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Full Research Article

PRE-SLAUGHTER FACTORS THAT INFLUENCE THE OCCURRENCE OF SKIN LESIONS IN PIGS – A CROSS-SECTIONAL STUDY

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Abstract

Skin lesions are iceberg indicators of animal welfare. The study of the bruises in pig carcasses allows the inference of how and when a traumatic moment that resulted in the injury occurred, as well as its severity.

A cross-sectional study to investigate the association between pre-slaughter factors and the type of skin lesions in cross-breed fattening domestic pigs was performed on 300 pigs slaughtered in a slaughterhouse in Northern Portugal. Data on the sex of the animals, animals' origin, transport time and lairage time were collected. Skin lesions were evaluated according to location (region) on the carcass, shape, size, number of

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lesions per region and lesion age (colour). Descriptive, univariate and logistic regression analyses were performed (considering $p \leq 0.01$).

A total of 468 injuries were recorded, distributed by different carcass regions. Most of these injuries occurred on the back (37.2%) and temporally close to slaughter (94.2%). Castrated males were more predisposed to present bruises probably related to fights between animals. Females and animals subjected to longer transport times were more likely to have skin lesion injuries resulting from poor handling. The study highlights the importance of regular monitoring of welfare indicators in a pre-slaughter context for more efficient surveillance of animal welfare.

Key words: animal welfare, slaughter, skin lesion, swine

INTRODUCTION

Skin lesions in pigs can be considered indicators of well-being and a reflection of the quality of the social and physical environment (Faucitano, 2001; Driessen *et al.,* 2020). Most of the skin lesions found during the sanitary inspection at the slaughterhouse are traumatic in origin, often due to fights between animals, but are also inflicted by humans (Nielsen et al., 2014; Barington et al., 2016; Bottacini et al., 2018).

Skin lesions linked to aggressive behaviour can be divided into bruising and penetrating injuries that vary according to severity, size and shape (Nielsen et al., 2014). Extensive and deep injuries could suggest that the animal has been trampled, and rectangular injuries suggest the use of blunt objects, such as the electric prods and sticks used to drive the animals (Varón-Álvarez et al., 2014).

As for injuries inflicted by other pigs, bite injuries are characterised by having a comma shape and will be more concentrated in the cranial region (Tönepöhl et al., 2013; Dall et al., 2016). However, longer, thin, comma-shaped lesions concentrated in the posterior region can be related to mounting behaviours and are caused by the hooves of the forelimbs of other pigs (Tönepöhl et al., 2013). Injuries inflicted by humans are mostly characterised as multiple, and their uniform pattern can help to deduce the type of object used to inflict the injury; they are often located in the dorsocaudal and dorsolateral regions of animals (Barington et al., 2016). Infrastructure can also leave marks on the skin of animals, as is the case with rhomboid lesions, originating from the animal's contact with the gondola of the CO_2 chamber (Varón-Álvarez et al., 2014).

To help to determine when a trauma that led to a skin lesion occurred, the colour can be used to date the bruise (Varón-Álvarez et al., 2014) and as reported in other studies. A bright red colour indicates a recent bruise, dark red an old one, and yellow or greenish can indicate a very old bruise (Teiga-Teixeira et al., 2021).

Assessment of the impact of animal welfare factors on the characterisation of skin lesions in pig carcasses, a species sensitive to stress, is scarce in Portugal. The main objective of the current study was to evaluate how the factors of transport time, lairage time in the abattoir and pig sex can influence the appearance and characterisation of skin bruises in fattening pigs from a sample analysed in a Portuguese slaughterhouse.

MATERIALS AND METHODS

Study area & sampling strategy

A cross-sectional study was conducted in a pig slaughterhouse located in Northern Portugal, during December of 2021. In this industrial slaughterhouse were slaughtered cross-breed (Landrace × Yorkshire) fattening domestic pigs. The slaughterhouse had a single, automatic slaughter line, running at an average speed of 150 animals/h, using stunning through exposure to CO_2.

Based on the slaughter map for December, animals from three different geographic locations were slaughtered: Central and Southern Portugal and Spain. For data collection, the days on which at least 50 animals from the same farm would be slaughtered were selected, with the aim of obtaining a sample at the end of the study in which each farm would be equitably represented. Data from 300 pig carcasses were collected. The animals came from six different farms (one from Spain, three from Central Portugal and two from the Southern Portugal). The pre-slaughter period comprised: loading of animals on the holding for transport; travelling to the slaughterhouse; unloading animals at the slaughterhouse; staying at the slaughterhouse until the moment of stunning and; moving the animals to the stunning area.

