Original Articles

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# Effect of floor space on the behavior of laying hens in commercial cages¤

***Area de piso y su efecto sobre la conducta de gallinas alojadas en jaulas comerciales***

***Área de piso e seu efeito sobre o comportamento de galinhas alojadas em gaiolas comerciais***

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**Summary**

**Background:** the size of commercial cages has been raised as the major component in the welfare of laying hens. **Objectives:** to describe the effect of floor space on the behavior of laying hens housed in commercial cages. **Methods:** one hundred and thirty-five Hy-Line Brown laying hens (aged 25 ~ 50 weeks) were housed in different sized commercial cages and monitored using video technology during 10 h per day at 2-week intervals. **Results:** total time spent standing, dozing, and sleeping were significantly higher in small cages than in medium and large cages. Total time spent walking was higher in large cages. Cage-pecking frequency was higher in small cages while stretching frequency was higher in large cages. Moreover, preening frequency was lower in small cages. Conspecific pecking was higher in small cages. **Conclusions:** cage size is a critical factor affecting the behavior of laying hens. This study can help managers to understand spatial relations in caged hens.

**Key words:** *animal welfare, cage size, conspecific pecking, Hy-Line Brown, spatial relations.*

**Resumen**

**Antecedentes:** el tamaño de la jaula para gallinas en explotaciones comerciales es el principal problema de bienestar animal en esa especie. **Objetivo:** describir el efecto del espacio de piso sobre el comportamiento de las gallinas ponedoras alojadas en jaulas comerciales. **Métodos:** ciento treinta y cinco ponedoras Hy - Line Brown (25 ~ 50 semanas de edad) fueron alojadas en jaulas comerciales de diferentes tamaños y se monitorearon utilizando tecnología de vídeo durante 10 horas diarias en intervalos de 2 semanas. **Resultados:** la duración total de permanencia en pie, yaciendo y durmiendo fue significativamente mayor en jaulas pequeñas que en las medianas y grandes. El tiempo gastado caminando fue mayor en las jaulas grandes. La frecuencia de picoteo a la jaula fue mayor en las jaulas pequeñas y la frecuencia del estiramiento de alas fue mayor en las grandes. Por otra parte, la frecuencia de acicalamiento fue menor en las jaulas pequeñas. El picoteo entre gallinas fue mayor en las jaulas pequeñas. **Conclusiones:** se encontró que el tamaño de la jaula es un

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factor crítico que afecta el comportamiento de las gallinas ponedoras. Este estudio podría ayudar en el manejo de la gallina ponedora enjaulada al mejorar la comprensión sobre las relaciones espaciales en dicha especie.

**Palabras clave:** *bienestar animal, Hy-Line Brown, picoteo conespecífico, relaciones espaciales, tamaño de la jaula.*

**Resumo**

**Antecedentes:** o tamanho da gaiola para galinhas de granjas comerciais é a principal questão do bem-estar animal nesta espécie. **Objetivo:** descrever o efeito do espaço sobre o comportamento de galinhas poedeiras alojadas em gaiolas comerciais. **Métodos:** 135 Hy-Line Brown (25-50 semanas de idade) foram alojadas em gaiolas comerciais de diferentes tamanhos e foram monitoradas utilizando a tecnologia de vídeo durante 10 horas por dia, em intervalos de duas semanas. **Resultados:** o tempo total gasto em pé, deitado e dormindo foi significativamente maior em gaiolas pequenas do que em gaiolas de porte mediano e grande. O tempo gasto caminhando foi maior em gaiolas grandes. A frequência de bicar a gaiola foi maior nas gaiolas pequenas e a frequência de alongamento das asas foi maior em gaiolas grandes. Além disso, a frequência de limpeza por elas mesmas foi menor em gaiolas pequenas. A bicagem entre as galinhas foi maior em gaiolas pequenas. **Conclusões:** Verificou-se que o tamanho da gaiola é um fator crítico que afeta o comportamento das galinhas poedeiras. Este estudo pode ajudar no manejo de galinhas poedeiras para melhorar a compreensão das relações espaciais nesta espécie.

**Palavras chave:** *bem-estar animal, Hy-Line Brown, bicar conspecífico, relações espaciais, tamanho da gaiola.*

## Introduction

Domestication implies that humans must support animal survival and well-being (Budiansky, 1992). However, domestication process has broken the previous close link between fitness and welfare (Keeling, 1995). Despite the major impact of density variations on the health and welfare of farm animals, it is still unclear how it affects social dynamics within the population (Estevez *et al.*, 2007; Broom, 2011).

