EU Reference Centre
for Animal Welfare *Pigs*

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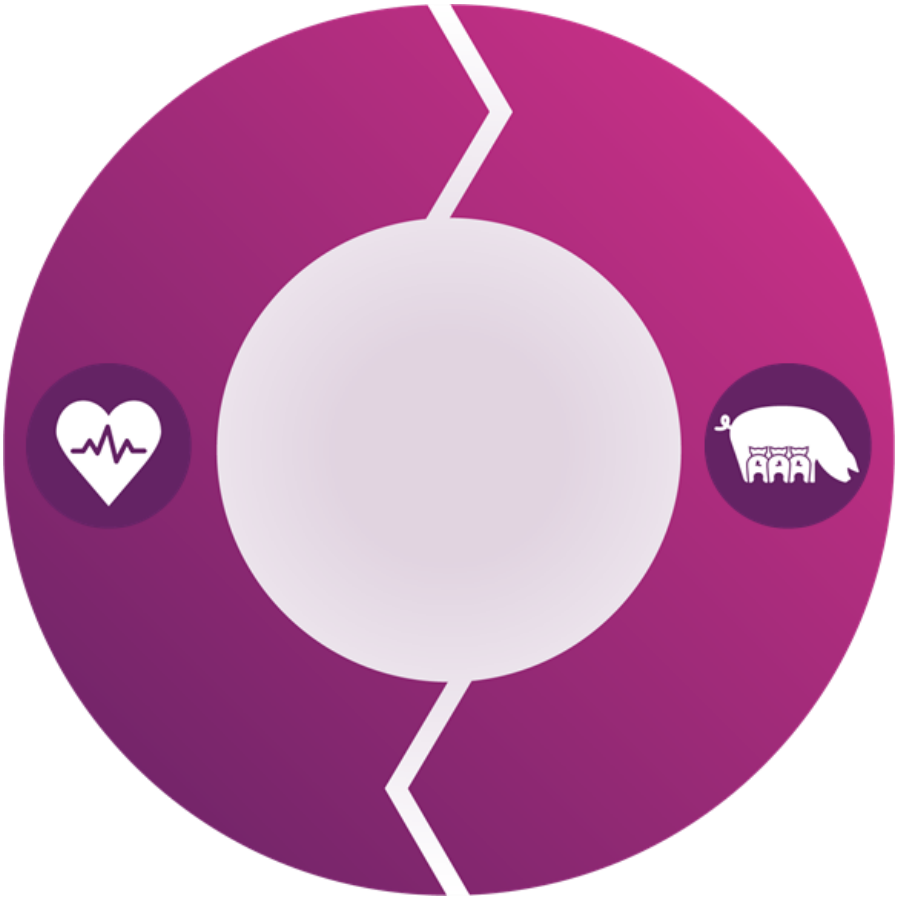

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Each EURCAW-Pigs review provides background information on the biological relevance of the welfare topic. It then presents the most important key areas to focus on during welfare inspections, describes why welfare issues occur and lists specific animal-based indicators that can help official inspectors to identify these welfare issues. Finally, the review summarizes ways of good and better practices that can help to solve the previously described welfare issues, and deals with related legislative requirements.

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1 Executive Summary

Transport is a multifactorial stressor. For some pigs with certain pre-transport characteristics, the challenges of transport make their fitness for transport questionable from a scientific point of view. The European regulation (**Council Regulation 1/2005** and to a lesser extent **853/2004**) lays down rules for the protection of animals during transport including information about fitness for transport of pigs. In 2016, DG Health and Food Safety (DG SANTE) published a report providing an overview of systems to prevent the transport of unfit animals in the EU (DG SANTE, 2016). In this EURCAW-Pigs review, the scientific knowledge about fitness for transport is reviewed against the background of the relevant European legislation, including a discussion of central terms in the European regulation – such as injury and unnecessary suffering. In addition, the usefulness of these terms as indicators of fitness for transport, to be used during inspection, is discussed, and potential indicators of fitness for transport of different categories of pigs are proposed, in addition to the criteria listed in the legislation.

2 Introduction

Across the different pig categories, transport is a multifactorial stressor (Marchant-Forde and Marchant-Forde, 2009). For some pigs with certain pre-transport characteristics (of which some, but not all, are related to animal health), the challenges of transport are larger than average, possibly leading to serious welfare concerns or even death. Such pigs are unfit for transport. In the scientific literature, it is generally agreed that – in terms of animal welfare - the assessment of fitness for transport is important (Grandin, 2001; Cockram, 2019), and in 2016, DG Health and Food Safety published a report providing an overview of systems to prevent the transport of unfit animals in the EU (DG SANTE, 2016).

Over the last decades, European pig production has undergone structural changes including increasing herd sizes and changes in the slaughter industry towards fewer and larger units (as discussed by Lambooij (2014)), thereby leading to increased transport distances from farms to slaughterhouses. In addition, the pig industry has become increasingly specialised to minimize production costs and focus the expertise of staff at certain parts of the production process. As a result, pigs are often not spending their life in one herd, but are moved between herds, often travelling relatively long distances. As a consequence, pig movements (number of journeys per pig and distance crossed per journey), seem to be increasing globally. The increased number and duration of journeys amplify the importance of the pre-transport fitness of pigs. The diversity of pig categories makes the assessment of fitness for transport extra complex: pigs may be transported as weaners to a finishing farm, at slaughter weight to a slaughterhouse, as breeding animals to a multiplier farm, and/or as cull sows and boars to a slaughterhouse after finishing their productive life. The criteria and circumstances leading to a decision of 'unfit for transport' probably vary considerably across the different categories of pigs, thereby posing extra challenges for the professionals involved in decision making: farmers, livestock drivers, veterinarians, and competent authorities.

In this review, the scientific knowledge on fitness for transport, including central terms in the European Regulation – such as injury and unnecessary suffering – is reviewed, and the usefulness of these terms as indicators of fitness for transport is discussed. Animal-based indicators for different categories of pigs, known from animal welfare science (e.g., from Welfare Quality®, 2009), are discussed and proposed as potential

indicators of fitness for transport of pigs in addition to the criteria listed in the legislation. Even though European farmers, livestock drivers, veterinarians and inspectors all play a role in ensuring that pigs are fit for transport, it is beyond the scope of this review to include how tasks and responsibilities are distributed between these professional groups. In the final section, relevant parts of the European Regulation laying down rules for the protection of animals during transport (Council Regulation 1/2005), for the hygiene of food stuffs (Regulation 853/2004), as well as for control posts and route plans (Council Regulation 1255/97) is introduced.

3 Scientific knowledge on fitness for transport and how this concept links to animal welfare

In order to protect animals during transport, they have to be fit when the journey starts (Grandin, 2001; Cockram, 2019). Almost all research on animal transport has been conducted on fit and healthy animals (as reviewed by Cockram, 2019). Below, the few studies providing direct scientific knowledge about the concept of fitness for transport, and selected results from studies providing indirect evidence, are presented.

3.1 Research relevant for/related to fitness for transport in pigs

Within the area of fitness for transport, until recently, studies involving transport of pigs with reduced health did not specifically mention the concept of fitness for transport. For example, studies have focused on transit loss in market weight pigs, but included no mention nor discussion of fitness for transport (Dewey et al., 2009). Hence, it is not known whether the pigs in these studies were checked for fitness for transport before being loaded, or whether the transit losses in any way were related to the pre-transport condition of the pigs, or solely were the outcome of the transport conditions. Irrespectively, studies like these do provide evidence that transport can be stressful, and even fatal, for pigs.

