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The welfare of dogs and cats during transport in Europe: a literature review

Alessandra Tateo^a, Leonardo Nanni Costa^b  and Barbara Padalino^b 

^aDipartimento di Medicina Veterinaria, Università di Bari, Bari, Italy; ^bDipartimento di Scienze e Tecnologie Agro-alimentari, Univeristà di Bologna, Bologna, Italy

ABSTRACT

Commercial activities involving dogs and cats have become increasingly important and contribute significantly to the European economy. One of the most important activities is undoubtedly their translocation for commercial purposes. This is governed by the Council Regulation (EC) No. 1/2005 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. Unfortunately, Regulation EC No. 1/2005 reports only a few specific mentions of companion animals. Since scientific studies on the effects of transport on the welfare of dogs and cats are scarce, much of the available information is in the form of recommendations based on practical experience, rather than evidence-based research. Up to date, the effects of food and water deprivation, the use of some drugs (e.g. sedatives and anxiolytics), or weather impacts on companion animal health and welfare during transport are still a matter of debate. Therefore, the aim of this narrative review is to summarise the European Regulation on dog and cat welfare during transport, suggesting possible implementation, and to document the negative effects of transportation, suggesting how to mitigate them based on scientific evidence. To date, habituation to containers and travelling, particularly using positive reinforcement training, seems to be the most effective strategy to reduce transport stress in these animals. However, still many gaps of knowledge are present and further studies are needed. This review may be useful for all people involved in the companion animal industry.

HIGHLIGHTS

- Pet commercial transportation is a growing reality.
- Pets should be trained to become familiar with containers and journeys.
- More research on the effects of transportation of pets is needed.
- The Regulation EC 1/2005 should be revised using research-based evidence.

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Introduction

The pet industry is growing worldwide. In Europe, it was estimated that there were 89.8 million dogs and 110 million cats in 2020 (FEDIAF 2021). The keeping, breeding, and trade of pets represent a major economic activity with the annual value of cat and dog sales in the European Union (EU) estimated at 1.3 billion euros and generating direct employment of 100,000 people (FEDIAF 2021). It was also calculated that pet food and care (e.g. toilette products, collars, toys) accounted in 2015 for 22 billion euro and a further 2.1 billion euro for pet health products (SANCO 2013/12364 2015). This high revenue may be related to dogs and cats being the most popular companion species in the EU, where they are often considered a

member of the family (Passantino and De Vico 2006). Given their important role within families, societal concern for their welfare is high. According to OIE (2021), animal welfare means the physical and mental state of an animal in relation to the conditions in which it lives and dies, and animals in a good welfare state are those healthy, comfortable, well-nourished, safe, and able to express their natural behaviour, not suffering pain, fear, and distress. Transport is a stressful event for all animal species including dogs and cats, as it represents a variety of stimuli disrupting homeostasis and metabolism in animals and affects their physiological and emotional state (Broom 2000; Bergeron et al. 2002; Gruen et al. 2013; Fazio et al. 2015). In some cases, those stimuli may represent a major

CONTACT Dr Barbara Padalino  barbara.padalino@unibo.it  Dipartimento di Scienze e Tecnologie Agroalimentari, Università di Bologna, Viale Giuseppe Fanin 46, Bologna 40127, Italy

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threat to animal welfare and health, due to the restricted space allowances, prolonged fasting periods, and poorly constructed containers.

Animal welfare during transport within the EU is regulated by Council Regulation (EC) n. 1/2005, which dictates the requirements that must be met during commercial transport of all animals. However, the legislation shows very few references to cats and dogs. Given the lack of scientific guidance, the owner of the pet is responsible for personally ensuring their health and fitness for transport, and must have the correct documentation. Correct means of transport, travel practices, and consideration of ethological characteristics of species (Marahrens et al. 2011) are fundamental to protect animals. Poor rearing conditions, such as early separation from the mother, isolation, and environmental stimulus deprivation, and bad transport experience in the earlier stage of life can affect the proper socialisation of dogs and cats, causing subsequent behavioural problems. The latter will cause severe anxiety and suffering that can lead to insistent barking, over-excitement, phobia, and vomiting at home or during transport and this will be reflected on the adoptive family (Houpt 2018).

Up to date, there is much less information available on the effects of transport conditions on the welfare of dogs and cats than on many other domestic species, particularly farm animals. Furthermore, much of the available information is in the form of recommendations based on practical experience, rather than on controlled experiments. This study consequently critically reviews the few scientific studies documenting the effects of transportation on dogs' and cats' health and welfare and summarises the current European regulation and guidelines, highlighting if those laws are based on scientific evidence or not. The current gaps of knowledge are also highlighted and possible studies are proposed. The present narrative review has been redacted using studies (i) identified by the authors from their knowledge on this topic area; (ii) using 'forward citation chasing' entering the keywords 'travel', 'transport', 'transportation' together with the words 'dog' and/or 'cat' in the web search engine 'Google Scholar' and in Medline database; (iii) using backwards citation chasing by analysing the bibliography of the references found.

