SEMINA
Ciências Agrárias

DOI: 10.5433/1679-0359.2022v44n1p301

Prevalence and severity of claw lesions in sows in intensive systems in Brazil

Prevalência e severidade de lesões de casco em porcas confinadas no Brasil

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Highlights

Claw health monitoring in sows can be quickly and efficiently performed in herds.
The high prevalence of claw lesions justifies the need for frequent monitoring.
The high occurrence of severe lesions shows that claw integrity requires attention.

Abstract

Swines raised in intensive systems are highly susceptible to claw lesions. Moderate to severe lesions trigger an inflammatory response, causing pain and impairing reproductive and economic performance. Foot lesions in sows can cause considerable losses owing to reduced fertility and herd longevity. Proper diagnosis is an important step in correcting this problem; however, the seriousness of the impact of these lesions on swine herds remains unclear to most farm owners. Health monitoring has become an essential tool for veterinarians because it enables the detection of disease incidence and severity. In this study, we assessed claw lesions in sows reared under an intensive system to ascertain the prevalence and severity of lesions in Brazilian herds. The hind limb claws of 2,660 sows from 30 farms were examined for the following lesions: heel overgrowth and erosion (HOE), heel-sole cracks, white line lesions (WL), horizontal and vertical cracks in the toe wall, overgrown toes, and overgrown or missing dew claws. Claws were classified as normal (score = 0), mild (score = 1), moderate (score = 2), or severe (score = 3). At least one type of lesion was observed in 99.1% of the sows, whereas 29.7% displayed severe lesions. HOE was the most common

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Received: Nov. 28, 2022 Approved: Mar. 09, 2023

lesion (89.9% of sows) and severe WL was observed in 16.8% of the sows. Lesions increased in prevalence and severity with parity, except for WL. In young females, lesions on the volar surface were more common than those on cracked walls or overgrown toes, which should be considered when selecting gilts for breeding. A high prevalence of claw lesions was observed in Brazilian sows. Monitoring of these lesions is fast and simple. Regular monitoring provides information on claw health in a herd over time, allowing us to take measures to control and treat claw lesions, avoiding worsening of the problem, early culling of animals, and the associated productive and economic losses.
Key words: Claw integrity. Lameness. Parity order. Sow longevity.

Resumo

Suínos criados em sistemas intensivos são altamente suscetíveis a lesões de casco. Quando moderadas a graves, essas lesões desencadeiam uma resposta inflamatória, causando dor e prejudicando o desempenho reprodutivo e econômico. Em porcas, as lesões nos cascos podem causar consideráveis perdas devido à redução da fertilidade e longevidade do rebanho. O diagnóstico adequado é um dos passos mais importantes para corrigir esse problema, mas a gravidade do impacto dessas lesões nos rebanhos suínos passa despercebida na maioria das propriedades. O monitoramento sanitário tornou-se uma ferramenta essencial para os médicos veterinários, pois possibilita a detecção da incidência e gravidade da doença. O presente estudo utilizou um método de avaliação de lesões de casco em porcas criadas em sistema intensivo para verificar a prevalência e gravidade das lesões em rebanhos brasileiros. Os cascos dos membros pélvicos de 2.660 porcas, de 30 granjas, foram examinados para as seguintes lesões: crescimento e erosão da almofada plantar (AP), rachadura entre almofada plantar e sola, lesão na linha branca (LB), rachaduras horizontal e vertical da parede do casco, sobrecrescimento da unha principal e sobrecrescimento ou amputação da unha acessória. Os cascos foram classificados como normais (escore = 0) ou apresentando lesões leves (escore = 1), moderadas (escore = 2) ou graves (escore = 3). Pelo menos um tipo de lesão foi observado em 99,1% das porcas, enquanto 29,7% apresentaram lesões graves. AP foi a lesão mais comum (89,9% das porcas) e LB severa foi observada em 16,8% das porcas. As lesões aumentaram em prevalência e severidade com as ordens de parto, com exceção para LB. Em fêmeas jovens, as lesões na face plantar foram mais comuns do que as rachaduras ou sobrecrescimento das unhas, algo que deve ser levado em consideração na seleção de leitoas para reprodução. Alta prevalência de lesões de casco foi observada em porcas brasileiras. A avaliação dessas lesões é rápida e simples. O monitoramento frequente fornece informações sobre a saúde dos cascos de um rebanho ao longo do tempo, permitindo tomar medidas para o controle e tratamento das lesões dos cascos, evitando o agravamento do problema, o descarte precoce dos animais e as perdas produtivas e econômicas associadas.
Palavras-chave: Claudicação. Integridade do casco. Longevidade das porcas. Ordem de parto.