Grandin (2019) defined compromised pigs as animals with reduced capacity to withstand handling or transport. One category of compromised pigs observed in slaughterhouses after transport, is the so-called non-ambulatory non-injured (NANI) pigs. In short, such pigs are unable to walk but not obviously injured. Sutherland et al. (2008) compared clinical and physiological characteristics of NANI-pigs versus healthy controls identified in the slaughterhouse upon arrival. The authors found that NANI-pigs differed from the healthy controls in a number of traits such as increased occurrence of feet and leg problems, the presence of an active infection, ulcers, liver damage and subtle bone injury. However, no systematic patterns between these could be found, and the authors concluded, that the NANI condition may have many contributing factors, and that these may differ from slaughterhouse to slaughterhouse (underlying reasons for such differences can be multiple – e.g. transport conditions, involved herds or hauliers or different inspection level/type). The authors were not mentioning fitness for transport as such, and hence the potential for the pathological conditions observed in the slaughterhouse to act as indicators of fitness for transport, were not discussed by Sunderland et al. (2008).

During the last five years, some studies involving pigs and the concept of fitness for transport have been published, mainly focussing on cull sows. Fogsgaard et al. (2018) described the clinical condition of 522 sows before loading onto the trucks, with a median parity of 5 (range: 1–11), from 12 Danish farms, selected for

slaughter by the farmers, and all considered fit for transport according to the Council Regulation (EC 1/2005). Approximately 10% of the sows showed an abnormal gait, and 0.8% were lame. Wounds were observed in 54.6% of the sows, and 11% had decubital shoulder ulcers (often called shoulder sores). These findings support statements from previous research (e.g., Grandin, 2016) suggesting that cull sows may deviate more from a healthy condition than most other pig categories, as they are typically culled after several production cycles and may have health-related issues. As part of the same study, Thodberg et al. (2019) examined the clinical condition of the sows upon arrival to the slaughterhouse, after journeys by road of a mean of 232±113 minutes. Half of the clinical variables recorded before and after transport changed significantly. Among these were **injuries** (e.g., superficial skin lesions, wounds), gait score, and measures possibly related to heat stress (e.g. skin elasticity). Three sows (0.6%) arrived in a condition as legally unfit for transport according to the Council Regulation (EC 1/2005). Overall, the study showed that the clinical condition of the cull sows deteriorated from farm to slaughterhouse. This finding adds to the debate on fitness for transport of cull sows, as transport compromised the welfare of several animals, even though all sows met the criteria in the Council Regulation (EC 1/2005) when examined on farm. However, as discussed below, the concepts of fitness for transport and injury require further scientific elaboration/attention. Fitness for transport seems to be a so-called 'wicked problem', a term used in social and environmental sciences for problems that are difficult or impossible to solve fully, and where there are no single solution (Herskin et al. 2020a). 'Wicked problems' have complex underlying cause-and-effect relationships, no clear definition, and stakeholders typically have radically different frames of reference concerning their cause and solution (Peterson, 2013).

3.2 Fitness for transport

Fitness for transport is a central concept in the Council Regulation (EC 1/2005). However, the regulation does not define the term. Instead it seems to describe a condition that should not happen. Recently, the Committee on Agriculture and Rural Development of the European Parliament, in a report on the implementation of Council Regulation No 1/2005 within and outside the EU (2018/2110(INI)) (2019), called upon the Commission to develop a full working definition of what constitutes fitness for transport. This lack of a legal definition is a challenge for the development and validation of direct indicators of 'fitness for transport' to be used during inspections. Below, we examine central components in the wording on animal fitness for transport in the Council Regulation (EC 1/2005) - injury and unnecessary suffering – and discuss the possibilities to use these terms as the basis for the development of indirect indicators of fitness for transport.

The term injury

In the Council Regulation (EC 1/2005; Annex I, Chapter I), it is clearly stated that animals must not be transported under conditions leading to injury. As mentioned above, however, this term is not clearly explained in the Regulation, and often not in the field of animal welfare science either. Langley and Brenner (2004) stated that the term injury is fraught with challenges and complexities. Originally, injury refers to damage to the body produced by energy exchanges that have relatively sudden discernible effects (Robertson, 1998). However, in animal welfare science the suddenness of the damage is often not considered a prerequisite for 'injuries', and the term can be used, for example, to describe any kind of clinically evident damage to the body, or includes only few pre-determined clinical conditions, typically involving damage to the integrity of the skin and also of its underlying tissue, or damaged or even fractured bones.

In insurance cases involving humans, the definition of injury is often expanded to include not only bodily damage caused by transfer of energy but also damage caused by the absence of vital resources (Robertson, 1998). Translated into animal transport conditions, such an addition would mean that for example pathological changes induced by low ventilation, elevated temperatures or lack of oxygen, may also be considered injuries. Another unclear aspect of the definition of injury, and its usefulness as indicator of animal welfare or fitness for transport, is whether macroscopically identifiable tissue damage is a prerequisite. This becomes particularly relevant considering that the Council Regulation (EC 1/2005) states that 'sick or injured animals may be considered fit for transport if they are slightly injured or ill and transport would not cause additional suffering'. From a practical point of view, working with animal welfare and fitness for transport, it may therefore be an advantage to have a standardised definition of the term that delineates it, such that it is clear among users as to what is and what is not to be referred to as an injury.

Unnecessary suffering

The other central concept in the description of fitness for transport in the Council Regulation (EC 1/2005) is that animals must not be transported under conditions leading to unnecessary suffering. The term implies that for transport to be unacceptable, the mere presence of suffering is not sufficient, i.e. the suffering should also be unnecessary (Lundmark et al., 2013). As indicated earlier, the concept of 'unnecessary suffering' is not defined or explained in the regulation. Based on UK historical sources, Fordyce (2017) reviewed how animal protection legislation has transitioned from being based on the concept of cruelty, to the inclusion of the concept of unnecessary suffering. Having this term in the centre of the Council Regulation on fitness for transport (EC 1/2005) means that non-compliance per definition will involve both a) suffering, and b) that the suffering is unnecessary.

In a paper surveying assessment of unnecessary suffering by veterinary experts in legal cases of animal abuse, Baumgaertner et al. (2016), and later also Fordyce (2017) discussed criteria regarding necessity. The discussions are based on the UK Animal Welfare Act of 2006, and state that several aspects should be taken into account, such as:

1) The suffering could reasonably have been avoided or reduced;
2) The conduct was in compliance with e.g. codes of practice or had a legitimate purpose such as benefiting the animal; and
3) Whether the suffering was proportionate to the purpose of the conduct concerned.

The justification for letting animals suffer because it is necessary will diverge between different normative ethical views (Lundmark et al., 2013), and falls outside the scope of this review.

