Comparing Health and Welfare of Pigs Farmed in Conventional and in Organic Systems Housed Indoors

Johanna Piibor[1], Julia Jeremejeva[2], Ragnar Leming[1] and David Arney[1]
[1]*Chair of Animal Nutrition, Institute of Veterinary Medicine and Animal Sciences, Estonian University of Life Sciences, Tartu. Estonia*
[2]*Chair of Clinical Veterinary Medicine., Institute of Veterinary Medicine and Animal Sciences, Estonian University of Life Sciences, Tartu. Estonia*

Keywords: *organic farming, parasitic diseases, free range husbandry, behaviour, African swine fever, tail biting.*

Abstract. *Since 2014, it has been forbidden to keep pigs outside in Estonia, because of African swine fever. This study compared the welfare and health of pigs raised in indoor conventional and organic systems in Estonia. Selected parameters for comparison were included: stocking densities, behaviour, a human-animal approach test, lameness, dirtiness, tail biting, skin wounds and faecal samples for parasitic egg counts. Organic farms had poorer human-animal interactions compared with conventional farms, but were better in regards to the social and exploratory behaviour among pigs. They were also slightly better regarding lameness and dirtiness compared with conventional farms. Organic farms had less tail biting and skin wounds than conventional farms. Of 16 faecal samples from organic farms, 12 had parasite eggs, while none of the samples from conventional farms were positive. Welfare problems remain to be solved on organic pig farms irrespective of whether they are kept indoors or outdoors, but there are benefits to pig welfare under organic regulations even if they have no access to an outdoor area.*

Introduction

It has been argued that pigs reared in intensive indoor conventional farms have lower levels of animal welfare and health compared with pigs reared in less intensive organic farms (Alban et al., 2015), and the arguments have been reviewed by Spoolder (2007). However, reliable and practical worldwide welfare assessment criteria are yet to be developed. It might be impossible to have a common standard, because different countries rear their animals in different environments. Also, there is a diverse understanding of what good welfare is. Nevertheless, there are some protocols (e.g., Welfare Quality® protocol 2009) to assess factors that are considered to be reliable indicators, such as diseases, fertility, morbidity, mortality, animal productivity, stress hormone levels and behaviour (reviewed by Botreau et al., 2007). The Estonian government and the European Union Council have set minimum requirements for organic pig production systems (e.g., Regulation of Estonian Ministry of Agriculture RT I, 11.12.2012, 2 & RT I, 12.10.2018, 8; European Union Council Directive 2008/120/EC; European Union Council Regulation 834/2007/EC & 889/2008/EC). These state that organic farms must have lower stocking densities, have access to outdoors, bedding material should be provided, later weaning, no use of farrowing crates and feeds have to be organic; and there are health treatment restrictions, particularly prophylaxis, compared with conventional farms.

African swine fever was detected in Estonia in September 2014 among the wild boar population, but the first domestic pig farm was infected in July 2015 (Nurmoja et al., 2018). The Estonian Veterinary and Food Board reacted to limit the spread of the disease and passed a decree on 25.07.2014 that forbade swine to have access to outside and the storage of their feed outside. Since then all swine in Estonia have been kept inside all year around (Veterinaar ja Toiduameti käskkiri 25.07.2014 no. 117). This might be expected to have an impact on pig welfare in organic systems. This study considered some welfare and health parameters to evaluate the differences of production systems in regards to the new regulation. In addition, organic and conventional pig production *per se* can be compared in the current conditions without the confounding factor of access to outdoors. Observation of behaviour is crucial to ensure that pigs are coping with their environment. The expression of normal behaviours and abnormal behaviours is key to understanding this. Pigs living in stressful environments can show abnormal behaviours, such as tail and ear biting and floor licking (Arney et al., 2018; Zimmermann et al., 2012).

The aim of this study was to evaluate and compare the health and welfare of pigs kept on farms in conventional systems and on organic farms where the pigs are kept indoors. The selected animal-based indicators were lameness, dirtiness, skin wounds, tail and ear biting, shoulder ulcer, human-animal interactions, social and exploratory behaviours,

Correspondence to David Arney, Chair of Animal Nutrition, Institute of Veterinary Medicine and Animal Sciences, Estonian University of Life Sciences, Tartu. Estonia.
E mail david.arney@emu.ee

parasite infection and organ changes found on *post-mortem* inspection. The collapse of the organic pig sector in Estonia following the restrictions described above (the number of adult pigs declined from 1,455 in 2014 to 534 in 2018 (Põllumajandusamet, 2020)) limited the population size available for their inclusion in this study, and this paper has been presented as a case study rather than a statistically robust comparative analysis.

