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A tool for the evaluation of slaughter horse welfare during unloading

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Abstract

This study aimed to develop a scientific and practical tool to be used to assess horse welfare after commercial transport over long journeys. A set of physical, behavioural and environmental measures was selected, covering welfare aspects of both transport and unloading procedures. The protocol was field-tested on 51 intra-EU commercial transports arriving at different sites in Italy. Univariate analysis was implemented to look for associations between the input variables (environmental hazards potentially affecting the animal well-being during long transports) and the outcome variables (direct evaluation of the animal condition). No severe welfare impairments were recorded (ie dead on arrival, severe injuries, non-ambulatory animals), while milder ones were more frequent at unloading (eg slipping; 36.7%, reluctance to move; 9.6%). Correlations emerged between ramp slope and falling; type of ramp floor and slipping; fast gait and the presence of gaps between the ramp and the floor. The horses' behaviour was also related to the type of handling procedure used. The measures were repeatable and practical to apply and score during real-time unloading. This work provides a sound basis for a new and practical welfare assessment tool for horses travelling over long journeys. Careful and constant application of this protocol would provide stakeholders with the opportunity to track and monitor changes in the industry over time, as well as to identify high risk areas in transport routines.

Keywords: *animal welfare, long journey, slaughter horse, transport, welfare assessment, welfare indicators*

Introduction

Horse meat consumption, although declining over the last decade, is still significant in several European Union (EU) countries, with a considerable amount of consumption in Italy where nearly 100,000 horses were slaughtered in 2010 (Leadon 2012). Since the national production of slaughter horses is not sufficient to satisfy the market requirements (Mughini Gras *et al* 2011) and there is strong demand for live horses as opposed to carcases (Marlin *et al* 2011), a large number of live horses are transported to Italian slaughterhouses every year. More than 64,000 horses were transported to Italy according to the 2012 annual report on the protection of animals during transport (Italian Ministry of Health 2013), the vast majority of these for slaughtering purposes. Due to the distance between origin (mainly Poland, France and Spain) and market (Italy) these horses are often subject to long journeys (Marlin *et al* 2011). Research by Gebresenbet *et al* (2010) revealed that in 2009 more than 60% of horses transported across the EU were travelling for more than 8 h and about 20% of them for more than 24 h.

Transported horses can be subjected to a wide range of stressors, including isolation, forced close proximity to unfamiliar or aggressive horses, novel or threatening surroundings, exposure to new pathogens, forced adoption of an abnormal posture, extreme temperature and changing climate zones, water and feed deprivation etc, all potentially resulting in health and welfare impairments (Friend 2001). Furthermore, horses may injure themselves before and following transport due to falling on the ramp or whilst climbing it and entering the vehicle (Weeks *et al* 2012).

The Council Regulation (EC) 1/2005 (European Council 2004) on the protection of animals during transport provides for special requirements for all travel lasting more than 8 h ('long journeys'). These requirements aim to minimise possible negative impacts of transport on the welfare of transported animals (Nielsen *et al* 2011). Despite the legislative effort, animal welfare organisations continue to report poor welfare conditions for horses transported across the EU for slaughtering purposes, giving rise to public concern for slaughter horse welfare (Garcés *et al* 2008; Gavinelli *et al* 2008; Nielsen *et al* 2011; Leadon 2012). These conditions were confirmed in a study by Marlin *et al* (2011), who assessed several commercial international transports of slaughter horses to Italy which highlighted several cases of poor welfare among those animals (eg

injuries, unfitness to transport, excoriations). Animal welfare organisations are still striving to obtain a ban on the long-distance transport of horses for slaughter purposes. Such a ban would clearly have negative economic consequences and could produce animal welfare problems. A large number of unwanted animals would result, possibly leading to the creation of extra-EU trade flows, similar to what happened in the USA (Durfee 2009). Therefore, this solution seems to be unattainable (Leadon 2012).