Animal suffering

Leaving aside the question as to when suffering is necessary, animal welfare science seems better equipped to help decide if, when and to what extent animals may be suffering. In recent years, the scientific consideration of the term 'animal suffering' has been increasing, for example in relation to animal experimentation (Olsson et al., 2020), legal cases of animal abuse (Baumgaertner et al., 2016), but also in relation to fitness for transport of pigs (Thodberg et al., 2019; 2020; Herskin et al., 2020b) and other farm

animals (Cockram, 2019). Recently, Peden et al. (2020) surveyed stakeholder opinions regarding pigs' capacity to suffer across different societal groups, including pig farmers and veterinarians. All groups expressed widespread belief in the capacity of pigs to suffer (Peden et al., 2020). In the scientific literature, there seems to be an agreement that even though suffering in animals such as pigs probably is not identical or fully equivalent to human suffering, humans and animals probably share similar affective experiences to an extent where the use of the term suffering is appropriate (Yao, 2019). Indeed, the EU also acknowledged animals as 'sentient beings' in the Amsterdam Treaty of 1997.

Suffering has, however, no agreed scientific definition (as reviewed by Baumgaertner et al., 2016) (Table 1 shows examples of suggested definitions), and the concept is being debated scientifically. It is, for example, discussed whether suffering is a generic term, i.e. whether suffering can be induced by aversive experiences, such as for example pain, of a certain severity or duration and thus needs to pass some kind of threshold (Baumgaertner et al., 2016), or whether suffering itself can be graded from mild to severe (as discussed by Olsson et al., 2020). Ledger and Mellor (2018) stated that, regardless of the outcome of this scientific debate, negative affective states, such as for example hunger or thirst, will continue to exist in their own right, whether or not an animal has passed a certain threshold, and may be considered suffering.

In their recent review on animal experimentation, Olsson et al. (2020) suggested that suffering is more than an elevated level of negative state(s), and involves a qualitative shift whereby the normal mechanisms to control negative states no longer function properly. Suffering would then be a loss of ability to cope (another term that is not easy to define). In line with this, Tate and Pearlman (2019) characterized the feeling of suffering as negative, intense, prolonged and life-altering.

Dating decades back, Cassell (1982) wrote about human suffering and argued that to suffer, intense or long-lasting negative experiences (e.g. pain or disease) should be accompanied by other situational factors (e.g. loss of control, lack of social support), to the point that the condition of the sufferer seems unbearable and his/her sense of self is threatened. Later, Tate and Pearlman (2019) emphasised that suffering may not only take the form of a threat or an injury, but in humans may more often be conceived as a loss.

In recent years, the traditional view of pain as the primary component contributing to animal suffering, has been challenged by authors increasingly suggesting that other negative subjective experiences may also be involved (Mellor and Beausoleil, 2015). Among these - that may be relevant during transport of pigs – are thirst, hunger, cold, heat, fatigue and nausea (Ledger and Mellor, 2018). There are, however, also types of suffering that reflect how animals perceive their situation – and thus may also be relevant during transport - but not linked to specific forms of bodily sensation, such as for example fear or frustration (Olsson et al., 2020).

Table 1. Recent suggested definitions of animal suffering.

	Definition
Olsson et al. 2020	Occurs when negative experiences dominate attention, there is limited capacity for distraction or compensation, normal life cannot be pursued, full recovery cannot occur even if the external situation improves.
Fordyce, 2017	Unpleasant aversive subjective mental state, caused by physical or psychological stressors that impinge on the animal in such a way that a failure to avoid (or adapt easily to) them threatens (or potentially threatens) its viability as an organism
Ledger and Mellor, 2018	A term encompassing unpleasant, undesired states of being which are the outcome of the impact on an animal of one or more of a variety of noxious stimuli, often accompanied by the absence of important positive stimuli.

The criteria used for the assessment of animal suffering in a legal context seem to vary considerably (Baumgaertner et al., 2016). According to Ledger and Mellor (2018) indices used for animal suffering have previously been based primarily on physical or clinical indicators, as stimulated by the 'biological functioning' conception of animal welfare (Fraser et al., 1997). One challenge to the identification of indicators for animal suffering, is the phenomenological perspective. This line of thinking aims to understand how it feels to be in situations of suffering, and has recently been applied to animal health as well (Veit and Browning, 2021). In his comprehensive review on animal suffering, Fordyce (2017) noted that the term covers an aversive/negative subjective mental state originally inferred by humans in animals, using some kind of an anthropomorphic interpretation of an animal's situation, and the consequences of that situation on the animal's behaviour or physical state. Fordyce (2017) was critical towards this approach, and suggested that animal welfare science could provide tools, based on objective criteria, to render probable that an animal has experienced suffering, and that a zoocentric approach would be more objective. In the same line of thinking, Ledger and Mellor (2018) argued that the understanding of affective states in animals has a secure foundation in affective neuroscience and aligned animal behaviour science. In this context, the recent paper by Tate and Pearlman (2019) on suffering in human patients brings important considerations into the debate. The authors stated that suffering is an intimate experience, and that some patients may show hypo-engagement in terms of e.g. withdrawal, which may be difficult to pick up clinically. It is possible that also non-verbal beings such as animals may respond to suffering by hypo-engagement (e.g. being passive, withdrawing from pen-mates), the pick-up of which may be a challenge, especially during transport, where animals are stocked densely. In addition, Tate and Pearlman (2019) suggested that human patients who are suffering, may or may not show clinical symptoms of injury or disease. This means that suffering may occur in the absence of symptoms, again posing a challenge to the development of indicators for suffering, also in animals.

Until more valid indicators of animal suffering have been developed, the animal based indicators suggested in animal welfare science (for example Welfare Quality® (2009) and The Five Domains Model of animal welfare (Mellor and Beausoleil, 2015)), for assessing and grading animal welfare may be the most suited for use in practice. Below, we discuss and present such candidate indicators, of which some are suggested as focus areas during the inspection of fitness for transport of pigs.

4 Key areas to focus on during fitness for transport inspections

Inspection of the pre-transport condition of individual animals is needed for the assessment of fitness for transport. Under practical conditions, the clinical examination of each individual animal needs to be relatively fast as most journeys involve many animals. To the best of our knowledge, no studies have examined the working conditions of inspectors or other stakeholders checking fitness for transport in pigs. It is, however, important to prioritize checking both sides of all pigs, and to establish suitable working conditions e.g. ensuring proper light and animals walking calmly past the examiner. The professionals involved, such as inspectors, farmers, veterinarians and livestock drivers, need to know which fitness characteristics to look for in the animals. In addition, the Council Regulation (EC 1/2005) states that animals should be fit for 'the intended journey'. This may complicate the assessment to some degree, as the professionals need to take into account the planned journeys.

Some pre-transport characteristics are relevant for all categories of pigs, e.g. lameness. EURCAW-pigs has published factsheets on lameness in relation to tail biting, and for assessment in lairage (https://eurcaw.eu/en/eurcaw-pigs/output/scientific-output.htm). Other indicators are also relevant for all categories of pigs, but may need to be divided into sub-types to fit the different pig categories. In the case of for example wounds, the presence of decubital shoulder ulcers, or shoulder sores as they are often called (Herskin et al., 2011; Rioja-Lang et al., 2018) is more relevant for sows, whereas injured tails (vom Brocke et al., 2019) are more relevant for weaners and market weight pigs, while bitten ears (Smulders et al., 2018) are more relevant for weaners. Below, we suggest various indicators useful for inspectors to identify unfit pigs before transport, including indicators relevant for the different pig categories. Other relevant indicators can be found in the animal welfare protocol of Welfare Quality® (2009) (http://www.welfarequalitynetwork.net/en-us/reports/assessment-protocols/) and in the publication 'Practical guidelines to assess fitness for transport of pigs', published in 2015 (Eurogroup for Animals et al., 2015), as part of a two-year collaboration between a group of European stakeholders and animal scientists.

