ABSTRACT

Gestation sow housing is a contemporary animal welfare issue with legislative actions in the United States to ban individual gestation sow systems. This review sought to summarize the scientific literature since earlier reviews were published in 2004 and 2005. Seventeen papers comparing effect of housing systems on the welfare of gestating sows were published from 2005 to 2012. Stalls or crates, tether housing, and group pens including conventional group pens, loose-house pens, electronic sow feeders pens, and hoop barns were reported. The majority of recent findings were similar to the previous conclusions from papers and reviews. Cortisol concentrations were not different between stalled and group-penned sows but were higher shortly after mixing in concert with increased sow aggression and skin lesions. The effects of gestation housing system on neutrophil:lymphocyte ratio were still mixed. In the recent literature, stereotypes were greater among stalled sows compared with group-penned sows, which may reflect a change in sow genetics, because the basic housing systems have not changed. Recent papers indicated more sitting or standing inactive, leg and claw problems, and higher farrowing rate (in some studies) among stalled sows. Other studies reported more lying down among group-penned sows and no differences in other reproductive and productivity measures between stalled and group-penned sows. Weaning-to-estrus intervals were similar between stalled and group-penned sows in contrast to previous reviews that observed a shorter interval among stalled compared with group-penned sows. In conclusion, recent papers found similar productivity, physiology, health, and behavior among individually or group housed sows during gestation.

Key words: pig, sow, gestation housing, welfare

INTRODUCTION

Gestation sow housing is a social issue in Europe, North America, Australia, and New Zealand. The primary concern is about the welfare of pregnant sows kept in individual gestation crates (also called stalls). The gestation crate does not allow the sow to turn around or make normal postural adjustments. However, the gestation crate is the most common system used in the United States because it minimizes space needs and provides a means to individually feed and care for pregnant sows. Tether housing and crates or stalls for individual sows have been perceived as housing systems that cause poor welfare. Therefore, European countries and several states (FL, CA, AZ, OR, CO, RI, at least) have banned or are phasing out gestation crates. Retailers (grocery and restaurant) have made public statements that they will preferentially buy pork from farms that do not use gestation crates. Still, the industry defends the gestation crate as a viable sow housing system.

Two reviews of the scientific literature about the welfare of pregnant sows were published in 2004 and 2005 (McGlone et al., 2004; Rhodes et al., 2005). In the past 8 yr more research has been published that sought to compare the welfare of pregnant sows in individual gestation crates and group pens. The objectives of this review were (a) to summarize the current scientific literature on the welfare of gestation sow housing systems and (b) to determine if the conclusions of the recent literature differ from the
Table 1. Methodologies in reviewed recent literature