The welfare of horses during transport can be assessed by simple measurements, clinical data and behavioural observation, which may indicate subjective mental state (Broom & Fraser 2007). Welfare science is multi-disciplinary (Fraser 1995) and a variety of methodologies may be applied within disciplines (Broom 1996). Indirect methods of evaluating the welfare of animals are based on measuring the adequacy of input factors, such as the physical environment and resource availability (resource-based measures) and management provision (management-based measures) (Wood *et al* 1998; Bartussek 1999). As reported by Rousing *et al* (2001), these methods indicate the risk of welfare problems rather than provide an actual measure of welfare state. The advantage of such input-based assessment methods is that they are usually objective and repeatable; however, a positive score does not guarantee good welfare (Whay *et al* 2003). Responses to these inputs depend on animal characteristics (eg breed, sex, age) and can be assessed directly, using animal-based measures (EFSA 2012). As reported by Pritchard *et al* (2005), direct observations provide the measure of welfare status that is most relevant to the animal itself (also called outcome measures). Nevertheless, for some aspects, the available animal-based measures are less suitable or less feasible for field application, being too time-consuming or requiring specific equipment or specialist expertise to be collected (Keeling 2009), making the collection of the environmental-related measures necessary.

The development of tools allowing welfare evaluation of horses undergoing long journeys and the identification of the hazards that may have negative consequences for the animals' health and welfare are necessary to improve travel conditions, thus reducing consumers' concerns. Although several studies have investigated the welfare of transported horses, most of these refer to sport horses travelling under different conditions and have their behaviour and physiological responses monitored during the travel (ie Schmidt *et al* 2010). In one study that did investigate slaughter horses (Marlin *et al* 2011), an assessment protocol with 29 variables recorded at the origin, during the journey and at destination was used. The protocol used by Marlin *et al* (2011) seemed to cover most of the relevant welfare aspects. However, the assessment of animals over two different countries would, in practice, incur not inconsiderable costs in terms of labour and economic, thus a protocol assessing the trucks only at their arrival could maximise time and resources.

The present study aimed to develop a comprehensive and feasible method to assess slaughter horse welfare after long journeys on a commercial basis. Prior to the application of the protocol, a short training session was organised to ensure sufficient inter-observer reliability of the selected measures. The developed protocol was applied to 51 intra-EU commercial transports, with Italy as the destination. The applicability of the protocol was assessed during these transports. The collected data provided an overview of transport conditions and an insight into the possible welfare hazards related to long journeys for slaughter horses.

Materials and methods

Protocol development and selection of measures

The following protocol was developed to be applied during commercial transports, meaning that the measures had to be scored in real time, without the need to slow down or interfere with the normal unloading procedures. Since measures could not be recorded during the journey, it was decided to focus on the arrival of the lorry at the destination.

The selection of measures was performed by a group of experts (ie animal welfare and behaviour scientists and veterinary surgeons with experience of working with horses). A review of the available scientific literature concerning both sport and slaughter horse transport was performed and used as a basis for the identification of the measures to be included in the protocol. Questionnaires were developed and sent to national Competent Authorities in charge of enforcing Council Regulation (EC) 1/2005 in several EU member states to investigate which aspects of the transport of livestock (including horses) were most relevant to ensure the welfare of transported animals. The answers concerning horses were taken into account for a further refining of the protocol, together with the provision of the Council Regulation (EC) 1/2005 on the transport of animals (European Council 2004), and the EFSA Scientific Opinion on the welfare of animals during transport (EFSA 2011).

The protocol was inspired by the Welfare Quality® (WQ) project which was developed for cattle, pigs and poultry, and based on its measures for the four WQ welfare principles ('Good feeding', 'Good housing', 'Good health', and 'Appropriate behaviour') and their related criteria (Blokhuis *et al* 2010). Further inspiration was drawn from other welfare assessment protocols, such as the ones developed by Marlin *et al* (2011) during transport and by Visser *et al* (2014) to monitor the welfare of horses in Dutch housing systems.

