Risk factors for tail lesions in undocked fattening pigs reared on Swiss farms

A. Sell[1], B. Vidondo[2], B. Wechsler[1], J.-B. Burla[1], H. Nathues[3]

[1]Centre for Proper Housing of Ruminants and Pigs, Tänikon, Federal Food Safety and Veterinary Office; [2]Veterinary Public Health Institute, Vetsuisse Faculty, University of Bern; [3]Clinic for Swine, Vetsuisse Faculty, University of Bern

Risikofaktoren von Schwanzverletzungen bei nicht-coupierten Mastschweinen in Schweizer Schweinebeständen

Schwanzverletzungen durch Schwanzbeissen sind ein grosses Tierschutz- und wirtschaftliches Problem bei Mastschweinen. Ziel dieser Studie war es, die Prävalenz und Inzidenz von Schwanzverletzungen bei nicht-coupierten Schweinen während der Mast zu beschreiben, mögliche Risikofaktoren im Zusammenhang mit Schwanzverletzungen aufzuklären und die Haltung der Schweinehalter gegenüber Schwanzbeissen in Schweizer Zuchtbeständen zu beschreiben. Achtunddreissig Bestände wurden während der Mastperiode dreimal untersucht (Anfang, Mitte, Ende). Während jeder Bestandsuntersuchung wurden Schwanzverletzungen an 30–126 individuell markierten Schweinen pro Bestand (insgesamt: 2209 Schweine) bewertet, Informationen zu potenziellen Risikofaktoren für Schwanzverletzungen aufgezeichnet und eine standardisierte Befragung der Landwirte durchgeführt, um seine/ihre Meinung zum Schwanzbeissen zu untersuchen. Potenzielle Risikofaktoren wurden durch Indizes definiert. Ihr Einfluss auf das Auftreten von Schwanzläsionen wurde unter Verwendung eines gemischten logistischen Regressionsmodell analysiert. Während der ersten und zweiten Hälfte der Mast entwickelten durchschnittlich 14,1 bzw. 15,4 Schweine von 100 neue Schwanzverletzungen oder eine Verschlechterung alter Läsionen. Das Risiko für neue oder verschlechterte Schwanzläsionen stieg mit höheren Werten für einen «Krankheitsindex» und mit zunehmender Gruppengrösse, dagegen nahmen diese mit höheren Platzangeboten und mit restriktiver Fütterung im Vergleich zur ad-libitum-Fütterung ab. Die Prävalenz von Schwanzverletzungen war während der ersten oder zweiten Mastperiode weder auf Ebene der Bucht, noch auf Ebene des Bestandes abhängig vom Vorkommen etaiger Läsionen bei Ankunft. Während den Befragungen bekundeten die Landwirte ihr Interesse an professionellen Ratschlägen zur Reduzierung des Schwanzbeissens in ihren Betrieben.

Zusammenfassend identifizierte unsere Studie mehrere Risikofaktoren für Schwanzverletzungen bei nicht-cou-

Abstract

Tail lesions caused by tail biting are a major welfare and economic concern in fattening pigs. The aims of this study were to describe the prevalence and incidence of tail lesions in undocked pigs on individual animal level during the fattening period, to elucidate potential risk factors associated with tail lesions, and to describe the stockpersons' attitudes towards tail biting on Swiss farms. Thirty-eight farms were visited three times during the fattening period (beginning, mid-point, end). During each farm visit, tail lesions were scored on 30–126 individually marked pigs per farm (total: 2209 pigs), information on potential risk factors for tail lesions was recorded, and a standardized interview with the farmer was conducted to explore his/her opinion on tail biting. Potential risk factors were defined by indices when adequate, and their influence on the occurrence of tail lesions was analyzed using mixed effects logistic regression models. During the first and the second half of the fattening period, on average 14,1 and 15,4 pigs, respectively, out of 100 developed new tail lesions or aggravation of old lesions. The risk for new or aggravated tail lesions increased with higher scores for a «disease index» and with increasing group size, and it decreased with higher space allowances and with restrictive compared with ad libitum feeding. The prevalence of tail lesions on arrival was not associated with the incidence of tail lesions in the first and the second half of the fattening period, neither at farm level nor at pen level. In the interviews, farmers expressed their interest in getting professional advice on how to reduce tail biting on their farms.

In conclusion, our study identified several risk factors for tail lesions in undocked fattening pigs indicating that the incidence of tail lesions could be reduced by improving animal health and housing conditions.

Key words: attitude of stockperson, fattening pig, risk factor, tail biting

https://doi.org/10.17236/sat00278

Eingereicht: 21.06.2020
Angenommen: 07.09.2020

pierten Mastschweinen, was darauf hinweist, dass die Inzidenz von Schwanzverletzungen durch Verbesserung der Tiergesundheit und der Haltungsbedingungen verringert werden könnte.

Schlüsselwörter: Einstellung der Halter, Mastschwein, Risikofaktor, Schwanzbeissen

Introduction

Tail lesions caused by tail biting are a great welfare and economic concern in fattening pigs. Tail-bitten pigs suffer from pain, have a reduced weight gain[31] and show an increased risk of bacterial infections, resulting also in carcass condemnations at the abattoirs[34,37] and a negative impact on food safety. Although not allowed without evidence for necessity, over 90% of all pigs in the EU are tail docked in order to prevent tail biting.[3] Contrary to this custom, preventive tail docking was completely banned in Switzerland in 2008, but little is known about the prevalence of tail lesions in this country. In a study conducted in 2016, 1369 and 3066 fattening pigs were examined on-farm and at slaughter, respectively, and the overall prevalence of tail lesions was 12,4% and 39,7%.[38] These figures are higher than those found in earlier Swiss studies[9,27] and may indicate that tail biting has become more abundant.

Tail biting is of multifactorial origin, and numerous studies have identified a large number of risk factors for tail lesions, such as health status or lack of enrichment materials.[21,33] However, in many studies, such risk factors were examined under controlled experimental conditions that may not well represent the variety of, for example, housing and climatic conditions found on commercial farms. Furthermore, due to the Swiss Animal Welfare Ordinance, housing conditions on Swiss farms do not correspond to those found on farms in most EU member states.[5] For example, fully slatted floors are banned, and the minimum space allowance for pigs weighing 85–110 kg is 0,9 m^2. Consequently, it is of interest to identify risk factors for tail lesions in fattening units of high welfare standards and typical for Swiss pig farms.

In studies on risk factors for tail biting on commercial farms, tail lesions are usually assessed in a single farm visit. However, the conditions on a given farm may vary over time, and the situation described during the farm visit may not be the one that was causally linked to tail biting. Moreover, when tail lesions are scored only once, it is not known how many pigs already had such lesions on arrival at the fattening unit. It would be of interest to investigate whether the prevalence of tail lesions at a certain point in time may be related to the occurrence of tail biting later on. Furthermore, in most epidemiological studies on tail biting, tail lesions are assessed at pen level only. To the best of our knowledge, there has been no study that looked at the development of tail lesions in individual fattening pigs on commercial farms. However, it would be meaningful to analyze the development of tail lesions in individual pigs because this approach can ensure that the same pigs are assessed each time and the actual number of new lesions can be identified.