Past and present perspectives on animal transport

Animals have increasing importance within the global ecosystem and are the object of attention for many

reasons: social, cultural, economic, and emotional. The production of food, textiles, and companionship are among the main reasons why there is human interest in the different animal species. More recently, animals have also taken on an important role in sports, recreation, and scientific research. Animals are transported between nations for all these reasons and the translocation involved is a significant part of global trade and cultural exchanges. The transport of animals in the past has been reported in many documents but mainly concerned large animals or circus animals, while little is known of the transportation of dogs or cats by common people. Despite the few historiographical sources, we know with certainty that cats and dogs have always followed man during migrations, and travels. Cats were, for example, deployed on merchant ships in the Middle Ages to keep mice away from the goods being transported. Their presence on merchant ships was of such importance that having cats on board was recommended, if not prescribed, in the insurance contracts of the goods (The Editors of Encyclopaedia Britannica 1494). One of the sailors had the task of taking care of cats on board, making sure they did not get sick during the voyage. Furthermore, cats were introduced to Venice for the first time from the Dalmatian islands and then arrived in large quantities from Syria when the plague spread to Venice.

In the eighteenth and nineteenth centuries, animals often accompanied owners to markets, fairs or slaughterhouses, even over long distances. This was the case with large animals such as cattle or horses, but also sheep, goats, and turkeys (Abad 2002) but it cannot be excluded that pets participated in those journeys too. In the twentieth century, new means of transport, such as air transportation, proved to be significantly more convenient for animals. Close commercial and cultural ties between nations and the strong relationships that can be created between people and animals make it likely that the international transport of animals will continue (Schons 2003), and is expected to increase with the growing international mobility of people. Consequently, evolution and improvement of the forms of transport will be necessary. Worldwide experience over a long period shows that animals can travel between countries by modern means of transport without suffering. However, all modes of international transport are potentially dangerous and can be associated with disease, stress, and suffering (Adams 1994).

Transporting small animals by air has become popular over the past 20 years and now around 20,000 dogs and cats leave the UK every year by plane

(Ghandour 2017). However air transport requires additional information and documents, and owners are often concerned about the safety and welfare of their pets during the flight. For example, one of the major pet shipping companies in the EU found owners reluctant to fly their dogs and cats as they fear a lack of health control by competent authorities on animals travelling in plane holds with excess baggage (SANCO 2013/12364 2015). To address owners' concerns, innovative systems are being developed to offer real-time monitoring of pet status during transport (Choi et al. 2011; Gan et al. 2019). However, more studies on the effects of air transport on pet health and welfare are needed. Since planning an air trip still remains under the concept of responsible ownership, pet owners should be educated on best transport practices.

Current legislation on the transport of dogs and cats

The transport of pets is regulated differently if the animals are moved for commercial or non-commercial purposes. When non-commercial movements are performed by car, train, or ferry within the same country, they are subjected to rules concerning the highway code or special provisions issued by railway or ferry transport companies. Concerning public transport, recent studies have found that policies regulating dogs on public transport are highly dependent on the national cultures, and great variability exists among the policies of the different countries (Kent et al. 2020, 2021). Non-commercial transport relies on the owner, public transport policies, and the various highway codes and road safety rules of the EU states, which mostly protect the safety of the owner and do not take into consideration the welfare needs of the transported dogs and cats.

On the other hand, if the transport takes place for commercial reasons, i.e. in order to produce, directly or indirectly, a profit, it falls within the scope of the rules contained in EU Regulation no. 1/2005. This regulation applies to all commercial movements carried out in the European Union and for trade with non-EU countries. This regulation gives specific instructions on how pets must be transported in the different means of transport (vehicle, train, ferry, ship). However, if the transport takes place by plane, either to follow the owner or for commercial purposes, the conditions of transport are dictated by the International Air Transport Association (IATA). Those conditions are applied by the airline companies and

are applied in the EU and non-EU countries during national and international flights.

While no restrictions exist on the number of dogs and cats transported inside the national boards for non-commercial purposes (i.e. for hunting purposes), in the case of travel between the EU countries the number of dogs and cats must be equal to or less than 5, as required by EU Regulation No. 388/2010. If the number is greater than 5, the transport falls within the scope of commercial transport and therefore subject to the rules of Regulation No. 1/2005, unless the owner proves, with a registration document, that the animals will participate in a competition, at an exhibition or sporting event and that their age is over 6 months.