4.1 Pathological processes

One central requirement in the description of fitness for transport in the Council Regulation (EC 1/2005) is that animals presenting signs of pathological processes shall not be considered fit for transport. If an animal is not fully healthy or fit it will be less able to cope with the challenges occurring during transport, and the pre-transport internal condition is likely to deteriorate (Cockram, 2019). Animals sent for slaughter with pre-existing conditions are more likely to die in transit, become non-ambulatory, or be condemned as unfit for human consumption upon arrival at the slaughterhouse (Lambooij, 2014; Cockram, 2019). Diseases that limit the coping capacity of pigs during transport are for example cardiac issues (periocarditis, endocarditis), respiratory diseases (pneumonia, pleuritic) and infections (abcesses, metritis, nephritis etc.) (Cockram, 2019;

Ritter et al., 2020). In addition, transport- or stress-related myopathies observed in fast-growing pig breeds or lines (Zurbrigg et al., 2017; Semenova et al., 2019) may also challenge the fitness for transport of pigs. Below, we review examples of relevant clinical conditions, of which some are listed specifically in the Council Regulation (EC 1/2005), as reasons for not being fit for transport.

Lameness

Reduced ability to use one or more limbs in a normal manner has been articulated as a sign of animals being unfit for transport (Grandin, 2001). Cockram (2019) reviewed how most lameness is caused by pain, and explained how animals with painful foot lesions are more reluctant to bear weight on their feet than healthy animals, and therefore may be more challenged when ramps must be passed during loading and unloading, as well as a larger risk of losing balance during journeys. In general, having to put pressure on a lesion (such as a limb or hoof) will cause additional pain. Furthermore, the condition of lame animals during a journey is likely to deteriorate.

The Council Regulation (EC 1/2005) states that animals are unfit for transport if they are unable to move independently without pain or to walk unassisted. This phrasing is not directly operational, and leaves some room for interpretation to the observer. In the animal welfare assessment protocol published by Welfare Quality® (2009), lameness is defined as the inability to use one or more limbs in a normal manner, and it is specified that this condition may vary in severity from reduced ability or inability to bear weight to total recumbency. Somewhat similarly, the guidelines published by Eurogroup for Animals et al. (2015), used a combination of pictures and words to describe the gait of pigs from 'good mobility' and 'imperfect mobility' (both fit for transport), through 'impaired mobility' to 'severely impaired mobility', where the latter two are rendering a pig unfit for transport.

Prolapses

The Council Regulation (EC 1/2005) specifically lists prolapses as irreconcilable with fitness for transport. A prolapse describes a condition, where an organ is protruding from the body. For pigs, the most relevant conditions are prolapse of rectal or vaginal tissues (Smith and Straw, 2006). These conditions usually occur sporadically in pig herds but can appear as outbreaks. Although seldom seen in nursing pigs, all other age groups are susceptible.

Prolapse of the rectum is most often the result of cold stress (piling for warmth), transport stress (piling in trucks), or from severe coughing, and may be intermittent. The prolapse may also be associated with severe enteritis from any cause, especially enteritis caused by salmonellosis or ascariasis in young pigs. Prolapse of the vagina (most often irreversible) and/or rectum sometimes occur as a consequence of flaccidity and relaxation of the birth canal in sows close to parturition (Iida et al., 2019). Prolapse of the vagina usually occurs first and is followed by prolapse of the rectum. Uterine prolapse is among the relatively common reasons to cull sows (Engblom et al., 2007). The prolapsed organs can be easily damaged leading to pain and profuse bleeding and therefore these animals cannot be transported.

Wounds

By definition, a wound is a lesion to living tissue caused by a cut, blow, or other impact, typically one in which the skin is cut or broken. In the Council Regulation (EC 1/2005) it is specified that animals with severe, open wounds are not fit for transport. A wound may be so limited in diameter, that it is difficult to see macroscopically. However, the degree of severity is not necessarily coupled with the diameter, as for example

ocular lesions, the diameter of which is typically relatively low, but scored by veterinarians as severily painful (Thomsen et al., 2012). Hence, also the phrasing 'severe, open' leaves room for interpretation. In the Practical guidelines to assess fitness for transport of pigs (Eurogroup for Animals et al., 2015), it is recommended to consider the potential of the wound to cause pain and blood loss during transport as well as possibilities for deterioration. Hence, not only the size of wounds should be taken into account when wounds are assessed in terms of animal fitness for transport – also location, depth and stage of healing may for example be considered.

In many animal welfare studies, working definitions based on a diameter of 1 cm is used as the lower size threshold of wounds, and it is specified for example that the lesion must involve the dermis, to be classified as a wound. Based on this definition, Thodberg et al. (2019) found a higher prevalence of wounds in sows after transport as compared to pre-transport.

Ear lesions: Ear lesions are a collective term for lesions in/at the ears of pigs (typically at the lower rim), but also includes otohematomas or so-called blood-ears. Ear lesions are mainly seen in weaners, with the highest occurrence in pigs between 20-40 kg, after which the lesions usually heal. The prevalence of ear lesions varies considerably between herds and over time (Smulders et al., 2008). The aetiology and risk factors of the lesions are complex, not fully understood, and may involve abnormal biting behaviour from pen-mates, bacterial infections as well as interactions between the two. Irrespective of the causes, ear lesions are a welfare problem for pigs, and may be painful. During transport conditions, where lesioned pigs will have limited opportunity to withdraw or hide from other pigs, the ear lesions may deteriorate due to biting from other pigs.

Ear lesions are not specifically mentioned in the Council Regulation (EC 1/2005) nor in the Practical guidelines to assess fitness for transport of pigs (Eurogroup for Animals et al., 2015). Recently, the Danish Veterinary and Food Administration published national guidelines for fitness for transport in pigs (Fødevarestyrelsen, 2019), stating that pigs with healed or superficial skin lesions, as well as lesions covered by scab, are considered fit for transport. The guidelines also stress that inspection of fitness for transport in pigs with ear lesions, must involve the assessment of the general condition of the animals – for example including palpation of the ears and recording of signs of soreness or pain. According to these guidelines, pigs with severe ear lesions, involving a significant part of the ear, tissue loss and/or signs of soreness or pain can be considered as unfit for transport.

Tail lesions: Tail biting is an abnormal behaviour in pigs leading to lesions on the tip or larger parts of the tail, inflicted by pen-mates (Valros, 2018). The lesions are painful, and mechanical stimulation (e.g. touch) can lead to soreness. Over time, the lesions can result in infections of the skin, underlying tissue and bones, and become necrotic with infection spreading to joints or bones of the back. At this stage, the lesions are very painful. Numerous studies have dealt with tail biting, identifying several risk factors. EURCAW-Pigs has published factsheets on tail biting explaining the multitude of risk factors, and their indicators (https://eurcaw.eu/en/eurcaw-pigs/output/scientific-output.htm).

