Combined effects of transport distance and season on rabbit mortality during pre-slaughter transport

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Abstract

Transport of rabbits from farms to slaughterhouses represents an essential component of intensive rabbit production. Mortality during transport serves as an important indicator of animal welfare and transport conditions. This study evaluated the effects of transport distance (≤ 50 km, 51–100 km, 101–200 km, 201–300 km, > 300 km), season (spring, summer, autumn, winter), and their interaction on rabbit mortality during transport to slaughterhouses in the Czech Republic from 2017 to 2023. In total, 1,806,815 transported rabbits were assessed. Across all seasons, most rabbits were transported over ≤ 50 km, and the fewest over 51–100 km. Mortality was significantly higher in spring and autumn, while the lowest mortality occurred in winter. The mortality rate generally increased with transport distance, except for the shortest journeys (≤ 50 km), where mortality was higher than for distances between 51 and 300 km. A significant interaction was observed between season and transport distance, with the highest mortality rate (0.556%) recorded during spring transports exceeding 300 km. These findings demonstrate a clear synergistic effect of season and transport distance on rabbit mortality. The results underscore the need to refine species-specific transport requirements and to consider both journey characteristics and seasonal risk when shaping animal welfare policy and commercial transport practices.

Dead on arrival, slaughterhouse, veterinary inspection, welfare

Following both national and European regulations designed to protect animals during transport is mandatory in the Czech Republic when rabbits are transported from farms to slaughterhouses. This legislation specifies requirements for transport conditions, staff training, carrier registration, and other measures aimed at ensuring animal welfare. However, according to Lambertini et al. (2006), current legislation leaves a degree of discretion in its interpretation, particularly regarding rabbits. The absence of species-specific regulations may lead to reduced welfare standards and, consequently, lower production quality.

The dead-on-arrival (DOA) rate is routinely recorded at rabbit slaughterhouses and is considered an important 'iceberg indicator' of animal welfare during transport (Nielsen et al. 2022). Rabbits that die during commercial transport indicate that transport conditions failed to meet adequate welfare requirements. The lower incidence of pathological findings in slaughtered rabbits relative to other meat species may simply reflect that only healthier individuals reach the slaughterhouse, as animals in poorer condition die earlier during rearing or transport (Válková et al. 2021). Thus, rabbits encounter cumulative stress factors from housing to transport, reinforcing the need for comprehensive welfare monitoring (Kadlecová et al. 2024).

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Most studies on rabbit transport have focused on meat quality indicators (e.g. Lambertini et al. 2006; Liste et al. 2006; María et al. 2006, 2008; Mazzone et al. 2010; Składanowska-Baryza et al. 2018; Trocino et al. 2018), whereas only a limited number have examined the impact of transport on animal welfare (e.g. De la Fuente et al. 2004; Trocino et al. 2018; Voslářová et al. 2018; Válková et al. 2022).

In the Czech Republic, slaughter rabbits are typically transported in containers. However, the influence of animal placement within the vehicle on welfare remains unclear. Buil et al. (2004) identified the position of a specific cage as a critical transport factor, while Liste et al. (2006) observed variation in physiological stress indicators related to placement. In contrast, Trocino et al. (2018) did not consider cage position within the transport vehicle to significantly affect rabbit welfare.

Several critical points of transport have been identified, including insufficient driver training, prolonged waiting before loading, the loading process itself, frequency of stops during transport, and unloading procedures at the slaughterhouse (Buil et al. 2004). Environmental factors such as temperature (Buil et al. 2004; Liste et al. 2006), air circulation (Buil et al. 2004; Trocino et al. 2018), and season (María et al. 2006; Liste et al. 2008; Caucci et al. 2018) also play a role. Transport duration is another significant stressor (Liste et al. 2008; María et al. 2008; Caucci et al. 2018) and should be minimized whenever possible (Trocino et al. 2018). The distance between the loading site and slaughterhouse further influences welfare outcomes (Lambertini et al. 2006). Under European conditions, rabbit transport distances are relatively short, typically around 137.5 km (Buil et al. 2004), 160 km (Fazio et al. 2015), or up to 200 km (Válková et al. 2022).