An additional factor that has come more into focus and may contribute to the occurrence of tail biting is the stockperson's attitude towards this issue. Studies in Finland, Ireland, the Netherlands, Sweden and the UK have revealed some differences between the countries with respect to, for example, the effectiveness of different preventive measures.[8,12,35,36,41] In Switzerland, a survey on farmers' attitudes towards tail biting has not been conducted. Farmers base their opinions on their experience, and they know the situation on their own farm best. Therefore, it could be worth considering the stockpersons' experience when advising farmers on tail biting prevention.

The aims of the study were: 1) to describe the prevalence (existing) and incidence (new events) of tail lesions in undocked fattening pigs on Swiss pig farms on arrival, in the middle and at the end of the fattening period, 2) to assess the influence of the prevalence of tail lesions on arrival on the incidence of tail lesions for the first and the second half of the fattening period, 3) to elucidate potential risk factors for tail lesions under housing conditions typical for Swiss farms, and 4) to describe the stockpersons' attitudes towards tail biting based on standardized interviews.

Materials and Methods

This project was approved by the Committee of Animal Experimentation of Canton Thurgau, Switzerland (TG02/18).

Study farms

In total, 38 farms with fattening units (range: 96–1900 pigs per farm; median: 400 pigs) were recruited for this study by means of a letter distributed by two slaughterhouses (only farms that delivered pigs with tail lesions were contacted), an article in a farmers' journal, and contacts established at stakeholder events or with the support of marketers and feed suppliers. Twenty-one farmers produced slaughter pigs according to the minimum requirements of the Swiss Animal Welfare Ordinance of 2008 (hereafter referred to as conventional farms) whereas 17 farmers kept the pigs under enhanced housing conditions for label production (hereafter referred to as label farms).

Farm visits and study animals

Each farm was visited three times between March 2019 and December 2019. All visits were performed by the same trained veterinarian. The farm was visited a first time on the day of arrival of a new batch of pigs (age: 11–14 weeks; weight: 25–40 kg). The second visit was 35 days later, when the pigs weighed about 50–70 kg. The timing of the third visit depended on the length of the fattening period (age: 22–24 weeks; weight: 100–110 kg) lasting for 77 days on average (range: 60–90 days).

On every farm, a sample of 30–126 fattening pigs were marked individually on arrival. The number of pigs depended on the batch size on arrival and the number of pens in which these pigs were housed. In pens with <90 pigs, all pigs were marked, and in pens with >90 pigs, a maximum of 40 randomly chosen animals were marked. The study pigs were housed in one to seven pens per farm, depending on the group size per pen in use on a given farm. The mean pen size was 20 pigs per pen (range: 5–350 pigs) and 1.0 square meters per animal (range: 0,4–2,0 m^2/animal). During each of the three visits, tail lesions were scored in all marked pigs, information concerning risk factors for tail biting was recorded, and a standardized interview with the farmer was conducted to explore his or her opinion about tail biting.

Scoring of tails

Tail lesions were assessed with a scoring method used by von Gunten (2016)[38] in a previous study on the prevalence of tail biting in Switzerland and adapted from Keeling et al. (2012).[18] The length of the remaining part of a tail was scored according to a six-point scale: 0=100% of the tail is intact, 1=75–99% is intact, 2=50–74%, 3=25–49%, 4=1–24%, and 5=$<$1% of the tail is intact. In addition, lesions were classified as either acute (fresh or dark blood or red crust) or chronic (healed or in the process of healing). Moreover, swellings of the tail and other abnormalities were recorded but not considered in the analysis because they occurred very seldom. For each pig, the sex (barrow, gilt) and the approximate weight (based on visual assessment) were documented.

Risk factors

To collect information concerning risk factors for tail biting, concentrations of ammonia (NH_3) and carbon dioxide (CO_2), air temperature, air velocity, and relative humidity were measured in every pen containing study animals and during each farm visit. All measurements were carried out in the resting area and at the level of a pig's head. NH_3 and CO_2 were recorded by means of a multi-gas detector Dräger X-am® 7000 (Drägerwerk AG & Co. KGaA, 23558 Lübeck, Germany). Measurements were taken at three locations for 60 seconds each in a given pen, and the mean concentration per pen was documented. Air temperature and velocity were measured using a Testo 405-V1 thermal anemometer and relative humidity by using a Testo 177-H1 data logger (Testo North America, West Chester, PA 19382, United States). For data analysis, an indoor climate index was defined that included values of all these parameters (Table 1). When the measured value for a given parameter was within the recommended range, a score of one point was assigned to a given pen for this parameter. The scores for the different index parameters were summed up for each pen. The maximum score for the indoor climate index was five points.

Similarly, an enrichment index was calculated taking the availability of enrichment material into account (Table 1). Provision of straw as bedding material and availability of organic material (straw rack, etc.), organic objects (wood, etc.) and inorganic objects (plastic, etc.) enabling manipulative behavior resulted in a score of one point each for a given pen. The ratio of pigs per enrichment material or object was also considered for this index. Again, the points for the different index parameters were summed up. The maximum score for the enrichment index was eight points.

Moreover, all pigs of a given pen underwent a short visual clinical examination, and any symptom of disease as well as any other visual abnormality were recorded on an individual animal level. In particular, signs of respiratory diseases (sneezing, coughing) and diarrhea were documented. A runt was defined as an animal being 40% lighter than the average of the pen mates. Based on these data, a disease index was calculated at the pen level. To do so, the symptoms were assigned to different index parameters, and a given parameter had a score of one point if at least one animal in the pen showed a symptom related to this parameter (Table 1). Again, the points of the different parameters were summed up. The maximum score for the disease index was six points.
Finally, a water supply index was calculated considering the flow rate measured at the drinkers, the number of

Table 1: Indices defined to assess risk factors for tail biting in undocked pigs during the fattening period

Index	Index Parameters					
Indoor climate index	Temperature[1)]	Draft[2)]	NH_3[3)]	CO_2[4)]	Relative humidity[5)]	
Enrichment index	Straw bedding[6)]	Organic material[6)]	Organic objects[6)]	Inorganic objects[6)]	Pigs per organic object or organic material[7)]	Pigs per inorganic object[7)]
Disease index	Lameness[8)]	Conjunctivitis[8)]	Diarrhea[8)]	Runts[8)]	Sneezing, coughing, nasal discharge[8)]	Other symptoms[8)]
Water supply index	Flow rate[9)]	Animals per drinker[10)]	Cleanliness[11)]			

1) 0: Indoor temperature is too high or too low for the weight class of the pigs, 1: Indoor temperature is in the recommended range (<40 kg: 18–22 °C; 40–60 kg: 16–20 °C; >60 kg: 14–18 °C) 2
2) 0: Draft in the pen (>2 m/s), 1: No draft in the pen
3) 0: $NH_3 \geq 10$ ppm, 1: $NH_3 < 10$ ppm 1
4) 0: $CO_2 \geq 3{,}000$ ppm, 1: $CO_2 < 3{,}000$ ppm 1
5) 0: Relative humidity is too high or too low, 1: Relative humidity is in the recommended range (50–80%) 6
6) 0: None, 1: One point if available
7) 0: ≥22 pigs per object, 1: 11–21 pigs per object, 2: ≤10 pigs per object
8) 0: No symptoms on any animal, 1: At least one animal in the pen shows symptoms
9) 0: Water flow rate is too low for the weight class of the pigs for at least one drinker, 1: Water flow rate meets the recommended minimal flow rate with all drinkers (<50 kg: 0,6 L/min; 50–79 kg: 0,8 L/min; 80–120 kg: 1,5 L/min) 4
10) Liquid- or wet-dry-feeding: 0: >1:24, 1: 1:12 to 1:24, 2: <1:12; dry-feeding: 0: >1:12, 1: 1:6 to 1:12, 2: <1:6 5
11) 0: At least one drinking nipple is soiled with feces, 1: None of the drinking nipples is soiled with feces

animals per drinker (for a given feeding system), and the cleanliness of the drinker. The functionality of all drinkers was assessed, and the flow rate was measured on the weakest and on the strongest drinker with a measuring cup for 15 seconds. Based on the three index parameters, a water supply index score was calculated for each pen (Table 1) and the maximum score was four points.