Tail-biting lesions are not mentioned specifically in the Council Regulation (EC 1/2005) but the Practical guidelines to assess fitness for transport of pigs (Eurogroup for Animals et al., 2015) show detailed pictures and descriptions of conditions ranging from no evidence of tail biting to total loss of the tail with possible necrosis. However, as the number of pigs raised with intact tails is increasing, focus on the assessment of

lesions on intact tails is important. In addition to the visual inspection of the lesion itself, it is recommended to assess the general condition of the pig, including checks for e.g. reduced mobility, and whether the pig shows signs of soreness or pain as indicated, for example, by attempting to hide the tail (tucking in).

Decubital shoulder ulcers (also called shoulder sores): Decubital shoulder ulcers are lesions on the shoulders of sows kept in intensive production systems, in particular in farrowing crates. These ulcers may have a relatively high prevalence, and to some extent be comparable with human pressure ulcers (Herskin et al., 2011). In sows, the ulcers are caused by pressure inflicted by the flooring, leading to oxygen deficiency in the skin and the underlying tissue. In lactating sows, lesions on one or both the shoulder regions can be observed in the weeks after farrowing (Rioja-Lang et al., 2018). The lesions vary from superficial, where redness of the skin is the only clinical sign, to deep ulcers involving subcutaneous layers or even bone tissue (Jensen, 2009). These ulcers will normally heal after the lactation period but also tend to relapse in the next lactation when sows are returned to the farrowing crates or pens.

Recently, decubital shoulder ulcers of sows have received increasing scientific attention (e.g. Rioja-Lang et al., 2018). It has, for example, been shown that sows with even relatively small ulcers (2-5 cm) show behaviour that deviates from healthy control sows (Larsen et al., 2015). In addition, traumatic neuromas were found in both healed and unhealed shoulder ulcerations of sows. Viable nerve endings seen in shoulder ulcerations indicate that the ulcerations are probably associated with pain (Dahl-Pedersen et al. 2013).

The prevalence of decubital shoulder ulcers in European sows is not known. Thodberg et al. (2019) identified decubital shoulder ulcers (on at least one shoulder) in 11.5% of 522 Danish cull sows from 12 herds, examined on the day of slaughter. Based on visual inspection before and after transport, the authors found no evidence of skin covered ulcers re-bursting during transport, but did see signs of deterioration of the ulcers, in terms of increased redness in and around the ulcers following transportation.

Decubital shoulder ulcers are not mentioned specifically in the Council Regulation (EC 1/2005) nor in the Practical guidelines to assess fitness for transport of pigs (Eurogroup for Animals et al., 2015). Almost two decades ago, however, Grandin (2001) suggested shoulder ulcers were a clinical sign of sows being unfit for transport. At present there are two validated grading scales for decubital shoulder ulcers in sows. One grading scale is applied post mortem and considered the 'golden standard' as it is based on patho-anatomical assessment of the involvement of layers of skin and underlying tissue (Jensen, 2009). However, this grading scale only has limited value on live sows. In order to increase the feasibility, a new grading scale was developed and validated, specifically for the standing sow (Jensen et al., 2011). The new scale has, to the best of our knowledge, not yet been validated as a measure of fitness for transport. Therefore, the ulcers must be inspected in accordance with the wording of the Council Regulation (EC 1/2005) mentioning 'pathological processes' and 'severe open wounds' (Annex 1, Chapter 1).

Hernias

Hernia is the popular term used to describe outpouchings on the ventral aspect of the abdominal wall of pigs. They are relatively common in modern pig production and cover several types of underlying pathology, e.g., cysts, abscesses and fibrosis. True hernias (when abdominal viscera pass through weak areas in the inguinal ring or the navel without breaking through the skin) is only one type (Andersen et al., 2014). The general condition of pigs with umbilical outpouchings may appear anywhere from completely normal to un-thriving and depressed, with or without signs of pain. Depending on their size, the underlying pathology and the

anatomical location, umbilical outpouchings may limit the mobility of pigs. In addition, contact between the outpouching and the flooring (when lying, or for very big outpouchings, also when moving) may result in skin wearing off and the formation of sores. In the worst case, the outpouching may rupture.

The effects of umbilical outpouchings on animal welfare are not fully understood. Schild et al. (2015) focused on market weight pigs with abdominal outpouchings, and compared the behaviour of pigs with outpouchings (diameter 12 cm, ranging from 4-20 cm) versus healthy controls, while mixed in an on-farm pre-transport pick-up pen, where the pigs stayed for 6 hours. The behaviour of the pigs with outpouchings differed from the controls, for example in terms of a shorter latency to lie down, decreased aggression and increased sitting. During the mixing-induced fighting, some pigs were observed to direct bites at the umbilical outpouchings of pen-mates.

Hernias are not mentioned specifically in the Council Regulation (EC 1/2005), but are described in the Practical guidelines to assess fitness for transport of pigs (Eurogroup for Animals et al., 2015). According to these guidelines, outpouchings should be considered serious regarding fitness for transport if they are more than 15-20 cm wide and present sores. In addition to the visual inspection of the outpouching itself, it is recommended to assess the general condition of the pig, whether mobility is reduced, and whether the pig shows signs of soreness or pain when palpated.

4.2 Physiological weaknesses

The other central requirement in the description of fitness for transport in the Council Regulation (EC 1/2005) is that animals with physiological weaknesses shall not be considered fit for transport. It is however not specified how the terms should operationalized.

In the European pig industry different categories of pigs are transported, such as for example weaners (around 30 kg of body weight), market weight pigs (including heavy pigs of more than 150 kg), and adult sows and boars (Dahl-Pedersen and Herskin, 2021). Some characteristics of unfit animals can be recognised visually such as emaciation or anaemia, whereas others, such as genetically determined stress susceptibility is more difficult or impossible to verify by visual inspection. Other examples are age of piglets and stage of pregnancy of sows. In these cases, farm records may be useful.

Some characteristics rendering animals unfit for transport do not directly relate to health issues, but certain age groups or certain stages of the production cycle. Examples are listed in the Council Regulation (EC 1/2005), and include pregnant females for whom 90% or more of the expected gestation period has already passed, females who have given birth in the previous week, and pigs of less than three weeks of age (unless they are transported less than 100 km). It is worth noticing that the OIE guidelines for animal transport on land (OIE, 2011) also mention 'large or obese individuals', and animals that are 'excitable or aggressive'. These terms are not fully operational, and probably not relevant for all categories of pigs, but could – depending on how the different terms are defined – be relevant for sows and boars transported to slaughter at the end of their productive life.

A last example to draw attention to, is the statement in the Council Regulation (EC 1/2005) that 'lactating females of bovine, caprine and ovine species not accompanied by their offspring shall be milked at intervals of not more than 12 hours'. Interestingly, Thodberg et al. (2019) reported that almost 40% of the cull sows

in their study were sent to slaughter on the day (or day after) weaning from their piglets. This means that these animals were producing a substantial amount of milk at the time of transport to slaughter (Williams et al., 2013). However, the accumulation of milk in the porcine udder, and potential consequences of this in terms of animal welfare, has not received the same scientific attention, as for example udder engorgement post dry-off in dairy cows (Zobel et al., 2015). In a recent survey of opinions and experiences of livestock drivers transporting cull sows to slaughter in Denmark, Thodberg et al. (2020) reported that some drivers expressed concern over the fitness for transport in sows with engorged udders. Interestingly, however, none of the 360 sow farmers who answered questions about sow transport in the recent survey by Herskin et al. (2020b), chose 'on-going lactation' as a cause of doubt regarding fitness for transport. Whether being transported shortly after weaning is challenging for cull sows is, to the best of our knowledge, not known, but it could be an underestimated issue certainly deserving further study, and potentially be included as an example of a physiological weakness.

