Prevalence of heart lesions in cattle, pigs, sheep and goats detected during veterinary checks in slaughterhouses with respect to animal welfare

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Abstract

The incidence of heart damage in cattle, pigs, sheep and goats slaughtered in slaughterhouses in the Czech Republic between 2010 and 2021 was monitored. Findings classified as acute, chronic, and parasitic were recorded during postmortem slaughterhouse examination. Significantly the highest incidence of acute heart damage was found in piglets (14.92%) and calves (4.03%) compared to other animal categories. The incidence of chronic heart damage was found to be significantly the highest for piglets (14.13%). Among fattening animals, the prevalence of chronic heart damage was significantly the highest for finisher pigs (8.19%), followed by bulls (1.33%), lambs (0.20%) and kids (0.15%). Among adult animals, the incidence of chronic heart damage was significantly the highest for cows (7.10%) followed by sows (5.21%), does (1.46%) and ewes (0.86%). Parasitic findings were rare in the period under review (< 0.2% for ewes and < 0.03% for the other monitored species and categories). In general, the highest incidence found was for chronic damage, followed by acute damage, and the lowest for parasitic damage, except for sheep, where the incidence of parasitic findings was higher than the incidence of acute findings. Overall, the highest number of pathological findings on the heart was found for piglets (29.06%), followed by calves (10.87%), i.e. culled young. Relatively high numbers of findings were also found for cows (9.84%), finisher pigs (8.43%), and sows (5.80%). For the other monitored species and categories, heart lesions were found in less than 3% of cases. The results provide insights into the overall heart health and welfare of slaughter animals.

Livestock, slaughter inspection, heart lesion, welfare

The heart is an important organ in the animal body. Its health and fitness significantly determine the overall health of the organism and the level of animal welfare (Bettex et al. 2014). Heart disease in slaughter animals is usually associated with acute or chronic inflammation of the lungs and pleura (Carino et al. 1999; Kofer et al. 2001; Buczinski et al. 2010a). Acute or chronic heart disease is most often clinically manifested by increased fatigue, reduced physical fitness, reluctance to move, varying degrees of apathy and possibly respiratory problems (Buczinski et al. 2010b). Disturbances of the heart function can reduce the welfare of animals. Parasitic invasions of the heart are generally not of such a magnitude as to significantly affect cardiac function and thus overall animal health and welfare (Dorny and Praet 2007; Petersen et al. 2018). For cattle and pigs, however, parasitic invasions of the heart have a zoonotic potential in terms of the risk of parasite transmission from the heart muscle to undercooked food and from there to the human gastrointestinal tract, causing human parasitic diseases (Eichenberger et al. 2011; Dorbek-Kolin et al. 2018).

Heart and its health is subject of veterinary examination at the slaughterhouse. When a sufficiently large number of slaughtered animals are observed, the findings can provide insights into the overall heart health of different categories of animals and the welfare of slaughter animals on farms in relation to health of the heart muscle. Nielsen et al. (2015)

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compared the findings recorded at routine meat inspection with those performed at systematic health monitoring in Danish pigs at slaughter and recommended caution when using data from meat inspection for purposes unrelated to the food-safety purposes these data were originally intended for. However, Stärk et al. (2014) found current meat inspection activities to be effective for detecting the majority of animal welfare conditions considered by species.

The aim of the study was to compare the number of heart damage cases detected in slaughterhouses in different species and categories of slaughter cattle, pigs, sheep and goats during postmortem veterinary examination, both generally and in terms of acute, chronic, and parasitic heart damage, in order to determine the potential impact of heart damage on the health status of animals and consequently, on the level of animal welfare. The findings can be used to inform changes in animal farms leading to improved heart health and thus improve the welfare of cattle, pigs, sheep and goats slaughtered in abattoirs (Ninčáková et al. 2022). They can also be used to express the zoonotic risk to humans associated with parasitic invasion on the heart of slaughtered animals.