<table>
<thead>
<tr>
<th>Authors</th>
<th>Animal; parities</th>
<th>Housing systems compared</th>
<th>Space allowance (m²/sow)</th>
<th>Bedding</th>
<th>Group sizes, replicates</th>
<th>Measures</th>
</tr>
</thead>
</table>
| Chapinal et al. (2010a)  | Landrace × Large White; parities 1–9          | Stall (S), group pen (P), unprotected ESF group pen (ESF) | 1.29 (S), 2.76 (P), 2.32 (ESF) | No                | 20 Stalled sows, 2 group pens of 10 sows, and an ESF pen of 20 sows × 3 replicates | • Behavior (wk 1–2 and then every week)  
• Haptoglobin and acute phase protein (wk 11–13 and 16–18)  
• Reproduction  
• Productivity  
• Lameness and injury  
• Aggressive behavior |
| Chapinal et al. (2010b)  | Landrace × Large White; parities 1–9          | Group pen (P), ESF group pen (ESF) | 2.76 (P), 2.32 (ESF)     | No                | 2 Group pens of 10 sows and an ESF pen of 20 sows × 3 replicates |                                                                 |
| Ryan et al. (2010)       | Cull sows in 8–9 parities (studied at the abattoir) | Stall, loose house       | NA                       | Yes (straw for loose house) | 4,120 Stalled sows from 5 farms, 2,900 loose-housed sows from 2 farms (group size of 100) | • Lameness score  
• Joint pathologies |
| van der Staay et al. (2010) | Great Yorkshire/Large White × Dutch Landrace; parities 2–13 | Tethering (T), loose house (L) | 2.2 (L)                 | No                | 59 Loose-housed sows (65–130 sows/pen), 70 tethered sows | • Plasma cortisol  
• Weights of adrenal, pituitary, and spleen  
• mRNA of PrP and β-globin in brain  
• Behavior at 8 physiological stages from estrus to dry |
| Weng et al. (2009)       | Landrace × Yorkshire gilts                    | Stall (S), group pen (P), ESF group pen (ESF) | 1.41(S), 1.80 (P), NA (ESF) | No                | 16 Stalled sows, 16 group-penned sows (5 sows/pen), 32 ESF sows | • Behavior (d 27 after weaning)  
• Reproduction  
• Productivity |
| Munsterhjelm et al. (2008) | Yorkshire (64%), Yorkshire × Finnish Landrace (36%); averaged parities 2.4 | Stall, group pen         | 1.44 (S), 5.10 (P)      | Yes (deep litter for pen) | 240 Stalled sows, 240 group-penned sows (12 pens of 20 sows) |                                                                 |
| van Wettere et al. (2008)| Purebred maternal (Large White)/terminal (Duroc) | Stall, group pen         | 1.36 (S), 2.40 (P)      | No                | 24 Stalled sows, 4 group pens of 6 sows × 3 mixing treatments | • Reproduction |
| Anil et al. (2007)       | Gilts and sows; parities 0–8                  | Stall, ESF group pen     | 1.20 (S), NA (ESF)      | No                | 82 Stalled sows, 102 group-penned sows (no group size mentioned) | • Claw lesions measured at d 110 of gestation |

