Artículos originales

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# Effects of group size on agonistic behaviors of commercially housed growing pigs¤

## *Efecto del tamaño del grupo sobre la conducta agonística de cerdos en crecimiento alojados en instalaciones comerciales*

## *Efeitos do tamanho do grupo sobre a conduta agonística de suínos em crescimento alojados em instalações comerciais*

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***Summary***

***Objective: this study was conducted to understand the effects of group size on the agonistic behaviors of pigs reared at differing pen densities. Methods: thirty groups of pigs (a total of 350 individuals) housed at low, medium, and high group density (5, 10, or 20 individuals in 6.0 m x 6.0 m pens) were consecutively observed for 10 h on days 30, 90, and 180 with the aid of video technology. Results: the frequency of vocalizations was lower at low group density and higher at high group density on all investigated days. Pigs housed at high group density showed significantly more agonistic behaviors than those at low group density. Conclusions: the study reveals a higher level of aggression in older pigs and at high group density. It is concluded that group density is a major cause of the observed agonistic behaviors.***

**Key words:** *aggression, housing, pen density, swine, vocalization.*

***Resumen***

***Objetivo: este estudio busca comprender los efectos del tamaño del grupo sobre los comportamientos agonísticos de cerdos criados en corrales bajo diferentes densidades de animales por unidad de espacio. Métodos: treinta grupos de cerdos (un total de 350 animales) alojados en baja, media y alta densidad de animales (5, 10 ó 20 animales en corrales de 6.0 x 6.0 m) fueron observados durante 10 horas consecutivas en los días 30, 90, y 180 con la ayuda de tecnología de vídeo. Resultados: la frecuencia de vocalizaciones fue menor en el grupo de baja densidad de animales, y mayor en el grupo de alta densidad durante todos los días estudiados. Los cerdos alojados en grupos con alta densidad animal mostraron un comportamiento significativamente más agonístico que aquellos en baja densidad. Conclusiones: este estudio revela que***

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***existe un mayor nivel de agresión en los cerdos más viejos y en grupos con mayor densidad de animales. Se concluye que la densidad de alojamiento es una causa importante de la conducta agonística observada.***

**Palabras clave:** *agresividad, alojamiento, densidad en corral, porcino, vocalización.*

***Resumo***

***Objetivo: este estudo busca compreender os efeitos do tamanho do grupo acerca dos comportamentos agonísticos dos suínos criados em corrais sobre diferentes densidades de animais por unidade de espaço. Métodos: trinta grupos de suínos (um total de 350 animais) alojados em baixa, meia e alta densidade de animais (5, 10 ou 20 animais em corrais de 6.0 x 6.0 m) foram observados durante 10 horas consecutivas nos dias 30, 90 e 180 com a ajuda de tecnologia de vídeo. Resultados: a frequência de vocalizações foi menor no grupo de baixa densidade de animais, e maior no grupo de alta densidade durante todos os dias estudados. Os suínos alojados em grupos com alta densidade animal mostraram um comportamento significativamente mais agonístico que aqueles em baixa densidade. Conclusões: este estudo revela que existe um maior nível de agressão nos suínos mais velhos e em grupos com maior densidade de animais. Concluiu-se que a densidade de alojamento é uma causa importante da conduta agonística observada.***

**Palavras chave:** *agressividade, alojamento, comportamento agonístico, densidade, suíno.*

## Introduction

Mixing pigs is a common practice in modern swine husbandry. With the development of group housing systems for pigs, the benefits of group housing have been addressed in previous research (Weng *et al*., 2009; Baxter *et al*., 2010). However, the effects of group housing on behavior and welfare of pigs have not been well documented (Hillmann *et al*., 2003). The post-weaning regrouping of pigs is an especially highly stressful event and is one of the major welfare concerns of the pig industry (Arey, 1999). When mixing, nearly all unfamiliar individuals are involved in agonistic interactions (Frazer and Broom, 1997). The number of aggressive interactions following grouping correlates with the amount of lesions found on pigs (Barnett *et al*., 1992) and can provide a useful measure of welfare (Barnett *et al*., 1996). Aggression among pigs can be perpetuated and the welfare of subordinate group members may then suffer as a result of competition for food and space (Petheric and Blackshaw, 1987).