Materials and Methods

The study compares the incidence of heart damage among different categories of slaughtered animals. The study included the complete set of animals slaughtered in slaughterhouses in the Czech Republic for the period of 2010 to 2021, i.e. 1,348,393 cows; 315,406 heifers; 1,214,298 fattening bulls; 120,238 calves culled from farms; 683,912 sows; 29,628,524 finisher pigs; 152,088 piglets culled from farms; 26,026 ewes; 132,553 lambs; 1,680 does; and 7,690 kids. The numbers of findings on the heart, broken down into acute, chronic, and parasitic findings, were recorded by official veterinarians as part of the postmortem examination of the animals.

Based on the number of heart findings, we calculated the relative number of occurrences of these findings as a proportion of the number of animals slaughtered, expressed as a percentage. We evaluated the most and the least frequent findings on the heart for both acute, chronic, and parasitic damage are for each category of slaughter animals. From the overall numbers of heart lesions, we compared the individual animal categories to determine the one with the highest and the one with the lowest incidence of heart damage, and which categories of slaughtered animals are most likely to suffer heart dysfunction resulting in reduced welfare.

Chi-square test was used to statistically compare the number of findings. A value of $P < 0.05$ was considered to be significant.

Results

The numbers of pathological findings of acute origin in hearts of cattle, pigs, sheep and goats slaughtered in abattoirs are shown in Fig. 1. The results show that the highest numbers of acute heart damage cases were found for piglets culled for poor fitness or health (14.92%). Significantly ($P < 0.05$) lower numbers of acute heart lesions were found in calves (4.03%) and cows (2.72%). In other categories and species, they were less than 1%. No acute heart lesions were found in does and kids.

The numbers of findings of chronic heart damage for slaughtered cattle, pigs, sheep and goats are shown in Fig. 2. The highest number of cases of chronic heart damage were found in piglets (14.13%); these numbers were significantly different from other categories of slaughtered animals. High numbers of chronic heart damage were also found in finisher pigs (8.19%), while the incidence of chronic heart damage was significantly lower in other fattening animals (bulls, lambs, and kids at 1.33%, 0.20%, and 0.15%, respectively). For adult animals (cows, sows, ewes and does), the incidence of chronic heart damage was significantly the highest in cows (7.10%).

The numbers of findings of parasitic heart damage for slaughtered cattle, pigs, ewes and does are shown in Fig. 3. Parasitic findings were very low in the period under review, i.e. less than 0.2% for ewes and less than 0.03% for the other species and categories of animals monitored. No parasitic findings were found for does and kids.

Differences between acute, chronic, and parasitic findings for each animal category were found to be significant, except for the comparison of acute and parasitic findings for does

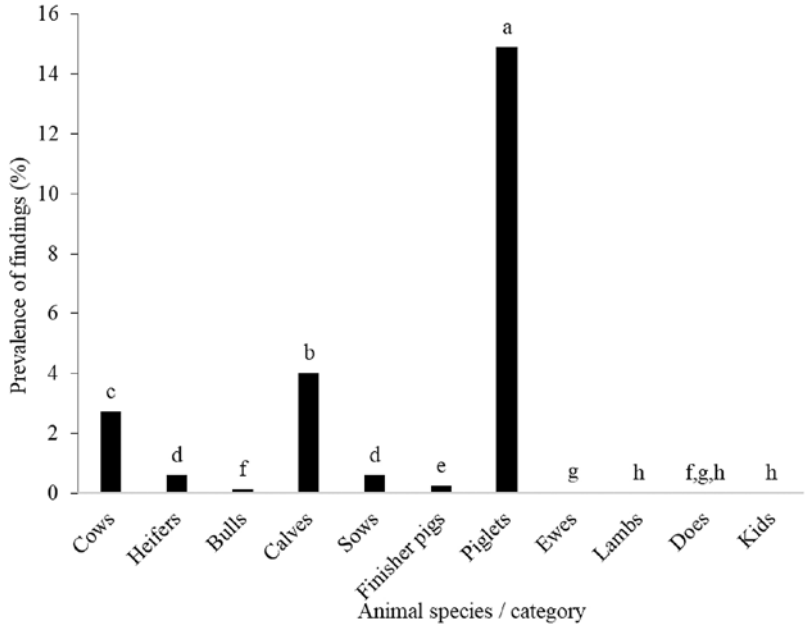

Fig. 1. Prevalence of pathological findings of acute origin in hearts of slaughtered animals.

