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Short as well as long transport duration can affect the welfare of slaughter pigs

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Abstract

Attention to the welfare of animals during slaughter transport and lairage at the abattoir is important not only to consumers, but also to the meat production industry. Inadequate transport conditions can result in higher animal mortalities and meat quality problems after slaughter of such animals. In the present study the development of mortality rates both during and after the transport of slaughter pigs, and the incidence of pathological findings, was investigated. It could be shown that the percentage of animals which died during transport and in lairage clearly decreased between 1999 and 2003. This improvement was due mainly to the reduction of animal losses in the summer season where the highest losses over the investigated years occurred. Considering the duration of the transport it could be shown that not only very long (8 h), but also short journeys (1 h) can affect the welfare of animals with increased mortalities and pathological findings during the veterinary inspection at the slaughterhouse, particularly in the summer season. The results presented indicate that the tightening of European animal welfare legislation concerning loading, transport, unloading and lairage of slaughter pigs improved mortality rates and the incidence of pathological findings. Another reason could be a reduction of the percentage of stress susceptible pigs in the porcine population. However, until now the regulations on animal welfare during pig slaughter transport focused only on long-term journeys; the results presented show that short journeys can also affect the welfare of the animals.

Keywords: *animal welfare, duration, lairage, season, slaughter pigs, transport*

Introduction

With regard to animal losses and meat quality failures, the welfare of animals during transport to the slaughterhouse is not only of interest to consumers, but also to the meat production industry. Exogenic (eg climate, transport duration, vehicle design, stocking density) and endogenic factors (eg anatomical disadvantages, stress susceptibility of the transported animals) can have a detrimental effect on the welfare of the transported animals (Guardia *et al* 2004), resulting in physiological responses such as increased blood cortisol and adrenaline, increased heart rate (tachycardia) or a higher concentration of neutrophils and lymphocytes (granulocytosis, lymphocytosis) (Bradshaw *et al* 1996; Broom 1996; Warriss 1998). These changes lead to disturbances to the circulatory and respiratory systems (Warriss 1998) which can result in a general circulatory breakdown in certain pigs. The latter effect occurs more often in stress susceptible pigs eg in animals with a mutation in the RyR gene – an alteration associated with malignant hyperthermia syndrome (MHS) (Fuji *et al* 1991). Animals surviving the stress of transport tend to show poor meat quality like pale and soft meat with a high drip loss (PSE) caused by the rapid drop in muscle pH immediately after slaughter (Hambrecht *et al* 2005). Other animals tend to show dark, firm and dry (DFD) meat. In these cases the meat has a higher pH 24 h after slaughter due to a stress-induced consumption of glycogen stores during transport and lairage (Warriss 1998).

Considering the described factors that influence welfare of slaughter pigs during transport, it is very important to avoid pain and suffering at all stages from the stable to the slaughterhouse (loading, transport, unloading and lairage). Since the public interest in adequate transport conditions increased in recent years much of the European and national legislation concerning the transport of slaughter animals was tightened. The purpose of these changes was to reduce the pain and suffering of these animals through improvements to transport vehicles and lairage facilities (eg stocking density, ventilation) and the capabilities of animal handlers at loading, transport, unloading and lairage. A further improvement could come with the implementation of the Council Regulation 1/2005; 'on the protection of animals during transport and related operations' which came into practice in the European Community in 2007.

The mortality rates of slaughter pigs during transport and the incidence of pathological findings provide welfare indicators for these animals. However, no actual data regarding the changes in animal welfare and the impact on mortality

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Table 1 Mean values of pigs that died on transport vehicles or in lairage in the years 1999 to 2003 (n = 7,194,520).

Year	Number of animals delivered	Pigs that died during transport (%)	Pigs that died in lairage (%)
1999	1,403,864	0.51[a]	0.017[a]
2000	1,429,371	0.138[ab]	0.015[ab]
2001	1,338,991	0.119[bc]	0.012[bc]
2002	1,466,004	0.095[cd]	0.009[c]
2003	1,556,290	0.085[d]	0.012b[c]

[abcd] Mean values with different superscripts in a column differ significantly ($P < 0.05$).