The aim of this study was to assess the combined effects of transport distance and season on rabbit mortality during transport to slaughterhouses in the Czech Republic.

Materials and Methods

The study was based on an analysis of data obtained from the supervisory activities of official veterinarians concerning the transport of animals to slaughterhouses during the period 2017–2023. In total, the transport of 1,806,815 rabbits to slaughterhouses was evaluated.

To assess the synergistic effect of season and transport distance on the number of rabbits that died, were euthanized, or had to be slaughtered during transport, the following categorizations were applied. Seasons were defined as: spring (March, April, and May), summer (June, July, and August), autumn (September, October, and November), and winter (December, January, and February). Transport distances were classified as very short (up to 50 km), short (51–100 km), medium (101–200 km), long (201–300 km) and very long (301 km or more).

For each season and transport distance category, mortality rates of rabbits transported to slaughterhouses were determined. The relative numbers of deaths over the entire study period were compared among seasons to evaluate the effect of season on mortality. Similarly, relative mortality rates were compared among transport distance categories to determine the effect of transport distance. Finally, relative mortality rates were analysed for all combinations of season and transport distance to identify which combination was associated with the highest mortality of rabbits during transport to slaughterhouses.

Statistical analysis was performed by comparing relative frequencies using the chi-squared (χ^2) test, with statistical significance set at $P < 0.05$. All calculations were carried out using Microsoft Excel (Microsoft Office Professional Plus 2019; Microsoft Corporation, Redmond, WA, USA).

Results

Table 1 presents the numbers of rabbits transported over various distances in different seasons. The lowest number of rabbits was transported in spring over a distance of 51–100 km (653 rabbits), while the highest number was recorded in autumn over a distance of ≤ 50 km (371,532 rabbits). In all seasons, the largest number of animals were transported over the shortest distance category (≤ 50 km), whereas the fewest rabbits were transported over 51–100 km.

Table 1. Number of rabbits transported by season and distance.

Season	Transport distance				
	≤ 50 km	51–100 km	101–200 km	201–300 km	> 300 km
Spring	357,716	653	6,719	61,198	19,949
Summer	328,236	1,225	8,372	72,309	29,423
Autumn	371,532	1,122	4,371	68,956	27,607
Winter	344,550	926	5,739	67,568	28,644

The percentage mortality rate of rabbits in each season is shown in Fig. 1. Significant differences in mortality during transport to slaughterhouses were found among the seasons, with the exception of spring (0.217%) and autumn (0.206%), between which no significant difference was observed. Summer transports were associated with a significantly lower mortality rate (0.188%). The lowest mortality was recorded in winter (0.154%).

Figure 2 shows the percentage mortality of rabbits in relation to transport distance, regardless of season. The highest mortality rate (0.346%) occurred during transports over > 300 km. Shorter transport distances were associated with significantly lower mortality rates. However, the mortality of rabbits transported over ≤ 50 km (0.187%) was significantly higher than that of rabbits transported over 51–100 km (0.026%), 101–200 km (0.123%), and 201–300 km (0.164%).

The combined effect of season and transport distance on rabbit mortality during transport to slaughterhouses is shown in Fig. 3. The highest mortality rate (0.556%) was observed in rabbits transported during spring over a distance of > 300 km.