Introduction

Foot lesions are highly prevalent in pigs reared via intensive farming, and cause substantial economic losses by decreasing fertility (Iida et al., 2020) and herd longevity (Pluym et al., 2013; Wang et al., 2019). Females with foot and/or leg disorders usually are culled from the breeding herd in early parities, which brings some negative consequences to the herd: 1) increased incidence of urinary disorders and impaired reproductive performance as lameness is directly associated with pain caused by lesions (Deen et al., 2007), and pain can reduce water and feed intake (Anil et al., 2009); 2) many sows do not remain in the herd long enough to be sufficiently productive and therefore, economically viable (Supakorn et al., 2018); 3) it is an indicator of poor animal welfare on farms, as it is associated with unfavorable conditions (Supakorn et al., 2018).

Although claw lesions are common in swine and affect animal health and welfare, most farm owners lack awareness or underestimate the problem. The proper diagnosis of claw lesions is one of the most important steps in taking corrective measures. Identifying the lesions, the affected area of the claw, and their severity, and understanding how a specific lesion develops, allows us to understand the possible causes, which can be local or systemic inflammation, trauma, or an interplay between poor health of the keratinized tissue of the claw and the environment in which the animal is being raised (Ossent, 2010; Heinonen et al., 2013).

Because claw lesions are a major cause of lameness, sows with early signs of lameness must be identified and moved to a sick pen for recovery (Iida et al., 2020), following which measures must be adopted to reduce the discomfort of the animals and correct the causes that lead to the development of lesions. In addition, ascertaining the severity of lesions, their prevalence, and understanding their evolution according to the age of the animals are essential to establish preventive and corrective measures aimed at reducing negative impacts on herd performance. This study aimed to determine the prevalence and severity of claw lesions in Brazilian herds according to parity using a monitoring method.

Material and Methods

This study complies with the ethical principles adopted by the Brazilian College of Animal Experimentation (*Colégio Brasileiro de Experimentação Animal - COBEA*) and was approved by the Animal Ethics Committee (*Comitê de Ética no Uso de Animais - CEUA*/ protocol number 16/2013) of the Federal University of Paraná (*Universidade Federal do Paraná - UFPR*), Palotina Sector.

Assessments were performed from July 2012 to August 2015 on the hind limbs of 2,660 sows on 30 farms in eight Brazilian states (Distrito Federal [DF], Goiás [GO], Minas Gerais [MG], Mato Grosso do Sul [MS], Paraná [PR], Rio Grande do Sul [RS], Santa Catarina [SC], and São Paulo [SP]). The inventory of each farm comprised 270-7,108 breeding sows, and nearly 64,760 crossbred (Landrace × Large White × Duroc) gilts and breeding sows were raised on these farms. The mean number of sows on these farms was 2,159 and the standard deviation was 1,832.

The gilts and sows included in these studies were obtained from the main breeding lines in Brazil, represented by Agroceres PIC (33%), Danbred (20%), farms with various breeding lines (13%), Topigs (10%), and others (24%). The gilts and sows were raised in intensive systems. However, feeding systems and facilities were not considered in isolation, and all evaluated herds followed the guidelines of the company to which they were integrated. The animals were managed and their nutritional requirements were met according to the annual guides of the genetic lines and/or consultants.