[a-h] Different letters express a significant difference ($P < 0.05$) between the individual species and categories of animals.

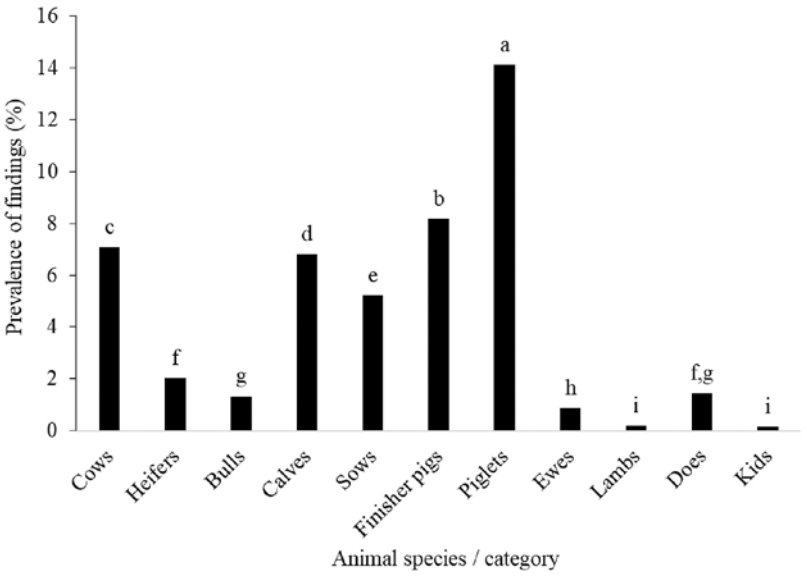

Fig. 2. Prevalence of pathological findings of chronic origin in hearts of slaughtered animals.

[a-i] Different letters express a significant difference ($P < 0.05$) between the individual species and categories of animals.

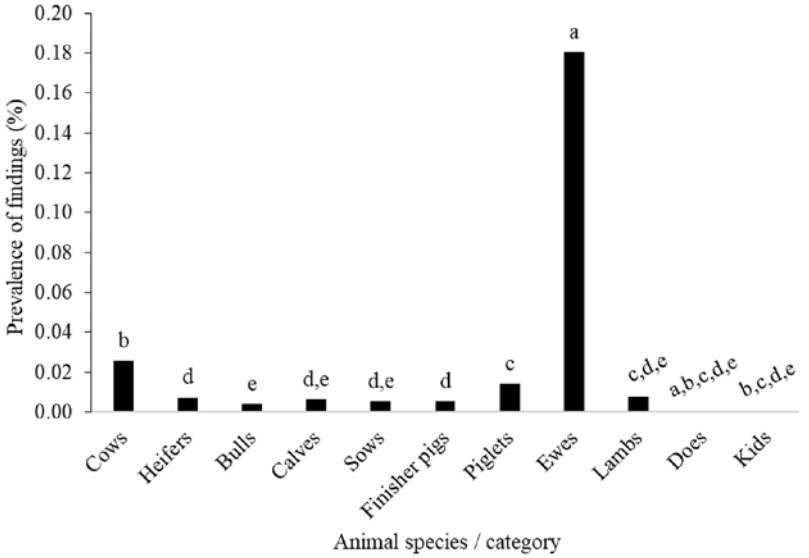

Fig 3. Prevalence of pathological findings of parasitic origin in hearts of slaughtered animals.

[a-e] Different letters express a significant difference ($P < 0.05$) between the individual species and categories of animals.