Table 2 Mean values of pigs that died on transport vehicles and in lairage in the years 1999 to 2003 relative to season (n = 7,194,520).

Year	Winter	Spring	Summer	Autumn
1999	0.16[ax]	0.192[ax]	0.176[ax]	0.144[ax]
2000	0.119[abx]	0.139[abx]	0.203[ay]	0.152[ax]
2001	0.11[abx]	0.127[bx]	0.18[ay]	0.107[abx]
2002	0.1b[x]	0.113[bx]	0.122[bx]	0.081[bx]
2003	0.082b[x]	0.099[bx]	0.116[bx]	0.0088[bx]
1999-2003	0.132[x]	0.151[x]	0.177[y]	0.132[x]

[abc] Mean values with different superscripts in a column differ significantly ($P < 0.05$). [xy] Mean values with different superscripts in a line differ significantly ($P < 0.05$).

Table 3 Mean percentages of pigs with circulatory problems, fractures and lameness (values relative to all pathological findings are shown in brackets) in the year 2003 relative to transport duration (n = 319,005).

Transport duration (hours)	Percentage of animals with circulatory problems	Percentage of animals with fractures	Percentage of lame animals
1	0.134[a] (45.8[a])	0.034[a] (11.0[a])	0.107[a] (22.3[a])
4	0.081[b] (27.9[b])	0.081[b] (30.4[b])	0.046[a] (19.8a)
6	0.033[c] (20.4[b])	0.048[ac] (29.6[b])	0.051[a] (27.1[a])
8	0.025[c] (16.8[b])	0.067[bc] (42.1[c])	0.041[a] (24.7[a])

[abc] Mean values with different superscripts in a column differ significantly ($P < 0.05$).

rates are found in the literature. For this reason slaughter information from a large commercial slaughter company were analysed to elucidate the development of pig losses in Germany, focusing on exogenic factors like journey duration and season.

Materials and methods

The data were collected from a large slaughter company that obtained slaughter pigs from a variety of regions throughout Germany. During the delivery of animals to the slaughterhouse, veterinarians inspected the health status of the pigs and the vehicles (eg ventilation systems, general equipment) and the transport conditions (eg stocking density) following the national regulations concerning the transport of slaughter animals.

In the first part of the investigation monthly documents from 1999 to 2003, showing the amount of slaughter pigs that died during transport and in lairage were analysed (n = 7,194,520 animals).

In the second part daily reports from the year 2003, concerning mortality rates during transport and lairage as well as specific pathological findings during animal and meat inspection in the abattoir, were analysed (n = 319,005 animals). The data were differentiated into animals transported for 1 h (n = 68,657), 4 h (n = 43,558), 6 h (n = 67,114) and 8 h (n = 139,676). Only data from carriers that regularly delivered slaughter pigs to the abattoir were considered.

The transport-related mortality rates include pigs that died during loading, transport and unloading whereas lairage-dependent mortality included only those animals that actually died in the slaughterhouse. Pathological findings, eg circulatory problems or lameness were determined by the veterinarians during unloading, lairage and movement to the stunning facility.

The data were analysed with the software Statistica 6.0 for Windows® (StatSoft, Hamburg) using the following statistical model for the two different investigations:

(1) $y_{ijk} = \mu + Y_i + S_j + e_{ij}$ whereby Y = Year, S = Meteorological season.

(2) $y_{ijk} = \mu + D_i + S_j + e_{ij}$ whereby D = transport duration, S = Meteorological season.

Significant differences were calculated with the Fischer-LSD-test considering a probability value $P < 0.05$.

Results

From 1999 to 2003 the percentages of slaughter pigs that died during transport or lairage decreased significantly ($P < 0.05$, Table 1). In 1999 0.15% of slaughter pigs did not survive transport and 0.017% died during lairage. These percentages decreased to 0.085% and 0.012%, respectively for 2003. From 1999 to 2003 the majority of the animals (89.9%) died during transport. Only 10.1% of the pigs passed away during lairage (Table 1).