Transport data, i.e., travel times and distance travelled by transporters were recorded. The animal entry map at the lairage allowed us to determine the waiting time in the lairage and fasting time. Data concerning the location of the farm of origin, for later organization and traceability of the data, the sex of the animals and their weight were also collected.

The information was collected from the Information System for the Approval and Control Plan of Establishments (SIPACE) and from the daily control documents provided under legal obligation to the Official Veterinarian (Food Chain Information document, list of unloaded animals in lairage and carcass weight list). The list of unloaded animals in lairage must contain information on the feeding of animals that have been in the lairage for at least 12h. The Food Chain Information document contains the place of origin, the estimated duration of the trip between the farm and the slaughterhouse, and the number of animals for slaughter. The sex of the observed animals was recorded during *post mortem* inspection of the respective carcasses.

Verbal informed consent was obtained from the owners. Animal welfare was guaranteed, as the entire study was carried out in an accredited and licensed slaughter establishment that operates under the National and European Community legislation regarding the protection of animal welfare. The slaughterhouse also operates under permanent supervision of the General Food and Veterinary Directorate (DGAV), which authorised the present study. The study was also monitored by at least one Official Veterinarian.

Skin lesions

At the lairage, the official veterinary doctor conducting the *ante mortem* inspection assessed the general condition of the animals and recorded bruises/fractures (categorised as non-existent, light injuries, moderate injuries or severe injuries).

The categorisation of skin lesions was performed during the *post mortem* inspection at the slaughterhouse. The categorisations of skins lesions by Tönepöhl et al. (2013) and, mainly, Varón-Álvarez et al. (2014) were adapted to our study. The skin lesions were classified according to their location by defined carcass region (pelvic limbs, ribs/belly (hereafter called ribs), back and head/forelimbs), shape (C: comma, R: rectangular, L: linear; D: diffuse; Ro: Rhomboid), size (Si1: 2-5 cm; Si2: 6-10 cm; Si3: 11-15 cm; Si4:>15 cm), number of skin lesions per region (N1:1-2; N2:2-5; N3:5-10; N4:>10) and age. The age of the lesions was determined from their colour (C1: recent light red, up to 1 to 2 hours; C2: dark red, from 3 to 10 hours and C3: black/old within 24 hours). Figure 1 shows the characterisation of skin lesions according to their shape.

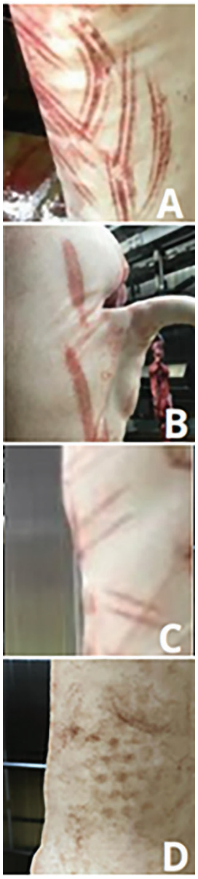

Figure 1. Shape characterisation of skin lesions: (**A**) – Comma-shaped skin lesions; (**B**) – Rectangular lesions; (**C**) – Linear injuries; (**D**) – Rhomboid lesions

More than one type of lesion could be recorded on each carcass, since it was divided into four regions and each was separately evaluated. Also, it should be noted that in any one carcass region, when there were several types of injuries, the injury recorded was the most severe (the one that occupied the greatest area). The characterisation of the lesions was recorded with the aid of a voice recorder and was a decision by one properly trained meat inspector. This was done to reduce deviations since the characterisation of skin lesions based on observation always has some subjective character. Two meat inspectors later manually transferred the characterisation data into Excel Office 2019 format.

Statistical analyses

Statistical analyses consisted of a descriptive analysis (animal origin, sex, weight, travel time, lairage time, total pre-slaughter time, occurrence of feeding in the lairage, rate of *ante mortem* injuries and *post mortem* injuries – location, shape, age), univariate analysis (determination of the impact of origin, sex, weight, travel time, lairage time, total pre-slaughter time, feeding and *ante mortem* injuries associated with the *post mortem* injuries), and multivariate analysis (determination of variables that have a real impact on differences in *post mortem* injuries).