Materials and Methods

This research was based on data from three organic pig farms and three conventional pig farms in Estonia, which were collected from July to October 2019. All of the organic farms were certified at the latest in 2005 according to the Estonian Organic Agriculture register. Collected data from the farms included assessment of an easily evaluated welfare protocol and health parameters *via* observation, collection of faecal samples for quantitative faecal flotation analysis for parasitic eggs, and description of management and husbandry procedures from an interview with the farm representative. Assessments were made on finishing pigs, weaners and dry sows. Piglets and lactating sows were not included. The organic pigs were housed with straw bedding. As there were small animal numbers, all animals were housed in one space, though grouped and separated by fences. Conventional farms were more intensive, larger, with slatted floors and resting area on concrete. Not all animals on the farms were housed in a single space, and not all farms provided environmental enrichments (such as toys).

A standardised on-farm assessment was carried out, with guidance from the literature (Dippel et al., 2014; Welfare Quality® Consortium, 2009). All assessments were made by one observer during a single-day visit to the farms, and sampled pigs were selected randomly. Health and welfare parameters were chosen to evaluate locomotion and skin quality. Also, social and exploratory behaviour and human-animal reaction interactions were evaluated. In total, 402 organic pigs and 612 conventional pigs were assessed. Each health and welfare parameter had their own scoring systems, which are described in Tables 1 and 2. Lameness was assessed from every randomly selected individual pig while moving. If the pig was reluctant to move, the pig was encouraged to move through vocal encouragement by the observer. Dirtiness was evaluated from one side of the pig at a 0.5–1 m distance and scored into three categories. Skin wounds, identified by physical injury where the integrity of the skin was compromised, were also observed from one side of the pig at a 0.5–1 m distance. A shortened tail (identified as such if a part of the tail had been removed), tail biting, ear biting and shoulder ulcer were assessed by observation. Signs of tail and ear bites were recorded as existent when fresh blood was visible on the tail/ear and/or there was evidence of swelling and infection and/or part of the tail/ear was missing.

Human-animal interaction, assessed by the distance permitted by an animal between itself and a human, should become shorter between the stockperson and the animal that is in his care. This

Table 1. Scoring scales of health and welfare parameters (adapted from Dippel et al., 2014; Welfare Quality® Consortium, 2009)

Parameters	Scoring scale
Lameness	0 – No detectable lameness, pig moves easily 1 – Pig moves relatively easily, but there are visible signs of lameness in at least one leg, reluctant to put on weight on the affected leg, but still weight bearing 2 – Lameness is apparent in one or more legs, pig shows compensatory behaviours such as arching the back and dipping the head 3 – Reluctance to walk and bear weight on one or more legs, pig does not want to move when encouraged
Dirtiness	0 – Up to 10% of the body surface is soiled 1 – 10–30% of the body surface is soiled 2 – More than 30% of the body surface is soiled
Skin wounds	0 – No visible skin wounds 1 – Less than 5 skin wounds 2 – 5-10 skin wounds 3 – More than 10 skin wounds
Shortened tail	0 – Tail has natural length 1 – Tail shorter than normal
Tail biting	0 – No visible signs of tail biting 1 – Visible signs of tail biting
Ear biting	0 – No visible signs of ear biting 1 – Visible signs of ear biting
Shoulder ulcers	0 – No visible signs of shoulder ulcers 1 – Visible signs of shoulder ulcers

Table 2. Scoring scales of welfare parameters (adapted from Dippel et al., 2014; Welfare Quality® Consortium, 2009)

Parameter	Scoring system
Human-animal reaction	0 – Observer can touch the pig and it does not flee or flees after touching, but then returns to the observer within 10 seconds 1 – Pig allows the observer to come as close as 0.5 m, but does not allow touching or allows the observer to come as near as 0.5 m, then flees, but returns within 10 seconds, or after allowing touching does not return to the observer within 10 seconds 2 – The pig does not allow the observer to come near it
Social and exploratory behaviour	Negative social behaviour (N) – aggressive behaviour; Positive social behaviour (P) – sniffing, licking, nosing and moving gently away from another pig; Pen investigation (S) – sniffing, licking or nosing floor, wall or pen fittings, except toy and straw; Exploratory behaviour (E) – playing with a toy or straw; Resting (R) – lying down; Other (O) – other behaviours

was assessed in stalls one pig at a time. All assessed pigs were standing during the assessment. The evaluation comprised three stages. First, the observer stood about 0.5 meters away from the selected pig and stayed in a relaxed position for 10 seconds. If the pig did not react, the observer proceeded to the next stage. The observer started slowly moving towards the pig, keeping the hands and arms close to their body. Once the observer reached near to the pig, the observer crouched down in front of the pig motionless for 10 seconds. If the pig did not react, the observer proceeded to the next stage. At this last stage, the observer reached out a hand and slowly attempted to touch the pig between the ears for 10 seconds. If the pig came close to the human in the first stage, the pig was slowly touched, missing out the second stage.