The assessment was divided into three different phases: before, during and after unloading. When the truck arrived and before the unloading started, the first measures were collected (Phase 1, P1; Table 1). The assessment of horse unloading (Phase 2, P2) started when the doors of the truck were opened and the first animal was led towards the ramp, and ended when the last animal had crossed an imaginary line on the floor 3 m after the end of the ramp (Table 2). After all horses were unloaded, a last group of measures was collected on the empty truck and at the resting pens, 20 min after the end of unloading (Phase 3, P3; Table 3). When scoring the animals in their resting pens, only those housed separately from other consignments (ie other trucks not assessed) were observed.

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Table 1 Measures assessed before the unloading (Phase 1, P1).

Measure	Description
Truck covering	Record the presence of a tarpaulin over the outside of the truck, entirely covering one of the lateral sides
Halters	Record the presence, for all animals older than eight months, of an halter having adequate design and material (ie constructed in a way that guarantees no injury to the animals, rope halters are inadequate) and tied with an adequate rope length (ie the rope should be long enough to allow animals to eat, drink, rest, and keep balance and be designed in such a way as to eliminate any danger of strangulation or injury, and so as to allow animals to be quickly released). The length of the rope is considered between the knot tying it to the truck and the halter
Deck height	Indicate if the height of the deck is adequate to the transported animals (ie 75 cm higher than the withers of the highest animal)
Ramp flooring	Indicate the type of ramp flooring (ie smooth metal, corrugated metal, rubber mat)
Foot battens	Indicate the presence/absence of foot battens on the ramp
Ramp floor condition	Indicate if the ramp floor is adequate (ie intact, not presenting harmful surfaces or slippery areas and if it is well drained)
Ramp covering	Ramp covering prevents light reflection, deadens sounds and reduces the slippery areas. Indicate the type of bedding on the ramp (ie straw, wood-shaving, sand) and the quantity (ie ramp totally covered/partially covered so that it is possible to see the ramp surface/none)
Ramp lateral protection	Indicate if the ramp lateral protections are present and if they present openings or sharp edges
Gaps or steps	Steps and gaps are any height difference or hollow space of more than 10 cm between two surfaces. Indicate the presence of any gap or step potentially endangering or frightening the animals, being between lorry/ramp/floor or lorry door/lateral protection
Ramp slope	Record the height (H) of the ramp 1 m from the terminal projection of the ramp from which the slope can be calculated. If H is more than 36.4 cm, the slope is more than 20°, being non-compliant with the requirements of the Regulation
Blocking zones	Indicate the presence of any blocking zone (ie shadows, holes or physical obstacles) on the ramp
Lighting for orientation	Indicate the presence of adequate lighting (ie sufficient to allow the animals to orientate, and that is not reflecting on the ramp or directly orientated toward the unloading animals)
Lighting for handling	Indicate the presence of adequate lighting (ie allowing the assessor to read the scoring sheet) at unloading for handling purposes
Direction of travel	Record the direction of the horses inside the truck in relation to the direction of the travel (90°, 45°, facing forward or backward)
Adjacent stalls	Record the presence of any stallion adjacent to a mare or to another stallion in the truck

General information on the transport journey itself was also collected from the journey log (eg origin and destination, date and hour of departure, number of animals, type of truck). These data were used to calculate travel duration, distance travelled and to estimate stocking density.

The scoring system involved either counting the events/items (eg number of animals per truck falling during unloading; number of drinkers) or recording the presence or absence of an event (eg handlers slapping/not slapping animals), or score a category (eg cover completely/cover partially/none), or it required taking surface measures (eg ramp slope). All animal-based measures, with the exception of diarrhoea and coughing, were scored at the individual level for descriptive analysis, although proportions at truck level were further derived and used for the statistical analysis. Coughing and diarrhoea were assessed in terms of presence/absence at truck level (ie less than two coughing events/at least two coughing events). All management-based measures (ie handling) were also assessed at group level (truck).