There has been considerable discussion regarding care of animals housed in groups under intensive production systems. Synchronization of feeding and resting behavior is necessary to facilitate management of animals living in groups (Rook and Penning, 1991). However, individuals compete for available resources. Limited resources in a given space create a competitive environment that may trigger aggression and social stress (Hughes *et al.*, 1997).

High stocking densities for poultry are generally considered to restrict behavior and reduce welfare, especially of caged laying hens (Adams and Craig, 1985; Carmichael *et al.*, 1999). Chicken welfare mostly depends on physical health mediated by environmental conditions (Newberry and Tarazona, 2011). An inadequate physical and social environment can be a source of discomfort and stress (Morgan and Tromborg, 2007). Cage and enclosure size is a critically important factor in laying hens because they actively try to gain access to sufficient space (Faure, 1991).

Space availability can be limited not only by the cage size *per se*, but also by the stocking density, and individual size—as well as animal welfare—is ultimately determined by the ongoing social interactions among the birds and physical space limitations (Leone and Estévez, 2008). High group size and density are expected to increase conflicts between birds, leading to increased stress, which can also increase fearfulness, higher glucocorticoid levels, and cause a decrease in bursa weight (Ravindran *et al.*, 2006).

One of the most controversial topics regarding battery cage conditions is the minimum acceptable space that should be provided to birds (Thogerson *et al.*, 2009). On the one hand, producers want to keep large numbers of birds within a small space in order to achieve greater economic benefits. On the other hand, many researchers see crowding birds together as a major cause of reduced animal welfare (Appleby, 2004).

While there is a point at which productivity is reduced due to poor conditions, there is also a responsibility towards welfare of animals kept under human care. In order to improve animal welfare, a greater knowledge of their behavior is necessary.

Most commercial laying hens are housed in battery cages in South Korea. Behavior of laying hens in conventional cages should be considered an aspect of their welfare. In this study, the effect of space on the behavior of laying hens housed in conventional commercial cages is examined. The aim of the study was to investigate the behavior of laying hens according to the cage size in which they are kept. Our hypothesis is that laying hens differ in active behavior and social interactions according to the cage size in which they are kept.

## Materials and methods

Protocols for this experiment followed the guidelines by the National Research Council (1996). This experiment was conducted at the Applied Poultry Research Facility, Chung-Ang University in Ansung (Gyeonggi Province, South Korea), from September 2008 through May 2009 using a total of 135 laying hens (Hy-Line Brown, 25 ~ 50 weeks). Three commercial battery cage sizes were evaluated in the study: small (0.70 x 0.30 x 0.55 m, length x width x height), medium (1.00 x 0.33 x 0.55 m), and large (1.30 x 0.36 x 0.55 m). Cage floor densities were 0.042 $m^2$/bird (small cage), 0.066 $m^2$/bird (medium cage), and 0.094 $m^2$/bird (large cage). All sides of the cage including floor and top were made of wire. The cage floor was horizontal. There were no perches, laying nests, or any other furnishings in the cages. Hens (2.28 ± 0.23 kg, mean body weight ± SD) were housed at 25 weeks of age in groups of 5 birds/cage (Table 1).

The smallest cage was the standard size certified for antibiotic-free animal products by the Ministry for Food, Agriculture, Forestry and Fisheries of South Korea. Groups were housed in cages generating three experimental treatments with nine replicates per treatment. Birds were maintained in a 16:8 h light:dark cycle. Light intensity at bird's eye level was approximately 10 lux. Room temperature was maintained at 20 ± 2 °C following common commercial practice using heaters. Axial fans were used for ventilation. Fans and heaters did not generate enough noise to influence bird behavior. Feed and water were available *ad libitum* in the cages.

One wide-angle video camera was installed in front of each cage so that all birds could be observed. 10 hours series of video were recorded at 2 week-intervals from weeks 26 through 50 of age. Behavior was analyzed using a jog-shuttle function from digitally recorded images from 08:00 to 18:00 h. Video recordings were assessed by a trained observer who was blinded to the treatment in order to eliminate subjective bias and inter-individual discrepancy (Li and Wang, 2011; Rhim, 2012). Occurrences of the following behaviors were recorded: feeding, standing, walking, sitting, dozing, sleeping, pecking, stretching, and preening. Frequency and duration (in seconds) of these behaviors were recorded. All agonistic interactions were registered by recording the time of occurrence as well as the dominant and defeated birds involved in the interaction. Conspecific pecking was defined as body, head, and vent pecking.