Regarding logistic regression analyses, it should be noted that the explanatory variables were all initially included (i.e., weight, sex, origin, travel time, lairage time, feeding, *ante mortem* injuries and *post mortem* injuries). Using the backwards selection method, only statistically significant variables were selected, occasionally including marginally significant variables, with the remaining ones being eliminated one by one. The evaluation of each of the intermediate and final models produced was mostly carried out through likelihood ratio tests in relation to the previous models, but for some, through the Akaike Information Criterion (AIC). The final models were tested on their assumptions, i.e., independence of observations, homoscedasticity and normal distribution of their standardised Pearson residuals. Analyses on possible occurrences of multicollinearity were also performed. The differences in deviations of the produced models were compared with the null model and with previous models, having accepted the best model in which the difference obtained a test statistic with a p-value less than 0.001 in the log-likelihood ratio test.

This study used univariate models and regression models to analyse the relationships between skin lesion shape and transport time, lairage time and sex, and between skin lesion colour (age) and transport time, lairage time and sex. R version 4.1.0 software and Microsoft Excel version 2019 were used to perform statistical analyses.

RESULTS

Ante mortem sample characterisation

Figure 2 presents a summary of frequencies of sex, weight, origin, transport time, lairage time, feeding and *ante mortem* lesions among the studied pigs.

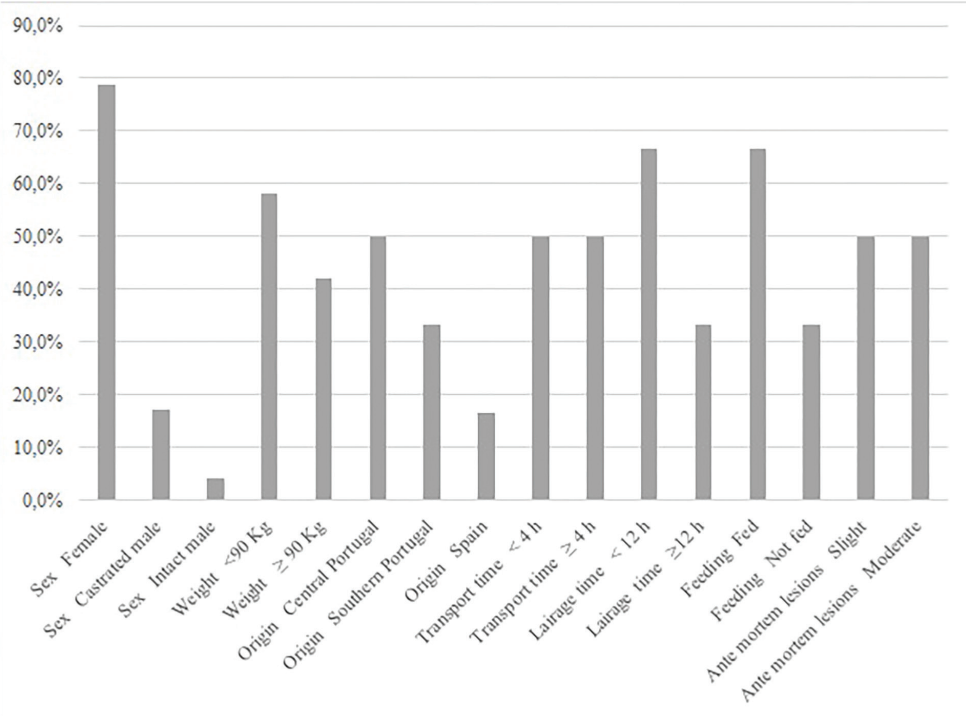

Figure 2. Frequencies (%) of each variable according to the categorisation of the studied pigs at slaughter

In this study, 78.7% of the animals studied were females, 17.3% were castrated males and 4.0% were intact males. Exactly 50.0% of the pigs were from Central Portugal, 33.3% were from the Southern Portugal and 16.7% were from Spain.

Half of the pigs were subjected to less than 4 h of transport and the other half had journeys of 4 hours or longer to the slaughterhouse. About 66.7% of pigs waited less than 12 h between arrival and slaughter, and 33.3% had a lairage time equal to or longer than 12 h. While they were waiting in the lairage, 66.7% of the pigs were fed and 33.3% were not.

In the lairage, minutes before the slaughter, in the *ante mortem* examination and while the pigs were still grouped in the parks, 50.0% presented slight skin lesions, whereas the other half of the sampled pigs had moderate bruises.