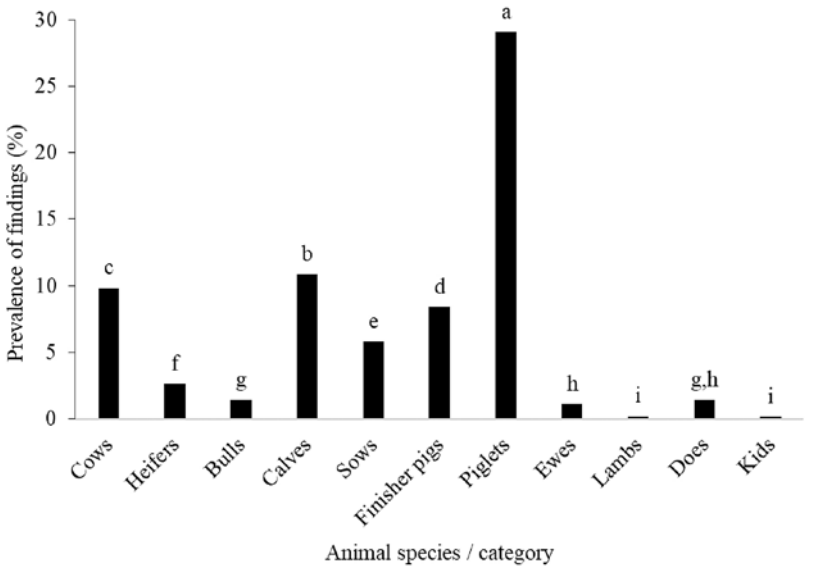

Fig. 4. Overall prevalence of pathological findings in hearts of slaughtered animals.

[a-i] Different letters express a significant difference ($P < 0.05$) between the individual species and categories of animals.

and kids (zero findings) and for lambs, where both acute and parasitic findings were very low.

Comparison of the incidence of chronic, acute and parasitic heart lesions found in slaughterhouses (Figs 1, 2, and 3) shows that the highest level of heart findings for all species and categories of slaughtered animals was for chronic damage, followed by acute damage, with the lowest number of findings for parasitic damage. The only exception were ewes, where the incidence of parasitic damage was higher than the incidence of acute damage.

The numbers of total heart findings for slaughtered cattle, pigs, sheep and goats are shown in Fig. 4. Overall, the highest number of pathological findings on the heart was found in piglets (29.06%), followed by calves (10.87%), i.e. in culled young. Relatively high numbers of findings were also found in cows (9.84%), finisher pigs (8.43%) and sows (5.80%). For the other species and categories of animals studied, heart damage was found in less than 3% of cases. The species and categories of animals studied differed significantly in the number of heart findings except for comparisons between does and ewes ($P = 0.16$), does and bulls ($P = 1.00$), and kids and lambs ($P = 0.26$).

Discussion

Compared to other categories of slaughtered animals, the highest numbers of findings of acute heart damage were found in piglets (14.92%) and calves (4.03%). The finding corresponds to the fact that piglets and calves are culled from farms due to lower levels of overall health, rather poor fitness and growth rates caused by disease processes. Respiratory diseases with subsequent manifestations of lung involvement by acute inflammation (Dutta et al. 2007; Lorenz et al. 2011) are a significant contributor to these disease processes in piglets and calves, which in many cases progress to the pleura and then to the pericardium. This association is also confirmed by comparison of acute lung findings between the different categories of slaughtered animals, with the highest numbers found again in piglets and calves (Válková et al. 2024). Acute inflammatory processes in the pericardium affect cardiac function and lead to varying degrees of circulatory failure in animals; the failures are manifested by reduced animal fitness, fatigue, apathy and reluctance to move, thereby reducing the welfare of affected animals (Buczinski et al. 2010b). Poor condition of calves and piglets culled from the farms was documented also by the highest incidence of acute liver damage (Válková et al. 2023a) and acute kidney damage (Válková et al. 2023b) when comparing the incidence of liver and kidney damage in livestock slaughtered in abattoirs in the Czech Republic.