Continued
<table>
<thead>
<tr>
<th>Authors</th>
<th>Animal; parities compared</th>
<th>Housing systems compared</th>
<th>Space allowance (m²/sow)</th>
<th>Bedding</th>
<th>Group sizes, replicates</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jansen et al. (2007)</td>
<td>Landrace and Yorkshire; parities 0, 1, 3</td>
<td>Stall, group pen</td>
<td>NA(S), 2.10 (P)</td>
<td>No</td>
<td>48 Stalled sows, 48 group-penned sows (mixed with other sows in 4 pens to form a group of 50)</td>
<td>• Behavior (0–3 d after mixing) • Lesion scores (+1, −1 d of mixing) • Salivary cortisol (+1, −1 d of mixing) • Reproduction • Behavior (wk 1, 9 of gestation) • Salivary cortisol (d 5, wk 9 of gestation) • Hematology and lymphocyte proliferation (wk 15 of gestation) • Reproduction • Productivity</td>
</tr>
<tr>
<td>Karlen et al. (2007)</td>
<td>Landrace × Large White; parities ≥1</td>
<td>Stall, group pen</td>
<td>1.26 (S), 2.30 (P)</td>
<td>Yes (deep rice hull for group pen)</td>
<td>640 Sows in total, group size of 85</td>
<td>• Productivity • Lesion scores (every 3 d for the first 2 wk, then every week of gestation) • Cortisol, cytokines, and acute phase proteins during gestation and after farrowing • Behavior (wk 4, 6, 9, and 13 of gestation) • Lesion scores (every 2 wk) • Productivity • Behavior (50–60 d of gestation) • Cortisol (50–60 d of gestation) • Hematology and immune (50–60 d of gestation) • Reproduction • Productivity • Lesion scores (+1, −1 d of mixing, then every week for 5 wk) • Productivity</td>
</tr>
<tr>
<td>Lammers et al. (2007)</td>
<td>25% Hamshire × 50% Yorkshire × 25% Landrace; parities 0–2</td>
<td>Stall (S), hoop barns (H)</td>
<td>1.26 (S), 3.44 (H)</td>
<td>Yes (deep cornstalks for hoop barns)</td>
<td>552 Stalled sows, 405 group penned in hoop barns (32 sows/pen, 2 pens/bam, 2 barns)</td>
<td>• Behavior (wk 1, 9 of gestation) • Salivary cortisol (d 5, wk 9 of gestation) • Hematology and lymphocyte proliferation (wk 15 of gestation) • Reproduction • Productivity</td>
</tr>
<tr>
<td>Salak-Johnson et al. (2007)</td>
<td>Sows (PIC) in parities ≥1</td>
<td>Stall, group pen</td>
<td>1.29 (S), 1.40, 2.30, and 3.30 (P)</td>
<td>No</td>
<td>51 Stalled sows, 166 group-penned sows (group size of 5)</td>
<td>• Productivity • Lesion scores (every 3 d for the first 2 wk, then every week of gestation) • Cortisol, cytokines, and acute phase proteins during gestation and after farrowing • Behavior (wk 4, 6, 9, and 13 of gestation) • Lesion scores (every 2 wk) • Productivity • Behavior (50–60 d of gestation) • Cortisol (50–60 d of gestation) • Hematology and immune (50–60 d of gestation) • Reproduction • Productivity • Lesion scores (+1, −1 d of mixing, then every week for 5 wk) • Productivity</td>
</tr>
<tr>
<td>Sorells et al. (2007)</td>
<td>Landrace × Yorkshire gilts</td>
<td>Stall, group pen</td>
<td>1.32 (S), 2.34 (P)</td>
<td>No</td>
<td>16 Stalled gilts, 8 group pens of 4 gilts</td>
<td>• Productivity • Lesion scores (every 3 d for the first 2 wk, then every week of gestation) • Cortisol, cytokines, and acute phase proteins during gestation and after farrowing • Behavior (wk 4, 6, 9, and 13 of gestation) • Lesion scores (every 2 wk) • Productivity • Behavior (50–60 d of gestation) • Cortisol (50–60 d of gestation) • Hematology and immune (50–60 d of gestation) • Reproduction • Productivity • Lesion scores (+1, −1 d of mixing, then every week for 5 wk) • Productivity</td>
</tr>
<tr>
<td>Harris et al. (2006)</td>
<td>Landrace × Yorkshire gilts</td>
<td>Stall, group pen</td>
<td>1.35 (S), 2.40 (P)</td>
<td>No</td>
<td>16 Stalled gilts, 8 group pens of 4 gilts</td>
<td>• Productivity • Lesion scores (every 3 d for the first 2 wk, then every week of gestation) • Cortisol, cytokines, and acute phase proteins during gestation and after farrowing • Behavior (wk 4, 6, 9, and 13 of gestation) • Lesion scores (every 2 wk) • Productivity • Behavior (50–60 d of gestation) • Cortisol (50–60 d of gestation) • Hematology and immune (50–60 d of gestation) • Reproduction • Productivity • Lesion scores (+1, −1 d of mixing, then every week for 5 wk) • Productivity</td>
</tr>
<tr>
<td>Hulbert and McGlone (2006)</td>
<td>Camborough 22 gilts</td>
<td>Stall, group pen</td>
<td>1.33 (S), 1.28 (P)</td>
<td>No</td>
<td>80 Stalled gilts, 80 group-penned gilts</td>
<td>• Productivity • Lesion scores (every 3 d for the first 2 wk, then every week of gestation) • Cortisol, cytokines, and acute phase proteins during gestation and after farrowing • Behavior (wk 4, 6, 9, and 13 of gestation) • Lesion scores (every 2 wk) • Productivity • Behavior (50–60 d of gestation) • Cortisol (50–60 d of gestation) • Hematology and immune (50–60 d of gestation) • Reproduction • Productivity • Lesion scores (+1, −1 d of mixing, then every week for 5 wk) • Productivity</td>
</tr>
<tr>
<td>Seguin et al. (2006)</td>
<td>Yorkshire; parities 2.8</td>
<td>Stall, group pen</td>
<td>2.00 (S), 2.30, 2.80, and 3.20 (P)</td>
<td>No</td>
<td>98 Stalled sows, 9 small group-penned sows (group size of 11–19), 6 large group-penned sows (group size of 22–31)</td>
<td>• Behavior (isolation test in piglets) • Cortisol, acute phase proteins, IgG, and TNF-α in piglets</td>
</tr>
<tr>
<td>Sorells et al. (2006)</td>
<td>Landrace × Yorkshire gilts</td>
<td>Stall, group pen</td>
<td>1.35 (S), 2.41 (P)</td>
<td>No</td>
<td>16 Stalled gilts, 8 group pens of 4 gilts</td>
<td>• Behavior (isolation test in piglets) • Cortisol, acute phase proteins, IgG, and TNF-α in piglets</td>
</tr>
</tbody>
</table>