Training of the assessors

Although all of the measures included in the protocol were selected to be straightforward, observer reliability between assessors was tested during training (Whay 2007). Without competent and credible assessors, no certification scheme will function in a way that will satisfy the users (Butterworth 2009). Studies on inter-observer agreement regarding animal-based measures on-farm confirm that satisfactory agreement can be reached through training (Kristensen *et al* 2006; March *et al* 2007; Laister *et al* 2009).

Video and photographic material was collected in the field and used as training material that was scored by experts whose scores were used as a reference for comparison with those scores given by the assessors. Three assessors (having veterinary or animal science background) were trained on a two-day course. The course included theoretical instruction, followed by an observer reliability study (exam based on photo and video clips). The training course was completed with a field exercise which involved assessing two trucks unloading horses at a slaughterhouse.

Table 2 Measures assessed during unloading (Phase 2, P2).

Measure	Description
Duration of unloading	Record the time when unloading starts and when it is completed
Dead on arrival	Record the number of animals found dead in the truck on arrival
Non-ambulatory (downer)*	Record the number of animals that cannot rise or are unable to stand or walk unaided
Reluctance to move*	Record the number of animals per truck that are showing unwillingness to go forward (not caused by physical problems) or suddenly stopping just before the beginning or during the unloading for at least 3 s
Severe lameness*	Record the number of animals per truck that are showing reduced ability to use one or more limbs in a normal manner. Score only severe lameness (ie reluctance to bear weight on one foot)
Slipping**	Record the number of animals per truck that are showing a loss of balance during unloading, without a non-limbic part of the body touching the ground
Falling**	Record the number of animals per truck that are showing a loss of balance during unloading causing any part of the body (other than hooves) to touch the ground
Fast gait	Record the number of animals per truck that gallop or jump approaching the ramp, on the ramp and/or within 3 m after the point where the ramp touches the ground
Body Condition Score	Record the number of animals per truck that are presenting poor (0–1) or too high (5) BCS, according to scoring technique by Carrol and Huntington (1988)
Sweating	Record the number of animals per truck that are presenting visible signs of sweating (ie wet animals, dried sweat spots, salt deposits)
Severe injuries	Record the number of animals per truck that have wounds through the skin which involve damage to deeper tissue (ie muscles, tendons), a cut through the skin so big that it would normally be stitched or with extensive and serious injuries that may cause loss of function over a long period of time (eg serious damage to a tendon or joint, fracture). Scoring technique for severe injuries adapted from Jørgensen *et al* (2009)
Coughing***	Record the presence of coughing events. Coughing is defined as a sudden and noisy expulsion of air from the lungs. Record if more or less than one coughing events occur during the whole unloading phase
Handler moving excitedly***	Assess whether or not the handler is moving the animals excitedly (ie rapid movements of arms or body that could induce fear reactions in the animals)
Handler making loud noises***	Assess whether or not the handler is making loud noises to induce the animals to move, potentially inducing fear reactions (ie banging on the truck wall/metal partitions, shouting)
Handler slapping***	Assess whether or not the handler is slapping the animal without reasons (eg the animal is already moving) or to make them move when they are not in the condition to do it
Appropriate handling***	Assess whether or not the handler gives the horses the opportunity to slow down and inspect start of the ramp and if the handler is able to control the speed of movement
Handler performing forbidden practice***	Assess whether or not the handler is performing forbidden practices, according to Regulation EC 1/2005: • strike or kick the animals; • press sensible areas to cause unnecessary pain; • suspend the animals by mechanical means; • lift or drag the animals by the head, ears, legs or tail or handle them in such a way as to cause them unnecessary pain or suffering; • use prods or other implements with pointed ends; and • knowingly obstruct any animal which is being driven or led through any part where animals are handled

* 'Non-ambulatory', 'reluctance to move' and 'severe lameness' are mutually exclusive.
** 'Slipping' and 'falling' are mutually exclusive.
*** Measures assessed at group level (where group is defined as the total number of horses unloaded from one deck of the truck).