Social and exploratory behaviours were assessed outside of the feeding period in the passageway for 5 minutes. Observations started 2 minutes after the observer approached the group in the passageway to standardise the response of pigs to the observer. During the observation, the observer did not move. For the assessment, all animals were standing. Lying animals were encouraged to stand up through vocal encouragement by the observer. Over a period of 5 minutes, the observer recorded how many animals showed negative or positive social behaviours, explored the pen or the enrichment material, or lay down. If an observed pig showed behaviour distinct from these, such as standing idle, this was classified as "other" behaviour.

Faecal samples (around 10 g) were taken from assessed pigs either from the rectum or from fresh faeces. Sixteen samples from the organic farms and 20 samples from the conventional farms were taken. All samples were stored in a cooling box. If faecal analysis was not done on the same day as collection, then the samples were stored in a refrigerator at +4°C for a maximum period of 16 h. Depending on the size of the farm, 4–8 samples per farm were taken. Faecal analysis was performed according to the Concentration McMasters quantitative faecal flotation method. Around 4.0 g of a faecal sample was taken and 56 mL of tap water was added. Faeces and water were stirred and left to rest in a container for 30 min. Then, 10 mL of the faecal suspension was poured through a single layer of gauze into a test tube. The test tube was centrifuged for 7 min at 1,200 rpm. Shortly before counting, flotation fluid (saturated NaCl with 500 g glucose per litre) was added to a volume of the 4 mL mark and the solution was suspended using a Pasteur pipette. A McMaster counting chamber was then filled with the faecal suspension. Microscopic examinations of parasitic eggs were made at 100x magnification. Results were presented as number of eggs per gram (Roepstorff et al., 1998).

An interview was made with a representative of the farm who had knowledge of the farm's management, husbandry procedures and *post-mortem* inspection data regarding changes in abnormalities. During the interview, questions regarding disinfection methods, manure removal and management, anthelminthic treatment, grouping, animal quarantine, disease history, castration, teeth cutting and tail docking procedures were asked.

The number of farms of each system was small, because the national number of organic farms is only three, and thus analytical statistics were not used as they might be considered to claim significance where this was not justifiable. Statistics of raw data presented here are descriptive and should be considered in the light of an observational case study.

Results

The organic pigs had around twice as much area as the conventionally reared pigs. The mean measured stocking densities were higher than required by law, although this was not the case for individual farms. Some farmers knew how densely they can stock their pigs, because they had already measured the areas and read the law. Other farmers did not know the area size and stocked their pigs according to their experience, particularly in regard to their estimates to minimise tail biting. On the conventional farms, the minimum measured density of sows was 1.94 m^2 and the maximum was 5.75 m^2, and among finishers, the minimum density was 0.82 m^2 and the maximum was 2.06 m^2. On the organic farms, the minimum stocking density of sows was 2.07 m^2 and the maximum was

37.5 m^2, while among finishers, the minimum density was 0.87 m^2 and the maximum was 5.42 m^2. In both systems, there were sows at a higher stocking density than they should be according to the regulations. The farms that had too high densities were aware that they were higher than should be, but they had lack of space to accommodate all the pigs, and thus decided to put more pigs in groups than there should have been.

From the human-animal interaction evaluations, among conventional pigs, 93.6% were scored 0 and 6.4% as 1. There were no conventionally raised pigs that were given score 2. Among organic pigs, 86.3% were scored 0; 9.7% were scored 1 and 4.0% were scored 2. In the conventional systems, higher prevalences of aggressive behaviour (fighting for food and space) among pigs were recorded compared with organic farms (Table 3). And an opposite result was seen regarding positive behaviours; the organic farms had higher prevalences of positive behaviours (sniffing and gently nosing of another pig) than on the conventional farms (Table 3). There were no differences in resting behaviour between the two management systems (Table 3).

On the conventional farms, 97.9% of pigs were not lame, and 2.1% of pigs were lame. Of the latter, 1.8% were scored with a lameness score 1, 0.2% with a score 2 and 0.2% with a score 3. On the organic farms, 99.3% of pigs were not lame, while 0.7% were lame. Lameness score 1 was detected in 0.2% of pigs and 2 in 0.5%. There were no pigs that had a lameness score of 3. Therefore, organic farms had slightly fewer lameness cases. On the conventional farms, 86.8% of pigs were scored clean (score 1), 13.0% were scored slightly dirty (score 2) and 0.2% were dirty (score 3). On the organic farms, 92.8% pigs scored clean, 5.5% scored slightly dirty and 1.7% scored dirty. Pigs on the organic farms were cleaner compared with those on conventional farms, although there were more pigs with score 3 on the organic farms than conventional.