Data analysis

Data were collected in Microsoft Excel® and further analyzed in R (Version 1.2.5033-1; 250 Northern Ave, Boston, MA 02210, United States). Due to sample and data structure constraints, and to make the most of the available data, analyses were carried out at farm level ($n=38$), pen level ($n=99$ for the first half of the fattening period, $n=117$ for the second half of the fattening period) and animal level ($n=2{,}209$).

The prevalence of tail lesions was defined as the percentage of pigs (per pen or per farm) with tail lesions at a certain point in time. The incidence of tail lesions was defined as the number of pigs with new tail lesions per 100 pigs that occurred during a time period. We considered both farm- and pen-specific incidences. New lesions refer to 1) new lesions, 2) lesions with a higher score than at the previous point in time (aggravated lesion) and 3) an acute lesion (aggravated lesion).

Variables were inspected visually using histograms, summary statistics were computed, and their normality was tested using Shapiro–Wilk tests.

Farm level

The prevalence of tail lesions on arrival at farm level was continuously distributed (not normally distributed) and analyzed as a numeric variable. However, the incidences of tail lesions for the first and the second half of the fattening period and over the whole fattening period presented a high proportion of zeros (e.g., more than 30%) and were recoded into binary variables (yes if new or aggravated lesion was present in ≥1 pig, and no otherwise). The association between prevalence on arrival (numeric, not normally distributed) and incidence (binary [yes, no], grouping variable) was tested using Wilcoxon signed-rank paired tests.

Pen level

At the pen level, only pens in which the group composition did not change (due to animals being re-grouped) during the complete fattening period were taken into account ($n=46$ of a total of 99 pens in the first and of 117 pens in the second half of the fattening period), because the re-grouping or splitting of the pens would influence the results. At each point in time, every pen was assigned to the following categories: 1) presence or absence of lesions on arrival, 2) presence or absence of new or aggravated lesions at the mid-point or the end of the fattening period. The association between incidences (binary) and prevalence on arrival (binary) was tested using McNemar tests.

Animal level

To analyze the influence of potential risk factors on the presence of new or aggravated tail lesions at animal level, new outcome variables were created to distinguish 1) pigs with new or aggravated lesions (yes, no; pigs with existing lesions that did not worsen over time were excluded) at the mid-point (1a), at the end (1b), and over the whole fattening period (1c), and 2) pigs with or without lesions (yes, no) on arrival and at the mid-point of the fattening period. Risk factors for all outcome variables (1a, 1b, 1c) were analyzed using mixed effects logistic regression models with pen as a random factor. Variables (2) at the previous time point were used as explanatory variables for the outcomes at the following time point. The following risk factors were considered: enrichment, indoor climate, disease and water supply (indices calculated as described above in *Risk factors* and Table 1) as well as feeding system (restrictive, ad libitum, sensor-controlled), animal-to-feeder-ratio, stocking density, group size, change of pen, change of group composition, label production (yes, no), sex, and having lesions (yes, no) on arrival or at the mid-point of the fattening period. The effect of these factors was analyzed separately for the first and the second half of the fattening period. For the presence of new or aggravated lesions per pen over the whole fattening period (outcome variable 1c), the influence of label production, sex, and having lesions (yes, no) on arrival was considered, because these factors stayed constant over the whole period. Collinearity between risk factors was analyzed, and only variables that did not correlate with each other (correlation coefficient <0,5) and showed p-values <0,05 in the univariate models were included in the multivariate models. Some models failed to converge due to some pens lacking one or more of the combinations of the categories of the included variables and thus were discarded.

Even though some of the considered risk factors might have changed in time, we assumed that the measurements of risk factors during the second farm visit (at the mid-point of the fattening period) adequately represented the situation for the pigs during the first half of the fattening period. Likewise, for the second half of the fattening period, the measurements of risk factors during the third farm visit (at the end of the fattening period) were used to study the presence of new or aggravated tail lesions during the second half of the fattening period.

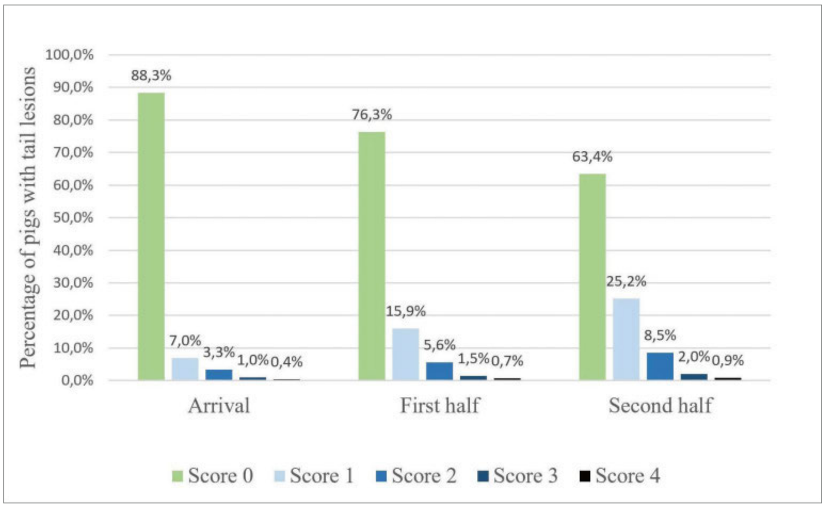

Figure 1: Percentage of pigs with tail lesions of different scores at each point in time: Score 0 = 100% of the tail is intact, no lesion; Score 1 = 75–99% intact; Score 2 = 50–74% intact; Score 3 = 25–49% intact; Score 4 = 1–24% intact; Score 5 = <1% intact; both acute and chronic lesions are shown.

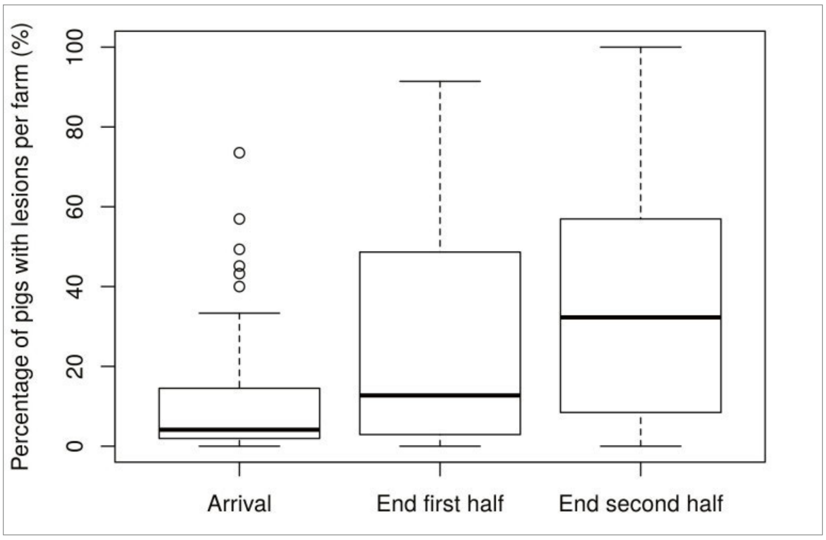

Figure 2: Percentage of pigs with tail lesions per farm (n=38) on arrival, at the mid-point and at the end of the fattening period; box plot showing the median (black line inside box), interquartile range (IQR) (box), values outside IQR but not more than 1,5 times (whiskers) and outliers (circles).