Considering the impact of season on mortality rates during transport and lairage it could be shown that in the summer months of June, July and August, between 1999 and 2003, significantly more ($P < 0.05$) pigs died (0.177%) in comparison to other seasons (winter: 0.132%; spring: 0.151%; autumn: 0.132%). In particular, the summer seasons of 2000 and 2001 showed a high percentage of dead pigs (0.20% and 0.18%, respectively; $P < 0.05$). The data also show that the reduction in mortality rates in 2002 and 2003 occurred mainly in the summer seasons (Table 2).

Investigating the effect of the transport duration on the mortality rates during transport and lairage resulted in significantly higher percentages of dead pigs ($P < 0.05$)

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Figure 1

Mean values of pigs that died on transport vehicles and in lairage and percentage of animals with significant pathological findings after veterinary inspection in 2003 relative to mean transport duration.
[abc] Mean values with different superscripts between the transport durations differ significantly ($P < 0.05$).

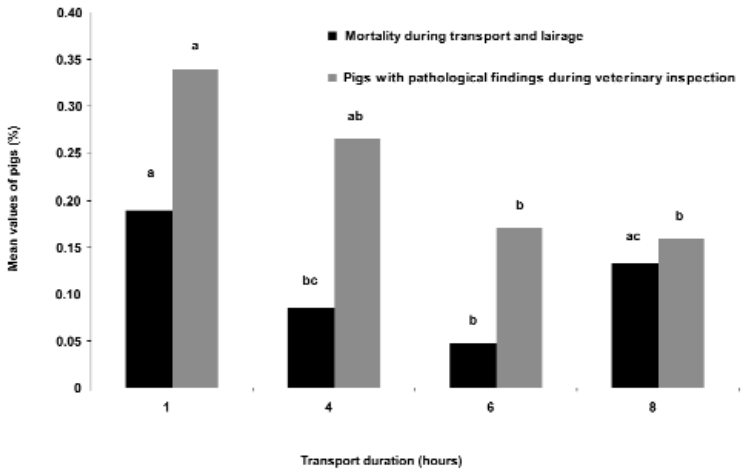
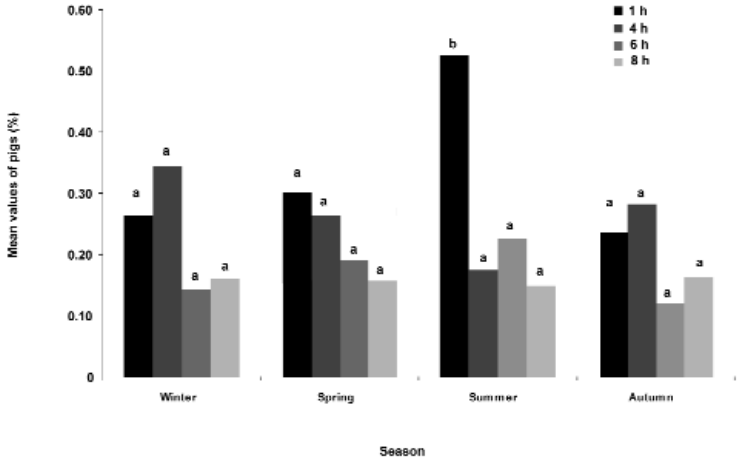


Figure 2

Mean percentages of animals with significant pathological findings during veterinary inspection in 2003 relative to the mean transport duration and season (n = 319,005).
[ab] Mean values with different superscripts between the seasons differ significantly ($P < 0.05$).



after short (1 h, 0.188%) in comparison to the mean (4 h) and long (6 h) transport durations (0.08 and 0.05%). With regard to the amount of animals with significant pathological changes during veterinary inspection, the highest percentages were seen after short journeys (0.34%) decreasing with increased journey time to 4 h (0.27%), 6 h (0.17%) and 8 h (0.16%). The differences were only significant ($P < 0.05$) between the short (1 h), the long (6 h) and the very long (8 h) journey times (Figure 1).