At each farm, 10% of the breeding sows were assessed, up to a limit of 100 sows per farm, in keeping with the sample size and confidence intervals proposed previously (Gardner, 2012; Sobestiansky et al., 2012). Parity order was recorded for the assessed animals (P = 1 to ≥ 6). Up to 2.5 hours per farm was spent on each evaluation, including lesion scoring and data recording.

Random animal assessments took place in farrowing crates, with sows lying naturally on their sides. A flashlight (Coast® PX25, Coast Products, Inc., Portland, OR, USA) was used to ensure that all claw areas were adequately observed. The same assessor examined all the animals. Animals were assessed at different lactation stages. Only the hind limbs were assessed because this is where lesions were found to be more prevalent and severe (Grégoire et al., 2013); The animals lay on their sides (Nalon et al., 2013), allowing the assessor to more easily observe all areas of the foot, especially the volar surface.

Claw lesions were classified according to type and site (Figure 1) and scored according to severity (0, normal; 1, mild; 2, moderate; 3, severe) (Deen et al., 2009). These were characterized as heel overgrowth and erosion (HOE), heel-sole cracks (HSC), white line lesion (WL), cracked wall horizontal (CWH), cracked wall vertical (CWV), toe overgrowth (T), and overgrown or missing dew claws (DC) (Table 1).

The lesions were further classified as volar surfaces (HOE, HSC, and WL), walls (CWH and CWV), and toe overgrowths (T and DC). Only the most severe lesion on either the left or right limb was considered for each site or type. Data were collected from the farm, using the Zinpro® Feet First® mobile application for iPad® (Torrison et al., 2015), and gathered on a spreadsheet (Microsoft® Excel for Mac, version 15.17). The mean score was calculated farm-wise for each lesion, using the arithmetic mean scores for each animal and the type or site of the lesion.

Statistical analyses were performed using the Statistical Analysis System (SAS), version 9.0, at a significance level of 0.05. A normality test (PROC UNIVARIATE) for the degree of individual severity indicated that the variables were not normally distributed. The variables were therefore transformed (PROC RANK) to normalize the data and then submitted to an analysis of variance (PROC GLM) as a function of parity (P = 1; P = 2 and 3; P = 4 and 5; and P ≥ 6). The Student-Newman-Keuls test (SNK) was performed to compare the means that displayed significant between-group variation (PROC MEANS).

Figure 1. Classification of lesions according to type and site.
A - Normal claw, no lesion; **B** - Mild heel overgrowth and erosion and moderate white line; **C** - Severe heel-sole crack and severe white line; **D** - Severe white line; **E** - Severe horizontal cracked wall and moderate overgrowth of main toe; **F** - Moderate vertical cracked wall; **G** - Severe overgrowth of main toe; **H** - Severe overgrowth of dew claw and moderate overgrowth of main toe.

Table 1
Claw lesion characterization and scoring according to site and severity

Site[A]	Score		
	1 (Mild)	2 (Moderate)	3 (Severe)
HOE	Slight overgrowth and/or erosion in soft heel tissue	Numerous cracks with obvious overgrowth and erosion	Substantial overgrowth and erosion with deep cracks
HSC	Slight separation at the heel-sole junction	Moderate separation at the heel-sole junction	Long, deep separation at the heel-sole junction
WL	Slight separation along the white line	Moderate separation along the white line	Long, deep separation along the white line
CWH	Hemorrhage evident or grooves or slightly cracked walls, parallel to the coronary band or sole	Long, shallow cracked walls, parallel to the coronary band or sole	Multiple, long, or deep cracked walls, parallel to the coronary band or sole
CWV	Slightly cracked walls, perpendicular to the coronary band or sole	Long, shallow cracked walls, perpendicular to the coronary band or sole	Multiple, long or deep cracked walls, perpendicular to the coronary band or sole
T	One or more toes from 6 to 7 cm long on dorsal side of toe	One or more toes from 7 to 10 cm long on dorsal side of toe	One or more toes longer than 10 cm on dorsal side of toe
DC	One or more dew claws longer than 2.5 cm that do not reach floor surface when pig is standing	One or more substantially long dew claws, extending to floor surface when pig is standing	Dew claw is partially or completely missing, with blood present and obvious inflammation

[A]HOE - Heel overgrowth and erosion; HSC - Heel-sole crack; WL - White line lesion; CWH - Cracked wall horizontal; CWV - Cracked wall vertical; T - Overgrown main toe; DC - Overgrown or missing dew claw.
Adapted from Deen et al. (2009).