Still, in the context of the transport of pets between EU countries not related to economic activities, it is necessary to consider some obligations for owners in the application of EU Regulation No. 576/2013 which establishes biosecurity conditions. Regardless of the means used to travel, the requirements for the pet dog or cat concern the presence of a microchip or a legible tattoo if applied before 3 July 2011, vaccination against rabies, treatment against tapeworm *Echinococcus multilocularis*, when necessary (not required for dogs travelling directly between Finland, Ireland, Malta, UK, and Norway) and a valid European pet passport.

As previously indicated, the commercial transport of pets is governed by EU Regulation No. 1/2005 and by Regulation 2016/429/EU of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending and repealing Directive 2013/31/EU as far as it concerns the health rules governing trade and imports into the Union of pets.

Regarding Regulation No. 1/2005, the general requirements and some specific rules contained in the annexes must be respected in the transport of pets. The first relates to the organisation of the trip which includes the figure of a driver and attendant able to provide, at any time, information on the planning, execution, and completion of the transport. These operators should also be informed on the possible use of sedatives, on the management of health conditions, the discomfort of animals, and on written provisions regarding, for journeys over 8 hours, the administration of food and water and travel planning in order to reduce the time. Furthermore, Regulation EC 1/2005 reports that road drivers and attendants shall have successfully completed the training and have passed an examination, attesting their knowledge on animal

physiology and in particular water and food needs; animal behaviour and the concept of stress; practical aspects of the handling of animals; the impact of driving behaviour on the animal welfare; emergency care for transported animals; and safety considerations for personnel handling animals.

In the Regulation EC 1/2005, the requirements regarding the fitness for transport (Annexe 5) also apply to pets. The Regulation further specifies when the animals are not allowed to be shipped, because they are not considered 'fit for transport'. Those cases relate to non-ambulatory animals, animals with serious open wounds, with prolapses, and physiological states that create conditions in the animal predisposing them to the harmful effects of transport stress, pregnancies over 90% of the normal period of gestation, birth within 48 hours, or unhealed umbilical cord. In this regard, for dogs and cats, there is a ban on transport if they are less than 8 weeks of age, except when accompanied by their mother (Annexe I, chapter 1, point 2f).

In general, it is the duration of the trip, below or above the 8-hour limit, which differentiates the requirements for the transport of animals, pets included. The general rules provided for in Regulation N.1/2005 impose the obligation for the transporter to have acquired a specific authorisation for the species being transported. This can be Type 1 for journeys lasting up to 8 hours and Type 2 for longer journeys, the latter can be given only to vehicles equipped in compliance with the EC 1/2005, so for instance vehicles with watering systems and sensors to record environmental parameters. Furthermore, in order to obtain a Type 2 authorisation, the transporter must demonstrate that they have vehicles approved by the health authority which verifies their compliance according to the species being transported. For pets, regulation No. 1/2005, in Annexe I, indicates that dogs and cats must be fed at intervals not exceeding 24 hours and watered at intervals not exceeding eight hours. This obliges the carrier to have water available onboard for journeys longer than 8 hours and water and food for journeys longer than 24 hours. The water and food must be of good quality and be presented to the animals in such a way as to minimise the possibility of contamination (Annexe I, Chapter III, point 2.7). In the same annexe, it is reported that the approval of means for the transport of dogs and cats is in any case subject to the presence of clear written instructions on the administration of food and water (Annexe I, Chapter V, point 2.2).

During transport and handling, the containers must always be kept in an upright position, preventing urine and faeces from falling onto the animals placed at the lower level and jolts must be minimised. The containers are fixed in such a way as to prevent them from moving during the movement of the means of transport (Annexe I, Chapter III, point 1.7-a). The indications reported in EC Regulation 1/2005 refer to commercial transport and thus are not valid for non-commercial transport. However, even with regard to commercial transport, the regulation does not report any information regarding the dimensions of the containers used for the transport of dogs and cats, leaving a regulatory gap.

The only suggested dimensions for dogs and cats containers are those reported in IATA regulations, which are valid both for commercial and non-commercial transport (IATA 2022). Those containers must be clearly and visibly marked to indicate the presence of live animals and which is the top of the container; drinkers and food containers must be easily accessible from the outside to allow the administration of water and food and be fixed to the walls of the container; for air transport, the container must be equipped with bar handles on the two side walls to make it safe to carry by hand. They must also have the following characteristics: the maximum size of the individual elements of the ventilation openings must be 25×25 mm to ensure ventilation, the structure of the container door must be strong enough to prevent escape and at the same time guarantee a good view of the interior and the maximum ventilation surface (frame with mesh), the ventilation openings must be on the upper third of the side and the rear walls and the ventilation surface must represent at least 16% of the entire surface of the four walls. The IATA rules provide also the dimensions of the container and the number of subjects it can contain. For the former, the height of the container must be 15 cm greater than that of the dog's head in a natural position, the length of the container must be 15 cm greater than that of the dog calculated from the rhinarium to the base of the tail and the width must be equal to double that of the dog measured between the two shoulder blades. Regarding the maximum number of dogs per container, this varies according to the weight and age of the dog. In particular, dogs over 6 months of age should always be transported in individual containers, as well as those weighing more than 14 kg. Subjects from 8 weeks of life to 6 months, weighing less than 14 kg, can be transported in a maximum number of three per container. When transporting two or three