Classification of skin lesions observed *post mortem*

A total of 468 injuries were recorded, distributed in different carcass regions, remembering that in the same carcass region, when there were several injury types, the recorded injury was the most severe type. Altogether, 31 pigs had no lesions in any of the studied carcass regions (10.2%). A big part of the sampled animals presented no lesions in one or more of the considered carcass regions (Table 1). Lesions located on the back constituted about 37.2% of the total considered skin lesions, in the pelvic limb region were about 22.0%, on the ribs were about 20.5% and in the head/thoracic limb region were about 19.0% of the considered skin lesions.

From analysis of Table 1, in the pelvic limb region, 13.67% of the lesions observed were linear and 8.67% were comma lesions. On the back, 38.0% of the lesions observed were linear lesions, while 14.0% of the pigs had rectangular lesions. In the head/thoracic limb region, about 24.67% of pigs had comma lesions. On the ribs, 25.0% of the animals had comma lesions.

Lesions 6-10 cm long were mostly observed on the pelvic limbs (15.0%), back (26.7%), head/thoracic limbs (18.0%) and ribs (16.0%) (Table 1). Lesions 2-5 cm long occurred more frequently on the back (10.3%), pelvic limbs (8.7%) and ribs (8.7%) (Table 1).

Concerning lesion colour, the majority of recorded lesions were classified as recent, light red lesions in all four carcass regions, i.e., pelvic limb (33.3%), back (56.0%), head/thoracic limb (28.3%) and rib (29.3%) (Table 1).

Table 1. Frequencies of the sampled animals according to the shape, size (Si1: 2-5 cm; Si2: 6-10 cm; Si3: 11-15 cm; Si4:>15 cm), age (C1: recent light red, up to 1 to 2 hours; C2: dark red, 3 to 10 hours and C3: black/old within 24 hours) and number of lesions (N1:1-2; N2:2-5; N3:5-10; N4:>10) per carcass region.

Parameter	Classification	Pelvic limb lesions (%)	Back lesions (%)	Head/ Thoracic limb lesions (%)	Rib lesions (%)
Shape	No Lesions	63.3%	42.3%	70.3%	67.3%
	Diffuse	9.7%	2.3%	1.0%	0.7%
	Linear	13.7%	38.0%	2.3%	3.0%
	Rectangular	4.3%	14.0%	1.3%	4.0%
	Rhomboid	0.3%	1.7%	0.3%	0.0%
	Comma	8.7%	1.7%	24.7%	25.0%
Size	No Lesions	64.0%	42.3%	70.3%	67.0%
	Si1	8.7%	10.3%	7.3%	8.7%
	Si2	15.0%	26.7%	18.0%	16.0%
	Si3	9.3%	14.3%	4.0%	7.7%
	Si4	3.0%	6.3%	0.3%	0.7%
Number of lesions/ carcass region	No Lesions	63.7%	42.0%	67.0%	70.3%
	N1	7.7%	11.3%	8.7%	5.0%
	N2	16.3%	29.0%	16.0%	14.7%
	N3	9.3%	9.3%	7.7%	7.0%
	N4	3.0%	8.3%	0.7%	3.0%
Colour (Age)	No Lesions	64.3%	42.0%	70.7%	68.7%
	C1	33.3%	56.0%	28.3%	29.3%
	C2	2.0%	1.7%	1.0%	1.3%
	C3	0.3%	0.3%	0.0%	0.7%

Table 2. Shape of *post mortem* skin lesions vs. predictors in the different carcass regions, calculated by logistic regression and multinomial logistic regression.

		Odds-Ratio	p-value
Skin lesion shape on the head/thoracic limbs	**Comma**		
	Spain origin (vs. Central Portugal origin)	0.336	0.02246 *
	Southern Portugal origin (vs. Central Portugal origin)	0.074	<0.0001 ***
	Lairage Time	0.288	0.00393 **
Skin lesion shape on the ribs	**Comma**		
	Spain origin (vs. Central Portugal origin)	0.335	0.0115 *
	Southern Portugal origin (vs. Central Portugal origin)	0.071	<0.0001 ***
	Lairage Time	4.19	<0.0001 ***
Skin lesion shape on the back	**Linear**		
	Spain origin (vs. Central Portugal origin)	5.62	0.0001 ***
	Southern Portugal origin (vs. Central Portugal origin)	1.59	0.143
	Rectangular		
	Spain origin (vs. Central Portugal origin)	4.37	0.0054 **
	Southern Portugal origin (vs. Central Portugal origin)	0.642	0.3196
	Castrated Male (vs. Female)	0.072	0.012 *
	Non Castrated Male (vs. Female	1.11	0.9307
Skin lesion shape on the pelvic limbs	**Diffuse**		
	Castrated Male (vs. Female)	0.5123	0.8455
	Non Castrated Male (vs. Female)	9.82e-02	0.036 *
	Linear		
	Transport Time	6.8218	0.0023 **
	Castrated Male (vs. Female)	0.1062	0.0882
	Non Castrated Male (vs. Female)	8.013e-08	<0.0001 ***
	Comma		
	Castrated Male (vs. Female)	0.8965	0.94138
	Non Castrated Male (vs. Female)	1.3785e-06	<0.0001 ***
	Ante-mortem lesions	7.5639e-07	<0.0001 ***
	Lairage Time	3.706e-07	<0.0001 ***
	Spain origin (vs. Central Portugal origin)	2.969e-01	0.4605
	Southern Portugal origin (vs. Central Portugal origin)	1.414e-07	<0.0001 ***