Tail bites were observed on 5.0% (31 pigs) of pigs on the conventional farms and 0.0% on the organic farms. A small proportion of pigs raised on conventional farms (1.1%, 7 pigs) and on organic farms (2.0%, 8 pigs) had their ears bitten. There was no difference for incidences of ear biting between pigs on the organic and conventional farms. There were few observations of shoulder ulcers. On the conventional farms, 0.2% (2 pigs) were affected by shoulder ulcers and 0 pigs were detected with this problem on the organic farms. On the conventional farms, there was a higher prevalence of skin wounds than on the organic farms. On the conventional farms, 9.9% of pigs were observed with skin wounds and there were 2.5% of such pigs on the organic farms. Most skin wounds were located in the middle and hind sections of the body (Table 4). In both production systems, the commonest number of wounds was 5–10 per animal, then fewer than 5 wounds, and least frequently more than 10 wounds were observed (Table 5). In both systems, the material for pens was wood and metal, so the wounds inflicted because of rubbing against the walls should not have influenced the overall scores.

All faecal samples taken from conventional farms were negative for parasites, while only 4 negative samples were from the organic farms (all of which were taken from one farm). Median egg counts per gram on the organic farms were 150, with a mean of 260 (Table 6). Of positive samples, the following species were identified: *Eimeria spp*, *Ascaris suum* and *Strongylida spp*. Of these samples, 7 contained *Eimeria spp*, 6 *Ascaris suum* and 11 *Strongylida spp*. Most frequently seen were *Strongylida spp* eggs with a

Table 3. Social and exploratory behaviours among conventional and organic pigs

	Conventional pigs (%)	Organic pigs (%)
Negative social behaviour	1.6	0.69
Positive social behaviour	14.8	19.7
Pen investigation	33.2	25.9
Exploratory behaviour	2.0	15.5
Resting	11.9	11.7
Other	35.8	26.6

Table 4. Location of skin wounds and percentages in conventional and organic pigs

Skin wound location	% of pigs with skin wounds among conventional pigs (number)	% of pigs with skin wounds among organic pigs (number)
Head-neck	0.7% (4)	0.5% (2)
Middle body	6.5% (40)	0.5% (2)
Hind body	2.1% (13)	0.7% (3)
Legs	0.7% (4)	0.7% (3)

Table 5. Distribution of numbers of wounds in pigs at different body locations

	Conventional farms (no. wounds)			Organic farms (no. wounds)		
	< 5	5–10	> 10	< 5	5–10	> 10
Head-neck	3	1	0	0	2	0
Middle body	8	21	11	1	1	0
Hind body	2	9	2	1	2	0
Legs	3	1	0	1	2	0
Total	16	32	13	3	7	0

Table 6. Total egg counts on conventional and organic farms (epg – eggs per gram)

	Conventional farms (epg)	Organic farms (epg)
Positive farms (% of farms)	0 (0%)	2 (67%)
Mean (min/max)	0 (0/0)	260 (0/1,235)
Median	0	150
Samples taken	20	16

Table 7. Total egg count of *Eimeria spp*, *Ascaris suum* and *Strongylida spp* on organic farms (epg – eggs per gram)

Organic farms			
	Eimeria spp (epg)	*Ascaris suum* (epg)	*Strongylida spp* (epg)
Average (min/max)	87 (0/1,146)	35 (0/288)	137 (0/638)
Median	0	0	36

median of 36 epg, while the highest number of eggs of the groups was *Eimeria spp* with 1,146 epg (Table 7). The intensity between positive samples was variable, ranging from 10 epg to 1,235 epg.

Unfortunately, only two of the conventional and one of the organic production systems knew their herd *post-mortem* inspection data. One conventional farm and one organic farm did not know that it was possible to ask for feedback from the slaughterhouse. One of the organic farms has not slaughtered pigs for the past three years. It was noted that most of the farms did not use *post-mortem* inspection data to improve the pigs' living conditions. The conventional farms that had analysed their *post-mortem* data reported a higher prevalence of respiratory problems compared with other pathologies. Also, there were mild cases of liver spots. One conventional farm reported that they had had problems with urinary tract infections recently according to the *post-mortem data*: around 14% of slaughtered animals. On organic farms, the farmers reported a high prevalence of liver spots, not recalling any other changes that might be of interest. Among the conventional farms, the most often reported pathological problem reported involved the respiratory tract. The prevalence of respiratory disease varied greatly among the conventional farms. The prevalence of respiratory diseases ranged from 25–35% on one conventional farm to 5–7% on another. None of the organic farms reported a high prevalence of respiratory disease, although one farm said that they had had a brief period of a respiratory disease in the herd that had been treated with antibiotics.

