behaviour	1st	0.30	(0.14) b	0.07	(0.05) b	0.88	(0.14) a	8.75	<0.001
	4th	1.12	(0.24) a	0.20	(0.20) b	1.08	(0.23) a	3.94	0.026
Oral Behaviour	1st	11.09	(1.35) b	24.78	(2.07) a	10.45	(0.50) b	47.25	<0.001
	4th	43.3	(6.21) a	38.98	(3.87) a	14.07	(1.66) b	25.96	<0.001
Maintenance Behaviour	1st	4.08	(0.91) a	2.07	(0.40) a	1.15	(0.17) b	12.99	<0.001
	4th	12.19	(3.69) a	2.99	(0.53) b	3.26	(0.40) b	10.40	<0.001

Data from 1st and 4th pregnancy are shown for each behaviour.
sem denotes standard error of the mean.
a,b,c denote results of post-hoc Duncan multiple range tests. Housing systems with different letters are significantly different at $p<0.05$ level.

Focal observations of three types of oral stereotypies showed that stall-housed gilts performed most sham-chewing and bar-biting while gilts in the small groups performed most trough-

biting behaviour. In total, stall-housed sows spent most time performing these behaviour patterns (see Table 2).

Table 2. Oral Stereotypies Shown By Pigs

Behaviour (s/h)		Stall mean	(sem)	Small group mean	(sem)	Large group mean	(sem)	ANOVA F-ratio	p-value
Sham-Chew	1st	27.44	(9.56) a	0.00	(0.00) b	1.68	(1.63) b	13.11	<0.001
	4th	340.1	(153.6) a	99.15	(59.9) b	7.58	(4.04) b	5.46	0.008
Bite-Bar	1st	18.19	(4.89) a	3.55	(1.04) b	0.09	(0.06) b	26.25	<0.001
	4th	166.0	(52.0) a	1.99	(0.74) b	3.61	(3.41) b	17.0	<0.001
Bite-Trough	1st	0.39	(0.39) b	2.37	(0.64) a	0.00	(0.00) b	17.11	<0.001
	4th	0.03	(0.03)	2.24	(2.11)	0.00	(0.00)	1.20	NS
Total	1st	46.03	(9.13) a	5.92	(1.32) b	1.77	(1.62) b	37.07	<0.001
	4th	506.1	(146) a	103.4	(59.5) b	11.2	(5.02) b	13.29	<0.001

Data presented as in Table 1.

Table 3. Pig Social Behaviour

Behaviour		Stall mean	(sem)	Small group mean	(sem)	Large group mean	(sem)	ANOVA F-ratio	p-value
Agonistic (/h)	1st	0.49	(0.21) c	2.17	(0.24) a	1.29	(0.11) b	17.30	<0.001
	4th	1.93	(0.45)	2.32	(0.34)	2.42	(0.27)	0.48	NS
Non-agonistic (/h)	1st	8.33	(2.06) a	4.54	(0.44) b	5.56	(0.43) b	3.70	0.03
	4th	6.53	(1.00) a	2.34	(0.26) b	1.94	(0.42) b	18.3	<0.001
Fights (/h)	1st	0.00	(0.00) b	0.00	(0.00) b	0.04	(0.01) a	5.55	0.006
	4th	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	no occurrences	
Percentage of agonistic interactions in which:-									
pig uses aggression	1st	67.7	(13.0) a	63.7	(4.78) a	32.2	(3.22) b	15.6	<0.001
	4th	58.21	(5.51) a	23.49	(5.15) b	30.81	(3.06) b	13.04	<0.001
pig actively avoids	1st	0.00	(0.00) b	2.45	(0.98) b	21.87	(2.07) a	29.10	<0.001
	4th	1.23	(0.59) c	49.06	(5.49) a	32.76	(1.91) b	40.10	<0.001
a clear result occurs	1st	16.83	(6.89) c	51.07	(4.48) b	80.13	(1.59) a	85.55	<0.001
	4th	66.54	(4.38) b	87.84	(3.50) a	92.33	(1.19) a	23.80	<0.001
escalation occurs	1st	1.28	(0.84)	2.24	(0.77)	3.97	(0.84)	1.71	NS
	4th	21.48	(2.97) a	0.72	(0.49) c	5.41	(0.87) b	47.35	<0.001

Data presented as in Table 1.

Stall-housed gilts were involved in the lowest levels of agonistic behaviour and the highest levels of non-agonistic behaviour. However, their agonistic interactions were less likely to have a clear outcome than those of gilts housed socially. Animals in the large group had the highest percentage of decisive agonistic interactions. They also used aggression least and active

avoidance most during these encounters. However, they were involved in the largest number of fights (see Table 3).

Fourth pregnancy
By the fourth pregnancy, the activity of the stall-housed sows had increased dramatically and they were now least inactive. They showed the highest levels of social behaviour (together with sows in the large group) and maintenance behaviour, and they now also showed the highest levels of oral behaviour (together with sows in the small groups). Sows in the large group were most inactive (see Table 1).

Stall-housed sows spent the most time sham-chewing and bar-biting, and showed levels of these behaviour patterns which were far higher than those seen during the first pregnancy, probably accounting for the high proportion of time that they now spent performing oral behaviour. Total stereotypy levels were also highest in the stall-housed sows (see Table 2).