The experimental unit was the cage. Birds were housed in different-size cages generating three experimental treatments (Table 1). Each treatment was replicated nine times. Mean cage values were used for statistical analyses. All analyses were conducted using SAS software (SAS Institute, Cary, NY). The effect of treatment was modeled for all parameters. Separate mixed-model ANOVAs were performed for each of the parameter analyses. All models included a covariance structure for repeated observations. Model

**Table 1.** Size of cages used to keep laying hens.

| Treatment | Group size | Length (m) | Width (m) | Height (m) | Length : Width |
|---|---|---|---|---|---|
| Small | 5 | 0.70 | 0.30 | 0.55 | 2.3 : 1.0 |
| Medium | 5 | 1.00 | 0.33 | 0.55 | 3.0 : 1.0 |
| Large | 5 | 1.30 | 0.36 | 0.55 | 3.6 : 1.0 |

assumptions of normality and homogeneity of residual variances were conducted. The model was checked for over/under dispersion using the scaled deviance, and corrected for this if either occurred. Tukey's post hoc tests were used to determine pair-wise differences between treatments (Zar, 1999). Significance was determined at $p<0.05$.

## Results

Duration of feeding and sitting behaviors did not differ among treatments. Duration of standing (ANOVA, $F_{2,16} = 5.32$, $p<0.05$), dozing ($F_{2,16} = 4.74$, $p<0.05$), and sleeping ($F_{2,16} = 6.19$, $p<0.05$) were, however, significantly different among treatments. Duration of standing, dozing, and sleeping was higher in small cages compared to medium and large cages (Tukey's test, $p<0.01$). Duration of walking was also significantly different ($F_{2,16} = 12.58$, $p<0.01$), being higher in large cages compared to small and medium cages ($p = 0.001$, Table 2).

There were no significant differences in feed-pecking and water-pecking frequency among treatments. However, cage-pecking ($F_{2,16} = 6.41$, $p<0.05$), stretching ($F_{2,16} = 6.08$, $p<0.05$), and preening frequencies ($F_{2,16} = 8.19$, $p<0.05$) were different among treatments. Cage-pecking frequency was higher in small cages compared to medium and large cages ($p<0.05$). Stretching frequency was higher in large cages compared to small and medium cages ($p<0.01$). Moreover, preening frequency was higher in medium and large cages compared to small cages ($p<0.05$) (Table 3).

Conspecific pecking was also significantly affected by cage size ($F_{2,18} = 7.50$, $p<0.05$). Time spent in agonistic interactions was not different for pecking behavior in large cages. However, in small ($F_{2,18} = 15.9$, $p<0.01$) and medium cages ($F_{2,18} = 4.60$, $p<0.05$), conspecific pecking was different among the different pecking behaviors. Body-pecking frequency was higher in small cages compared to medium and large cages ($p<0.05$). Head-pecking frequency was higher in small and medium cages compared to large cages. However, there was no difference in vent-pecking frequency among treatments (Figure 1).

## Discussion

There is an inevitable interaction between social requirement and space allowance (Keeling, 1995). Behavior modeling shows that crowding increases in small enclosures (Appleby, 2004). Moreover, movement restriction caused by limited space is related to social interaction (Febrer *et al*., 2006). The impact of cage size may be especially relevant for

**Table 2.** Mean time spent (±SD) in major behaviors of laying hens kept in small, medium, and large cages, from 25 to 50 weeks of age. Analyses were performed using a separate mixed-ANOVA.

| Duration (min/h) | Treatment | | | F | p-value |
|---|---|---|---|---|---|
| | Small (n = 9) | Medium (n = 9) | Large (n = 9) | | |
| Feeding | 10.2±2.5 | 11.6±2.1 | 11.4±1.8 | 0.36 | 0.25 |
| Standing | 11.4±1.9 | 5.2±1.4 | 6.3±2.1 | 5.32 | 0.05 |
| Walking | 0.6±0.3 | 4.4±0.5 | 10.1±2.2 | 12.58 | 0.01 |
| Sitting | 10.3±2.1 | 13.6±4.3 | 11.8±2.4 | 0.17 | 0.34 |
| Dozing | 11.0±4.2 | 6.4±2.6 | 6.4±1.7 | 4.74 | 0.05 |
| Sleeping | 12.4±3.5 | 7.0±1.7 | 5.8±1.2 | 6.19 | 0.05 |

**Table 3.** Mean (±SD) laying hen behaviors in small, medium, and large cages. Analyses were performed using a separate mixed-ANOVA.

| Behavior (#/h) | Treatment | | | F | P-value |
|---|---|---|---|---|---|
| | Small (n = 9) | Medium (n = 9) | Large (n = 9) | | |
| Feed-pecking | 15.7±3.2 | 16.1±2.5 | 14.6±1.9 | 0.75 | 0.42 |
| Water-pecking | 12.1±2.3 | 8.9±1.6 | 9.2±1.4 | 0.02 | 0.57 |
| Cage-pecking | 5.2±1.2 | 1.9±0.4 | 1.1±0.3 | 6.41 | 0.05 |
| Stretching | 0.9±0.2 | 2.1±0.1 | 4.3±0.5 | 6.08 | 0.05 |
| Preening | 0.5±0.1 | 5.0±1.1 | 4.7±0.6 | 8.19 | 0.05 |