On conventional farms, a small number of cases of liver spots during *post-mortem* inspection was found. One farm had a prevalence of 0.0–0.8% while another had around 2%. Regarding two organic farms, the farmers reported that there had been high numbers of parasites found in their animals. One farmer said that they had had several incidences of high numbers of liver spots and they had changed anthelminthic schemes. This indicated that the conventional farms had a very mild infestation of endoparasites in the herd, while organic farms had higher infestation rates of internal parasites. It was noted that the organic farms had no proper disinfection schemes, because they were not able to remove all pigs from the pens for whole-pen disinfection, so they often just cleaned one group at a time after sending specific groups of pigs to slaughter. Also, all of them used deep straw bedding, where new was added on top of old and removed depending on the farm (ranging from once a week to once a year). This might have had a negative effect on the eradication of parasitic eggs in the environment and higher probability of reinfection.

Discussion

Good human-animal interaction scores were observed among 93.6% of conventional pigs and among 86.3% of organic pigs. On the organic farms, the handling frequency of animals was lower

compared with conventional farms, which might have made the animals more cautious of humans. Several studies have shown that the human–animal interaction depends on the workforce and management of the farm (Hemsworth, 1989, 1999; Pearce et al., 1989; Waiblinger et al., 2006), which confirmed the finding that a lower frequency of positive handling causes pigs more stress, thus increasing fearfulness to humans. The human–animal interaction was possibly influenced by the farmers' handling frequency. On one organic farm, the farmer did not see their pigs regularly and they rarely saw other people, and on this farm the pigs would flee at the sight of humans. The slightly poorer scores for organic farms in this regard may thus be explained by this unfamiliarity with humans and not be indicative of poorer stockmanship on organic farms. The low prevalence of exploratory behaviour on the conventional farms was possibly linked to the low availability of enrichment material. On all organic farms, there was straw available for every pig, which would be expected to encourage play behaviour in the pigs. Positive social behaviour and exploratory behaviour are expressed more when pigs have a natural environment, where they can express their normal behaviours (Roy et al., 2019; Studnitz et al., 2007; Van de Weerd et al., 2003). The deep straw bedding provided on organic farms allows pigs to forage, and this might indicate that on organic farms pigs can show exploratory and positive behaviours more often than on conventional farms. Where there was no free access to enrichment material, on the conventional farms, the pigs were forced to express other behaviours more often, such as investigating their surroundings and just standing. This may explain the higher prevalence of pen investigation and other behaviours in the conventionally reared pigs. Negative social behaviours, resting and other behaviours were more prevalent on the conventional farms than on the organic farms. Positive social behaviours and exploratory behaviours were less frequently observed on the conventional farms than on the organic farms.

Lameness was recorded in 2.1% of pigs on the conventional farms and in 0.7% on the organic farms. Several studies have shown that lameness is more prevalent on conventional farms than on organic farms (Leeb et al., 2019; Pluym et al., 2013; Knage-Rasmussen et al., 2014). The use of fully slatted floors is only allowed on conventional farms and it is not required to provide bedding material on conventional farms as it is for organic farms (Council Regulation 889/2008/EC; Council Directive 2008/120/EC), which increases the risk of lameness in conventional systems (Heinonen et al., 2006; Maes et al., 2016). The pigs detected with severe lameness were all on one farm that had had an accident regarding management. They had mistakenly left open the faucet tap with quicklime, thus pigs sat on the caustic alkaline ground and burnt their hind legs. Due to this, they were in too much pain to move properly. Pigs scored with a lameness score 1 or 2 had different reasons for limping (trauma or hoof diseases).

While 86.8% of conventional pigs were scored clean, this compared with 92.8% of organic pigs, therefore, this does not seem to have been different between the two systems. There have been no studies comparing the cleanliness of pigs in different production systems, although several studies state that cleanness indicates good hygiene (Sanchez-Vazquez et al., 2010; Van Breda et al., 2017; Wagner et al., 2018). Straw bedding, which was used only on the organic farms, absorbs moisture, thus leaving pigs cleaner. On one organic farm, the farmer said that the worker constantly forgets to add new straw, and thus the pigs on the farm were dirtier than they ought to have been. This may have influenced dirtiness scores among organic farms' pigs. On conventional farms, there were mostly slatted floors, and thus, the faeces dropped into the passage underneath leaving the floor dry.

Both tail biting and ear biting are linked with similar risk factors, which are high stocking density and absence of enrichment material (Beattie et al., 2005; Brunberg et al., 2011). According to minimum standards, organic farms should have twice as much area as conventional farms and are required to provide bedding material, which conventional farms are not (Council Regulation 889/2008/EC; Council Directive 2008/120/EC). Thus, conventional farms would be expected to have more tail and ear biting than in organic systems. This study did not observe that either tail or ear biting were higher on conventional farms, although there was a slightly higher incidence of tail biting, possibly because of the higher stocking densities and absence of enrichment material. As reported earlier, the stocking densities in conventional farms were twice those on the organic farms. In total, two conventional farms and all three organic farms had enrichments – chains, car tyres, balls or straw, which showed that conventional farms had less enrichment for pigs, thus having higher likelihood of tail biting.