The influence of season and transport duration on the mortality rates and percentages of pathological findings could only be seen for short journeys during the summer months of June, July and August 2003. The mean values were almost twice as high (0.52%) than the percentages in the spring and autumn (0.31% and 0.26%, respectively). The percentages of pathological findings differ significantly ($P < 0.05$) between the summer and the spring and autumn seasons (Figure 2). Considering the mortality rates a significant difference ($P < 0.05$) could only be calculated between the spring and summer season (data not shown).

With regard to specific pathological findings 2003 revealed mainly circulatory and lameness problems (0.134% and 0.107%, respectively; Table 3). Prolongation of journey time lead to significant decreases in circulatory problems ($P < 0.05$) to 0.081% (4 h), 0.033% (6 h) and 0.025% (8 h). The amount of animals showing lameness also reduced (0.046% [4 h]; 0.051% [6 h]; 0.041% [8 h]). However, there were no significant differences between all transport durations. As far as fractures are concerned a significant increase from 0.034% after 1 h to 0.081% (4 h) was seen. After further prolongation percentages decreased to 0.048% (6 h) before rising to 0.067% after very long (8 h) journeys.

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It is interesting to note that after short journeys 45.8% of pigs with pathological findings during the veterinary inspection showed circulatory problems and only 11% had fractures. Both percentages differed significantly ($P < 0.05$) from the results from other lengths of journey. In contrast to this after very long journeys (8 h) 42.1% of all pathological findings were fractures and this value was significantly higher ($P < 0.05$) in comparison to the other transport durations. The percentages of lameness were similar during all transport durations (Table 3).

Discussion

The data from a large German slaughter company showed that percentages of slaughter pigs that died during transport to the abattoir or in lairage decreased from 1999 to 2003 (Table 1). The mortality rates decreased mainly in the summer months of 2002 and 2003 (Table 2). The transport-related mortality rates were lower than those seen by Warriss (1998), who found mortality rates of 0.5% in Germany. The generally higher summer mortality, in comparison to other seasons, corresponds with data presented by other authors (Abbott *et al* 1995; Warriss 1998; Guardia *et al* 2004). For the discussion the following parameters influencing the animals during transport and their consequences have to be considered.

Welfare of animals during and after transport is influenced by both exogenic and endogenic factors. Exogenic factors tend to be physical eg temperature extremes, vibration, noise, crowding, and psychological indisposition due to mixing with unfamiliar animals and smells, hunger, thirst or fatigue. Endogenic factors tend to be anatomical disadvantages eg lack of sweat glands in the skin, small heart-to-bodyweight ratio and stress susceptibility brought about by the malignant hyperthermia syndrome (MHS) genotype (Fischer 1995; Randall *et al* 1995; Warriss 1998). MHS creates a disturbance in the calcium metabolism of the muscle cells and has been traced to a mutation of a calcium-release channel (CRC) in the sarcoplasmic reticulum (SR). The alteration is accompanied by a greater susceptibility to stress. Excitement during loading, transport, unloading and lairage can result in a general breakdown or reduced meat quality eg pale, soft and exudative (PSE) or dark, firm and dry (DFD) meat after slaughter (Fuji *et al* 1991). In a study by Fabrega *et al* (2002) 71% of pigs that died during transport or lairage were MHS positive. Inadequate transport conditions can result in physiological responses like increased blood cortisol and adrenaline, tachycardia, heat production, granulocytosis and lymphocytosis (Bradshaw *et al* 1996; Broom 1996; Warriss 1998). Improper handling of pigs during loading and unloading, rough driving, high stocking density, inadequate ventilation of the transport vehicles; particularly in the summer season, or prolonged fasting should all be prevented as much as possible. The individual reaction of each animal to these alterations depends on their ability to compensate for either or both their general anatomical (eg lack of sweat glands on the body surface, low heart-to-weight ratio) or specific physiological disadvantages (eg MHS). A dysfunction of the circulatory and respiratory system that leads to the death of the animal on the transport vehicle or lairage is the worst consequence (Fischer 1995). Animals that show pathological symptoms during transport and lairage but survive go on to have an increased risk of poor meat quality after slaughter (Guardia *et al* 2004).