The prevalence and severity of claw lesions presented by animals in each parity group were analyzed based on the prevalence of individual scores within each group. The data were analyzed using a mixed model (PROC MIXED) with a fixed effect of parity group and a random effect of farm. The most appropriate covariance structure for the analyzed variables was defined according to the corrected Akaike (AICc) and Bayesian (BICc) information criteria. When the fixed effect of parity was significant, the means were compared using Fisher's test (LSMEANS Statement).

A Pearson correlation analysis (PROC CORR) was run on individual scores and parity (P = 1 to ≥ 6), considering the information on individual breeding sows and farm averages. The correlation coefficient for individual scores and parity order was adjusted for each farm using the partial option of PROC CORR.

Results and Discussion

Lesions were found in at least one claw region in 99.1% of the sows (2,636/2,660). The prevalence rates of volar surface lesions, wall lesions, and toe overgrowth were 93.7%, 89.6%, and 84.8%, respectively (Table 2). Earlier assessments and cross-sectional studies on claw lesions in sows have reported a prevalence ranging between 60-100% (Anil et al., 2007; Pluym et al., 2011; Díaz et al., 2014; Lisgara et al., 2015; Cerutti et al., 2021; Skampardonis et al., 2022), which is in agreement with the findings of this study (99.1%). Managers must be aware of this prevalence and the specific situation on their farms, as claw lesions substantially impact animal welfare, reproductive performance, sow longevity, and offspring performance (Olsson et al., 2016).

Table 2
Prevalence and severity of claw lesions in sows according to site (n = 2,660)

Score	Severity	Prevalence of lesions (%) according to site[A]						
		Volar surface			Wall lesions		Toe overgrowth	
		HOE	HSC	WL	CWH	CWV	T	DC
0	Normal	10.1	84.3	51.4	10.1	84.3	25.2	32.4
1	Mild	30.4	8.1	15.7	30.4	8.1	61.1	25.0
2	Moderate	50.5	4.8	16.1	50.5	4.8	11.6	40.5
3	Severe	9.0	2.8	16.8	9.0	2.8	2.1	2.0

[A]HOE - Heel overgrowth and erosion; HSC - Heel-sole crack; WL - White line lesion; CWH - Cracked wall horizontal; CWV - Cracked wall vertical; T - Overgrown main toe; DC - Overgrown or missing dew claws.

Evaluation of prevalence demonstrated that HOE was the most common lesion (89.9%), followed by CWH (86.4%), T (74.8%), DC (67.6%), WL (48.6%), CWV (32.6%), and HSC (15.7%) (Table 2). The high occurrence of HOE (89.9%) was consistent with other studies that reported high prevalence of HOE in sows in Brazil (Cerutti et al., 2021), Greece (Lisgara et al., 2015), Japan (Sasaki et al., 2015), and Canada (Grégoire et al., 2013). Heel lesions are normally a consequence of chronic weight overload or friction with an uneven or abrasive floor, which results in hyperkeratinization of the epidermis, forming a callus. It is primarily a physiological reaction that can trigger injuries to the claw, leading to the formation of WL, HSC, CWH, CWV, and T (Ossent, 2010). However, the observed variations in the prevalence of other lesions across studies are multifactorial and derived from differences in conditions, especially facilities, nutrition, and handling of animals before and during the study.