1ESF = electronic sow feeders; NA = not available.
Finally, the current status of the welfare of pregnant sows in housing systems is presented based on the newer scientific literature.

**SYSTEMS REVIEWED**

The control system by which other systems were compared is the gestation stall (also called crate). This is the control or standard system because at this time, in North America, it is the most common system to keep pregnant sows. Any change away from the crate will incur an economic cost to pork producers and ultimately the consumer. The industry and consumers should know if this seemingly inevitable economic cost is associated with better, worse, or the same sow welfare. Although a plethora of systems can be found in which to keep pregnant sows, only a few have generated sufficient scientific literature in which comparisons can be made. These group-housing systems include the (a) group penning with or without individual feeding stalls and (b) electronic sow feeders (ESF). Other systems included in the earlier reviews (McGlone et al., 2004; Rhodes et al., 2005) from which there was insufficient new literature were the outdoor system, neck or girth tethers, turn-around stalls, and the Hurnik-Morris system. Because only 1 paper investigated girth tethers and only 2 papers examined loose-housing in hoop barns, these system will be mentioned but not highlighted.

The scope of this updated literature review is to compare individual with group keeping systems for pregnant sows. Papers have been published with single systems or in ways that ask specific questions about sow preferences or other questions about sow behavior, physiology, or health. These papers were not considered here because they did not compare sow keeping systems.

Group housing systems are more accepted by some people because as they allow the animals to express social behaviors and sows can turn around. However, group pens also pose welfare problems due to fighting of sows to compete for limited resources and in the establishment of a social hierarchy (Spoolder et al., 2009). Adopting a housing system that is good for the overall welfare of the sows should rely on scientific research results that cover several relevant welfare indicators such as behavior, physiology, health, reproduction, and productivity (CAST, 2009).

### Table 2. Effects of housing on physiology of gestating sows

<table>
<thead>
<tr>
<th>Findings from the previous reviews in 2004 (McGlone et al., 2004) and Rhodes et al. (2005)</th>
<th>Findings from 2005 to 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cortisol</strong></td>
<td><strong>• Tethered sows had higher plasma cortisol than did loose-housed sows (van der Staay et al., 2010). No variation in concentrations of plasma cortisol measured during 50–60 d of gestation between sows housed in crates and group pens (Hulbert and McGlone, 2006).</strong></td>
</tr>
<tr>
<td><strong>• Circulating cortisol concentrations of stalled and group-penned sows did not differ. However, the concentrations in tethered sows were greater compared with those in stalled or group-penned sows.</strong></td>
<td><strong>• Salivary cortisol concentrations measured at 1 and 9 wk of gestation were not different between stalled and group-penned sows (Karlen et al., 2007). However, Jansen et al. (2007) found significantly higher salivary cortisol concentrations in group-penned sows the day of relocation compared with prior moving. In addition, group-penned gilts had higher salivary cortisol levels shortly after moving to farrowing crates compared with stalled gilts (Sorrells et al., 2007).</strong></td>
</tr>
<tr>
<td><strong>Immune responses</strong></td>
<td><strong>• There were no differences in neutrophil:lymphocyte ratio, percent neutrophil phagocytosis, and neutrophil chemotaxis between crated and group-penned sows (Hulbert and McGlone, 2006).</strong></td>
</tr>
<tr>
<td><strong>• Housing did not influence neutrophil:lymphocyte ratio, immunoglobulin concentrations, antibody response against sheep red blood cell antigens, and natural killer cell activity.</strong></td>
<td><strong>• Stalled sows had higher neutrophil:lymphocyte ratio than did group-penned sows (Karlen et al., 2007).</strong></td>
</tr>
<tr>
<td><strong>Cardiovascular functions</strong></td>
<td><strong>• No differences in cytokines mRNA expressions and acute phase proteins between stalled and group-penned gilts (Sorrells et al., 2007).</strong></td>
</tr>
<tr>
<td><strong>• There was no information comparing cardiovascular response of sows in different housing systems.</strong></td>
<td><strong>• Stalled and group-penned sows had similar heart rates at rest and during activities (Harris et al., 2006).</strong></td>
</tr>
</tbody>
</table>
Multiple measures of sow welfare should be used in any evaluation of housing or penning systems. For this review, as with past reviews, 3 types of measures were considered to be direct or indirect measures of sow welfare. These categories include (a) physiology; (b) behavior; and (c) health, reproductive performance, and productivity. The categories could be split or merged, however, given that relatively few papers collected all measures.