Results

Prevalence of tail lesions

On the day of arrival at the fattening unit, 11,7% (n=258) of all pigs had tail lesions, whereas 23,7% (n=524) and 36,6% (n=808) of all pigs had tail lesions at the end of the first half and at the end of the whole fattening period, respectively (Figure 1). For each point in time, the majority of lesions were of score one. There were no lesions of score five at any point in time.

On arrival, 7,4% (n=19) of all lesions were acute and 92,6% (n=239) were chronic. At the end of the first half of the fattening period, 8,2% (n=43) of all lesions were acute and 91,8% (n=481) chronic. At the end of the fattening period, 3,3% (n=27) of all lesions were acute and 96,7% (n=781) were chronic.

On conventional farms (n=21), 12,6% of the pigs had tail lesions on arrival, 30,9% at the end of the first half and 44,8% at the end of the second half of the fattening period. On label farms (n=17), 10.7% of the pigs had tail lesions on arrival, 16,3% at the end of the first half and 28,1% at the end of the whole fattening period.

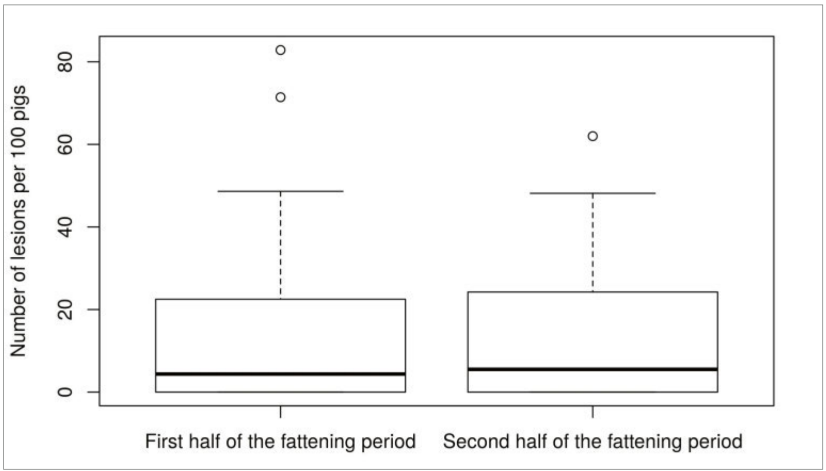

Figure 3: Number of pigs per 100 pigs with new or aggravated tail lesions calculated for each farm separately (*n*=38) per observation period; box plot showing the median (black line inside box), interquartile range (IQR) (box), values outside IQR but not more than 1,5 times (whiskers) and outliers (circles).

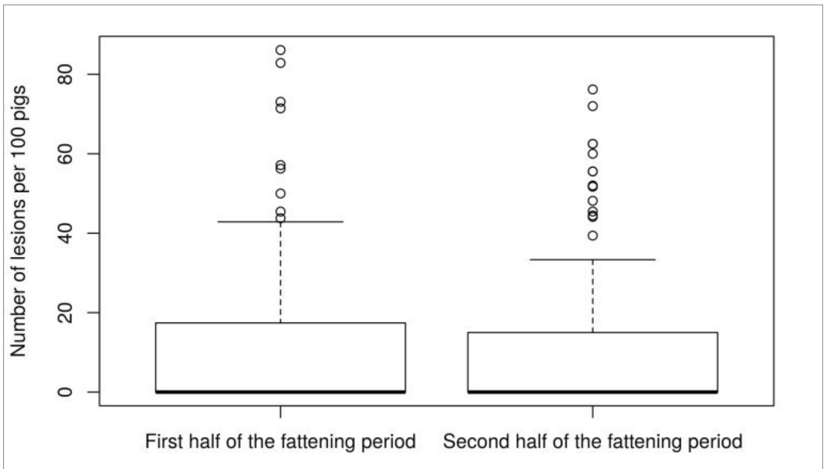

Figure 3: Number of pigs per 100 pigs with new or aggravated tail lesions calculated for each pen separately (*n*=99 first half, *n*=117 second half of the fattening period); box plot showing the median (black line inside box), interquartile range (IQR) (box), values outside IQR but not more than 1,5 times (whiskers) and outliers (circles).

Farm-specific prevalence of tail lesions at different points in time was large, ranging from 0% to 100% with median values increasing from 4% to 32% (Figure 2).

Incidence of tail lesions

During the first half of the fattening period, 14,1 pigs per 100 (*n*=311) developed new or aggravated tail lesions in comparison with the lesions noted on arrival. The result was similar for the second half, in which 15,4 pigs per 100 (*n*=341) developed new or aggravated tail lesions. Only 1,8 pigs per 100 (*n*=40) developed new or aggravated lesions both in the first and in the second half. Farm-specific incidence of tail lesions varied largely from zero to 83 with median values of four to six new lesions per 100 pigs per assessed period (Figure 3).

Calculated for each pen separately, the incidence of tail lesions varied largely from zero to 86 per 100 pigs during the first half and from zero to 76 per 100 pigs during the second half of the fattening period (Figure 4), with median values at zero. Out of 99 pens in the first half of the fattening period, pigs from 39 pens from 12 farms had developed new or aggravated lesions. Out of 117 pens in the second half of the fattening period, pigs from 53 pens from 15 farms had developed new or aggravated tail lesions.

Influence of the presence of tail lesions on arrival on the incidence of new or aggravated tail lesions during the fattening period

Farm level

The prevalence of tail lesions on arrival was only slightly higher (but non-significant) on farms with new or aggravated tail lesions (binary variable yes) compared with farms without (binary variable no) in the first half of the fattening period (p=0.0524; Wilcoxon signed-rank test). For the second half of the fattening period and for the fattening period in total, we found no evidence of a difference (second half: p=0.6773; total: p=0.8097; Wilcoxon signed-rank test).

Pen level

At pen level, and considering only pens in which group composition did not change (*n*=46), the incidence of tail lesions in the first and in the second half of the fattening period was not influenced significantly by the occurrence of tail lesions on arrival (first half: p=0,1213; second half: p=0,4237; McNemar test).

Risk factors

The results from the univariate analyses with mixed effects logistic regression models at animal level (*n*=2209) with pen as a random factor are shown in Table 2.

The results from the final multivariate analysis with mixed effects logistic regression models are presented in Table 3.

Having a tail lesion at the end of the first half of the fattening period had a protective effect on the occurrence of a tail lesion in the second half of the fattening period. This result was the same for having a tail lesion on arrival, but because both variables were correlated, only the first of the abovementioned variables was chosen for the final model.

Although there were more barrows than gilts that developed new or aggravated lesions (first half: 16,07% barrows, 11,48% gilts; second half: 16,39% barrows, 14,20% gilts), the influence of the sex could not be proven consistently. For the first half of the fattening period, being

Table 2: Results of risk factor analysis from univariate analyses; reference category is the one not listed. Some models failed to converge due to some pens lacking observations for each of the categories considered.