5 Minimising welfare problems: training

In this section of the review, we draw attention to one important element in the work to align and improve the assessment of fitness for transport of pigs: the training of inspectors.

Despite a relatively large number of studies focusing on opinions and experiences of veterinarians, including challenges related to the use of clinical measures (Kristensen et al., 2006), almost no studies have focused on these measures as indicating fitness for transport. Two studies, however involve other professional groups, namely livestock drivers (Thodberg et al., 2020) and farmers sending sows for slaughter (Herskin et al., 2020b). These studies suggest that doubts about fitness for transport are not uncommon among livestock drivers or farmers. In bovines, Dahl-Pedersen et al. (2018) showed short video clips of walking cows (in different stages of lameness) to dairy farmers, veterinarians and livestock drivers. For each video clip, the respondents should decide – based on the gait of the cow - whether she was fit for transport or not. The study did not have a massive sample size, and thus could not draw strong conclusions, but the results indicated that the level of agreement in the assessment of fitness for transport was at best moderate. It is unknown to what extent this applies to fitness for transport in pigs. Similarly, it is not known whether such an assessment would be easier for e.g. market weight pigs or weaners than for cull sows, which tend to have a worse clinical condition than the younger animal categories (Fogsgaard et al., 2018). In any case, training of assessors is essential to standardise outcomes.This involves training regarding technical aspects of fitness, but also the dialogue and alignment between the different actors in the process.

Recently, Overstreet and Anneberg (2020) published a review for EURCAW-Pigs on 'farmers, inspectors and animal welfare: possibilities for change' (https://edepot.wur.nl/514920), in which the authors discuss options for inspection-driven improvement of animal welfare, and focus on the role of inspectors as operating between the domains of legislation and research. In the review, Overstreet and Anneberg (2020) provide suggestions for inspector training with an emphasis on improved communication. As current research shows, communication between inspectors and farmers is essential if inspections are to enforce animal welfare legislation. For 'fitness for transport', where scientific knowledge is limited (Herskin and Duffield, 2020), and the wording of the legislation is leaving room for interpretation, focus on training and communication seems imperative.

6 Legal requirements

The legal requirements regarding fitness for transport are stated in the **Council Regulations (EC) No 1/2005 and 1255/97** and additional text can be found in **853/2004** as well. The sections of the legislation relevant for pigs are presented below:

6.1 Council Regulation (EC) No 1/2005 on the protection of animals during transport and related operations

Checks to be carried out by the competent authority at any stage of long journeys: "In the case of long journeys between Member States and with third countries, the checks at the place of departure for fitness for transport, as referred to in Chapter I of Annex I, shall be performed before the loading as part of the animal health checks as set out in the corresponding veterinary community legislation, within the time limits provided by such legislation." {Article 15, Point 2.}

Fitness for transport {Annex I, Chapter I}:

"1. No animal shall be transported unless it is fit for the intended journey, and all animals shall be transported in conditions guaranteed not to cause them injury or unnecessary suffering.

2. Animals that are injured or that present physiological weaknesses or pathological processes shall not be considered fit for transport and in particular if:

(a) they are unable to move independently without pain or to walk unassisted;
(b) they present a severe open wound, or prolapse;
(c) they are pregnant females for whom 90 % or more of the expected gestation period has already passed, or females who have given birth in the previous week;
(d) they are new-born mammals in which the navel has not completely healed;
(e) they are pigs of less than three weeks, unless they are transported less than 100 km;"

"3. However, sick or injured animals may be considered fit for transport if they are:
(a) slightly injured or ill and transport would not cause additional suffering; in cases of doubt, veterinary advice shall be sought;
(b) transported for the purposes of Council Directive 86/609/EEC (1) if the illness or injury is part of a research programme;
(c) transported under veterinary supervision for or following veterinary treatment or diagnosis. However, such transport shall be permitted only where no unnecessary suffering or ill treatment is caused to the animals concerned;
(d) animals that have been submitted to veterinary procedures in relation to farming practices such as castration, provided that wounds have completely healed."

"4. When animals fall ill or are injured during transport, they shall be separated from the others and receive first-aid treatment as soon as possible. They shall be given appropriate veterinary treatment and if necessary undergo emergency slaughter or killing in a way which does not cause them any unnecessary suffering."

"5. Sedatives shall not be used on animals to be transported unless strictly necessary to ensure the welfare of the animals and shall only be used under veterinary supervision."

6.2 Regulation (EC) No 853/2004 laying down specific hygiene rules for on the hygiene of foodstuffs

The term 'fitness' cannot be found in this regulation, the content of which, however, mentions animal welfare at the time of arrival to slaughterhouses {Annex II, Section II, 2.f):

Food business operators operating slaughterhouses must ensure procedures to guarantee that the condition of each animal is in a satisfactory state as regards welfare on arrival at the slaughterhouse.

6.3 Council Regulation (EC) No 1255/97 concerning Community criteria for control posts

"Before the animals leave the control post, the official veterinarian or any veterinarian designated for this purpose by the competent authority shall confirm on the journey log as referred to in Annex II of Regulation (EC) No 1/2005 that the animals are fit to continue their journey." {Article 6, Point 1.}

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7 References

Andersen, E. M. O., Spangsberg, R., Pedersen, K. S., Barington, K., & Jensen, H. E. (2014, June). Umbilical hernia and differential diagnoses in slaughter pigs. In *Proceedings of the 23rd International Pig Veterinary Society (IPVS) Congress* 8-11th of June, Cancun, Quintana Roo, Mexico (p. 126).

Baumgaertner, H., Mullan, S., & Main, D. C. J. (2016). Assessment of unnecessary suffering in animals by veterinary experts. *Veterinary Record*, *179*(12), 307-307. https://doi.org/10.1136/vr.103633

Cassell, E. J. (1998). The nature of suffering and the goals of medicine. *Loss, Grief & Care*, *8*(1-2), 129-142. https://doi.org/10.1300/J132v08n01_18

Cockram, M. S. (2019). Fitness of animals for transport to slaughter. *The Canadian Veterinary Journal*, *60*(4), 423. https://edepot.wur.nl/537760

Committee on Agriculture and Rural Development of the European Parliament (2019). Report on the implementation of Council Regulation 1/2005 within and outside the EU. European Parliament. https://www.europarl.europa.eu/doceo/document/A-8-2019-0057_EN.pdf

EC, 1997. Regulation (EC) No 1255/97 of 25 June 1997 concerning Community criteria for control posts and amending the route plan referred to in the Annex to Directive 91/628/EEC. Available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31997R1255

EC, 2004. Council Regulation (EC) No 853/2004 of 29 April 2004 laying down specific hygiene rules for on the hygiene of foodstuffs. Available online at: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32004R0853

EC, 2004. Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97. https://edepot.wur.nl/521414

Dahl-Pedersen, K., Foldager, L., Herskin, M. S., Houe, H., & Thomsen, P. T. (2018). Lameness scoring and assessment of fitness for transport in dairy cows: agreement among and between farmers, veterinarians and livestock drivers. *Research in veterinary science*, *119*, 162-166. https://doi.org/10.1016/j.rvsc.2018.06.017

Dahl-Pedersen K., Herskin, M. S. (2021). Trade of cattle and pigs between EU Member States 2014-2018 – an overview and discussion of potential welfare consequences. Submitted for publication in *Journal of Applied Animal Welfare Science*.