Measures of physiology focused on the stress-hormone cortisol (which may rise during stress) and immune measures (which may increase or decrease during stress; Salak-Johnson and McGlone, 2007). Other measures of physiology such as heart and respiratory rates were not often measured in the more recent literature.

Measures of behavior include maintenance behaviors (sitting, standing, lying, feeding, drinking) and various forms of oral-nasal-facial (ONF) behaviors, including stereotyped behaviors. One particular type of ONF behavior called stereotypies is thought by some to be a critical measure of sow welfare and thus was summarized. Because of the difficulty of defining which ONF behaviors are and are not stereotypies, this review considered all ONF behaviors. However, an alterna-
The category of measures including health, reproduction, and productivity is very broad. Health measures that were tied to a putative stress response were included in measures of physiology. Measures of reproductive health and productivity are connected and logically can be in one category. Health also includes bone and foot and leg health and body and vulva lesions.

**METHODS**

The scientific literature was searched electronically. Agricola, PubMed, and Google Scholar were searched from the period of January 1, 2005, through August 1, 2012.


**FINDINGS**

Results from 17 publications from 2005 to 2012 comparing housing systems for gestating sows in a variety of aspects relating to welfare were summarized in each animal-welfare category. Methodologies used in the reviewed studies are presented in Table 1. Details of the findings by measure are provided in Tables 2, 3, 4, 5, 6.

**Physiology**

Blood or salivary cortisol concentrations have been used to determine stress among gestating sows in housing systems. Comparing stall- and group-kept sows, most authors found no differences in cortisol concentrations. The recent literature confirms the earlier reviews that sows in stalls or loose-housed pens were not different.
in a single system but not including a comparison of sows in crates and group pens. Therefore, these papers were not included in this review. After the social hierarchy was established, no differences were observed in cortisol concentrations between crated and group-penned sows (Hulbert and McGlone, 2006; Karlen et al., 2007). Cortisol was also elevated when group-penned gestating sows were moved to farrowing crates compared with sows crated during gestation and moved to farrowing crates (Sorrells et al., 2007). The restricted movement and individual housing of the farrowing crate may cause the cortisol rise among previously group-housed sows.

For stress-related immune measures, there were inconsistent results. Karlen et al. (2007) found higher neutrophil:lymphocyte ratios measured at 15 wk of gestation among stalled sows compared with group-penned, bedded sows. One could argue that with advancing pregnancy, the crate may become more cramped and therefore elicit a stress response. In contrast, Hulbert and McGlone (2006) did not find differences in neutrophil:lymphocyte ratios, percent neutrophil phagocytosis, and neutrophil chemotaxis measured at mid gestation between individually crated and group-housed sows; however, they did not collect samples over time of advancing pregnancy.

**Behavior**

Some authors argue ONF behavior should include feeding and drinking behaviors (McGlone et al., 2004), whereas others argue ONF should not include feeding and drinking oral behaviors (Damm et al., 2005). Setting this argument aside, one class of ONF behaviors—the stereotypies directed to objects such as bars and feeders—was greater among stalled sows compared with group-penned sows (Karlen et al., 2007). These recent findings are consistent with the results from the previous reviews.