Piglets culled for poor fitness or health also had the highest number of findings of chronic heart damage (14.13%). Similarly, very high numbers of findings of chronic lung damage were detected by Válková et al. (2024) in calves (34.0%) and piglets (31.3%) culled from farms. In many cases, chronic pneumonia progresses to the pleura, and as pleural inflammation develops, it spreads to the pericardium, leading to pericarditis (Bottacini et al. 2021; Vitali et al. 2021).

Among fattening animals (bulls, finisher pigs, lambs and kids), the incidence of chronic heart damage was significantly the highest for finisher pigs (8.19%), followed by bulls (1.33%), and lower for lambs and kids (0.20% and 0.15%, respectively). Ceccarelli et al. (2018) found the heart to be the second most eliminated organ (10.77%) in pigs slaughtered in Italy from 2010 to 2016, due to pericarditis in 99.8% of cases of seizure of the cardiovascular system. Lesser numbers were found in cattle, the heart was seized in 3.70% of slaughtered animals. Guardone et al. (2020) reported condemnation of hearts in 6.94% of pigs slaughtered in Tuscany, Italy in 2010–2019. The main cause of condemnation for the heart was pericarditis (66.63% of the condemned hearts) and polyserositis (20.88%).

Tăbăran et al. (2018) found the most common pathological finding with a localisation in the heart in cattle slaughtered in Transylvania between November 2016 to September 2017 to be fat atrophy (11%) followed by pericarditis (6%). The incidence of chronic heart damage in our study had the same order from highest to lowest when comparing the categories as the incidence of chronic lung damage in fattened animals reported by Válková et al. (2024), but it was lower for the heart than for the lung. Thus, there is a clear association between the incidence of chronic lung damage findings at a higher frequency level and the incidence of chronic heart damage findings at a lower frequency level. Chronic pericarditis is then detected during postmortem examination of animals as a finding of chronic heart damage (Vitali et al. 2021). Reduced cardiac function due to chronic heart damage causes increased fatigue in animals during locomotor activities and/or respiratory dysfunction, thereby negatively affecting animal welfare (Buczinski et al. 2010b; Correia-Gomes et al. 2017; Buchanan et al. 2023).

For adult animals (cows, sows, ewes and does), the incidence of chronic heart damage was significantly the highest for cows (7.10%), followed by sows (5.21%), and lower for does and ewes (1.46% and 0.86%, respectively). There is also a clear similarity in the order of frequency of chronic heart damage comparing the individual species of adult animals in our study with the order of frequency of chronic lung damage in adult animals reported by Válková et al. (2024). Only the incidence of chronic heart damage is lower than the incidence of chronic lung damage in all categories. As for fattening animals, there is again a clear correlation for adult animals between the frequency of findings of chronic heart damage and chronic lung damage.

Findings of parasitic damage to the heart were very low. With the exception of ewes (0.18%), the prevalence was below 0.03%. No parasitic findings were detected for does and kids during the monitored period. For ewes, the findings involved the developmental stages of tapeworms (*Taenia ovis*) with a frequency of approximately 1 finding per 500 animals. For cows, heifers, bulls and calves, low numbers of findings were recorded at approximately one finding per 12,500 to 20,000 slaughtered animals; however, even these low findings are important as they involved the developmental stages of tapeworms (*Taenia saginata*) with the potential to pose a risk to humans (Dorny and Praet 2007; Geysen et al. 2007). For sows, finisher pigs and piglets, findings were reported in the range of one finding per 9,000 to 16,000 slaughtered animals; even these low numbers of findings are important in terms of the detection of developmental stages of tapeworms (*Taenia solium*) that are dangerous to humans (Gómez-Morales et al. 2017).