White line lesions were the most severe lesions, observed in 16.8% of sows, followed by HOE (9.0%) (Table 2). The WL is formed of

a cornified, delicate, and flexible tissue that joins the elastic heel tissue with the hard tissue of the toe wall and the wall with the sole (Anil et al., 2007). White line lesions are typically caused by HOE, particularly in adult animals. This overgrowth exerts excessive tension in this region when the animal is stationary or moving, leading to lesion development (Ossent, 2010). Owing to its tissue fragility, WL is also highly susceptible to the abrasive effect of concrete and the erosive effect of bacterial enzymes. Consequently, cell replacement is accelerated, resulting in the presence of many immature cells on the support surface (Van Amstel, 2010). Lesions in the WL, especially in young animals, are related to the rearing phase of the animals and may be associated with excessive moisture on the floor, such as water depth or constant contact with feces and/or urine. In these cases, injury to the abaxial WL is common, extending beyond the foot pad and forming flaps in the hoof wall and deep fissures, which are subject to bacterial infections. White line lesions are difficult to recover due to tissue fragility and the characteristic of developing "zipper type" separation (Mülling et al., 2013). This characteristic results in the deepening of the lesion perpendicular to the sole if there is no interruption of the causative agent of the injury or increased tissue resistance.

Among all lesions, 51.2%, 38.9%, and 9.9% were mild, moderate, and severe, respectively, varying according to parity (Figure 2). The observed distribution of lesion prevalence conforms to the findings of an 18-month study of 201 sows at the University of Arkansas, in which 57%, 28.5%, and 14.5% of the lesions were noted as mild, moderate, and severe, respectively (Bradley et al., 2007).

Severe lesions were observed in 29.7% of the sows assessed (790/2,660) in the present study. Sows with severe lesions may be culled precociously from the herd because of lameness or poor performance associated with pain and inflammation (Anil et al., 2009).

Considering volar surface lesions, 59.5%, 42.5%, and 32.9% of the sows displayed scores of 2 or 3 for HOE, DC, and WL, respectively (Table 2). Analysis of the prevalence of lesions by parity showed that CWH was more common than HOE in sows of parity 1. In the other age groups (2-6 years), HOE was the most common lesion (Figure 2).

The highest prevalence of CWH lesions in sows of parity 1 (83%) was also reported by Kim et al. (2019) and may be due to the greater nutritional demand of first-parity sows compared to other parities, given their continued growth, handling stress (Cador et al., 2014), physiological changes associated with birth (Lean et al., 2013), and lower feed intake at the end of gestation and early lactation (Van Riet et al., 2013), which restrict adequate nutrient intake, especially of proteins. A reduced protein supply reduces keratin formation and thus weakens the horn tissue (Van Riet et al., 2013), leading to horizontal cracks.

Starting at parity 2, HOE was the most common lesion (91.86%), although it was also meaningful at parity 1 (79,6%). Similar results were observed in an earlier study (Lisgara et al., 2015), in which older sows were more likely to present with heel lesions. The environment in which the animals are kept, friction of the heels with flooring, condition of slats, humidity, and waste, in addition to weight

gain with parity, are factors that favor heel overgrowth through hyperkeratinization and crack formation through heel displacement (Papadopoulos et al., 2021).

Analysis of the mean scores of the lesions, which established the relationship between prevalence and severity, showed that HOE was the most severe (mean score = 1.58), followed by CWH (mean score = 1.20), DC (mean score = 1.12), WL (mean score = 0.98), and T (mean score = 0.91) (Table 3). Moderate-to-severe lesions have been associated with inflammatory responses, pain, and lameness (Anil et al., 2007; Deen et al., 2007; Pluym et al., 2013) and the possibility of developing infectious lesions within the distal portions of the limbs (Engiles et al., 2022).