*** Highly significant ($p<0.001$); ** Very significant ($p<0.01$); * Significant ($p<0.05$).

Transport time vs. skin lesions

In the pelvic limb region, on average, animals traveling for 4 h or more were more likely to have linear lesions (*odds ratio*=6.8218, *p*=0.0023) (Table 2). Furthermore, in the pelvic limb region, animals subjected to transport times of 4 h or more were more likely to have lesions measuring 6-10 cm (*odds ratio*=5.40, *p*=0.0056) or measuring 11-15 cm (*odds ratio*=6.85, *p*=0.0195) (Table 3).

Table 3. Size of *post mortem* skin lesions vs. predictors in different carcass regions, calculated by logistic regression and multinomial logistic regression.

		Odds-Ratio	***p-value***
Skin lesion size on the head/thoracic limbs	**2-5 cm**		
	Castrated Male (vs. Female)	3.63	<0.0001 ***
	Intact Male (vs. Female)	1.48	0.7225
	6-10 cm		
	Castrated Male (vs. Female)	4.51	<0.0001 ***
	Intact Male (vs. Female)	1.14	0.9079
	Spain origin (vs. Central Portugal origin)	0.56	0.2186
	Southern Portugal origin (vs. Central Portugal origin)	0.11	0.0004 ***
Skin lesion size on the ribs	**2-5 cm**		
	Spain origin (vs. Central Portugal origin)	5.39	0.00135 ***
	Southern Portugal origin (vs. Central Portugal origin)	0.76	0.65
	6-10 cm		
	Castrated Male (vs. Female)	2.88	0.00914 **
	Intact Male (vs. Female)	0.83866	0.8736
	Spain origin (vs. Central Portugal origin)	0.89	0.7948
	Southern Portugal origin (vs. Central Portugal origin)	0.19	0.0018 **
	11-15 cm		
	Spain origin (vs. Central Portugal origin)	0.18	0.100
	Southern Portugal origin (vs. Central Portugal origin)	0.13	0.00897 **

		Odds-Ratio	p-value
Skin lesion size on the back	**2-5 cm**		
	Castrated Male (vs. Female)	0.2622	0.100
	Intact Male (vs. Female)	8.7933e-7	<0.0001 ***
	Spain origin (vs. Central Portugal origin)	8.96	0.00213 **
	Southern Portugal origin (vs. Central Portugal origin)	2.05	0.144
	6-10 cm		
	Castrated Male (vs. Female)	0.6289	0.3116
	Intact Male (vs. Female)	6.9055	0.0109 *
	Spain origin (vs. Central Portugal origin)	3.55	0.013 *
	Southern Portugal origin (vs. Central Portugal origin)	0.72	0.369
	11-15 cm		
	Transport Time	0.36	0.024 *
Skin lesion size on the pelvic limbs	**2-5 cm**		
	Castrated Male (vs. Female)	0.2894	0.2311
	Intact Male (vs. Female)	4.144e-7	<0.0001 ***
	6-10 cm		
	Spain origin (vs. Central Portugal origin)	0.2517	0.2721
	Southern Portugal origin (vs. Central Portugal origin)	0.1545	0.0371 *
	Transport Time	5.40	0.0056 **
	11-15 cm		
	Transport Time	6.85	0.0195 *

*** Highly significant (p<0.001); ** Very significant (p<0.01); * Significant (p<0.05).

The pelvic limb region was more likely to have 1-2 lesions/carcass region (*odds ratio*=2.49, p=<0.0001) or >5-10 lesions/carcass region (*odds ratio*=8.35, $p<0.0001$) (Table 4).