Dependent Variable	Independent Variable	N (%) of pigs	Odds Ratio	97,5% Confidence Interval	p-value
New or aggravated tail lesion in the first half of the fattening period (yes, no)	Sex (gilt)	958 (43,37)	0.52	0,43–0,63	0.0000
	Disease index 1	909 (41,15)	7.24	1,60–39,58	0.0125
	Disease index 2, 3, 4	200 (9,05)	24.56	3,28–287,83	0.0038
	Space per pig (>0,8–1,1 m²)	802 (36,31)	0.10	0,02–0,41	0.0016
	Space per pig (>1,1 m²)	607 (27,48)	0.18	0,03–0,92	0.0360
	Restrictive feeding (yes)	1,001 (45,31)	0.10	0,02–0,50	0.0080
	Sensor feeding (yes)	276 (12,49)	–	–	0.8470
	Animal-to-feeder-ratio (1–4,9)	398 (18,02)	–	–	0.9188
	Animal-to-feeder-ratio (≥5)	924 (41,83)	6.95	1,52–41,03	0.0166
	Tail lesion on arrival (yes)	258 (11,68)	Model failed to converge		
New or aggravated tail lesion in the second half of the fattening period (yes, no)	Disease index 1	559 (25,31)	4.29	1,59–12,72	0.0048
	Disease index 2, 3, 4	83 (3,76)	16.86	2,12–158,58	0.0085
	Water supply index 2	1,125 (50,93)	–	–	0.1894
	Water supply index 3	892 (40,38)	0.03	0,00–1,80	0.0936
	Water supply index 4	111 (5,02)	0.01	0,00–0,51	0.0275
	Enrichment index 2	651 (29,47)	–	–	0.1787
	Enrichment index 3	646 (29,24)	0.18	0,04–0,66	0.0120
	Enrichment index 4, 5	248 (11,23)	0.09	0,01–0,54	0.0108
	Enrichment index 6, 7	275 (12,45)	–	–	0.4480
	Restrictive feeding (yes)	1,044 (47,26)	0.20	0,07–0,54	0.0020
	Sensor feeding (yes)	276 (12,49)	–	–	0.2052
	Animal-to-feeder-ratio (1–4.9)	648 (29,33)	12.10	3,89–45,63	0.0000
	Animal-to-feeder-ratio (≥ 5)	881 (39,88)	11.33	3,65–41,74	0.0000
	Group size (11–20)	334 (15,12)	18.77	4,94–86,84	0.0000
	Group size (21–30)	727 (32,91)	6.37	1,82–25,68	0.0052
	Group size (>30)	775 (35,08)	19.93	5,17–95,06	0.0000
	Tail lesion on arrival (yes)	258 (11,68)	0.25	0,11–0,52	0.0004
	Tail lesion in the first half of the fattening period (yes)	524 (23,72)	0.52	0,33–0,82	0.0048

a gilt had a protective effect on the occurrence of tail lesions. In the multivariate analysis, models with sex failed to converge due to some pens lacking either barrows or gilts.

Interview

When farmers were asked what are the main reasons for tail biting, 29% (*n*=11) of all farmers mentioned poor air quality (noxious gases) and 24% (*n*=9) mentioned poor indoor climate (inappropriate temperature or draft). The third most named reason for tail biting was disease (21% of all farmers; *n*=9). According to the farmers engaged in production with enhanced housing conditions (label farmers), the most common reason for tail biting is a change of weather, which was mentioned by 35% (*n*=6) of all label farmers. The second most mentioned cause was poor air quality, which was mentioned by 29% (*n*=5), and the third

Table 3: Results of risk factor analysis from the multivariate analysis; reference category is the one not listed. Some models failed to converge due to some pens lacking observations for each of the categories considered.

Dependent Variable	Independent Variable	N (%) of pigs	Odds Ratio	97,5% Confidence Interval	p-value
New or aggravated tail lesion in the first half of the fattening period (yes, no)	Sex (gilt)	958 (43,37)	Model did not converge, therefore excluded		
	Disease index 1	909 (41,15)	5.83	1,46–26,86	0.0137
	Disease index 2, 3, 4	200 (9,05)	18.57	2,81–172,82	0.0038
	Space per pig (>0,8–1,1 m²)	802 (36,31)	0.11	0,02–0,42	0.0013
	Space per pig (>1,1 m²)	607 (27,48)	0.11	0,02–0,53	0.0067
	Restrictive feeding (yes)	1,001 (45,31)	0.24	0,06–0,91	0.0381
	Sensor feeding (yes)	276 (12,49)	–	–	0.4091
	Tail lesion on arrival (yes)	258 (11,68)	Model did not converge, therefore excluded		
New or aggravated tail lesion in the second half of the fattening period (yes, no)	Disease index 1	559 (25,31)	2.69	0,88–8,37	0.0767
	Disease index 2, 3, 4	83 (3,76)	9.23	1,08–84,75	0.0403
	Group size (11–20)	334 (15,12)	12.81	3,12–63,51	0.0007
	Group size (21–30)	727 (32,91)	5.41	1,56–21,43	0.0100
	Group size (>30)	775 (35,08)	14.23	3,68–67,90	0.0003
	Tail lesion in the first half of the fattening period (yes)	524 (23,72)	0.48	0,30–0,75	0.0014

was inadequate feed, mentioned by 24% (*n*=4) of all label farmers.

The second question asked for the most efficient methods to stop tail biting. The most frequent answers were identical for the conventionally producing and the label farmers. Extra enrichment was mentioned by 74% (*n*=28) of the farmers, followed by identifying the «biter» and separating it from the pen (45%; *n*=17) and by supplementation of mineral nutrients (29%; *n*=11).

Although 53% of the farmers (*n*=20) said that tail biting is a minor problem on their farm, 61% (*n*=23) were willing to change some aspect of the housing conditions to reduce tail biting. Thirty-nine percent (*n*=15) of the farmers expressed zero tolerance towards tail biting. For 45% (*n*=17) of the farmers, tail biting was acceptable when it affected only 1–2% of the pigs. For 11% (*n*=4) of the farmers, tail biting was acceptable in 3–5% of the pigs. Graphical analysis showed no clear effect of different tolerance level in this matter on the incidence of tail lesions.

Most farmers, namely 82% (*n*=31), named tail biting to be a very serious (*n*=18) or a serious (*n*=13) animal welfare problem. Moreover, 34% (*n*=13) and 29% (*n*=11) of the farmers stated that tail biting was financially a moderate or serious problem, respectively.

Finally, 53% (*n*=20) of the farmers would like to get professional advice on how to reduce tail biting on their farms, and another 37% (*n*=14) would consider such advice. This demand was not strongly affected by years of experience in pig production, because in every age category, most farmers wanted to be advised.

Discussion

We found that even though median values of the incidence of tail lesions were moderate, tail lesions varied largely from farm to farm and from pen to pen indicating that opportunities for improvement exist. Even though not all factors studied were present in every pen (i.e., despite some data limitations or sample heterogeneity limitations), several relevant and plausible risk factors were detected.

However, the data on risk factors were collected at a given time point in the fattening period, and this timing may not have reflected precisely the situation in which tail lesions developed in the period before. For example, indoor climate is variable over time, and continuous measurements of noxious gases and climate parameters would thus have been favorable but were not feasible in our study.