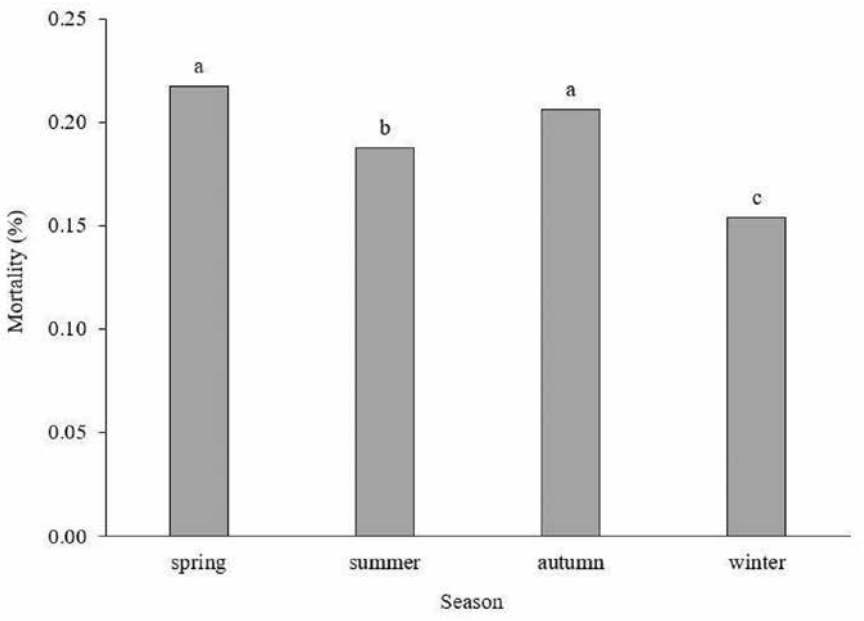

Fig. 1. Rabbit mortality rates by season

[a–c] Different letters above columns indicate significant differences in mortality rates ($P < 0.05$)

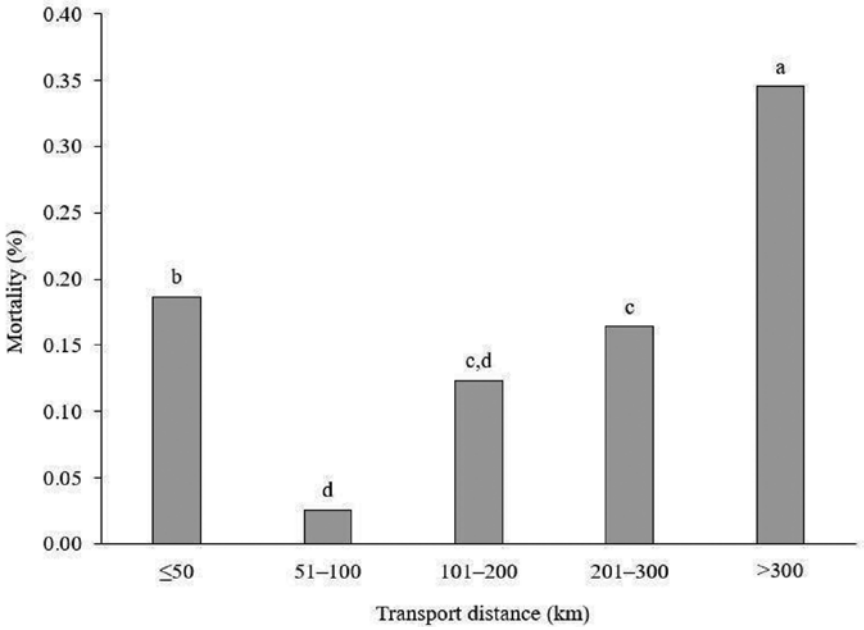

Fig. 2. Rabbit mortality rates by transport distance

[a–d] Different letters above columns indicate significant differences in mortality rates ($P < 0.05$)