Dewey, C. E., Haley, C., Widowski, T., Poljak, Z., & Friendship, R. M. (2009). Factors associated with in-transit losses of fattening pigs. *Animal Welfare*, *18*(4), 355-361.

Directorate General for Health and Consumers (DG SANTE), European Commission (2016). Overview report – systems to prevent the transport of unfit animals in the EU. https://op.europa.eu/en/publication-detail/-/publication/2bdfe42c-e33f-409e-8f02-4f0308205ede

Engblom, L., Lundeheim, N., Dalin, A. M., & Andersson, K. (2007). Sow removal in Swedish commercial herds. *Livestock science*, *106*(1), 76-86. https://doi.org/10.1016/j.livsci.2006.07.002

Eurogroup for Animals, UECBV, Animals' Angels, Cooperl Arc Atlantique, Copa-Cogeca, ELT, FVE, IRU, INAPORC and IFIP. (2015). *Practical Guidelines to Assess Fitness for Transport of Pigs*. Retrieved April 23, 2021, from http://www.animaltransportguides.eu.

Fogsgaard, K. K., Herskin, M. S., & Thodberg, K. (2018). Transportation of cull sows-a descriptive study of the clinical condition of cull sows before transportation to slaughter. *Translational Animal Science*, *2*(3), 280-289. https://doi.org/10.1093/tas/txy057

Fordyce, P. (2017). Suffering in Non-Human Animals. *Global Journal Of Animal Law, 5*(1), 12-53. Retrieved from http://ojs.abo.fi/ojs/index.php/gjal/article/view/1587.

Fraser, D., Weary, D. M., Pajor, E. A., & Milligan, B. N. (1997). A scientific conception of animal welfare that reflects ethical concerns. *Animal Welfare*, *6*, 187-205.

Fødevarestyrelsen (2019). T*ransport-guide – assessment of fitness for transport and transport-related injuries* (in Danish) Miljø- og Fødevareministeriet, Fødevarestyrelsen, Glostrup. Retrieved April 22, 2021, from https://www.foedevarestyrelsen.dk/SiteCollectionDocuments/Dyresundhed/Transportegnethed/Transportguide%20-%20Vurdering%20af%20transportegnethed%20og%20%20skader%20opst%C3%A5et%20under%20transport.pdf

Grandin, T. (2001). Perspectives on transportation issues: The importance of having physically fit cattle and pigs. *Journal of Animal Science*, *79*(suppl_E), E201-E207. https://doi.org/10.2527/jas2001.79E-SupplE201x

Grandin, T. (2016). Transport fitness of cull sows and boars: a comparison of different guidelines on fitness for transport. *Animals*, *6*(12), 77. https://doi.org/10.3390/ani6120077

Grandin, T. (2021). Recommended animal handling guidelines and audit guide. *A systematic approach to animal welfare. American Industry Foundation: USA*. http://www.animalhandling.org/sites/default/files/forms/Animal_Handling_Guide012021.pdf

Herskin, M. S., Bonde, M. K., Jørgensen, E., & Jensen, K. H. (2011). Decubital shoulder ulcers in sows: a review of classification, pain and welfare consequences. *Animal*, *5*(5), 757-766. https://doi.org/10.1017/S175173111000203X

Herskin, M. S., Overstreet, K., & Anneberg, I. (2020a). Are veterinary inspections the best way to improve animal welfare during transport?. *Veterinary Record*, *187*(6), 242-242. https://doi.org/10.1136/vr.m3647

Herskin, M. S., Aaslyng, M. D., Anneberg, I., Thomsen, P. T., Gould, L. M., & Thodberg, K. (2020b). Significant variation in the management of cull sows before transport for slaughter: results from a survey of Danish pig farmers. *Veterinary Record*, *186*(6), 185-185. https://doi.org/10.1136/vr.105671

Herskin, M. S., & Duffield, T. (2020c). Animal Transport and Related Management. *Frontiers in Veterinary Science*, *7*:614317. https://doi.org/10.3389/fvets.2020.614317

Iida, R., Piñeiro, C., & Koketsu, Y. (2019). Incidences and risk factors for prolapse removal in Spanish sow herds. *Preventive veterinary medicine*, *163*, 79-86. https://doi.org/10.1016/j.prevetmed.2018.12.016

Jensen, H. E. (2009). Investigation into the pathology of shoulder ulcerations in sows. *Veterinary Record*, *165*(6), 171-174. https://doi.org/10.1136/vr.165.6.171

Jensen, H. E., Bonde, M. K., Baadsgaard, N. P., Dahl-Pedersen, K., Andersen, P. H., Herskin, M. S., ... & Jensen, K. H. (2011). A simple and validated scale for the clinical assessment of shoulder lesions. *Dansk Veterinærtidsskrift*, *94*(9), 6-12. https://www.cabdirect.org/cabdirect/abstract/20113223707

Kristensen, E., Dueholm, L., Vink, D., Andersen, J. E., Jakobsen, E. B., Illum-Nielsen, S., ... & Enevoldsen, C. (2006). Within-and across-person uniformity of body condition scoring in Danish Holstein cattle. *Journal of Dairy Science*, *89*(9), 3721-3728. https://doi.org/10.3168/jds.S0022-0302(06)72413-4

Lambooij, E. B. (2014). Transport of pigs. In T. Grandin(Ed.). *Livestock Handling and Transport*. (1st ed., pp. 280-98). Oxfordshire, UK: CAB International. https://doi.org/10.1079/9781780643212.0280

Langley, J. & Brenner, R. (2004). What is an injury?. *Injury Prevention 10*: 69-71

Larsen, T., Kaiser, M., & Herskin, M. S. (2015). Does the presence of shoulder ulcers affect the behaviour of sows?. *Research in veterinary science*, *98*, 19-24. https://doi.org/10.1016/j.rvsc.2014.11.001

Ledger, R. A., & Mellor, D. J. (2018). Forensic use of the Five Domains Model for assessing suffering in cases of animal cruelty. *Animals*, *8*(7), 101. https://doi.org/10.3390/ani8070101

Lundmark, F., Berg, C., & Röcklinsberg, H. (2013). 'Unnecessary suffering'as a concept in animal welfare legislation and standards. In The ethics of consumption. In H. Röcklingsberg and P. Sandin (Eds.). *The ethics of consumption: the citizn, the market and the law* (pp. 114-119). Wageningen: Wageningen Academic Publishers.

Marchant-Forde, J. N., & Marchant-Forde, R. M. (2009). Welfare of pigs during transport and slaughter. In J. N. Marchant-Forde JN (Ed.). *The Welfare of Pigs* (pp. 301-330). Dordrecht: Animal Welfare, vol 7. Springer,. https://doi.org/10.1007/978-1-4020-8909-1_10

Mellor, D. J., & Beausoleil, N. J. (2015). Extending the 'Five Domains' model for animal welfare assessment to incorporate positive welfare states. *Animal Welfare*, *24*(3), 241-253. https://doi.org/10.7120/09627286.24.3.241

OIE (2011). *Terrestrial Animal Health Code. Transport of Animals by Land*, (20th ed., pp. 306- 322.), Paris, France: World Organisation for Animal Health (OIE).