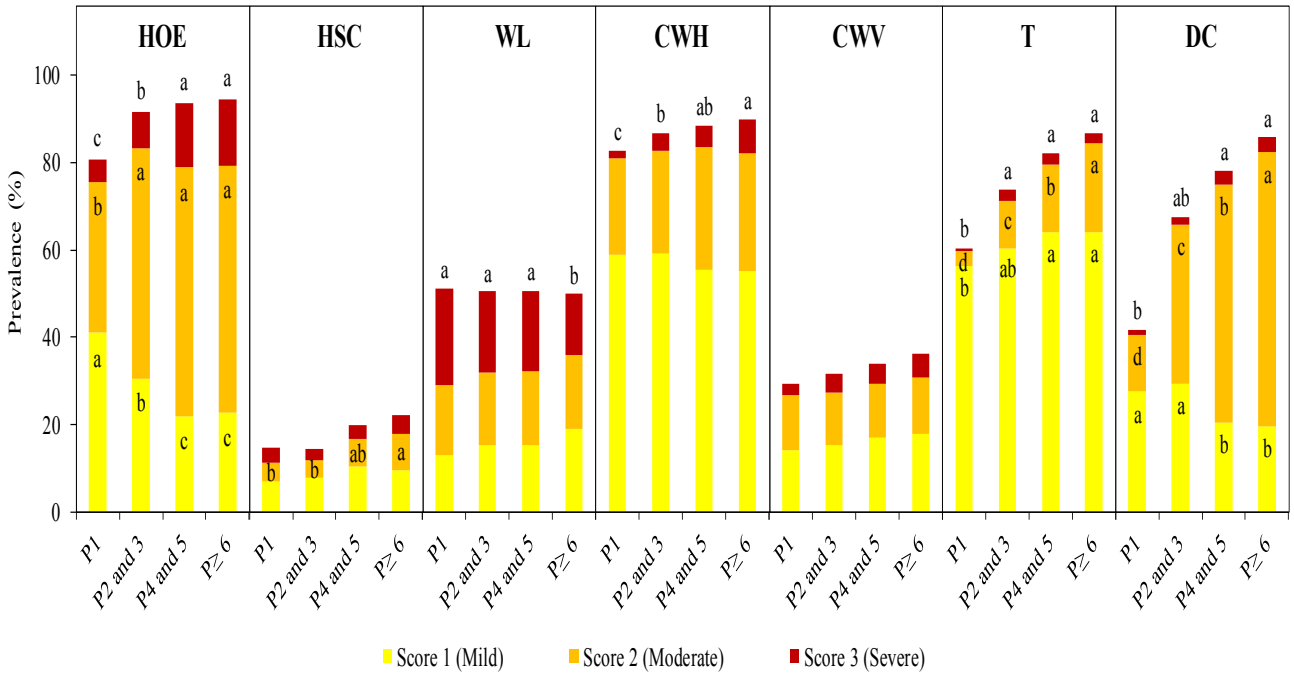

Figure 2. Prevalence and severity of claw lesions in breeding sows by parity (P).
HOE - Heel overgrowth and erosion; HSC - Heel-sole crack; WL - White line lesion; CWH - Cracked wall horizontal; CWV - Cracked wall vertical; T - Overgrown main toe; DC - Overgrown or missing dew claws.
Different lowercase letters indicate a statistically significant difference between prevalence and lesion severity according to Fisher's test ($p < 0.05$).

Table 3
Mean claw lesion scores by parity

Lesion[A]	P1 (n = 671)	P2 and 3 (n = 924)	P4 and 5 (n = 556)	P ≥ 6 (n = 509)	Mean (n = 2,660)
HOE	1.22[c]	1.60[b]	1.79[a]	1.81[a]	1.58
HSC	0.20[b]	0.24[b]	0.31[a]	0.33[a]	0.26
WL	1.06[a]	1.00[ab]	0.98[ab]	0.86[b]	0.98
CWH	1.05[c]	1.21[b]	1.28[ab]	1.32[a]	1.20
CWV	0.47[b]	0.53[ab]	0.54[ab]	0.61[a]	0.53
T	0.61[d]	0.93[c]	1.03[b]	1.12[a]	0.91
DC	0.56[c]	1.14[b]	1.41[a]	1.52[a]	1.12

[A]HOE - Heel overgrowth and erosion; HSC - Heel-sole crack; WL - White line lesion; CWH - Cracked wall horizontal; CWV - Cracked wall vertical; T - Overgrown main toe; DC - Overgrown or missing dew claw; P - Parity.
Different superscripts on the same line indicate statistically significant differences according to the SNK test ($p < 0.05$).