animals in a group, the height and length that meet the needs of the longest and tallest dog must be considered. The width will be obtained by multiplying the width of the widest dog by 3 if there are two dogs in the container, multiplying by 4 if there are three. However, none of the required dimensions in the IATA regulations refer to scientific evidence.

Furthermore, IATA regulations state that animals between 8 and 12 weeks of age are accepted for air transport only if accompanied by a specific veterinary certificate of suitability for travel, while females with suckling puppies or in heat are not permitted to travel. Listed within the types of animals not allowed for air transport, an addendum to the IATA Live Animals Regulations of 2021 includes 21 brachycephalic dog breeds and 6 brachycephalic cat breeds. Their exclusion is due to deaths involving subjects of these breeds and to the particular structure of their skull, which causes potential respiratory risks. Both the EU and IATA promote the drafting of guidelines for the welfare and transport of dogs and cats, encouraging owners to utilise the information contained in those documents to improve the welfare of their pets.

The European Regulation EC 1/2005 mainly includes information and obligations regarding livestock species, but little information about specific aspects of dog and cat transportation. As reported in Regulation EC 1/2005, specific provisions about dog and cat transportation were not included as the EU planned to include further indications based on European Food Safety Authority opinion (point 9, Regulation EC 1/2005), which has not been published yet. Future legislation shall fill this gap by including specific requirements for the transport of these animal species. The enforcement of current legislation must in particular address transport environmental conditions and the spaces available to dogs and cats in the containers, which are not currently considered.

Although the commercial transport regulation of dogs and cats needs further revisions and additions, it is worth highlighting that the few current rules are often not respected. Compared to other animal species, vehicles carrying dogs and cats for commercial purposes were more likely to be fined for a lack or incompleteness of the veterinary documents and the absence of the mark indicating the presence of live animals on the vehicle during on-road inspections carried out in Italy (Padalino et al. 2020). A major welfare problem during transport is related to illegal trade, which poses several legal, ethical, and health issues to the entire community (Cocchi et al. 2021; Maher and Wyatt, 2021). The movement of livestock (and thus

also dogs and cats for commercial purposes) across the EU Member States is monitored using the Trade Control and Expert System (TRACES), a web-based veterinarian certification tool. Two recent analyses on TRACES in beef cattle and pigs documented several irregularities as TRACES were often inadequately filled in (Dahl-Pedersen and Herskin 2021; Padalino et al. 2021). To date, the scientific literature lacks studies concerning TRACES for dogs and cats transported across EU Member States, and future studies investigating the types of irregularities found during dogs' and cats' commercial transport are highly recommended.

Effect of transport in dogs

Dogs often travel with the owners by car to spend holidays or weekends together, to visit parks or areas specifically dedicated to walking within the city, to visit the vet, for hunting activities, exhibitions, sporting, and breeding. In some cases, travel is a source of stress for the animal and, consequently, discomfort for the family. The most obvious signs of car-related stress are relentless movement, barking or whimpering around people, jumping at windows, salivation, nausea, and vomiting (Doring-Schatzl and Erhard 2004). This has prompted many researchers to take an interest in this problem in order to evaluate the dog's physiological response to transport and to quantify the incidence of stress-related behaviour and identify any non-pharmacological interventions to mitigate the unwanted effects.

Transport, like other stressors, causes a physiological and behavioural response in dogs that causes consistent changes in many blood and salivary parameters and in the heart and respiratory rate. Transport stress activates the hypothalamus–pituitary–adrenal axis, which leads to the release of glucocorticoids and catecholamines, followed by an increase in neutrophils and a decrease in lymphocytes (Chmelíková et al. 2020). In fact, in response to the action of glucocorticoids, circulating lymphocytes adhere to the endothelium of the blood vessel walls and then migrate to other tissues such as lymph nodes, spleen, bone marrow, and skin, where they are sequestered. Furthermore, the release of glucocorticoids and catecholamines promotes, through cytokines, the production of acute-phase proteins (APPs) in hepatocytes, thus increasing their serum levels (Vogel et al. 2019). APPs are a group of proteins produced by the liver as the first defence mechanism, in response to internal or external changes in the body such as inflammation,

infection, trauma, surgery, and stress (Murata et al. 2004). The analysis of heart rate variability also plays an important role in the evaluation of transport stress, considered as an evaluation parameter of the activities belonging to the autonomic nervous system and the balance between sympathetic and parasympathetic activities (Von Borell et al. 2007). For the evaluation of the behavioural response, the ethogram usually includes postures, vocalizations, self-grooming, urination, vomiting, and some activities such as digging or escape attempts (Barnard et al. 2012).