The findings are consistent with the fact that some sheep graze on pastures where dogs have access that could be infected with adult tapeworm and their faeces may contain tapeworm eggs. By grazing on them, the sheep may be invaded by developmental stages of the tapeworm which settle in the muscle and also in the heart (Petersen et al. 2018). For cattle and pigs, tapeworm eggs are introduced into livestock by feed that has received tapeworm eggs from a person with an adult tapeworm shedding tapeworm eggs in their faeces; after feeding on such infected feed, cattle and/or pigs are invaded by developing stages of tapeworms which settle in the muscle tissue and also in the heart muscle, where they are found during veterinary examinations of animals in slaughterhouses (Dorny and Praet 2007). For sheep, cattle or pigs, parasitic invasion is usually not so massive as to affect the heart function and, subsequently, the health and welfare of the animals. The importance of *Taenia* is mainly relevant to the meat industry as infestation with intermediate stages of these cestodes leads to important financial losses due to downgrading and condemnation of meat and hearts (Petersen et al. 2018).

Comparison of the incidence of chronic, acute, and parasitic lesions found in slaughterhouses shows that the incidence of heart damage findings for all species and categories of slaughtered animals is the highest for chronic damage, followed by acute

damage, and the lowest for parasitic damage, with ewes being the only exception where the incidence of parasitic findings is higher than the incidence of acute findings. The structure of the incidence of acute and chronic cardiac findings in the comparison of individual categories of animals with each other in our study corresponds in principle to the structure of the incidence of acute and chronic lung findings reported by Válková et al. (2024) and demonstrates a certain interconnection of the incidence of lung and heart diseases in slaughtered animals, i.e. also of lung and cardiac findings detected during inspection at slaughterhouses. Similarly, Bottacini et al. (2021) suggest that pleuritis plays a role in the pathogenesis of pericarditis as documented by the co-existence of pericarditis and pleuritis (73.5% of all pericarditis cases) in their study investigating associations with pulmonary, pleural, and hepatic lesions in pigs slaughtered in Northern Italy over a 12-month period.

Comparison of the order of occurrence of total heart findings found in our study with the order of occurrence of total lung findings reported by Válková et al. (2024) shows that for cattle and pigs the order of occurrence of findings from the highest to the lowest number is identical for both heart and lung damage, only the level of damage occurrence differs in that heart damage occurs at a lower level than lung damage in all categories of cattle and pigs. Associations between respiratory lesions and non-respiratory lesions (e.g. association between enzootic pneumonia and pericarditis, pleurisy, and pericarditis) have been documented also by Sanchez-Vazquez et al. (2012), Teixeira et al. (2016) and Correia-Gomes et al. (2017). The level of parasitic findings on the heart and lungs is low compared to chronic and acute findings in cattle and pigs, and therefore the overall numbers are not much affected by parasitic findings. As a result, the incidence of total findings on the lungs identically models the incidence of total findings on the heart, just at a lower level. However, Nielsen et al. (2015) pointed out that chronic pericarditis may be overlooked at routine meat inspection in the abattoir. In their study, abattoirs using visual meat inspection reported very few cases, despite a high percentage of pericarditis being found by a trained pathologist at the laboratory. Thus, the actual prevalence may be higher.

For sheep and goats, similarity in the order of occurrence of findings from the highest to the lowest number for both heart and lung damage was not found, since the overall lung findings in sheep and goats were influenced by the high number of findings of parasitic origin (Válková et al. 2024), in contrast to the occurrence of findings of parasitic origin on the heart. When comparing the rate of the total heart findings in sheep and goats recorded in our study with the total findings without parasitic damage (i.e. only chronic and acute findings) on the lungs for sheep and goats reported by Válková et al. (2024), the similarity in the order of occurrence of the findings from the highest to the lowest number is obvious.

In conclusion, there was an apparent similarity in the order of total findings excluding parasitic findings (i.e. only chronic and acute findings) between the different categories of slaughtered animals, with the numbers of heart damage findings replicating the numbers of lung damage findings, but at a lower level, as evidenced by the fact that a proportion of chronic and acute pneumonia passes to the pleura and then to the pericardium, thereby causing heart damage in the animals. Heart damage can cause disruption of the heart function, which can lead to reduced mobility, fatigue, reluctance to move, or respiratory problems, and thus a reduced level of welfare of the farm animals.

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