There were few observations of shoulder ulcers among conventionally reared pigs, and no organic pigs were detected with shoulder ulcers. The prevalence of shoulder ulcers varies greatly within the production system, which indicates that it is influenced by the management within farms (Cleveland-Nielsen et al., 2004; Rosendal and Nielsen, 2005). Shoulder ulcers are affected by low body condition scores (Rosendal and Nielsen, 2005). All pigs in the study had good body condition scores, which might have been the reason for the similar and low numbers of shoulder ulcers observed. Skin wounds have been linked with aggression, which can be decreased with less frequent regrouping, smaller group sizes, lower stocking densities and provision of enrichment materials

(Roy et al., 2019; Thomansen et al., 2016; Van de Weerd et al., 2003). As stated by the minimum requirements (Council Regulation 889/2008/EC; Council Directive 2008/120/EC), organic pigs should have twice as much space as conventional systems, and are to be provided with bedding, so the prevalence of skin wounds would be expected to be higher on conventional farms. This was confirmed in this study as more pigs had skin wounds in conventional systems than in organic. The average number of lesions discovered in this study was 5–10 wounds per pig in both systems, although in the conventional systems there were more pigs with wounds than in the organic systems. This was evaluated when pigs had already established a hierarchical order, which might have influenced the results. In newly mixed groups, the number of wounds could be even higher, as Thomansen et al. (2016) and Turner et al. (2006) showed.

None of the 20 faecal samples taken from conventional farms contained parasite eggs, while 12 of 16 faecal samples from organic farms had parasite eggs. Järvis et al. (2012) also discovered that all organic farms in their sample had parasites, compared with 41.9% on large conventional farms. However, at that time in 2012, organic pigs were kept outdoors. The similarity in these rates suggests that it is not only the outdoor keeping of pigs that contributes to the higher parasite infection rates on organic farms; the risk of an endoparasitic infection on organic farms was not higher solely because of them being outdoors, but because of some other factors. One of these factors may have been that the organic farms had poorer disinfection schemes, and it was not considered practicable to do full room disinfection, which would have impaired the eradication of the parasite eggs from the environment. Also, the practice of laying new straw bedding on top of old can be considered important. On one of the organic farms, no parasite eggs were found in any of the faecal samples. It might also be that the likelihood of infection is smaller in low density populations. Regarding the intensity of the parasitic infection it should be considered that parasitic eggs are not distributed equally in a faecal sample. Also, it should be noted that the host immune response is different between individuals, and different species of endoparasites have variable fertility (Järvis et al., 2012). Unfortunately, only two of the conventional and one of the organic production systems knew their herd *post-mortem* inspection data, so it is impossible to make overall conclusions. Nevertheless, the available data showed that organic farms had more liver spots compared with conventional farms, but had fewer signs of respiratory disease. Higher occurrence of liver spots on organic farms was also found by Kongsted and Sørensen (2017) in a three year *post-mortem* data analysis in Denmark. Bonde et al. (2010) reported similar results regarding *post-mortem* reports of respiratory disease as the analysis of the available data in this study.

This study did not contain any analytical statistics because of the small number of farms in the sample; thus, only descriptive statistics are presented. Unfortunately, in Estonia, there are only four organic pig farms (one excluded organic farm had only three sows); thus it was impossible to have a greater sample size in Estonia for this investigation.

Conclusion

Positive findings for the welfare of pigs on indoor organic farms included the following. On organic pig units, the minimum stocking density was twice as much as in conventional farming and the stocking densities were lower than regulations permit. Organic pigs had more positive social behaviours and less negative behaviours compared with those on the conventional farms. In addition, there were higher incidences of exploratory behaviour by these pigs. Tail biting occurred more often on the conventional farms than on the organic farms. Pigs on the conventional farms had more skin wounds than those on the organic farms. Organic farms pigs were scored cleaner compared with conventional farms, but this did not mean that they had better sanitary conditions. Organic farms had worse human-animal interaction scores than on the conventional farms, possibly due to less frequent handling of pigs in those farms. Parasite eggs in faecal samples were found on two of the three organic farms, while all samples taken in the conventional systems were negative. The higher prevalence of parasitic infections on the organic farms compared with the conventional systems in this study suggests that access to outdoors alone is not the only influence on endoparasitic infection prevalence on organic pig farms. Numbers of shoulder ulcers were infrequent. Despite being restricted to indoors, organic pigs had better welfare scores than conventional pigs and poorer parasite scores, as would be expected from organic pigs that are allowed access to an outdoor facility.

Acknowledgements

The study was supported financially with a UFAW (Universities Federation for Animal Welfare) student scholarship for JP. The authors record their thanks to all farm representatives who allowed collection of the data and answered questions with honesty. We also thank Jaanika Pajuste of the Institute of Veterinary Medicine and Animal Sciences of the Estonian University of Life Sciences for help analysing faecal samples.