Anil *et al*. (2006) showed that the process of mixing unacquainted sows is associated with an increased stress level, which leads to a rise in salivary cortisol concentration. Lower ranking animals may be especially affected by impaired welfare due to social stress, which influences physiological and reproductive parameters (Hoy *et al*., 2009; Strawford, 2006). Under natural conditions unfamiliar pigs are hardly ever integrated into an established group (Gonyou, 2001).

Aggressive behavior can be observed in various behavioral contexts and occurs, for example, while competing for limited resources (Csermely and Wood-Gush, 1987) or in order to secure the social position of an individual animal and to establish a social structure within a group of individuals (Hagelso Giersing and Studnitz, 1996). Agonistic behaviors, such as opposing aggression and defensiveness, are part of the normal behavior patterns of pigs. As agonistic interactions inevitably occur when unfamiliar sows are grouped (Mendl and Deag, 1995; D'Eath and Turner, 2009), great challenges arise from keeping sows in groups (Gonyou, 2003). Severe manifestations of social stress can lead to delayed estrous, aborted fetuses, increased farrowing time, and failure to lactate (Varley and Stedman, 1993).

There is little evidence of an optimum group size at which fighting and aggression between pigs is minimized. Similarly, there is little evidence of an optimum space allowance to reduce fighting, although the provision of more space can decrease the levels of aggression over the long term. More work is needed to determine whether pigs adopt different agonistic strategies according to group size and composition. This study was conducted in order to assess the effects of group size (confined or

loose housing) on agonistic behavior of pigs that are mixed during the growing period.

## Methods

The experiment was conducted at a commercial swine farm located in Ansung (Gyeonggi Province, Korea) using a total of 350 pigs (Yorkshire x Landrace). Pigs were farrowed in 6.0 m x 6.0 m pens with solid concrete flooring and a heat lamp. Piglets were weaned at 20 (± 1.2) days of age and mixed at different densities: five (low density), ten (medium density), or twenty (high density) individuals in a 6.0 m x 6.0 m pen. The environmental control systems were the same among all housing facilities. The temperature in each room was controlled by ventilation fans and heaters and was maintained at approximately 20 ± 2 ºC. Pigs had *ad libitum* access to feed and water.

Ten replicates of each treatment were evaluated during 2006 and 2007. Two wide angle video cameras were installed at opposing corners at the ceiling of the stable so that the pen could be observed from two directions. The behavior of the pigs in the group was video-recorded continuously for 10 h per day during three non-consecutive days. Behaviors were analyzed from images digitally recorded from 08:00 to 18:00 h on days 30, 90, and 180 (day 0 = birth day). Video tapes were analyzed using a video recorder with jog-shuttle function. Instantaneous scan sampling was carried out at 2-min intervals. All video recordings were viewed by a trained observer who was blinded to the treatments to eliminate subjective bias and inter-individual discrepancy (Li and Wang, 2011).

Vocalizations were registered by direct observation from the videos. Occurrences of the following behaviors were recorded: inactivity, chewing on other animals, locomotion, pen exploration, drinking, feeding, excretion, tail biting, belly nosing, agonistic behavior, fighting, and other social interactions and behaviors (Table 1). The frequency and duration (in seconds) of these behaviors was recorded from the videos on days 30, 90, and 180, together with which individual pigs were performing and receiving the behavior.