Stall-housed sows continued to show the highest levels of non-agonistic behaviour, but they now performed as much agonistic behaviour as sows housed socially. Of the agonistic interactions in which they were involved, they were considerably more likely to use aggressive behaviour, to escalate the interaction, to use the lowest levels of active avoidance behaviour and to have the fewest clear outcomes in comparison to sows housed socially (see Table 3).

Pituitary-adrenal function

First pregnancy
A repeated measures ANOVA showed that gilts in the three housing systems did not differ in their salivary cortisol response to the DXM ($F=0.42$, df 2,38, $p=0.66$) and ACTH ($F=2.15$, df 2,39, $p=0.13$) injections (Fig. 1).

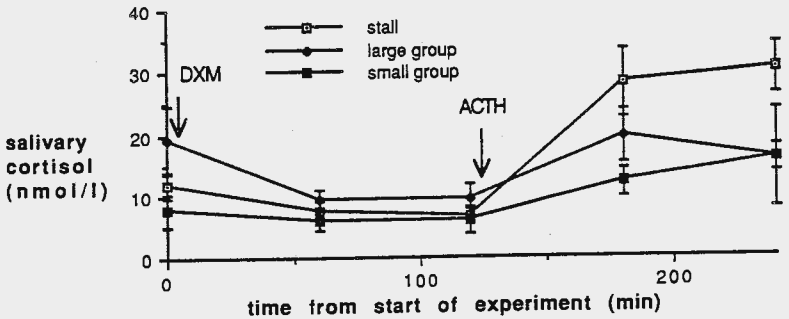

Figure 1. Mean Salivary Cortisol Levels During First Pregnancy DXM And ACTH Challenge Tests (± sem)

Data on the cortisol response in the large group were presented in Mendl et al (1992). The samples for the three conditions were reanalysed because the cortisol levels were low and, in stalls and small groups,there appeared to be no increase after ACTH injection. In the reanalysis presented here, the pattern of change for the large group is the same as in the original analysis, the levels are generally higher, and there is a clear rise after ACTH in stalls and small groups.

Fourth pregnancy
There was no significant difference between sows from the three housing systems in their plasma cortisol responses to the DXM test ($F=2.81$, df 2,20, $p=0.084$) or the ACTH test ($F=1.63$, df 2,21, $p=0.22$) during the fourth pregnancy (Fig. 2).

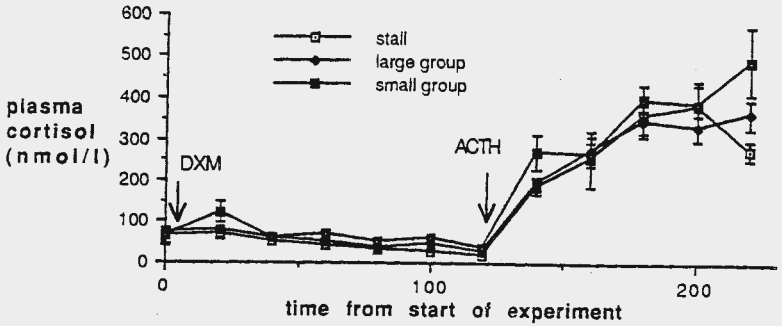

Figure 2. Mean Plasma Cortisol Levels During Fourth Pregnancy DXM And ACTH Challenge Tests (± sem)

DISCUSSION AND CONCLUSIONS

The DXM and ACTH tests did not demonstrate a clear difference in the pituitary-adrenal function of gilts housed in the three systems during the first three weeks after introduction. The behaviour data suggest that agonistic behaviour and socially induced stress may have been higher in group-housed gilts. Although stall-housed gilts appeared to be less able to sort out agonistic interactions decisively (perhaps due to the bars impeding their interactions (Barnett et al., 1987)), they were generally involved in fewer agonistic interactions and more non-agonistic interactions than gilts housed socially. In particular, vigorous fighting was only observed in the large group and may have resulted in the high levels of active avoidance behaviour and low levels of aggression used during agonistic interactions which were observed in this housing system.

At the fourth pregnancy, no differences in response to the DXM and ACTH tests were detected. At this time, agonistic interactions occurred at similar levels in all systems, and no fighting behaviour was seen. The socially-housed sows used high levels of avoidance behaviour, low levels of aggression and had high levels of clear outcomes during agonistic interactions, all indicating the presence of a well organised social hierarchy. However, this was not the case in the stall-housed sows. In addition, these sows performed considerably higher levels of stereotypies than those housed socially, and this behaviour made up a large proportion of the time that they spent active, which itself was high relative to that of sows housed socially.

The data suggest that sows housed in groups had settled down after the social stress of mixing during the first pregnancy, while the stall-housed sows continued to experience relatively high levels of unresolved aggressive encounters with their neighbours and had developed high levels of oral stereotypies. These often occur in frustrating situations (Mason, 1991) and indicate poor welfare (Broom, 1988; 1991). In the long-term, therefore, housing sows in groups would appear to be no more stressful than housing them in stalls. In fact, the behaviour data point to considerably more long-term problems for stall-housed sows. The data also emphasise the need for research into ways of mixing pregnant pigs together to avoid undue social stress.

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