Ethical Approval

The animals in this study were only observed, and they were not subjected to any interference in their management regime and nor were animals injured or harmed. No blood samples were taken. Body tissue was sampled *post mortem*.

Funding

The study was funded in part with a student scholarship awarded by the Universities Federation for Animal Welfare (UFAW).

Competing Interest

There were no conflicts of interest excepting the student scholarship from UFAW mentioned above.

References

1. Alban L, Petersen JV & Busch ME (2015) A comparison between lesions found during meat inspection of finishing pigs raised under organic/free-range conditions and conventional, indoor conditions. Porcine Health Management, 1:4.
2. Arney D, Kass M, Leming R, Ariko T, Tummeleht L, Õkva K, Kiiroja L, Maran T, Randveer T, Päkk P, Zõbin T & Jalakas S (2018) Loomade heaolu. Õpik kõrgkoolile. Tartu, Eesti Maaülikool, 26-36 & 86-87
3. Beattie VE, Breuer K, O'Connell NE, Sneddon IA, Mercer JT, Rance KA, Sutcliffe MEM & Edwards, SA (2005) Factors identifying pigs predisposed to tail biting. Animal Science, 80:307-312
4. Bonde M, Toft N, Thomsen PT & Sørensen JT (2010) Evaluation of sensitivity and specificity of routine meat inspection of Danish slaughter pigs using Latent Class Analysis. Preventive Veterinary Medicine, 94:165-169
5. Botreau R, Bonde M, Butterworth A, Perny P, Bracke MBM. Capdeville J & Veissier I (2007). Aggregation of measures to produce an overall assessment of animal welfare. Part 1: a review of existing methods. Animal, 1: 1179-1187
6. Brunberg E, Wallenbeck A & Keeling LJ (2011). Tail biting in fattening pigs: Associations between frequency of tail biting and other abnormal behaviours. Applied Animal Behaviour Science, 133:18-25
7. Cleveland-Nielsen A, Bækboc P & Ersbølla AK (2004) Herd-related risk factors for decubital ulcers present at post-mortem meat-inspection of Danish sows. Preventive Veterinary Medicine, 64:113-122
8. Council Directive 2008/120/EC laying down minimum standards for protection of pigs (passed 18.12.2008, changed on 14.12.2019) Official Journal of the European Union, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02008L0120-20191214.
9. Council Regulation 843/2007/EC on organic production and labelling of products and repealing Regulation (EEC) No 2093/91 (passed 28.06.2007, changed on 01.07.2013). Official Journal of the EU, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32007R0834.
10. Council Regulation 889/2007/EC laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control (passed 5.09.2008, changed on 12.11.2018). Official Journal of the European Union, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008R0889.
11. Dippel S, Leeb C, Bochicchio D, Bonde M, Dietze K, Gunnarsson S, Lindgren K, Sundrum A, Wiberg S, Winckler C & Prunier A (2014) Health and welfare of organic pigs in Europe assessed with animal-based parameters. Organic Agriculture, 4:149-161
12. Heinonen M, Oravainen J, Orro T, Seppä-Lassila L, Ala-Kurikka E, Virolainen J, Tast A & Peltoniemi OAT (2006) Lameness and fertility of sows and gilts in randomly selected loose-housed herds in Finland. Veterinary Record, 159:383-387
13. Hemsworth PH, Barnett JL, Coleman GJ & Hansen C (1989) A study of the relationships between the attitudinal and behavioural profiles of stockpersons and the level of fear of humans and productive performance of commercial pigs. Applied Animal Behaviour Science, 23:301-314
14. Hemsworth PH, Pedersen V, Cox M, Cronin GM & Coleman GJ (1999) A note on the relationship between the behavioural response of lactating sows to humans and the survival of their piglets. Applied Animal Behaviour Science, 65:43-52.
15. Järvis T, Mägi E & Lassen B (2012) Sigade parasiidid Eestis ja nende levikut mõjutavad tegurid. Agaarteadus, 23:28-37.
16. Knage-Rasmussen KM, Houe H, Rousing T & Sørensen JT (2014) Herd- and sow-related risk factors for lameness in organic and conventional sow herds. Animal, 8, 1:121-127
17. Kongsted H. & Sørensen JT (2017) Lesions found at routine meat inspection on finishing pigs are associated with production system. The Veterinary Journal, 223:21-26
18. Leeb C, Rudolph G, Bochicchio D, Edwards S, Früh B, Holinger M, Holmes D, Illmann G, Knop D, Prunier A, Rousing T, Winckler C & Dippel S (2019) Effects of three husbandry systems on health, welfare and productivity. Animal, 13 (9):2025-2033
19. Maes D, Liesbet P & Peltoniemi O (2016) Impact of group housing of pregnant sows on health. Porcine Health Management, 2, 17
20. Nurmoja I, Mõtus K, Kristian M, Niine T, Schulz K, Depner K & Viltrop A (2018) Epidemiological analysis of the 2015-2017 African swine fever outbreaks in Estonia. Preventive Veterinary Medicine, 231-243
21. Pearce, G.P., Paterson, A.M. & Pearce, A.N. 1989. The influence of pleasant and unpleasant handling and the provision of toys on the growth and behaviour of male pigs. Applied Animal Behaviour Science, 23:27-37
22. Pluym LM, Van Nuffel A, Van Weyenberg S & Maes D (2013) Prevalence of lameness and claw lesions during different stages in the reproductive cycle of sows and the impact on reproduction results. Animal, 7:1174-1181
23. Põllumajandusamet, Estonian Agricultural Board (2020) Organic Livestock Production. Available from: www.pma.agri.ee/index.php?id=104&sub=128&sub2=296&sub3=298 [Accessed 4th November 2020]
24. Roepstorff A, Nilsson O, Oksanen A, Gjerde B, Richter SH, Örtenberg E, Christenson D, Martinsson KB, Barlett PC, Nansen P, Eriksen L, Helle O, Nikander S & Larsen K (1998) Intestinal parasites in swine in the Nordic countries: prevalence and geographical distribution. Veterinary Parasitology, 76:305-319.
25. Rosendal T & Nielsen JP (2005) Risk factors for the development of decubital ulcers over the scapula in sows. Proceedings of the 36th Annual meeting. Toronto: American Association of Swine Veterinarians, 361-362.
26. Roy C, Lippens L, Kyeiwaa V, Seddon YM, Connor LM & Brown JA (2019) Effects of Enrichment Type, Presentation and Social Status on Enrichment Use and Behaviour of Sows with Electronic Sow Feeding. Animals, 9, 369
27. Sanchez-Vazquez MJ, Smith RP, Kang S, Lewis F, Nielsen M, Gunn GJ & Edwards SA (2010) Identification of factors influencing the occurrence of milk spot livers in slaughtered pigs: A novel approach to understanding Ascaris suum epidemiology in British farmed pigs. Veterinary Parasitology, 173:271-279
28. Spoolder HAM (2007) Animal welfare in organic farming systems. Journal of the Science of Food and Agriculture, 87:2741-2746
29. Studnitz M, Jensen MB & Pedersen LJ (2007) Why do pigs root and in what will they root?: A review on the exploratory behaviour of pigs in relation to environmental enrichment. Applied Animal Behaviour Science, 107:183-197
30. Thomansen R, Edwards SA, Rousing T, Labouriau R & Sørensen JT (2016) Influence of social mixing and group size on skin lesions and mounting in organic entire male pigs. Animal, 10:1225-1233
31. Turner SP, Farnworth MJ, White IMS, Brotherstone S, Mendl M, Knap P, Penny P & Lawrence AB (2006) The accumulation of skin lesions and their use as a predictor of individual aggressiveness in pigs. Applied Animal Behaviour Science, 96:245-259
32. Van Breda LK, Dhungyel OP, Ginn AN, Iredell JR & Ward MP (2017) Pre- and Post-weaning scours in southeastern Australia survey of 22 commercial pig herds and characterisation of Eschrechia coli isolates. PloS One, 12
33. Van de Weerd HA, Docking CM, Day JEL, Avery PJ & Edwards SA (2003) A systematic approach towards developing