**Table 1.** Observed behaviors and their respective definitions (adapted from Hötzel *et al*., 2004; Statham *et al*., 2011). All behaviors were recorded in the scan sampling.

| Behavior | Description |
|---|---|
| Inactive | Motionless or sleeping. |
| Chewing | Chewing (not on another pig) with its head raised and away from the feeder. |
| Locomotion | Any movement including walking, running, scampering, and rolling. |
| Pen exploration | Sniffing, touching, sucking or chewing any object that is part of the pen. |
| Drinking | Drinking water or manipulating the drinker with or without ingestion of water. |
| Feeding | Head positioned in the feeder or chewing food displaced from the feeder. |
| Excretion | Defecating or urinating. |
| Tail biting | Having the tail of another pig in its mouth and biting or pulling hard enough to cause a reaction in the other pig. |
| Belly nosing | Repeated thrusting of snout into the belly of another pig. |
| Agonistic | Head-thrusting, ramming, biting, or pushing another pig. |
| Fighting | Biting another pig. |
| Other social | All other social interactions including mounting, head rubbing and nosing parts of the body other than the belly. |
| Other | All other behaviors not listed above. |

All agonistic interactions were registered by recording the time of occurrence, the pigs involved, and the dominant and defeated animal resulting from the interaction. In this context, agonistic behavior was defined as follows: aggressive behavior between two pigs involving physical contact (biting, knocking, or lateral fighting with the opponents standing in antiparallel position, both performing bites or knocks) starting with the first physical contact and ending with submissive behavior (escape) shown by one of the opponents, or when both pigs moved away from each other (Borberg and Hoy, 2009; Krauss and Hoy, 2011).

In particular, fighting behavior within agonistic interactions was monitored. Fighting was considered to have begun when a pig bit another pig and the fight lasted for more than 1 s, and to have terminated when the pigs were separated for 5 s after a fight (Samarakone and Gonyou, 2009). The number of fights, duration of fights, and latency to the first fight was registered. Behavioral time values presented are the means and standard errors of the

relative frequencies of each behavior, by calculating results obtained from each observation of each group.

All data were analyzed by using the Glimmix procedure of the SAS software (SAS Inst. Cary, NY) with the pen as the experimental unit. The residual data sets were tested for normal distribution using the Univariate Procedure of SAS. The data were not distributed normally and were transformed using the logarithm ($X'$ = log 10($X$ + 0.5) + 0.5) to achieve normal distribution (Zar, 1999). The data were analyzed by ANOVA. Tukey's *post hoc* tests were used to determine pair-wise differences between treatments. *P* values are presented.

## Results

The frequency of vocalizations was significantly affected by density (ANOVA, $F_{2,18}$ = 21.3, $p$<0.001) and time ($F_{2,18}$ = 9.7, $p$<0.05). At medium and high density, the frequency of vocalizations was highest on day 180 and lowest on day 30. The frequency of vocalization on day 180 was higher at the high group density than at low and medium densities (Tukey's test, $p$<0.01) (Figure 1).

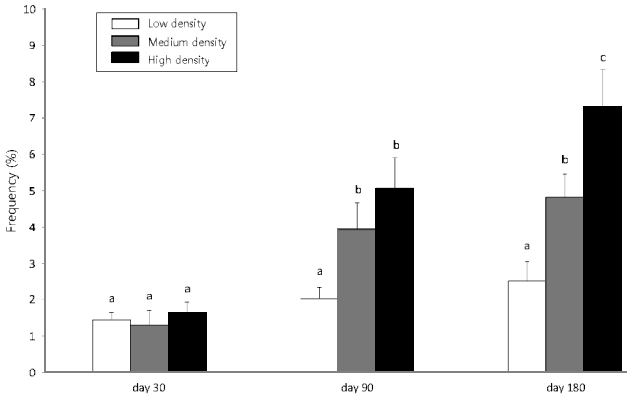


**Figure 1.** Square root transformed least square means (± SE) for proportion of time spent vocalizing at days 30, 90, and 180 in groups of pigs mixed at different densities (low, medium, and high). Different letters indicate significant differences between mean values on a given day ($p$<0.05).

The agonistic interactions among pigs were also significantly affected by density ($F_{2,18}$ = 6.4, $p$<0.05) and time ($F_{2,18}$ = 17.5, $p$<0.01). On day 30, the time spent in agonistic interactions was not significantly different among the density groups ($F_{2,18}$ = -2.5, $p$=0.21). However, on day 90 ($F_{2,18}$ = 5.6, $p$<0.05) and day 180 ($F_{2,18}$ = 19.2, $p$<0.01) agonistic interactions were significantly different among the density groups. Agonistic interaction was greater on day 180 than on days 30 and 90 ($p$<0.05) (Figure 2).

