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Planimetric measurement as a method for scientific assessment of space requirements of young suckling piglets in the creep area

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ABSTRACT

In recent years, litter sizes of pigs have continuously increased. In modern pig production, litters with up to 15 or even more piglets born alive are no longer an exception. However, the size of heated creep areas, in which the piglets can retire to rest, has not yet been adapted to the increasing number of piglets per litter. Therefore, the objective of this study was to determine the space requirements of piglets lying in a creep area in order to assess whether common sizes of creep areas are still sufficient to accommodate all piglets of a litter. Thus, the exact floor space that suckling piglets of different weight classes occupied due to their physical size and shape was measured automatically using the colour contrast planimetric method "KobaPlan". A total number of 234 images of piglets from 0.5 kg to 6 kg was taken from top view in a special planimetric box. In the digital photo, the number of animal associated pixels was counted by the "KobaPlan" software and compared to a reference area. Thus, the area covered by the individual piglet was calculated. Thereby, it was possible to determine the space the piglets dissipated in lateral and ventral recumbent positions up to the age of three weeks. The results revealed that the space requirements of piglets increased linearly with their weights, independent of lying position. The mean floor space covered by piglets weighing 0.5–1.5 kg lying on their bellies was 249 ± 42 cm^2, and piglets lying in lateral position covered 275 ± 33 cm^2. Piglets weighing 3.0–4.5 kg covered more space than lower weight classes in ventral (554 ± 68 cm^2) and lateral positions (502 ± 41 cm^2). Piglets in the heaviest weight class (4.5–6.0 kg) required 633 ± 52 cm^2 when lying in a lateral position. Assuming that all piglets were lying in lateral recumbency, for a litter size of 12 piglets weighing up to 6.0 kg, a space requirement of 0.76 m^2 was calculated. For 14 piglets, an area of 0.9 m^2, and for 16 piglets 1.01 m^2 is needed. Bearing in mind that litter sizes are growing, a creep area of approximately 0.9 m^2 is recommended for piglets up to three weeks of age based on a space requirement of 0.06 m^2 per piglet.

1. Introduction

In modern pig production, the reproductive performance of sows is continuously increasing followed by growing litter sizes. Litters with 15 or even more piglets born alive are frequently found in modern pig breedings (Prado et al., 2013) and these large litters currently represent a major challenge for pig farming management (Baxter et al., 2013). In addition to an increased risk of piglet losses, lower birth weights and a stronger variation in birth weights within a litter (Edwards, 2002; Milligan et al., 2002; Rutherford et al., 2013), the question arises whether the current sizes of heated creep areas in farrowing pens are still sufficient to accommodate all piglets of a litter concurrently until weaning age of three or four weeks. This issue is gaining in importance because nowadays there is the possibility of rearing more piglets in the farrowing pen than the sow has functional teats by using artificial rearing systems or milk cups to supplement the milk supply of the sow (Baxter et al., 2013; Pustal et al., 2015). However, the size of the heated creep area is usually not adapted to these increased litter sizes and less space is available per piglet (Meyer, 2012). Young suckling piglets need particularly high ambient temperatures. At birth, piglets have few energy and fat reserves to maintain their body temperature by thermogenesis. Directly after birth, a particularly high energy demand is caused by evaporating of moisture on the piglets' skin. The critical body temperature leading to hypothermia of young piglets is considered to be close to 34 °C (Herpin et al., 2002). Therefore, during the first days of life, temperatures of lying surfaces in the creep area between 36 °C and 42 °C are recommended (Zentner, 2006; Schormann, 2007; Vasdal et al., 2010). Within the first week of life, piglets spend most of the day (24 h) in the creep area (Ziron and Hoy, 2003). During the second and third week of life, surface temperatures of 34 °C and

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32 °C were advised, respectively (Schormann, 2007). A creep area heated by underground heater and an additional heat lamp can reduce the drying time of the piglets after birth and meet the high temperature demands of the young animals (Le Dividich, 1983). When the piglet nest remains unheated, piglet losses within the first three days of life can increase significantly (Adams et al., 1980). On the market for barn components, different sizes of heated piglet nests are offered which can be installed in different farrowing pens. In the European Union, the legal framework for space requirements of pigs is provided by the EU Directive 2008/120/EC. However, specific guidelines for the space requirements of suckling piglets in the farrowing pen or in the creep area are lacking. Nevertheless, it is postulated that all piglets of a litter can rest in the creep area simultaneously (2008/120/EC).