Regarding the mean score by parity, all lesions except WL increased with parity, whereas WL scores decreased (Table 3 and Figure 2). Previous studies (Pluym et al., 2011; Díaz et al., 2014) have shown an increased severity of lesions with aging and a greater likelihood of WL in younger sows (Anil et al., 2007), which may be related to the decrease in the WL mean score across parity orders due to the culling of animals with severe WL lesions. This pattern of WL severity with parity order was evidenced by the correlation analysis, where the correlation between parity and claw lesions showed positive results for all lesions when analyzed, both according to sow and farm, except for the WL lesion, which reduced the score throughout the productive life of the sows (Table 4).

Table 4
Correlation between parity and mean claw lesion score

Lesion[A]	Pearson correlation			
	by breeding sow		by farm	
	r	*p*-value	r	*p*-value
HOE	0.25	< 0.0001	0.37	< 0.0001
HSC	0.07	0.0006	0.21	0.0048
WL	-0.06	0.0028	-0.04	0.6229
CWH	0.14	< 0.0001	0.13	0.0682
CWV	0.05	0.0172	0.05	0.4842
T	0.26	< 0.0001	0.30	< 0.0001
DC	0.37	< 0.0001	0.53	< 0.0001

[A]HOE - Heel overgrowth and erosion; HSC - Heel-sole crack; WL - White line lesion; CWH - Cracked wall horizontal; CWV - Cracked wall vertical; T - Overgrown main toe; DC - Overgrown or missing dew claw.

According to the site of the lesion, volar surface lesions are more prevalent after parity 1 (Figure 3), which highlights the need for greater care in the selection and preparation of gilts to make animals available for reproduction, with less prevalence and severity of lesions.