In dogs, a study evaluating stress due to short road transport showed, as the first physiological response, an increase in plasma and salivary cortisol, accompanied by an increase in the neutrophil/leukocyte (N/L) ratio (Beerda et al. 1997). To determine the effect of transport-related stress, Beerda et al. (1997) transported 10 Beagle dogs by car for 50 minutes after which the dogs were introduced to a new environment. Cortisol was analysed in saliva and neutrophils and lymphocytes were counted in blood taken before transport, immediately upon arrival, and 3 hours later, the average salivary cortisol value was found to increase 10 times immediately after arrival compared to the pre-transport value and, after 3 hours, it was significantly reduced. Again, compared to the values prior to transport, the total leukocyte count was significantly increased 3 hours after arrival and was characterised by a significant increase in neutrophils and a non-significant decrease in lymphocytes, which significantly increased the N/L. These results highlight that a short transport lasting 50 minutes is able to induce a relevant increase in salivary cortisol and N/L ratio, which are considered the markers of acute stress in dogs (Palsgaard-Van Lue et al. 2007; Chmelíková et al. 2020).

Radisavljević et al. (2017) investigated the response to an approximate hour-long caged transport of 40 stray female dogs taken from public spaces and housed for 24 hours in unfamiliar environments awaiting sterilisation. The glucose concentration, leukocyte and neutrophil counts, and the N/L ratio were significantly higher after transport compared with the level of the same parameters found in the females after housing in the new environments. For cortisol, cholesterol, triglycerides and lymphocyte counts, there was a tendency to show higher values immediately after transport than the levels recorded 24 hours after accommodation. The authors concluded that the transport itself was more stressful for free-roaming dogs than their housing in the new environment.

Significant changes in cortisol and leukocytes were highlighted by Herbel et al. (2020), in 18 Beagle dogs aged between 1.4 and 3.8 years of age, transported in single cages. None of the dogs had been transported by car at any previous time. The authors found a significant increase in the concentration of cortisol, both blood and salivary, after a series of transports lasting 1 or 2 hours. The increase in cortisol was found equal to twice the basal blood level and eight times the salivary level respectively and remained constant with the repeated transports. The N/L ratio was also found to increase after travel and to exhibit similar increases in all replications.

Fazio et al. (2015) transported ten dogs with previous travel experiences and ten never transported by road, a distance of approximately 230 km and taking about 3 hours. Blood haptoglobin, serum amyloid protein A, C-reactive protein, white blood cells, the reactive oxygen metabolites, the antioxidant barrier, and the thiol groups, which are a significant component of the plasma/serum barrier to oxidation, were measured before the trip, at arrival and after 6 and 24 hours. The trip caused a significant increase in the concentrations of almost all the measured parameters which was maintained up to 6 hours after the end of the transport, after which a decrease was observed. According to the authors, the higher concentrations of biomarkers of the oxidative state observed after transport can be explained by the increase in glucocorticoids and catecholamines induced by the stress response mechanisms previously described. Furthermore, the transport induced a change in the oxidant/antioxidant balance and the endogenous and exogenous antioxidants to counterbalance the oxidative processes and maintain homeostasis.

In addition to short-term road transport, some research has focussed on the effects of prolonged journeys which dogs may undergo, in particular those intended for experimentation or adoption in places far away from their origin. Kuhn et al. (1991) in a 9.5-hour transport of Beagle dogs transported in a commercial vehicle found that plasma levels of cortisol and corticosterone were significantly increased during the journey but returned to their pre-transport levels in the following 12 hours. An increase, but very limited, was also observed in the haematocrit, haemoglobin, erythrocytes, and leukocytes. These findings confirm that the transport leads to physiological responses and suggest that the length of recovery increases according to the journey duration.

Ochi et al. (2016) examined the effects on Beagle dogs, aged between 19 and 46 months, of a 600 km

journey carried out in approximately 22 hours in an air-conditioned vehicle. To prevent vomiting during transport, the animals were fasted, including water, one day before transport. The main serum biochemical parameters were determined on the blood taken before departure, on arrival, and after 7 and 14 days of travel. Upon arrival, an increase in cortisol (+69%) and total bilirubin (+78%) levels were found compared to pre-departure levels, while triglyceride levels were reduced. Their levels returned to normal within a week of being transported. No significant changes were observed in the levels of the other serum parameters examined. The authors paid particular attention to the increase of bilirubin, hypothesising an effect of oxidative stress on its increase, considering that this parameter is a major intravascular product of haem catabolism from red blood cells induced by oxidative stress (Vitek and Ostrow, 2009). Moreover, they highlighted its role as an indicator of transport stress, much like cortisol.