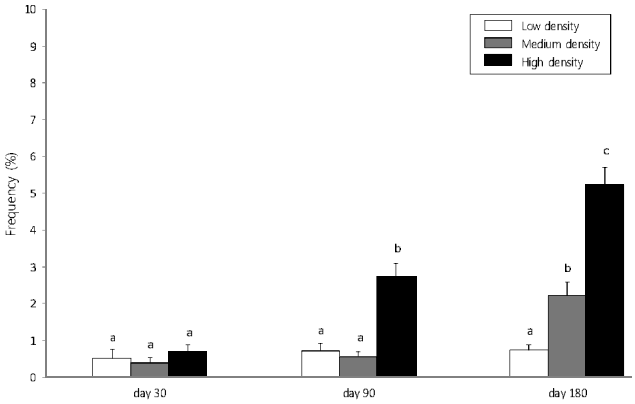


**Figure 2.** Square root transformed least square means (± SE) for proportion of time spent in agonistic interactions at days 30, 90, and 180 in groups of pigs mixed at different densities (low, medium, and high). Different letters indicate significant differences between mean values on a given day ($p$<0.05).

On day 30, fight latency ($F_{2,18}$ = -2.6, $p$=0.12), total duration of fighting ($F_{2,18}$ = -4.3, $p$=0.34), and fight frequency ($F_{2,18}$ = -9.4, $p$=0.31) were not significantly different among the density groups. At day 90, fight latency ($F_{2,18}$ = 6.9, $p$<0.05) and total duration of fighting ($F_{2,18}$ = 3.8, $p$<0.05) were significantly higher in the high-density group compared with groups in the low and medium densities ($p$<0.05). Fight frequency was not significantly different among the density groups on day 90 ($F_{2,18}$ = -3.7, $p$=0.37). All variables (fight latency, $F_{2,18}$ = 6.5, $p$<0.05; total duration of fighting, $F_{2,18}$ = 18.2, $p$<0.01; fight frequency, $F_{2,18}$ = 12.7, $p$<0.01) were significantly different among the density groups on day 180 with higher values in the high-density group ($p$<0.05) (Table 2).

**Table 2.** Fighting at days 30, 90, and 180 in groups of pigs housed at different densities (low, medium, and high).

| | Day 30 | | | Day 90 | | | Day 180 | | |
|---|---|---|---|---|---|---|---|---|---|
| | low | medium | high | low | medium | high | low | Medium | high |
| Fight latency (min) | 2.4 | 2.7 | 3.1 | 2.9 | 4.6 | 12.4 | 9.4 | 11.3 | 28.6 |
| Transformed data | 0.8[a] | 0.8[a] | 0.9[a] | 0.9[a] | 1.1[a] | 1.8[b] | 1.6[b] | 1.7[b] | 2.2[c] |
| Total duration of fighting (sec/h) | 15.2 | 11.7 | 14.3 | 17.2 | 19.8 | 52.6 | 23.1 | 69.4 | 104.8 |
| Transformed data | 1.6[a] | 1.5[a] | 1.6[a] | 1.6[a] | 1.7[a] | 2.3[b] | 1.8[a] | 2.4[b] | 2.9[c] |
| Figh frequency (n/h) | 0.2 | 0.2 | 0.3 | 0.4 | 0.7 | 0.8 | 0.5 | 1.8 | 5.3 |
| Transformed data | 0.1[a] | 0.1[a] | 0.2[a] | 0.2[a] | 0.3[a] | 0.3[a] | 0.2[a] | 0.9[b] | 1.4[c] |

Different letters indicate significant differences between mean values on a given day ($p$<0.05).