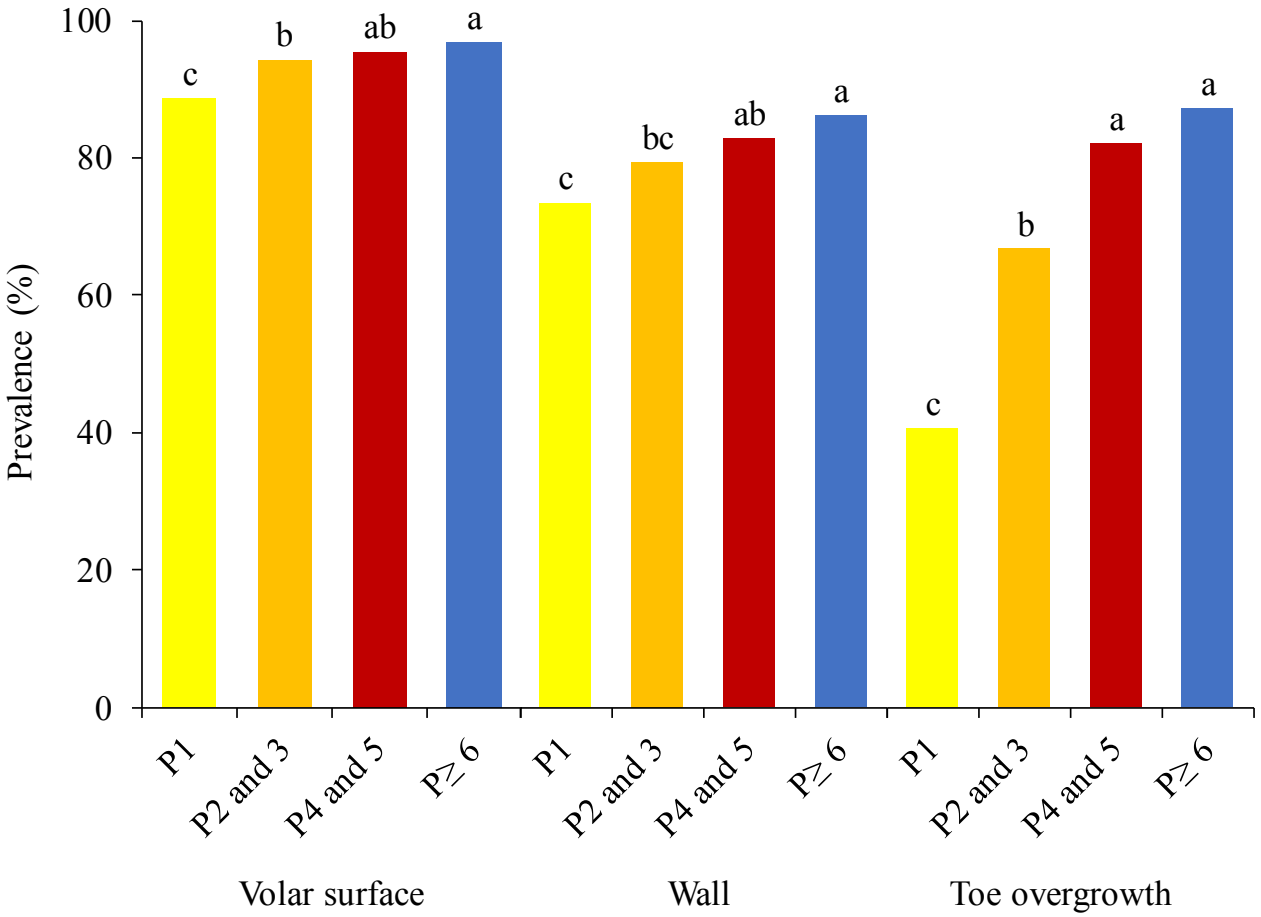

Figure 3. Prevalence of lesions in breeding sows grouped by site and by parity (P).
Different lowercase letters indicate a statistically significant difference between parity orders according to Fisher's test ($p < 0.05$).

The method used to assess claw lesions is inexpensive, but subjective because it depends on observer sensitivity, perception, training, and bias (Tuyttens et al., 2014). Assessor training and periodic retraining are vital to ensure that assessment standards and criteria are constant and that inter-observer differences are minimized (Díaz et al., 2014). To minimize the risk of variation, all assessments in the present study were performed by the same evaluator with prior experience in the task.

External validity refers to how relevant or valuable the findings of a study can be or how they can be extrapolated or "generalized" to other situations or practical applications (Knauer et al., 2007). The present study assessed sows on 30 farms, including independent and integrated systems, located in eight major pig-farming states in Brazil, representing the country's main breeding lines. The high prevalence and severity of claw lesions found in this study demonstrate their importance and the possible impact of these lesions on the health and well-being of animals, and on the productive performance and longevity of sows.

Gestation crate housing was the most common type, with only one farm using group housing and electronic sow feeders. Gestational crates are a welfare concern, and especially with slatted floors, they are important contributors to claw lesions (Cador et al., 2014). However, the farms evaluated in this study did not have the facility for pen gestation; therefore, we could not compare the differences between housing types.

The assessment of claw lesions requires minimal investment in time, especially considering the benefits of inspection and the required frequency. This is a major concern regarding on-farm monitoring, given that herds are increasingly larger and the method must be easy to use. This monitoring is not a common practice in farms; however, considering the results of this study, we recommend regular monitoring, preferably every five or six months. The higher the frequency of evaluations, the better and faster the decisions and actions to control and treat claw lesions, avoiding worsening of the problem, early culling of the animals, and the associated productive and economic losses (Abell et al., 2014; Torrison et al., 2015).

The use of the tablet application made the assessment, data collection, and storage processes faster and more reliable, primarily because it eliminated the step of entering the data into a database.

Conclusions

The prevalence of claw lesions in sows on Brazilian commercial farms assessed in this study was high, with volar surface lesions being the most common and with high incidence of lesions scored as severe. The prevalence and severity of claw lesions increased with parity, except for white line lesion, which was more common in younger sows. Claw monitoring is a fast and reliable method for estimating the prevalence of claw lesions and determining necessary interventions.

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