Regarding dogs from stray situations and adopted in some European countries, Buckley (2020) highlighted that these subjects, in particular those from Romania and intended for new owners in the United Kingdom, are subjected to particularly long road trips, including 36 and 42 hours if the destination is a rest kennel, but can reach 96 hours if they are delivered directly to the homes of the new owners. While the effects of such prolonged transport have not yet been studied, upon arrival at kennels or collection points before delivery, dogs should have the possibility to recover from transport stress for 48 hours before moving to their new home (Buckley 2020).

In general, dogs transported for both short and long durations showed increased levels of glucocorticoids and catecholamines. Regardless of the tested length of travel, the scant literature available highlights an increase in cortisol level considered a marker of stress. Some authors identified an increase in total bilirubin and alkaline phosphatase, suggesting that these two parameters can also be used as stress markers. However, the few studies available to date do not allow a clear delineation of the metabolic response to travel stress as the environmental conditions applied were variable among studies, and behavioural parameters were not evaluated. Further studies, in particular on useful animal-based measures to assess the welfare of the transported animals, are therefore needed to provide evidence useful to enhance the current legislation about the transport of dogs and cats.

A different approach to studying the effects of road transport on dogs is to collect information from their owners using a questionnaire. This approach was used by Cannas et al. (2010) who, to assess the frequency of transport anxiety and nausea in transported dogs, interviewed the owners of 151 male and female dogs ranging in age from 6 months to 12 years. The questionnaire, administered at general veterinary clinics, clinics specialising in behavioural problems, private clinics, and to veterinary medical students, requested information on the general condition of the dog, on the behaviour during the journey and on the conditions of transport. The responses suggested that over 40% of participants reported behavioural problems associated with car transport such as panting, restlessness, and vocalisation, and 29% of them reported vomiting during the trip. The high percentage of reports mainly concerned the responses collected from veterinary behavioural clinics and veterinary medicine students. In addition, half of the owners with dogs suffering from transport problems used toys, blankets, or other pets to comfort the animal.

A similar survey to highlight the problems related to transport was carried out by Mariti et al. (2012) on 907 dog owners who had received the questionnaire at 30 Italian veterinary clinics. Over 80% of these stated that subjects had been accustomed to travelling since they were puppies and this may explain the low incidence of responses, equal to 23.8%, relating to subjects with transport-related problems. Almost all owners who reported these problems (96.3%) said they never used drug treatments or other substances to eliminate or mitigate them. In addition, the study found that dogs were more prone to a negative reaction if transported solely to visit the vet. In this questionnaire, the devices used in transport were also examined in detail and the most frequent piece of equipment used was the partition or the net (34.2%), the cage or the pet carrier (22.4%), and the seat belt or leash (15.9%). In addition, during the trip, the owners provided the dogs with a blanket (47.9%), water (27.0%), toys (13.1%), or food (3.5%). Overall, the investigations carried out have highlighted how accustoming dogs to transport from an early age is a practice that greatly reduces the behavioural problems associated with travel in adulthood (Ricci et al. 2017).

While the use of the cage or carrier is very frequent, often no information is available on the correct dimensions that these devices must have. Information to this effect comes from a study carried out by Skånberg et al. (2018) on working dogs that spend a lot of their time in cages placed on service vehicles.

The study tried to answer the question about which cage is considered more comfortable if it is wide, or safer if it is narrow, using eight German Shepherd dogs and eight Springer Spaniel dogs belonging to the Swedish police force. For this purpose, four different cage dimensions were examined using cages that were adaptable or not to the size of the dogs. Two cages had the minimum size allowed according to Swedish regulations and equal to 110% of the animal's length and 250% of its width, a third was slightly smaller and a fourth larger. The trips, without a previous adaptation, lasted 30 minutes and were carried out at normal speed, dealing with curves and speed changes, or at a cruise pace, similar to that of the motorway. During the trips, heart rate was recorded, and behaviour was assessed using an ethogram that included postures, loss of balance, changes in position, and typical signs of stress. Regarding the effects of cage size, less overall movement and effort in body position changes were observed by the dogs in the three smaller cages compared to the largest one probably because the dogs had to curve their backs upwards or lower their rumps to turn around. Additionally, German Shepherd Dogs showed more reinforcement postures, i.e. more attempts to maintain their balance, in the small non-adaptable cage. Overall, smaller sized cages create more difficulties for dogs during travel and have no effect on reducing sliding, losing balance, and hitting the sides of the cage. These results highlighted the need for future research on containers' design to guarantee comfort and safety to the transported dogs.