Table 4. Number of lesions per region of post mortem skin lesions vs. predictors in carcass different locations, calculated by logistic regression and multinomial logistic regression.

		Odds-Ratio	***p-value***
Number of lesions per region on the head/ thoracic limbs	**>2-5 lesions**		
	Spain origin (vs. Central Portugal origin)	0.89	0.8113
	Southern Portugal origin (vs. Central Portugal origin)	0.23	0.0103 *
	Castrated Male (vs. Female)	4.88	0.00012 ***
	Intact Male (vs. Female)	0.00027	0.9133
	>5-10 lesions		
	Castrated Male (vs. Female)	4.06	0.0102 *
	Intact Male (vs. Female)	0.0005	0.9088
Number of lesions per region on the ribs	**1-2 lesions**		
	Spain origin (vs. Central Portugal origin)	1.62	0.3358
	Southern Portugal origin (vs. Central Portugal origin)	0.14	0.0123 *
	>2-5 lesions		
	Castrated Male (vs. Female)	3.08	0.011 *
	Intact Male (vs. Female)	0.74	0.7851
	>5-10 lesions		
	Spain origin (vs. Central Portugal origin)	0.53	0.3457
	Southern Portugal origin (vs. Central Portugal origin)	0.065	0.00912 *

		Odds-Ratio	*p-value*
Number of lesions per region on the back	**>2-5 lesions**		
	Spain origin (vs. Central Portugal origin)	4.61	0.0023 **
	Southern Portugal origin (vs. Central Portugal origin)	1.59	0.1527
	Transport Time	0.52	0.041 *
	>5-10 lesions		
	Spain origin (vs. Central Portugal origin)	6.40	0.0192 *
	Southern Portugal origin (vs. Central Portugal origin)	1.71	0.2817
Number of lesions per region on the pelvic limbs	**1-2 lesions**		
	Spain origin (vs. Central Portugal origin)	0.46	0.2856
	Southern Portugal origin (vs. Central Portugal origin)	0.14	0.01099 **
	Castrated Male (vs. Female)	0.18	0.0398 *
	Intact Male (vs. Female)	5.57e-7	<0.0001 ***
	Transport Time	2.49	<0.0001 ***
	>2-5 lesions		
	Transport Time	10.77	<0.0001 ***
	>5-10 lesions		
	Castrated Male (vs. Female)	1.30	0.6413
	Intact Male (vs. Female)	1.36e-7	<0.0001 ***
	Transport Time	8.35	<0.0001 ***

*** Highly significant ($p<0.001$); ** Very significant ($p<0.01$); * Significant ($p<0.05$).

In animals subjected to transport times of 4 h or more, the lesions were more likely to be a light red colour (1-2 h of age) (*odds ratio*=5.53, $p<0.0001$) than lesions on animals subjected to trips of less than 4 h (Table 5).

Table 5. Colour (age) of *post mortem* skin lesions vs. predictors in the different carcass regions, calculated by logistic regression and multinomial logistic regression.

		Odds-Ratio	***p-value***
Skin lesion colour (age) on the head/ thoracic limb	**Recent light red (up to 1-2 hours)**		
	Spain origin (vs. Central Portugal origin)	0.24	0.000855 ***
	Southern Portugal origin (vs. Central Portugal origin)	0.07	<0.0001 ***
	Lairage Time	0.22	<0.0001 ***
Skin lesion colour (age) on the ribs	**Recent light red (up to 1-2 hours)**		
	Spain origin (vs. Central Portugal origin)	0.48	0.068
	Southern Portugal origin (vs. Central Portugal origin)	0.13	<0.0001 ***
	Ante mortem lesions	4.19	<0.0001 ***
Skin lesion colour (age) on the back	**Recent light red (up to 1-2 hours)**		
	Spain origin (vs. Central Portugal origin)	3.95	0.0026 **
	Southern Portugal origin (vs. Central Portugal origin)	1.56	0.098
	Transport Time	0.54	0.0243 *
Skin lesion colour (age) on the pelvic limb	**Recent light red (up to 1-2 hours)**		
	Castrated Male (vs. Female)	0.69	0.2928
	Intact Male (vs. Female)	0.070	0.0124 *
	Transport Time	5.53	<0.0001 ***

*** Highly significant ($p<0.001$); ** Very significant ($p<0.01$); * Significant ($p<0.05$).

Lairage time vs. skin lesions

Pigs submitted to lairage times equal to or greater than 12 h were more likely to have comma lesions on the ribs (*odds ratio*=4.19) than be without lesions, compared to pigs submitted to lairage times of less than 12 h (p<0.0001) (Table 2).