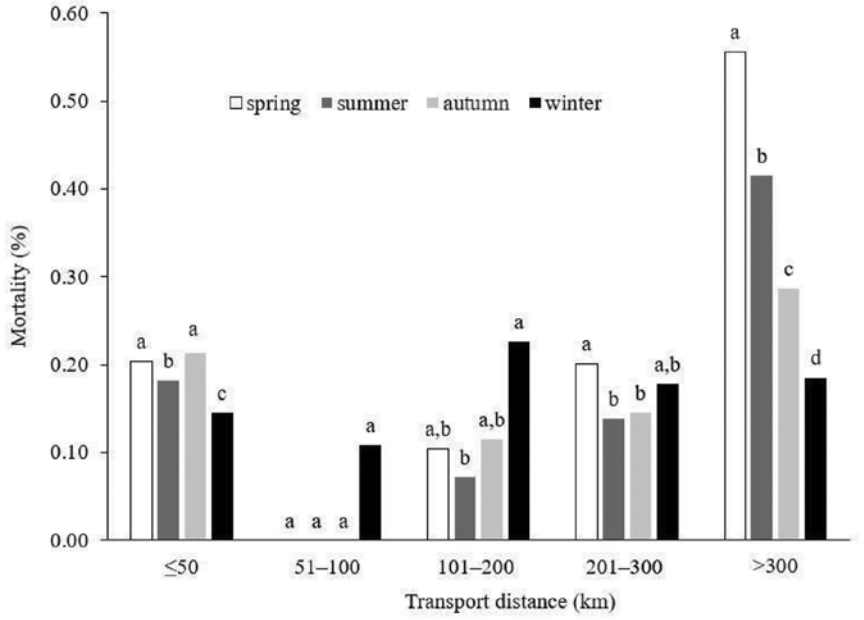

Fig. 3. Comparison of rabbit mortalities across seasons for monitored transport distances

[a–d] Different letters above columns within the same transport distance indicate significant differences in mortality rates ($P < 0.05$)

Discussion

The results of this study demonstrate that season, particularly differences in ambient temperature, has a significant effect on rabbit mortality during transport to slaughterhouses. The highest mortality rates were recorded in spring and autumn, whereas the lowest mortality occurred in winter. Seasonal variation in rabbit health (Ye et al. 2023) may influence their resilience to transport stress. Several factors throughout the year can affect the condition of farmed rabbits. According to Švestková et al. (2024), it is necessary to improve nutritional quality, ensure higher housing standards regarding space and equipment, and strengthen welfare controls on farms.

The increased mortality observed during spring transport may be associated with the onset of higher temperatures. Rabbits are highly susceptible to heat stress (Ebeid et al. 2023), which represents a major welfare concern, especially in spring and summer. From a physiological perspective, rabbits have a limited ability to dissipate heat because they lack functional sweat glands and rely primarily on respiratory evaporation for thermoregulation. Elevated temperatures may therefore lead to rapid dehydration, impaired cardiovascular function, and reduced resilience to additional transport-related stressors. Above their thermal comfort zone, rabbits exhibit compensation behaviours to dissipate heat, such as changing body position, increasing respiratory rate, and salivation. During transport, limited space in containers may restrict their ability to adopt optimal postures, potentially reducing the effectiveness of these thermoregulatory behaviours (Nielsen et al. 2022). Our findings are consistent with those of Caucci et al. (2018), who reported that pre-slaughter mortality is primarily influenced by high ambient temperatures. Similarly, María et al. (2006) characterized the season of transport as a moderate stressor that may act independently of transport duration, with heat having a greater impact than cold (De la Fuente et al. 2007). Contreras-Jodar et al. (2025a) reported that thermal conditions during transport affected the thermophysiological and metabolic responses of fattening rabbits, with effects depending on space allowance and cage height. Adjusting space allowance and cage height in transport containers according to thermal conditions is important to safeguard rabbit welfare during transport (Contreras-Jodar et al. 2025b).

The poorer condition of rabbits in spring may also be related to a higher prevalence of parasitic diseases, particularly coccidiosis. Demeter et al. (2023) reported seasonal variation in the occurrence of *Eimeria* spp. oocysts and *Passalurus ambiguus* eggs in rabbit faeces, with peak intensities in spring for *P. ambiguus* and in summer and autumn for *Eimeria* spp. In addition, diarrhoeal diseases associated with coccidiosis could further weaken rabbits during these periods. Seasonal health challenges, such as increased prevalence of coccidiosis and other parasitic infections in spring, may compromise rabbits' intestinal integrity and immune responsiveness. *Eimeria* spp. inhibit host immune responses (Lu et al. 2021). This reduced resilience can make rabbits more susceptible to transport-related stressors, including handling, vibration, and temperature fluctuations, potentially contributing to the higher mortality observed during spring transports. Conversely, the lowest mortality during winter transport may be attributed to the greater natural resistance of rabbits to cold temperatures (De la Fuente et al. 2007).