Sitting or standing inactive for long periods may indicate poor welfare according to both the previous reviews and the current literature. Lying, in the opposite way, may reflect good welfare as shown if the lying behaviors in group-penned sows increased. Hulbert and McGlone (2006) found no variation in farrowing rates of sows housed in stall and group pens.

Van Wettere et al. (2008) also detected a similar in ovulation rate, number of embryos, and embryo survival in gilts kept in stalls and group pens.

Body condition scores evaluated before and after entering gestation did not differ in stalled and group-penned sows (Seguin et al., 2006). Body weight and backfat thickness were also not different between stalled and group-penned sows (Harris et al., 2006; Hulbert and McGlone, 2006; Chapinal et al., 2010a). Space allowance positively affected BW, BCS, and backfat thickness (Salak-Johnson et al., 2007). There was a similarity in BW at farrowing and weaning and backfat thickness at breeding, farrowing, and weaning in sows housed in crates or group pens (Hulbert and McGlone, 2006).

### Table 5. Effects of housing on reproductive performance of gestating sows

<table>
<thead>
<tr>
<th>Findings from the previous reviews in 2004 (McGlone et al., 2004) and Rhodes et al. (2005)</th>
<th>Findings from 2005 to 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weaning-to-estrus interval</strong></td>
<td>Munsterhjelm et al. (2008) observed no difference in weaning-to-estrus interval between stalled and group-penned sows. This was consistent with a report by Jansen et al. (2007). Also, weaning-to-service did not differ between stalled and group-penned sows (Harris et al., 2006; Munsterhjelm et al., 2008). In contrast, Lammers et al. (2007) noticed shorter weaning-to-estrus interval among stalled sows than among group-penned sows.</td>
</tr>
<tr>
<td>• Sows housed in stalls had shorter weaning-to-estrus interval than did those housed in group pens. Group-penned sows had similar estrus-detection rate and estrus duration.</td>
<td>• Stalled sows had higher farrowing rate than did group-penned sows (Karlen et al., 2007). In contrast, Hulbert and McGlone (2006) found no variation in farrowing rates of sows housed in stall and group pens.</td>
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<td>• van Wettere et al. (2008) also detected a similar in ovulation rate, number of embryos, and embryo survival in gilts kept in stalls and group pens.</td>
</tr>
<tr>
<td>Farrowing rate</td>
<td>• Body condition scores evaluated before and after entering gestation did not differ in stalled and group-penned sows (Seguin et al., 2006). Body weight and backfat thickness were also not different between stalled and group-penned sows (Harris et al., 2006; Hulbert and McGlone, 2006; Chapinal et al., 2010a). Space allowance positively affected BW, BCS, and backfat thickness (Salak-Johnson et al., 2007). There was a similarity in BW at farrowing and weaning and backfat thickness at breeding, farrowing, and weaning in sows housed in crates or group pens (Hulbert and McGlone, 2006).</td>
</tr>
<tr>
<td>• Farrowing rate in stalled sows was higher than in group-penned sows. Tethered sows had a lower farrowing rate than did stalled and group-penned sows. There was no difference in farrowing rates of outdoor-reared sows compared with indoor-stalled sows. Stallized sows had greater farrowing rate than did loose-housed sows during summer.</td>
<td>• Stalled sows had higher farrowing rate than did group-penned sows (Karlen et al., 2007). In contrast, Hulbert and McGlone (2006) found no variation in farrowing rates of sows housed in stall and group pens.</td>
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<td>• van Wettere et al. (2008) also detected a similar in ovulation rate, number of embryos, and embryo survival in gilts kept in stalls and group pens.</td>
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Van Wettere et al. (2008) also detected a similar in ovulation rate, number of embryos, and embryo survival in gilts kept in stalls and group pens.
kept sows. Clearly, mixing sows into new social groups will elicit aggression that will resolve itself over time. And smaller spaces can lead to increased lesions among group-housed sows, possibly due to increased aggression with smaller floor space (but this was not directly studied).