As previously reported, the air transport of dogs is regulated by the rules of the IATA. Although this type of transport is quite common in some parts of the world, there is little research that has investigated the physiological and behavioural responses of subjects subjected to air travel. Leadon and Mullins (1991) examined the effects of container size used for the air transport of 12 Greyhound dogs between Ireland and the UK. The containers were made of wood with dimensions similar to the starting cages used in races, often criticised for their small size and considered to cause stress for the animal. The study compared the plasma levels of ACTH, cortisol, lactate, and the concentrations of non-esterified fatty acids in dogs transported in either wooden or plastic containers with larger dimensions located both in the main and in the lower compartment of the aircraft. The results showed a large individual variation in the physiological response to flight conditions. The increase in the size of the containers did not lead to changes in the

parameters examined while the most prominent effect was caused by their different arrangement inside the aircraft. This study suggests that responses to air transport may be very subjective, but only 12 animals were used. This study should be repeated on a larger population of dogs of different breeds to give directions to policy-makers about minimum space allowance/container dimension during air transport.

Bergeron et al. (2002) evaluated the physiological and behavioural reactions of 24 Beagle dogs in three different air transportations and during each journey four subjects were sedated with acepromazine maleate and four were not. Blood and saliva samples were collected from the subjects before transportation to the airport by car, before take-off and after landing. In addition, heart rate and behaviour were recorded during air transport. Sedation did not affect any of the measured variables. The average concentration of plasma cortisol was significantly higher after road transport to the airport, while that of salivary cortisol was higher both after road transport and after air transport. Neutrophils have also been observed to increase and lymphocytes to decline both after road and air transport. The average heart rate increased only in correspondence with the loading and unloading into and out of the plane.

More recently, Ochi et al. (2013) examined 59 6-month-old Beagle dogs transported in individual containers from Beijing to Osaka by air on seven different journeys. Of the haematological parameters assessed, only the serum alkaline phosphatase activity increased after transport and then subsequently decreased in the following days. The results, therefore, seem to attribute an important role to alkaline phosphatase in the evaluation of air transport stress.

Effect of transport in cats

Research to evaluate the effects of transport on cats is extremely scarce, despite the common belief that cats suffer particularly from travel experiences. Italian cat owners interviewed reported that cats become extremely stressed when they are handled in order to visit the vet, vocalising frequently, and showing signs of fear, from increased defaecation and urination, to flattened back ears and constricted pupils (Mariti et al. 2017). For this reason, cats are often not taken to veterinary visits regularly, to grooming facilities, or anywhere that requires handling and transport, which can become a problem for their health and well-being (Volk et al. 2011). Recently, Tateo et al. (2021) showed that cats that had not been accustomed to the carrier

and/or to travel by car had a higher frequency of stress-related behaviours (behavioural score) during veterinary visits. However, the study also highlighted that cats that already had experiences of travel and veterinary visits, with negative associations, were the ones that suffered the most and were, therefore, more aggressive. For this reason, a guide supported by images was prepared for educating dog and cat owners on how to train their pets to experience a 'positive' transport, preventing stress and fear (Yin 2009). An interesting aspect, which has already been highlighted in dogs, is the ability of these animals to respond positively to an educational intervention in order to overcome the stress and anxiety that travelling by car can induce. Pratsch et al. (2018) checked the reactions of two groups of 11 cats, one group used for control and the other subjected to positive reinforcements in two repetitions of 10-minute trips to the veterinary clinic. The subjects' reactions to the transport and visits were monitored by means of the Cat Stress Score together with the measurement of the ear temperature. The Cat Stress Score is a non-invasive method to assess short-term physiological stress based on behavioural and postural attributes. The stress level is assigned between score 1 'fully relaxed' and score 7 'terrorised' (Kessler and Turner 1997). The use of positive reinforcement (i.e. a food treat) immediately after the first visit helped to reduce the stress shown by the animals in the second visit as indicated by lowering the temperature of the ears and reducing the time needed to carry out the visit.

For cats used for experimental purposes, Gruen et al. (2013) proposed a conditioning protocol that is aimed at progressively familiarising the cats with the personnel, handling, and movement by the common carriers used for this species. The conditioning process starts with the cat entering the container without coercion and remaining in the container (commonly referred also as the carrier) in the same environment. This simple approach improves the welfare of cats during transportation because it helps the cats to familiarise themselves with the container without adding a second stressor, which usually is the car ride. It should be applied by owners before the real journey and it helps to decrease the stress felt by the cats. They indeed get used to being confined in their carrier, and when travelling there is not the added stressors effect (confinement + transport) (Moberg and Mench 2000). Moreover, since no coercive methods are used to force the cats to enter their containers, it may enhance the cat-owner relationship too.