To guarantee satisfactory agreement between observers, accuracy (agreement of the observer with the reference score) and inter-observer reliability were assessed during the final exam. This exam consisted of showing a number of videos and pictures to the observers, who were then asked to score the selected measures. To evaluate how accurate each assessor was compared to the reference score, a weighted Kappa value was calculated (Cohen 1968). Whereas to evaluate the inter-observer reliability, Fleiss' Kappa index of agreement between raters was computed (Fleiss 1971). Agreement levels were indicated for Kappa values according to Landis and Kock (1977) as follows: 0.00, no agreement; 0.01–0.20, slight agreement; 0.21–0.40, fair agreement; 0.41–0.60, moderate agreement; 0.61–0.80, substantial agreement; and 0.81–0.99, almost perfect agreement; 1, perfect agreement. For all analyses, a *z*-score was calculated and a *P*-value was given indicating whether agreement was more than could be expected by chance alone ($\alpha = 0.016$, applying Bonferroni correction).

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Table 3 Measures assessed during unloading (Phase 2, P2).

Measure	Description
Sharp edges in the truck	Indicate the presence/absence of sharp or harmful edges inside the truck
Individual stalls	Indicate the number and adequacy (ie absence of dangerous holes, presence of a higher part at the front part to avoid attack of adjacent horses)
Area per horse	Indicate the space allowance per animals in the truck (ie total deck area minus projection of the area of partitions on the floor)
Truck bedding	Bedding provides a more comfortable resting surface; it helps absorb urine and faeces, and reduces the risk of slipping. Indicate the type of bedding on the truck (ie straw, wood-shaving, sand) and its quantity (ie totally covers the deck/partially covers the deck so that it is possible to see the deck surface/none)
Water supply: drinkers	Indicate the number and type (ie nipples, bowls) of drinkers and if they are functioning
Water supply: tank	Record the amount of water on the truck tank (full/empty/nor full nor empty)
Temperature monitoring and control systems	Record the presence of the temperature monitoring and control system in the truck and if it is functioning
Diarrhoea*	Indicate if there are signs of diarrhoea inside the truck
Dead in pen**	Record the number of animals found dead in the resting pen
Hampered respiration**	Record the number of animals presenting dyspnoea: respiration is deep and overtly difficult. Expiration is supported by the muscles of the trunk, mostly accompanied by pronounced sound. Breathing rate may only slightly be increased
Exhaustion**	Record the number of animals showing severe fatigue or exhaustion (eg chin or limbs resting at partitions or troughs, closed eyes, high drive to rest in recumbent position)
Abdominal discomfort**	Record the number of animal showing signs of abdominal discomfort (eg colitis)
Increased respiratory rate**	Record the number of animals presenting polypnoea: breathing in short gasps carried out with the mouth and with increased frequency
Other severe health problem**	Record the number of animals showing any other clinically severe health problem

* Measures assessed at group level (where group is defined as the total number of horses unloaded from one deck of the truck).
** Measures assessed in the resting pens 20 min after the unloading.

Field assessment

Between November 2012 and March 2013 the welfare assessments of horses travelling over long journeys were performed on 51 trucks having Italy as their final destination. Twenty-five evaluations were carried out by Centro Ricerche Produzioni Animali (CRPA) and twenty-six by the Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise (IZSAM). The assessments took place at unloading of horses, either at control post (intermediate destination) or at slaughterhouses (final destination). All horses were transported for slaughtering purpose. All three of the assessors that participated in the training carried out the assessments. During field activities, assessors were dressed in dark clothes and all observations were performed from positions allowing a good view of unloading procedures but without interfering with both the animal and the handlers' movements. Horses were unloaded one at the time, leading them with the halter; in some cases, young animals were not haltered and directed only using voice and gestures.