Considering the results presented it could be suggested that the reduction in mortality rates from 1999 to 2003, particularly in the summer seasons, is as a consequence of increased attention paid to welfare of animals and general changes to the swine population. The first of these points can be traced to an intensification of regulations regarding animal welfare during slaughter transports, as rules were designed specifically to improve conditions during loading, transport, unloading and lairage as well as increasing the capabilities of animal handlers from stable to slaughterhouse. The second point may have its roots in the reduction of MHS-positive pigs and general improvements in body condition seen in the pig population. Other reasons such as negative meteorological influences can be ruled out as there were no unusually high temperatures or humidity observed in the years from 1999 to 2003 (German Weather Service 2004).

The analysis of the data from the large slaughter company also shows that journey duration is an important factor influencing animal welfare. The results elucidate that very long (8 h) and short transports (1 h) increase mortality rates for animals being transported and that the percentages of pathological findings (eg circulatory problems, fractures) were more of a problem after short journeys (Figure 1). Interestingly, animals transported for short periods died more often in summer. It is generally accepted that long journeys affect animal welfare (Schuette *et al* 1994; Fischer 1995), however, the negative impact of short journeys on animal welfare has also been documented (Leheska *et al* 2003; Guardia *et al* 2004).

During loading most pigs were stressed, resulting in physiological responses like tachycardia, increased blood cortisol and heat production (Bradshaw *et al* 1996; Broom 1996; Warriss 1998). If pigs are transported for only a short period they have less time to recover from loading-dependent excitement. Additional stress during transport and unloading increases the risk of general breakdown. Animals that survived show higher incidences of pathology, particularly circulatory problems and meat quality failures. During longer journeys most animals had time to recover from loading-related excitement. With even longer journeys, though, other factors like vibration, noise, balancing movements, hunger, thirst and high temperatures, especially in the summer months, adversely affect welfare resulting in increased mortality rates (Schuette *et al* 1994; Fischer 1995).

While we should also consider other reasons for this time-related impact on pig welfare eg the genetic component, vehicle design, transport conditions or the weather, it would appear their influence is minimal at best. This is due to the following points. Animals were from differing regions of

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Germany and no clear meteorological differences could be found (German Weather Service 2004). Moreover, the transported pigs were all crossbred, produced by mating F1-sows (German Landrace × Large White) with Piétrain or Hampshire × Piétrain boars. Negative effects of transport vehicles and conditions, especially during the short journeys, could also be excluded; all vehicles were regularly controlled by veterinarians at the slaughterhouse considering eg the stocking density (0.45 to 0.5 m^2 per slaughter pig [100-110 kg live weight]) and vehicles'equipment. Furthermore drivers had to demonstrate a degree of capability and knowledge prior to transport.

In conclusion, the study shows that in recent years the mortality rate of slaughter pigs during transport decreased, especially in summer months. One reason for this is the tightening of transport regulations, in particular those improving vehicle design and the animal-handling skills of those involved loading, transport, unloading and lairage. Another reason was the reduction in the stress susceptibility provoked by the eradication of the MHS genotype and by general improvements in the body condition. The investigation also shows that short (1 h) and very long (8 h) journeys negatively impact upon welfare with regard to mortality. In particular, short journeys lead to more pathological findings during veterinary inspection in the abattoir; ultimately leading to higher incidences of poor meat quality.

Although the intention of the EC regulation 01/2005 on the welfare of animals during transport, which came into practice in January 2007, was the advancement of transport conditions in comparison with the actual EC directives 91/628 and 95/29, a further problem is that only rules about maximal transport duration are defined. The data presented indicate that minimal journeys should also be considered as long since factors such as loading, waiting time on the transport vehicle and unloading will always confer a degree of stress to the transported animals.

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