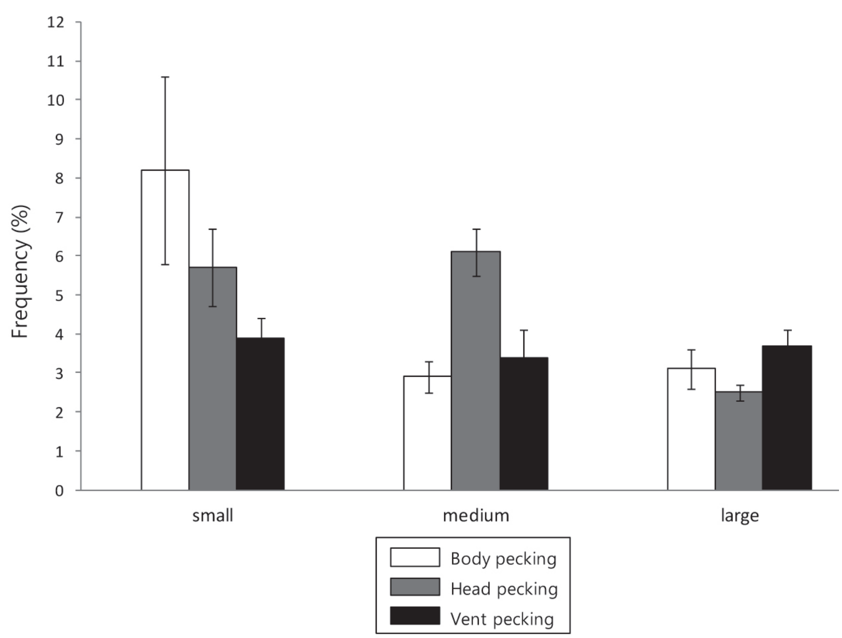


**Figure 1.** Square root transformed least square means (±SD) of time by cage-size interaction.

small cages in this study. Space provided in the small cages used in this experiment does not fit the standard size commercially used for laying hens.

Eating totaled approximately 17% of the observation period, and cage size had no effect on eating frequency in this study. Activity-related behavior (standing and walking) was affected by cage size. The number of birds standing decreased and the number walking increased in large cages (Table 2). Stereotypic back-and-forth pacing and less walking were observed in the small cages. Increased dozing and sleeping and reduced walking of birds in the small cages indicate passive responses that reduce the birds' frequency of social interactions.

Preening is necessary to keep feathers in good condition, and is affected by available space (Carmichael *et al.*, 1999). Preening behavior increased in medium and large cages (Table 3), and thus, it seems likely that the decreased frequency in small cages was the result of limited space. It is also possible that preening bouts were shortened as a result of disturbance of this behavior by jostling (Fraser and Broom, 1997).

Pecking remains a major welfare and economic problem in laying hens. In this study, body and head peckings were higher in small cages compared to medium and large cages. This seems most likely because pecking behavior is performed at small inter-individual distance. Furthermore, increased pecking could increase feather damage, feed consumption, and mortality rate, as well as decrease egg production (Lampton *et al.*, 2010; Rodenburg *et al.*, 2010).

Physical characteristics of the cage environment can have a major influence on movement and inter-individual distances (Leone and Estevez, 2008). Increased sleeping, dozing, standing, and pecking at the cage and at conspecifics are caused by reduced space (Meddis, 1975). Hens seldom performed activities such as wing flapping, stretching, body shaking, and tail wagging because they were housed in conventional cages (Nicol, 1987). Albentosa and Cooper (2004) reported significant reduction in the number of wing or leg stretches and tail wags in laying hens housed in small cages compared with birds in large cages.

Despite the fact that the small cage used in this study is the standard certified cage size for antibiotic-free laying hens in South Korea, welfare status of hens in these cages was the poorest compared to the medium and large cages. According to the results observed in this study, the standard cage size should be increased. Small cages could adversely affect welfare of laying hens. The welfare impact for hens not being able to walk, stretch, and preen should be assessed in future research.

Cage size is a critical factor affecting behavior of laying hens in commercial battery cages. Sleeping, dozing, standing, and pecking were increased in the small cages compared to medium and large cages. The increase of these behavioral bouts can be used as indicators of spatial stress in conventional cages. Knowing spatial relations in laying hens helps our understanding of their social behavior and can be used to improve welfare status in animal husbandry.

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