environmental enrichment for pigs. Applied Animal Behaviour Science, 84:101-118
34. Veterinaar ja Toiduameti käskkiri 25.07.2014 nr 117. (passed 25.07.2014) Täiendavate loomatauditõrje abinõude kehtestamine sigade klassikalise katku ja sigade Aafrika katku ohu vähenda-miseks. Available from: www.agri.ee/sites/default/files/content/toiduohutus/ 1400.25072014_kk_nr_117.pdf
35. Wagner KM, Schulz J & Kemper N (2018) Examination of the hygienic status of selected organic enrichment materials used in pig farming with special emphasis on pathogenic bacteria. Porcine Health Management, 4, 24
36. Waiblinger S, Boivin X, Pedersen V, Tosi M-V, Janczak AM, Visser EK & Jones RB (2006) Assessing the human-animal relationship in farmed species: A critical review. Applied Animal Science, 101:185-242
37. Van de Weerd HA, Docking CM, Day JEL, Avery PJ & Edwards SA (2003) A systematic approach towards developing environmental enrichment for pigs. Applied Animal Behaviour Science, 84:101-118
38. Welfare Quality® Consortium (2009) Welfare Quality® assessment protocol for pigs (sows and piglets, growing and finishing pigs). Welfare Quality® Consortium, Lelystad, Netherlands.
39. Zimmerman JJ, Karriker LA, Ramirez A, Schwartz KJ & Stevenson GW (2012) Diseases of Swine, 10th edition. John Wiley and Sons., UK, 32-49.

Received 25 February 2022
Accepted 7 April 2022