Transport distance—and consequently transport duration—also had a significant impact on mortality rates. Mortality increased progressively with distance, from the lowest level at 51–100 km to the highest level beyond 300 km. This finding aligns with Lambertini et al. (2006), who observed that transport time had a negative impact on rabbits, noticeable even after only two hours of travel.

An exception to this trend was the unexpectedly high mortality observed in rabbits transported over very short distances ($\leq$ 50 km). This may be explained by lower

welfare standards applied to short-distance transport. In the Czech Republic, detailed regulations for rabbit transport are lacking (Válková et al. 2022). Council Regulation (EC) No. 1/2005 on the protection of animals during transport and related operations (Council of the European Union 2005) does not apply to journeys shorter than 50 km. Similarly, Act No. 246/1992 Coll., on the protection of animals against cruelty, as amended (Czech Republic 1992), sets only basic requirements for the transport of farm animals up to 50 km. Our results show that the majority of rabbits (77.6%) were transported within this distance category. The absence of specific legal requirements for short transports may therefore explain the relatively higher mortality rate compared to longer journeys. The next most frequent distance categories were 201–300 km (14.9%) and > 300 km (5.8%), indicating that, unlike earlier reports (Buil et al. 2004; Fazio et al. 2015; Válková et al. 2022), rabbit transport distances in the Czech Republic can be considerably longer.

The results further revealed that the combination of very long transport distances (> 300 km) and the spring season had the most detrimental effect on rabbit survival during transport. Although this combination resulted in the highest mortality, similarly high mortality was also observed for long-distance transports during summer and autumn. In contrast, very long transports in winter were relatively safe, with mortality rates comparable to those at shorter distances. These findings correspond with the results of De la Fuente et al. (2007), who reported that rabbits exposed to cold exhibit less pronounced physiological stress responses than those exposed to heat.

Comparable research on the synergistic effects of season and transport distance in other farm animal species has yielded varying outcomes. In laying hens and broiler chickens, the most unfavourable combination—associated with the highest mortality—was winter transport over long distances, whereas in ducks, the greatest mortality occurred during summer long-distance transport. For turkeys, no clear synergistic effect was detected (Justová et al. 2025a). Similarly, Justová et al. (2025b) found a significant interaction between season and transport distance in cows, with the combination of winter and long-distance transport resulting in the highest mortality, but no such interaction in heifers, fattening cattle, or calves. These interspecies differences emphasize the importance of considering species-specific physiological responses when evaluating transport-related stress and mortality.

This study has several limitations that should be considered when interpreting the results. The analysis was based on data routinely recorded at slaughterhouses, which did not include information on transport duration, vehicle design, ventilation efficiency, stocking density, or specific handling procedures. These unmeasured variables are known to influence animal welfare during transport and may have contributed to the observed variability in mortality. Additionally, the study did not account for potential differences in farm management, health status, or pre-transport conditions, which could further affect the resilience of rabbits to transport stress. Future research including more detailed transport- and farm-level variables would help refine the understanding of risk factors associated with rabbit mortality during transport.

In conclusion, this study confirms a synergistic effect of season and transport distance on rabbit mortality during transport to slaughterhouses, with the highest mortality observed during long-distance transports in spring. These findings contribute to a better understanding of the species-specific welfare requirements of rabbits during transport and may help inform improvements in legislation, transport management, and on-farm preparation. Practical measures to reduce mortality risk include optimizing journey planning with respect to seasonal conditions, minimizing transport duration, and implementing stricter loading and handling protocols. Together, these considerations can support higher welfare standards in commercial rabbit production.

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