Band 162, Heft 11, November 2020, 683–695, © GST | SVS

Our study is the first study that registered lesions at the animal level at three time points on commercial farms. Because no behavioral observations were conducted, we cannot conclude that all lesions were due to tail biting. Other causes, such as tail necrosis due to endo- or mycotoxins cannot completely be excluded.[16,23] Differentiating such lesions from chronic lesions caused by biting is very difficult in practice. The prevalence of lesions at the end of the fattening period was 36,6%, which is similar to the latest findings at Swiss abattoirs (39,7%), but higher than found on farms (12,4%).[38] Our results regarding the prevalence are also considerably higher than found in a Swedish abattoir study with a similar scoring system (7,0–7,2%).[18] In our study, a strict scoring system was applied (chronic lesions were characterized as lesions even when they had healed completely), so our results can be considered an upper estimate. More than 90% of the lesions in our study were chronic, and often only the tip of the tail was affected (score one). Finally, all farms participated voluntarily, thus a potential bias towards increased prevalence and incidence cannot be excluded.

The claim made by many pig-fattening farmers that the more pigs with tail lesions on arrival are in a pen the more probable it is for the pigs in these pens to develop tail lesions during the fattening period could not be substantiated by our results (not enough evidence). On the contrary, at the animal level, we found that new lesions were less likely to occur among pigs that already had a lesion in the previous period. This result seems to be in contrast to earlier findings that pigs are attracted to blood[11] and that pre-weaning tail damage can predict the tail wounds after weaning.[13] However, in our study, there were very few acute lesions with blood, and even a healed lesion was counted as a tail lesion. Furthermore, Zonderland et al. (2011) reported that tail biters had no preferences for a specific pen mate, even when this pen mate had a damaged and bleeding tail.[42] They concluded that there might be other reasons for biting (e.g. the reaction of the bitten pig) or that bitten individuals might adjust their behavior and protect the tail from further biting.[43] Pigs that have a tail lesion that has not completely healed are likely to react more to a manipulation of the tail by a pen mate and, thereby, reduce the risk for developing an aggravated lesion. Moreover, a shortened tail (healed lesion) could have undergone traumatic neuronal development[14], similar to a tail stump with induced pain sensation after tail docking.[25,30] Finally, a tail of full length could also be more attractive for manipulation to the pen mates than a docked or shortened tail and thus have a higher risk of being injured.[10]

With regard to the rest of the risk factors for tail lesions, we found a positive relationship between the disease index in the pen and the presence of new or aggravated tail lesions for both halves of the fattening period. The presence of respiratory diseases has previously been shown to be associated with an increased risk of tail biting[21,22,39]. Moreover, several authors have shown an association between tail damage and various pathological findings in slaughtered pigs.[20,34,37] Not only can health impairment promote tail biting, but it can also be vice versa: tail damage can act as an entry port for bacteria and thus infect other organs, such as the lungs.[20] It should also be considered that the overall disease situation in Swiss pig production is good, because Switzerland is practically free from clinical *Actinobacillus* induced pleuropneumonia, enzootic pneumonia, progressive rhinitis atrophicans and free of *Porcine reproductive and respiratory syndrome virus*. In line with this situation, the disease index was zero in most pens of our study farms, and higher scores of this index were rare. Nevertheless, even with these relatively healthy pigs, the results underline the importance of taking care of pigs' health to prevent tail lesions.

In addition, we found an inverse relationship between increased space allowance and the incidence of tail lesions for the first half of the fattening period. In line with our results, a high stocking density was associated with a higher risk for tail biting in previous studies on commercial farms.[21,29] It is difficult to explain why space allowance only had a significant effect in the first half of the fattening period. Possibly, the social hierarchy in the groups was more stable in the second half of the fattening period, making it easier for the pigs to cope with limited space allowance. It should also be considered that minimum space allowances for fattening pigs in Switzerland are higher than in most EU countries. The fact that space allowance still had a significant effect in the present study underpins the importance of stocking density for tail lesions.

We also found a positive relationship between group size and the incidence of tail lesions for the second half of the fattening period. This effect is not supported well in the scientific literature. Schmolke et al. (2003) and Kritas and Morrison (2004) found no influence of group size on tail biting.[26,19] In a Finnish study, a group size of above nine pigs resulted in an increased risk for tail biting, although this effect might have been masked through other factors.[17] A possible explanation for the effect of group size found in our study is that with every additional pig in the pen there is also one additional potential biter or victim in the pen. Moreover, in larger groups, it may be more difficult to identify and separate the biter, which is a frequently mentioned intervention measure taken to reduce tail biting.[40] Finally, detecting tail biting itself may be more difficult in larger groups, and therefore intervention measures might be taken later than in smaller groups.

Our results suggest that pigs fed restrictively have a lower risk for developing tail lesions in the first half of the fattening period than ad libitum fed pigs. To our knowledge, this has not been shown before. In contrast with our results, it was found that ad libitum fed pigs performed less behaviors redirected towards pen mates than restrictively fed pigs.[24] In a study conducted in the UK, the feeding level (restricted, to appetite or ad libitum) did not have a significant effect on the probability of being tail bitten, but the use of double- or multi-space feeders in contrast to single-space feeders reduced the risk for tail biting.[15] It should also be considered that the feeding system was closely associated with the animal-to-feeder-ratio in the present study, because ad libitum feeding was only used in pens with at least four pigs per feeder. Consequently, it is possible that not the feeding system itself, or at least not solely, was responsible for the effect regarding the occurrence of tail lesions. Several studies have shown an association between an increase in the animal-to-feeder-ratio and a higher risk for tail biting.[21,32] It may also be easier for the farmer to detect tail biting and take intervention measures when fattening pigs are fed restrictively, because all pigs can be observed at the same time during feeding.

The majority of farmers stated that poor indoor climate and disease are the main reasons for tail biting. This result is similar to earlier findings.[8,12,35,36] Interestingly, for label farmers, the most common reason for tail biting is a change of weather. Possibly, these farms are more susceptible to weather conditions because 13 out of 17 label farms had an outdoor run. The influence of weather is not fully understood. However, it has been shown that tail biting is more frequent during winter months.[7,28] The farmers stated that the most efficient method against tail biting was providing extra enrichment material, followed by identifying and separating the biter. These two intervention measures were also frequently mentioned in other studies.[8,35,36] Furthermore, the interview revealed that the farmers had great interest in improving the situation on their farms and a demand for professional advice. However, it should be considered that a certain bias towards farmers that find tail biting a serious issue was likely to be present, because they participated voluntarily in our study.

Other potential risk factors, such as genetics and feed composition, were difficult to assess because the farmers did not always possess this information. Further on-farm research on a larger scale is recommended for better understanding of the multicausality of risk factors for tail lesions on commercial farms. Future studies should also address weaner pigs, because the prevalence of tail lesions on arrival in this study was non-negligible.

Conclusion

Our results indicate that the incidence of tail lesions in undocked pigs during the fattening period could be reduced by improving animal health and housing conditions. Further efforts are needed to inform, instruct and help farmers in the prevention of tail biting.

Acknowledgments

The authors wish to thank all farmers that participated in this study, the three abattoirs, the Pig Health Service of SUISAG and others that helped us with recruiting farmers. Furthermore, we thank Michael Simmler for data management, Matthias Hatt, Beat Kürsteiner and Markus Sax for technical support and the Federal Food Safety and Veterinary Office for financial support (Project No. 2.18.01).