Frequency of tail biting did not differ among the density groups on day 30 ($F_{2,18}$ = 0.2, $p$=0.26) and day 90 ($F_{2,18}$ = 1.3, $p$=0.14), but was significantly higher on day 90 compared with day 30 ($p$<0.05). On day 180, tail biting frequency was significantly different among the density groups ($F_{2,18}$ = 7.2, $p$<0.05), with a significantly higher frequency of tail biting among pigs in the high-density group than in those at low and medium densities ($p$<0.05). There was no difference in tail biting frequency between the low and medium densities (Figure 3). Both density (ANOVA, $F_{2,18}$ = 5.3, $p$<0.05) and day ($F_{2,18}$ = 4.7, $p$<0.05) had a significant effect on tail biting, but there was no interaction between these factors ($F_{2,18}$ = 0.5, $p$=0.08).

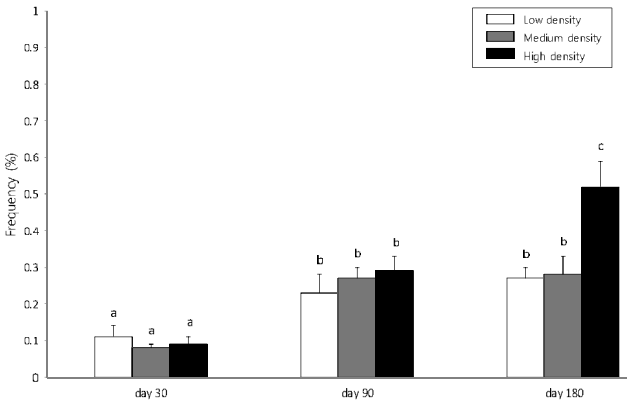


**Figure 3.** Square root transformed least square means (± SE) for proportion of time spent in tail biting per hour (means ± SE) at days 30, 90, and 180 for groups of pigs mixed at different densities (low, medium, and high). Different letters indicate significant differences between mean values on a given day ($p$<0.05).

## Discussion

The main objective of this study was to conduct a detailed investigation of the effect of group size on the agonistic behavior of pigs at different ages. Of particular interest was the impact that high density had on vocalization, agonistic interactions, fighting, and tail biting. The results of this study indicate that agonistic behavior increases as pigs grow. In particular, the older pigs (day 180) in the high-density group were more aggressive than those at low density.

Generally, fighting occurs between pigs that are unfamiliar with each other (Arey and Edwards, 1998). Fighting establishes relative social ranking (Meese and Ewbank, 1973) thereby reducing the need for outright aggression to settle future disputes between animals; however, there is a higher level of agonistic behavior among pigs in the groups of medium and high densities. Spacing between individual animals in a test pen with the high density group was previously shown to be associated with agonistic behavior (Rushen, 1988; Moorse *et al*., 1994; Jensen *et al*., 1996). Thus, aggressive interactions may continue between familiar animals, but they do so at much lower levels unless resources such as food (Baxter, 1989) or space (Arey *et al*., 1992) become limited.

Fighting for resources among pigs usually lasts longer than fighting for dominance hierarchy (Langbein and Puppe, 2004). In the present study, fighting among pigs in the high-density group was

more vigorous on day 180, with longer duration and higher fight frequency. On day 30, few fights among pigs were observed for all three densities because pen size was large enough for the piglets. However, by day 180 the older pigs were suffering from space stress and the number and frequency of agonistic interactions were higher at high group density compared with low group density.

Vocalization may be an indicator of status for pigs (Rhim *et al*., 2008). A large number of calls occurred in the groups that were housed at high density. Moreover, vocalization increased with the age of the pigs. The frequency of vocalization was the highest in the high-density group on day 180.

In conventional swine production, pigs are usually mixed at weaning and during the early growing stage to efficiently utilize housing facilities. Mixing of unacquainted pigs induces aggression and, consequently, can result in injuries (O'Connell *et al*., 2005). Mixing can also cause a setback in growth rate (Li and Johnston, 2009). Since fights among older pigs are more intensive and cause more injuries than fights among younger pigs (Weary *et al*., 2002), animals in commercial growing systems may modify their behavioral response to mixing during later stages of production.

It was observed in the present study that limiting space tends to increase aggression among growing pigs. In addition, aggression levels are greater at higher stocking rates. The aggression that occurs during mixing results in stress responses, and such responses could have detrimental effects on productive parameters.

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