**Health, Reproductive Performance, and Productivity**

Body lesions (mostly resulting from fighting especially shortly after mixing) and locomotory problems have been investigated to determine welfare of sows housed in different systems. Concerning foot and leg problems, results were mixed. Conventional group-penned sows and those kept in ESF had more lameness scores and claw lesions than did stalled sows as long as there was no bedding (Harris et al., 2006; Anil et al., 2007). In contrast, Karlen et al. (2007) reported more lameness among stalled sows than among group-penned sows provided deep bedding. However, in an epidemiological study, Ryan et al. (2010) observed similar lameness scores and joint pathologies between sows housed in stalls and loose-housed pens where bedding was provided. Therefore, lameness may be more a function of the absence of bedding rather than housing system.

The previous reviews concluded that weaning-to-estrus interval in gestating sows reared in stalls was shorter than in those kept in group pens. However, from the current results, weaning-to-estrus interval and weaning-to-service interval were not different between stalled and group-penned sows (Table 5). In one study, farrowing rates were reduced in group-penned sows compared with stalled sows (Karlen et al., 2007). However, Hulbert and McGlone (2006) did not find a difference in reproduction between crated and grouped sows. Other reproductive parameters also indicate no difference due to housing. On the whole, reproductive performance was similar for sows in group pens and individual crates in the current literature.

Several reports showed no difference in litter size for sows housed in stalls compared with any type of group pens (Harris et al., 2006; Hulbert and McGlone, 2006; Jansen et al., 2007; Karlen et al., 2007; Salak-Johnson et al., 2007; Chapinal et al., 2010a). However, Seguin et al. (2006) reported higher litter size in group-penned sows than in stalled sows (10.33 ± 0.20 vs. 9.59 ± 0.34 piglets). For group-penned sows, the increase in floor space resulted in the greater litter size (Salak-Johnson et al., 2007).

Sorrells et al. (2006) studied prenatal stress in piglets born from gilts housed in stalls or pens. Piglets from individually crated mothers were lighter and required more supplemental feeding than did piglets whose mothers were group housed. These findings may not be directly relevant to the welfare of gestating sows but may relate to the welfare in the entire system because the welfare of piglets may be affected by gestation housing system.
CONCLUSIONS

Cortisol concentrations may be used as a physiological sign of stress. Cortisol concentrations were higher among group-penned sows shortly after mixing (Jansen et al., 2007). However, cortisol concentrations were not different between stalled and group-penned sows in mid gestation. Differences in immune measures were not detected between crated and penned sows. Physiological measures, on the whole, were not different between individually crated and group-kept pregnant gilts and sows. This is consistent with the earlier reviews.

Overall ONF behaviors did not differ among sows in group or individual systems. In contrast, stereotypies were higher among stalled sows than among group-penned sows in one paper (Karlen et al., 2007) but not another (Hulbert and McGlone, 2006). Excessive sitting and standing inactive may indicate poor welfare. More sitting and standing inactive were reported in stalled sows compared with group-penned sows (Karlen et al., 2007; Jansen et al., 2007; Anil et al., 2007). Higher farrowing rates were reported among stalled sows compared with group-penned sows in one study (Karlen et al., 2007), but this was not found by Hulbert and McGlone (2006). Other reproductive parameters such as ovulation rate, number of embryos, embryo survival, backfat thickness, and BCS were similar among sows kept in stalls or group pens. Most studies indicated no difference in litter size and birth weight of piglets born from sows housed in stalls or group pens. Most current findings from 2005 to 2012 were not different from those in the previous review. On the whole, few physiological, behavioral, or health differences were reported between individually crated and group-kept pregnant gilts and sows.

IMPLICATIONS

Overall, group penning and individual crating of pregnant sows support about the same level of measurable sow welfare. Grouping has negative consequences such as more body lesions that occur due to aggressive behaviors when grouped. Individual crating may cause more stereotyped behaviors of unknown cause or consequence, although this observation was not consistent across studies. A compilation of the recent scientific literature does not draw one to a different conclusion than the literature summarized in 2004 and 2005. Improvements in the welfare of sows are possible in each pregnant-sow keeping system.

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LITERATURE CITED