Facteurs de risque de lésions de la queue chez les porcs d'engraissement non écaudés dans des exploitations suisses

Les lésions de la queue causées par morsure sont un problème majeur de bien-être et d'économie chez les porcs d'engraissement. Les objectifs de cette étude étaient de décrire la prévalence et l'incidence des lésions de la queue pendant la période d'engraissement chez les porcs non écaudés au niveau de chaque animal, d'élucider les facteurs de risque potentiels associés aux lésions de la queue et de décrire les attitudes des éleveurs à

Fattori di rischio per le lesioni alla coda nei suini da ingrasso non sottoposti a caudotomia allevati nelle aziende agricole in Svizzera.

Le lesioni alla coda causate da morsicature sono una delle principali preoccupazioni in termini di benessere ed economia nei suini da ingrasso. Lo scopo di questo studio è di descrivere la prevalenza e l'incidenza delle lesioni alla coda nei suini non caudotomizzati per ogni singolo animale durante l'ingrasso per poter definire i potenziali fattori di rischio associati a tali lesioni e di descrivere l'atteggiamento degli allevatori nei confronti l'égard des morsures de queue dans les exploitations suisses. Trente-huit exploitations ont été visitées trois fois pendant la période d'engraissement (début, mi-parcours, fin). Lors de chaque visite, les lésions de la queue ont été notées sur 30 à 126 porcs marqués individuellement par l'exploitant (total: 2209 porcs), des informations sur les facteurs de risque potentiels de lésions de la queue ont été enregistrées et un entretien standardisé avec l'éleveur a été mené pour connaitre son avis sur les morsures de queue. Les facteurs de risque potentiels ont été définis par des indices lorsqu'ils étaient adéquats et leur influence sur la survenue des lésions caudales a été analysée à l'aide de modèles de régression logistique à effets mixtes. Pendant la première et la deuxième moitié de la période d'engraissement, en moyenne 14,1 et 15,4 porcs, respectivement, sur 100 ont développé de nouvelles lésions de la queue ou une aggravation d'anciennes lésions. Le risque de nouvelles lésions de la queue ou d'aggravation augmentait avec des scores plus élevés pour un «indice de maladie» et avec l'augmentation de la taille du groupe et il diminuait avec des allocations d'espace plus élevées et avec une alimentation restrictive par rapport à l'alimentation à volonté. La prévalence des lésions de la queue à l'arrivée n'était pas associée à l'incidence des lésions de la queue dans la première et la seconde moitié de la période d'engraissement, ni au niveau de l'exploitation ni au niveau des boxes. Dans les entretiens, les agriculteurs ont exprimé leur intérêt à obtenir des conseils professionnels sur la façon de réduire les morsures de queue dans leurs exploitations.

En conclusion, notre étude a identifié plusieurs facteurs de risque de lésions de la queue chez les porcs d'engraissement non écaudés indiquant que l'incidence des lésions de la queue pourrait être réduite en améliorant la santé animale et les conditions de logement.

Mots clés: attitude de l'éleveur, porc d'engraissement, facteur de risque, morsure de la queue

delle morsicature nelle aziende di allevamento in Svizzera. Trentotto aziende sono state visitate tre volte durante il periodo dell'ingrasso (all'inizio, a metà e alla fine). Durante ogni visita le lesioni alla coda sono state marcate su 30–126 suini per fattoria (in totale di 2209 suini), sono state raccolte informazioni sui potenziali fattori di rischio di tali lesioni alla coda ed è stata condotta un'intervista standardizzata con l'allevatore per determinare la sua opinione sulle morsicature alla coda. I potenziali fattori di rischio sono stati definiti da indici, se adeguati, e la loro influenza sulle occorrenze delle lesioni alla coda è stata analizzata utilizzando il modello di regressione logistica ad effetti misti. Durante il primo e il secondo periodo dell'ingrasso, in media 14,1 e 15,4 suini, su 100, hanno sviluppato rispettivamente nuove lesioni alla coda o aggravamento delle vecchie lesioni. Il rischio di nuove lesioni della coda o dell'aggravamento delle lesioni esistenti è aumentato con punteggi più alti per un «indice di malattia» e con l'aumento delle dimensioni del gruppo, ed è diminuito aumentando lo spazio a disposizione e con restrizioni rispetto all'alimentazione ad libitum. La prevalenza di lesioni alla coda alla fine non era associata all'incidenza delle lesioni alla coda nella prima e nella seconda metà del periodo di ingrasso, né a livello dell'allevamento né a livello del porcile. Nelle interviste, gli allevatori hanno espresso il loro interesse nel ricevere consigli professionali su come ridurre le morsicature della coda nelle loro aziende. In conclusione, il nostro studio ha identificato diversi fattori di rischio per le lesioni alla coda nei suini da ingrasso non caudotomizzati, indicando che l'incidenza delle lesioni alla coda potrebbe essere ridotta migliorando la salute degli animali e le condizioni di stabulazione.

Parole chiave: atteggiamento dell'allevatore, suino da ingrasso, fattore di rischio, morsicatura alla coda

Referencens

[1] Scientific Veterinary Committee. The welfare of intensively kept pigs. European Commission, Brussels: https://ec.europa.eu/food/sites/food/files/animals/docs/aw_arch_1997_intensively_kept_pigs_en.pdf (accessed 19.05.2020).

[2] DLG-Arbeitsunterlage: Lüftung von Schweineställen. DLG-Verlags-GmbH, Frankfurt am Main, Germany: https://www.dlg.org/fileadmin/downloads/landwirtschaft/themen/publikationen/merkblaetter/DLG-Merkblatt_AU_lueftung.pdf (accessed 19.05.2020).

[3] European Food Safety Authority (EFSA). Scientific Opinion of the Panel on Animal Health and Welfare on a request from Commission on the risks associated with tail biting in pigs and possible means to reduce the need for tail docking considering the different housing and husbandry systems. The EFSA Journal (2007) 611, 1-13: https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2007.611 (accessed 19.05.2020).

[4] DLG-Merkblatt 351: Tränketechnik für Schweine DLG e.V., Frankfurt am Main, Germany, Fachzentrum Land- und Ernährungswirtschaft, DLG-Ausschuss für Technik in der Tierproduktion https://www.dlg.org/fileadmin/downloads/landwirtschaft/themen/publikationen/merkblaetter/dlg-merkblatt_351.pdf (accessed 19.05.2020).

[5] The Federal Department of Home Affairs (FDHA), Federal Food Safety and Veterinary Office. Animal Welfare Ordinance (TSchV). https://www.admin.ch/opc/de/official-compilation/2008/2985.pdf (accessed 18.05.2020).

[6] The Federal Department of Home Affairs (FDHA), Federal Food Safety and Veterinary Office. Fachinformation Tierschutz. Stallklimawerte und ihre Messung in Schweinehaltungen https://www.blv.admin.ch/dam/blv/de/dokumente/tiere/nutztierhaltung/schweine/fachinformationen-schwein/stallklima-schwein.pdf.download.pdf/6_(1)_d_Schweine_Stallklima.pdf (accessed 18.05.2020).

[7] Blackshaw JK: Some behavioural deviations in weaned domestic pigs: persistent inguinal nose thrusting, and tail and ear biting. Anim. Sci. 1981: 33(3): 325–332.

[8] Bracke MBM, De Lauwere CC, Wind SMM, Zonderland JJ: Attitudes of Dutch pig farmers towards tail biting and tail docking. J. Agr. Environ. Ethic. 2013: 26(4): 847–868.