Sex vs. skin lesions

In the head and forelimb region, on average, castrated males were more likely to have lesions measuring 2-5 cm (*odds ratio*=3.63, p<0.0001) (Table 3) and greater probability of having 6-10 cm lesions (*odds ratio*=4.51, p<0.0001) in relation to females (Table 3). The castrated males were more likely to have >2-5 lesions/region (*odds ratio*=4.88, p=0.00012) and to have >5-10 lesions/region (*odds ratio*=4.06, p=0.0102) compared to females (Table 4).

On the ribs, on average, castrated males were more likely to have lesions measuring 6-10 cm (*odds ratio*=2.88, p=0.00914) compared to females (Table 3) and to have >2-5 lesions/region (*odds ratio*=3.08, p=0.011) compared to females (Table 4).

On the back, castrated males were, on average, less likely (*odds ratio*=0.072, p=0.012) to have rectangular lesions than to not have lesions, compared to females (Table 2). In the pelvic limb region, on average, intact males were less likely (*odds ratio*=0.070, p=0.0124) to have light red coloured (1-2 hours of age) lesions than to not have lesions, in relation to females (Table 5).

DISCUSSION

To the best of the authors' knowledge at this time, there are a few studies within the area that have the goal of knowing more about welfare in the slaughterhouse context and how it is translated into the animals' physical integrity that reflects carcass quality.

According to the results of this study, and with regard to carcass region, more injuries were recorded on the back and pelvic limbs, as was the case in the studies by Varón-Alvarez et al. (2014) and Corrales et al. (2018), while fewer head and thoracic limb injuries were detected, which was also observed by Corrales et al. (2018). Since the back and pelvic limb areas are more exposed to infliction of injuries by operators who drive the animals, these results could indicate there was a higher prevalence of injuries that could be related to poor handling. Driessen et al. (2020) reported that damage to the head and thoracic limb region is caused by fights.

From the results obtained, the predominant forms of lesions on the pelvic limbs and back were linear and in the head/thoracic limbs and ribs were comma-shaped. Recent lesions were predominant. According to the literature, comma injuries and those concentrated in the cranial region are associated with biting and aggression (Tönepöhl et al., 2013; Dall et al., 2016). In this regard, it is likely that the high incidence of comma lesions in the cranial region of the carcass resulted from aggressive behaviour among animals.

Linear injuries were predominant on the pelvic limbs and back and could be related to the infliction of injuries by operators, given the dorsocaudal and dorsolateral location. The linear shape in an area that, according to Varón-Álvarez et al. (2014), is exposed and vulnerable to injuries from human behaviours, leads to the deduction that these injuries resulted from whipping by the handlers when driving the animals, either at unloading from the transport, or when driving to the stunning area.

According to Varón-Alvarez et al. (2014), the frequency of rectangular lesions could be linked to the use of blunt objects by handlers, while the prevalence of rhomboid lesions could be associated with the contact of the animal with the infrastructure of the gondola of the CO_2 chamber. In the present study, as well as in the study of Varón-Alvarez et al. (2014), the frequencies of rectangular and rhomboid skin lesions were low. These results suggest generally correct compliance with animal welfare measures in the stunning phase. However, some animals did carry these lesions, so their welfare could have been compromised by the use of objects or by excess density of animals in the same CO_2 chamber shelf at the time of stunning, causing stress and pain.

Driessen et al. (2020) suggested that damage to the back of the carcass can be associated with mounting behaviours and poor handling. Our study corroborates that, as females were more likely to have linear, recent lesions on the pelvic limbs and rectangular lesions on the back, a region where females also showed more skin damage (Driessen et al., 2020). The prevalence of linear and recent injuries on the pelvic limbs could be because these regions are more vulnerable to the whipping by operators while driving the animals to the lairage and to the stunning area.

Males have naturally more aggressive behaviour than females and, perhaps for this reason, castrated males showed a greater predisposition to lesions of light to moderate size and a moderate to high number of lesions in the cranial area of the carcass. Driessen et al. (2020) concluded that castrated males had a higher incidence of skin lesions compared to females, but castrated males suffered less skin damage in the shoulder area, i.e., cranial region. In fact, it can be expected that intact males would present more evident aggressive behaviour than castrated males and, thus, would be more predisposed to characteristic skin lesions in the regions of the ribs, head and forelimbs. The fact that intact males comprised only 4.0% of the animals analysed in this study, and neutered males made up 17.3%, could have prevented correct assessment of the predisposition of intact males to lesions correlated with aggression between animals.