Olsson, I. A. S., J Nicol, C., Niemi, S. M., & Sandøe, P. (2020). From unpleasant to unbearable—why and how to implement an upper limit to pain and other forms of suffering in research with animals. *ILAR Journal* ilz018. https://doi.org/10.1093/ilar/ilz018

Peden, R. S., Camerlink, I., Boyle, L. A., Loughnan, S., Akaichi, F., & Turner, S. P. (2020). Belief in pigs' capacity to suffer: An assessment of pig farmers, veterinarians, students, and citizens. *Anthrozoös*, *33*(1), 21-36. https://doi.org/10.1080/08927936.2020.1694304

Peterson, H. C. (2013). Sustainability: a wicked problem. In E. Kebreab (Ed). *Sustainable Animal Agriculture* (pp. 1-10), CABI 10.1079/9781780640426.0001

Rioja-Lang, F. C., Seddon, Y. M., & Brown, J. A. (2018). Shoulder lesions in sows: a review of their causes, prevention, and treatment. *Journal of Swine Health and Production*, *26*(2), 101-107.

Ritter, M. J., Yoder, C. L., Jones, C. L., Carr, S. N., & Calvo-Lorenzo, M. S. (2020). Transport losses in market weight pigs: II. US incidence and economic impact. *Translational Animal Science*, *4*(2), 1103-1112. https://doi.org/10.1093/tas/txaa041

Robertson, L. S. (1998). *Injury Epidemiology*(2nd ed., p. 265). New York: Oxford University Press.

Schild, S. L. A., Rousing, T., Jensen, H. E., Barington, K., & Herskin, M. S. (2015). Do umbilical outpouchings affect the behaviour or clinical condition of pigs during 6 h housing in a pre-transport pick-up facility?. *Research In Veterinary Science*, *101*, 126-131. https://doi.org/10.1016/j.rvsc.2015.06.005

Semenova, A. A., Kuznetsova, T. G., Nasonova, V. V., Nekrasov, R. V., & Bogolyubova, N. V. (2019). Myopathy as a destabilizing factor of meat quality formation. *Theory and practice of meat processing*, *4*(3), 24-31. https://doi.org/10.21323/2414-438X-2019-4-3-24-31

Smith, W. J & Straw, B. E. (2006). Prolapses. InB. E. Straw, J. J. Zimmerman, S. D'Allaire, D. J. Taylor (Eds.). *Diseases of Swine* (9th ed, pp. 965-970)., Ames, IA, USA: Iowa State University Press

Smulders, D., Hautekiet, V., Verbeke, G., & Geers, R. (2008). Tail and ear biting lesions in pigs: an epidemiological study. *Animal Welfare*, *17*(1), 61-69.

Sutherland, M. A., Erlandson, K., Connor, J. F., Salak-Johnson, J. L., Matzat, P., Smith, J. F., & McGlone, J. J. (2008). Health of non-ambulatory, non-injured pigs at processing. *Livestock Science*, *116*(1-3), 237-245. https://doi.org/10.1016/j.livsci.2007.10.009

Tate, T., & Pearlman, R. (2019). What we mean when we talk about Suffering—and why ERIC Cassell should not have the last word. *Perspectives in biology and medicine*, *62*(1), 95-110. https://doi.org/10.1353/pbm.2019.0005

Thodberg, K., Fogsgaard, K. K., & Herskin, M. S. (2019). Transportation of cull sows—Deterioration of clinical condition from departure and until arrival at the slaughter plant. *Frontiers in veterinary science*, *6*, 28. https://doi.org/10.3389/fvets.2019.00028

Thodberg, K., Gould, L. M., Støier, S., Anneberg, I., Thomsen, P. T., & Herskin, M. S. (2020). Experiences and opinions of Danish livestock drivers transporting sows regarding fitness for transport and management choices relevant for animal welfare. *Translational Animal Science*, *4*(2), 1070-1081. https://doi.org/10.1093/tas/txaa015

Thomsen, P. T., Anneberg, I., & Herskin, M. S. (2012). Differences in attitudes of farmers and veterinarians towards pain in dairy cows. *The Veterinary Journal*, *194*(1), 94-97. https://doi.org/10.1016/j.tvjl.2012.02.025

Valros, A. (2018). Tail biting. In M. Spinka (Ed.). *Advances In Pig Welfare* (pp. 137-166). Kidlington, UK: Woodhead Publishing Series in Food Science, Technology and Nutrition. https://researchportal.helsinki.fi/en/publications/tail-biting

Veit, W. & Browning, H. (2021). Phenomenology applied to animal health and suffering. In S. Ferrarello (Ed.). *Phenomenology of Bioethics: Technoethics and Lived Experience*. Springer, in press.

Vom Brocke, A. L., Karnholz, C., Madey-Rindermann, D., Gauly, M., Leeb, C., Winckler, C., ... & Dippel, S. (2019). Tail lesions in fattening pigs: relationships with postmortem meat inspection and influence of a tail biting management tool. *Animal*, *13*(4), 835-844. https://doi.org/10.1017/S1751731118002070

Welfare Quality ® (2009). *Welfare Quality assessment protocol for pigs (sows and piglets, growing and finishing pigs).* Welfare Quality Consortium, Lelystad, The Netherlands, 123 p.

Williams, A. M., Safranski, T. J., Spiers, D. E., Eichen, P. A., Coate, E. A., & Lucy, M. C. (2013). Effects of a controlled heat stress during late gestation, lactation, and after weaning on thermoregulation, metabolism, and reproduction of primiparous sows. *Journal of animal science*, *91*(6), 2700-2714. https://doi.org/10.2527/jas.2012-6055

Yao, V. (2019). Two Problems Posed by the Suffering of Animals. *The Journal of Speculative Philosophy*, *33*(2), 324-339. https://doi.org/10.5325/jspecphil.33.2.0324

Zobel, G., Weary, D. M., Leslie, K. E., & Von Keyserlingk, M. A. G. (2015). Invited review: Cessation of lactation: Effects on animal welfare. *Journal of Dairy Science*, *98*(12), 8263-8277. https://doi.org/10.3168/jds.2015-9617

Zurbrigg, K., van Dreumel, T., Rothschild, M., Alves, D., Friendship, R., & O'Sullivan, T. (2017). Pig-level risk factors for in-transit losses in swine: a review. *Canadian Journal of Animal Science*, *97*(3), 339-346. https://doi.org/10.1139/cjas-2016-0193

EU Reference Centre for Animal Welfare *Pigs*

About EURCAW-Pigs

EURCAW-Pigs is the first European Union Reference Centre for Animal Welfare. It focuses on pig welfare and legislation, and covers the entire life cycle of pigs from birth to the end of life. EURCAW-Pigs' main objective is a harmonised compliance with EU legislation regarding welfare in EU Member States. This includes:

- for pig husbandry: Directives 98/58/EC and 2008/120/EC;
- for pig transport: Regulation (EC) No 1/2005;
- for slaughter and killing of pigs: Regulation (EC) No 1099/2009.

EURCAW-Pigs supports:

- inspectors of Competent Authorities (CA's);
- pig welfare policy workers;
- bodies supporting CA's with science, training, and communication.

Website and contact

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