Thus, the heated creep area has to be sufficiently large in order to provide space for each piglet in different recumbent positions. Usually, the sizes of common creep areas in Europe are between 0.6 m^2 and 0.7 m^2 (Von Borell et al., 2002; Wheeler et al., 2007; Anonymous, 2010; Meyer, 2012). In the USA, the size of heated creep areas in pens with farrowing crates is about 0.5 m^2 (Johnson and Marchant-Forde, 2009). Nevertheless, standardised sizes for heated creep areas do not exist because they are installed individually on each farm, being adapted to the existing farrowing pens. However, the optimal size of the creep area depends on the litter size and the time the piglets spend in the farrowing pen before weaning (Meyer, 2012). If the creep area is intended as a heated place to lie in for all piglets of a litter with up to 12 piglets for a period of three weeks, a size of 0.72–1.1 m^2 is recommended by Meyer et al. (2012) based on manual measurement of body dimensions of suckling piglets. Recommendations from other studies vary considerably with values between 0.56 m^2 and 1.7 m^2 (Littmann et al., 1997; Zhang and Xin, 2005; Wheeler et al., 2007; Vasdal, 2007). In order to assess whether common piglet nest sizes are still sufficient for the growing numbers of piglets per litter, scientific data on the exact space requirements of suckling piglets of different body weights are indispensable. Therefore, the aim of the present study was to measure the exact floor space covered by suckling piglets of different weight classes in different recumbent positions and to collect biometric data in order to define a minimum space allowance for young piglets in the creep area. Earlier methods for calculating the floor areas covered by animals were based on manual measurements (Bogner et al., 1979; Freeman, 1983). In the present study, the colour contrast planimetric method "KobaPlan" (v.01teta © Briese, 2007–2013, eduToolbox@-Bri-C GmbH, Sarstedt, Germany) was used which had already proved to be suitable for providing reasonable results for space requirement of rabbits and poultry (Giersberg et al., 2015; Spindler et al., 2016). This method was based on the fact that digital images consist of pixels and each of these pixels has a constant surface. The number of pixels associated with the animal in the picture was automatically detected and compared to the known number of pixels of a reference area. In the present study, based on the measurement of the floor area covered by piglets of different weight classes in lateral or ventral recumbent positions, recommendations for optimal piglet nest size should be given.

2. Animals, material and methods

2.1. Animals and housing

The study was carried out on a commercial pig farm located in the north of Germany. At the farm, a total of 240 sows were kept and every three weeks, about 30 sows gave birth to piglets. One week before the expected farrowing, the pregnant sows were brought to the farrowing unit. Sows and their piglets (Genetics: Danbred) were kept in conventional farrowing pens (197 cm × 259 cm) with partially slatted floor where the sows were placed in farrowing crates. Male piglets were castrated on their fourth day of life and all piglets were tail docked at the same time. Each piglet was individually marked with an ear tag during the first week of life. In each farrowing pen, a creep area (47 cm × 152 cm) was installed, equipped with hot water underfloor heating. This piglet nest consisted of an inner heating core made of polymer concrete and protective sheathing of poly-resin. In addition, the creep areas were heated by an infrared heat lamp until the third day of the piglets' life. The sows were fed twice a day automatically. Water was available ad libitum via a drinker which was integrated in the feeding trough of the sow. From three days of age until weaning on the 28th day of life, piglets were given dry feed ad libitum in the farrowing pen in addition to the sow's milk. For the water supply of piglets, three nipple drinkers per pen were available. The stables were illuminated 12 h per day, turning the light on in the morning at 8.00 a.m. and turning it off in the evening at 8.00 p.m.

2.2. Planimetric study of suckling piglets

For the present study, a total number of 234 images of piglets originating from 10 different litters were taken and analysed using the colour contrast planimetric method "KobaPlan" (v.01teta © Briese, 2007–2013, eduToolbox@Bri-C GmbH, Sarstedt, Germany). Therefrom, 121 photos of piglets in ventral recumbent position and 113 photos of piglets in lateral recumbent posture were collected. Each piglet was weighed individually (balance Kern DE 150K2DL, Kern & Sohn, Germany) and subsequently, it was photographed digitally from the top view in a special box (63 cm × 63 cm floor area). The box was made from film coated plywood, it was closed on four sides and open at the top in order to photograph the animals from the top view. Photos of suckling piglets were taken from the first to the third week of life when piglets were weighed between 0.5 kg and 6 kg. Preferably piglets which had previously slept in the piglet nest, were photographed because of their less active behaviour and, as a consequence, the easier positioning in the box. Therefore, a camera (Canon EOS 600D, Canon Inc., Tokyo, Japan) was fixed to a metal frame, 140 cm above the ground of the box. The bottom of the planimetric box was equipped with a fluorescent foil (dc-fix, Messrs. Hornschuh AG, Germany). Two black lights (45 W, 0.45 m length) were installed laterally at 8 cm and at 18 cm above the ground of the box. Thus, a high contrast between the surface of the animal's body and the ground could be achieved. In addition, it was necessary to cover the box with a black curtain to achieve the highest possible contrast. This high contrast was required so that the colour contrast planimetric method "KobaPlan" could function properly and the space covered by the piglet's body could be calculated. The "KobaPlan" software was able to calculate the number of animal associated pixels resulting in a continuous area within the photograph corresponding to the surface of the animal.

In addition, images of a reference area with known surface (A4 sheet = 623.70 cm^2) were taken using the same camera settings. Before taking the photos of the reference area, the height of the piglets was measured manually in lateral and ventral recumbent positions. Subsequently, the A4 sheet was positioned at the same height as the piglet's height using a height-adjustable bench-table lift (model: Al Grün 240*240 cm, 60*275 cm, Bochem Instrumente GmbH, Germany) and it was photographed from top view. All photos were transferred to a personal computer and analysed using the "KobaPlan" software. The IMG_inverter.py program, a subunit of the KobaPlan software v.01.teta (© Briese, 2007–2013), inverted each photograph automatically and amplified the outlines of the animal depicted. In these negatives, the kobaplan.py