Varón-Alvarez et al. (2014) concluded that skin bruises are more common with longer travel time to the slaughterhouse. Our study shows that long travel times (equal to or greater than 4 hours) led to a greater predisposition to linear, recent and moderate-sized skin lesions on the pelvic limbs. It also led to a large number of injuries being recorded in that region. This is one of the areas on the animals that is most vulnerable to whiplash inflicted by handlers. Thus, we can assume that longer travel times could be associated with a greater reluctance of the animals to move during the unloading phase at the slaughterhouse or when the animals walk to the stunning area. This reluctance to move could, in turn, be linked to a greater impact of poor handling on the part of operators driving the animals who, to counter the animals' behaviour, apply more violence in their driving so that the pigs move. It should be noted that the longest recorded journey lasted about 7 h, but all the journey durations complied with European regulation (Council Regulation (EC) 1/2005), which states that the journey times for swine animals cannot exceed 8 h.

In some studies, longer lairage times were related to an increased incidence of skin lesions on the carcass and were shown to be more stressful (Tönepöhl et al., 2013; Zhen et al., 2013; Dokmanović et al., 2014, Dokmanovic et al., 2015; Čobanović et al., 2016; Driessen et al., 2020). This prolonged waiting period can exacerbate fighting behaviours of animals in the lairage (Driessen et al., 2020). Resultant lesions are characterised as comma-shaped and are more concentrated in the cranial region of the carcass.

CONCLUSION

In this study, skin lesions proved to be a sensitive indicator to monitor pig welfare. With regard to the sex of the pigs, castrated males were more predisposed to skin lesions resulting from aggressive behaviour between animals, while females had a higher prevalence of lesions possibly linked to poor management in the pre-slaughter period. Long travel time (of 4 h or more, and compared with shorter travel time) was associated with more injuries possibly related to exposure to poor handling. Most injuries observed on the pigs occurred at moments temporally close to the moment of slaughter, and they likely result mainly from exposure to poor management in the moments preceding slaughter, in addition to possible fights between animals during the waiting time in lairage.

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Authors' Contributions

RMA and TTP conceived the idea conceived the idea and applied the study in practice. EA, CAC and FMC supervised the writing of the manuscript. TTE performed the statistical analysis. All authors provided critical feedback and helped shape the research, analysis and contributed to the final manuscript.

Competing Interests

The authors declare that they have no competing interests.

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FAKTORI PRE KLANJA KOJI UTIČU NA POJAVU POVREDA NA KOŽI SVINJA – KROS-SEKCIONALNA STUDIJA

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Kratak sadržaj

Povrede na koži svinja su veoma značajni pokazatelji dobrobiti životinja. Ispitivanje prisustva povreda na trupovima svinja omogućava utvrđivanje stepena izraženosti, kao i načina i faze u kojoj je došlo do njihovog nastanka. Ispitivanje povezanosti između premortalnih faktora i nastanka povreda kod tovnih svinja je sprovedeno na 300 zaklanih jedinki u klanici u severnom Portugalu. U toku istraživanja su prikupljani podaci o polu, poreklu, dužini transporta i boravka svinja u depou. Povrede na koži svinja su ispitivane na različitim anatomskim regijama na trupu, a utvrđivani su i oblik, veličina i broj povreda po anatomskoj regiji, kao i starosti povreda. U statističkoj analizi podataka korišćeni su deskriptivni parametri, jednovarijantna analiza i logistička regresija ($p \leq 0.01$). Utvrđeno je ukupno 468 povreda na različitim anatomskim regijama trupova zaklanih svinja. Najveća učestalost povreda je zabeležena na leđima (37,2%) i neposredno pre klanja (94,2%). Kastrati su imali veću predispoziciju za povrede na trupu nastale kao posledica borbi između jedinki. Kod nazimica i jedinki koje su bile podvrgnute dugotrajnom transportu utvrđena je veća verovatnoća za nastanak povreda na trupu koje su posledica grubog postupanja. Rezultati istraživanja ukazuju na značaj kontinuiranog praćenja pokazatelja dobrobiti svinja tokom perioda pre klanja u cilju što efikasnijeg monitoringa dobrobiti životinja.

Ključne reči: dobrobit životinja, klanje, povrede na koži, svinje