[9] Cagienard A, Regula G, Danuser J: The impact of different housing systems on health and welfare of grower and finisher pigs in Switzerland. Prev. Vet. Med. 2005: 68(1): 49-61.

[10] Di Martino G, Scollo A, Gottardo F, Stefani A, Schiavon E, Capello K, et al.: The effect of tail docking on the welfare of pigs housed under challenging conditions. Livest. Sci. 2015: 173: 78-86.

[11] Fraser D: Attraction to blood as a factor in tail-biting by pigs. Appl. Anim. Behav. Sci. 1987: 17(1-2): 61–68.

[12] Haigh A, O'Driscoll K. Irish pig farmer's perceptions and experiences of tail and ear biting. Porc. Health Manag. 2019; 5. https://doi.org/10.1186/s40813-019-0135-8 (accessed 19.05.2020).

[13] Hakansson F, Lahrmann HP, Forkman B: A longitudinal study of pre- and post-weaning tail damage in non-docked pigs. animal 2020: 1–8.

[14] Holling C, Tölle K-H, Otto G, Blaha T: Haltung von Schweinen mit nicht kupierten Schwänzen in konventionellen Betrieben. Tierarztl. Prax. G 2016: 44(5): 296–306.

[15] Hunter EJ, Jones TA, Guise HJ, Penny RHC, Hoste S: The relationship between tail biting in pigs, docking procedure and other management practices. Vet. J. 2001: 161(1): 72–79.

[16] Jaeger F: Das Projekt «intakter Ringelschwanz» beim Schwein – stehen wir vor dem Durchbruch? (The project «intact curly tails» in pigs – are we just before a breakthrough?). Tierarztl. Umsch. 2013: 68: 3–11.

[17] Kallio PA, Janczak, A. M., Valros, A. E., Edwards, S. A., & Heinonen, M.: Case control study on environmental, nutritional and management-based risk factors for tail-biting in long-tailed pigs. Anim. Welfare 2018: 27(1): 21–34.

[18] Keeling L, Wallenbeck A, Larsen A, Holmgren N: Scoring tail damage in pigs: An evaluation based on recordings at Swedish slaughterhouses. Acta Vet. Scand. 2012: 54(1): 32.

[19] Kritas SK, Morrison RB: An observational study on tail biting in commercial grower-finisher barns. J. Swine Health Prod. 2004: 12(1): 17–22.

[20] Kritas SK, Morrison RB: Relationships between tail biting in pigs and disease lesions and condemnations at slaughter. Vet. Rec. 2007: 160(5): 149.

[21] Moinard C, Mendl M, Nicol CJ, Green LE: A case control study of on-farm risk factors for tail biting in pigs. Appl. Anim. Behav. Sci. 2003: 81(4): 333–355.

[22] Munsterhjelm C, Simola O, Keeling L, Valros A, Heinonen M: Health parameters in tail biters and bitten pigs in a case-control study. animal 2013: 7(5): 814–821.

[23] Reiner G, Lechner M, Eisenack A, Kallenbach K, Rau K, Müller S, et al.: Prevalence of an inflammation and necrosis syndrome in suckling piglets. animal 2019: 13(9): 2007–2017.

[24] Robert S, Matte JJ, Girard CL: Effect of feeding regimen on behavior of growing-finishing pigs supplemented or not supplemented with folic acid. J Anim Sci 1991: 69(11): 4428-4436.

[25] Sandercock D, Smith S, Di Giminiani P, Edwards S: Histopathological characterization of tail injury and traumatic neuroma development after tail docking in piglets. J Comp Pathol 2016: 155(1): 40–49.

[26] Schmolke SA, Li Y, Gonyou H: Effect of group size on performance of growing-finishing pigs. J Anim Sci 2003: 81(4): 874–878.

[27] Schnider R: Gesundheit von Mastschweinen in unterschiedlichen Haltungssystemen. FAT-Schriftenreihe Nr. 55, FAT, Tänikon, Switzerland 2002.

[28] Schrøder-Petersen DL, Simonsen HB: Tail Biting in Pigs. Vet. J. 2001: 162(3): 196–210.

[29] Scollo A, Contiero B, Gottardo F: Frequency of tail lesions and risk factors for tail biting in heavy pig production from weaning to 170 kg live weight. Vet. J. 2016: 207: 92–98.

[30] Simonsen HB, Klinken L, Bindseil E: Histopathology of intact and docked pigtails. Brit. Vet. J. 1991: 147(5): 407–412.

[31] Sinisalo A, Niemi JK, Heinonen M, Valros A: Tail biting and production performance in fattening pigs. Livest. Sci. 2012: 143(2-3): 220–225.

[32] Smulders D, Hautekiet V, Verbeke G, Geers R: Tail and ear biting lesions in pigs: An epidemiological study. Anim. Welfare 2008: 17(1): 61–69.

[33] Taylor NR, Main DCJ, Mendl M, Edwards SA: Tail-biting: A new perspective. Vet. J. 2010: 186(2): 137–147.

[34] Valros A, Ahlström S, Rintala H, Häkkinen T, Saloniemi H: The prevalence of tail damage in slaughter pigs in Finland and associations to carcass condemnations. Acta Agr. Scand., A-AN. 2004: 54(4): 213–219.

[35] Valros A, Barber C: Producer Perceptions of the Prevention of Tail Biting on UK Farms: Association to Bedding Use and Tail Removal Proportion. Animals 2019: 9(9): 628.

[36] Valros A, Munsterhjelm C, Hänninen L, Kauppinen T, Heinonen M: Managing undocked pigs – on-farm prevention of tail biting and attitudes towards tail biting and docking. Porc. Health Manag. 2016: 2(1): 2.

[37] vom Brocke AL, Karnholz C, Madey-Rindermann D, Gauly M, Leeb C, Winckler C, et al.: Tail lesions in fattening pigs: relationships with postmortem meat inspection and influence of a tail biting management tool. animal 2019: 13(4): 835–844.

[38] von Gunten C: Prävalenz von und Risikofaktoren für Caudophagie bei Mastschweinen in der Schweiz. Master Thesis: University of Bern, 2016.

[39] Walker PK, Bilkei G: Tail-biting in outdoor pig production. Vet. J. 2006: 171(2): 367–369.

[40] Wallgren T, Lundeheim N, Wallenbeck A, Westin R, Gunnarsson S: Rearing Pigs with Intact Tails-Experiences and Practical Solutions in Sweden. Animals 2019: 9(10): 812.

[41] Wallgren T, Westin R, Gunnarsson S: A survey of straw use and tail biting in Swedish pig farms rearing undocked pigs. Acta Vet. Scand. 2016: 58(1): 84.

[42] Zonderland JJ, Kemp B, Bracke MBM, den Hartog LA, Spoolder HAM: Individual piglets' contribution to the development of tail biting. Animal 2011: 5(4): 601–607.

[43] Zonderland JJ, van Riel JW, Bracke MBM, Kemp B, den Hartog LA, Spoolder HAM: Tail posture predicts tail damage among weaned piglets. Appl. Anim. Behav. Sci. 2009: 121(3–4): 165–170.

Corresponding author

Heiko Nathues
Schweineklinik, Vetsuisse-Fakultät, Universität Bern
Bremgartenstrasse 109a
CH-3012 Bern
Telefon: +41 31 631 23 44
E-Mail: heiko.nathues@vetsuisse.unibe.ch