In the literature, the training methods that favour a positive association with the carrier and travel are the most suggested (Ghandour 2017; Pratsch et al. 2018). In particular, Houpt (2018) suggests accustoming cats to the carrier at home to reduce the cat's stress level prior to when it must be moved in a real situation. Owners should invest some time in training cats, at home, when they are calm so that the carrier becomes a safe place, where the cat finds tranquillity and is always associated with something positive, such as food. In this way, entering the carrier is a behaviour that can bring positive emotions, and when the cat travels, it feels safe, and therefore this is not an additional stressor to the journey, but on the contrary, a calming factor compared to travel stress (Ghandour 2017). Clearly, for the cat, becoming accustomed to car trips, starting with short trips, and ensuring that the trip does not end with a negative experience (such as a veterinary visit with injections), but instead returning home or in any other positive situation, would be the ideal training to conduct. Training cats is possible, and owners should be educated to do this (Mariti et al. 2017). Familiarising cats with the carrier and car travel would not only improve the cats' level of health and well-being, but would also decrease aggressive events, and therefore the injuries that cats could cause to both the owners and to the grooming staff and veterinary clinicians.

When cats have already developed transport-related problem behaviours (TRPBs), the use of drugs may help. Stevens et al. (2016) tested the use of a single dose of trazodone in 10 cats with a history of anxiety during transport and veterinary examination. Cats' signs of anxiety and fear were recorded before the journey, during the journey, and during the veterinary visits using three scoring systems: the cat stress score, the behavioural response score, and the tractability score (Jaeger et al. 2007). Not surprisingly, the cats treated showed a significant decrease in their scores compared with the placebo, and only one owner reported signs of sleepiness. Similarly also a single dose of gabapentin was effective in reducing stress during transportation and veterinary visits in cats with a history of fractious behaviour (Van Haften et al. 2017). However, considering that the use of drugs before travelling may affect the results of some clinical evaluations or limit the access to competitions, in other species, such as horses, retraining for TRPBs is suggested (Yorke et al. 2017). This has not been investigated in cats yet.

When training and re-training are not possible, such as in stray cats, the use of drugs remains a valid

possibility to enhance their welfare. Gabapentin also has indeed been proved to reduce successfully fear responses in cage-trap confined community cats (Pankratz et al. 2018) with minimal adverse effects (i.e. hypersalivation). However, it is important to highlight that during air transport, IATA does not recommend the use of any tranquilising drugs. Consequently, an alternative to training and drugs could be the use of feline pheromone. The results of the effects of them (Feliway; Ceva Santé Animale) are still conflicting though. Pereira et al. (2016) claimed that the use of Feliway spray on the examination table during veterinary examinations improves the welfare of cats by reducing their stress, changing significantly their behaviour without contraindications. The use of Feliway Spray 20 minutes before the cat enters the carrier has been suggested (McConaghy 2013). However, there are still not robust studies on the effectiveness of Feliway sprayed during the journey to minimise transport stress.

A gap of knowledge is also present with regard to the type of carriers and their effects on transport stress in cats. As mentioned before, the EC 1/2005 regulates only commercial transportation of cats and it does not give any indication on the minimal space allowance for cats as for other large animals, and it only refers to the IATA rules for the carriers/containers dimensions. During non-commercial road transportation, cat owners should comply with the traffic law of their own country and take into consideration the duty of care and responsible ownership. So, spending a bit of their time to train their cats to the containers, the car rides, and the veterinary examinations seems to be the best practice to safeguard cat welfare in the prevision of both commercial and non-commercial movements.

Conclusions

This work focussed on the transport of dogs and cats with a particular emphasis on their well-being. To date, dogs and cats can face prolonged journeys to move with their families, for sporting activities, trade or adoption, and other commercial purposes. It is, therefore, necessary that these trips are strictly conducted following evidence-based best practices. To safeguard the welfare of our pets during transport, it is crucial to minimise transport stress. From the literature, it seems to be essential to habituate the animals to the carriers and the journey; loading and transport training with positive reinforcement is strongly recommended. However, since few studies have been

conducted, current legislation regarding container dimensions, duration of transport, and provision of feed and water, is not based on scientific evidence and may need refinement. Further research is required to fully understand the relationships between transport stress, psychological and physiological responses, and risk of transport related behavioural problems in companion animals. Transport stress is caused by a mosaic of stressors and the travelling pets' well-being can be best improved only through a multi-factorial approach.

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ORCID

Leonardo Nanni Costa  <http://orcid.org/0000-0002-5260-7248>

Barbara Padalino  <http://orcid.org/0000-0002-7630-8285>

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