Statistical analysis

Data management

A descriptive exploratory analysis was carried out to summarise the main characteristics of the assessment performed. Some of the animal-based measures were indicators of the travel conditions and its impact on the animals (eg death, non-ambulatory animals) whilst others were measuring the quality of the unloading procedures (eg slipping, falling on the ramp). Similarly, truck and handling measures could be categorised as factors affecting either the travel (eg deck height, type of coverage on the truck) or the unloading (eg ramp slope, blocking zones) and were therefore associated with the animal-based measures of one group or the other. Univariate analysis was performed to look for associations between the outcome and the input variables. This analysis may help to identify potential risk factors affecting animal health or welfare, and is performed in most epidemiolog-

ical studies (eg Cole *et al* 2005; Robinson *et al* 2006). However, it should be noted that epidemiological research allows associations to be identified between clinical measures and potential risk factors, and such associations do not necessarily refer to causal relationships.

Travel conditions

The prevalence of most outcome measures included in this category was close to zero (severe injuries, dead on arrival, downer, severe lameness, coughing). Statistical analysis for this section was therefore not possible.

Unloading conditions

The percentage of horses per truck slipping, falling or showing reluctance to move or having a fast gait was correlated to the travelled hours and to the ramp slope using Spearman correlation test. *P*-level was set at 0.006 applying Bonferroni correction for eight comparisons.

Wilcoxon test was used to evaluate if the presence/absence of inappropriate management procedures and if the presence of gaps around the ramp, lateral protections, blocking zones, slipping areas on the ramp, ramp flooring and adequate lighting was correlated to the behaviour of horses during unloading (slipping, falling, showing reluctance to move or fast gait). Finally, the association of the quantity of ramp covering was with these behaviours was tested using Kruskal-Wallis test.

All analyses were carried out using R version 2.15.3 software package for Windows 7, and alpha values were set = 0.05 unless otherwise specified.

Results

Training of the assessors

The level of accuracy of each assessor with the reference scores was high, ranging between moderate to perfect agreement (k between 0.52–1.00) for slipping, reluctance to move, injuries, fast gait, and BCS. For the appropriate handling measure the agreement was substantial for two raters and fair for the other one. Nevertheless, in all cases the binomial test was significant, meaning that the agreement was above chance level ($P < 0.01$).

Inter-observer reliability was almost perfect for one measure (reluctance to move, $k = 0.84$), substantial for slipping, fast gait and BCS ($k = 0.61$–0.80), and moderate for injuries and appropriate handling ($k = 0.41$–0.60). Agreement was above chance level for all comparisons.

Field assessments

All of the inspected vehicles were authorised for transport over long journeys, according to Council Regulation (EC) 1/2005. Most of the vehicles were coming from Poland (n = 44), then France (n = 3), Spain (n = 3) and Austria (n = 1). On average, the overall travelled distance between the place of departure and arrival at the site where the assessment took place was 1,379 km. The average duration of transport was 24 h, ranging between a minimum of 12.3 h and a maximum of 62.3 h.

In nine cases (17%) the travel duration exceeded the time limits imposed by Council Regulation (EC) 1/2005. Exceeding of the travel duration limit was more commonly observed at the slaughterhouses (final destination; 28%) as compared to the control post (intermediate destination; 8%). Unusual snowstorms were the cause of the serious delay of two trucks.

The total number of animals unloaded was 926, with an average of 18 animals per truck. Since access to animal passports was not always guaranteed, the estimation of animal age (according to Council Regulation [EC] 1/2005 age classes) was possible for 424 horses. Among them, the majority were adult mares (> 24 months; 58.7%), then young horses (6–24 months; 33.3%), adult stallions (> 24 months; 3.8%), foals (< 6 months; 3.5%) and ponies (0.7%). The assessor recorded whether stallions were kept adjacent to mares or other stallions. This was true for half of the observed trucks. The unloading procedures took, on average, 26 min.

Travel conditions

The prevalence of the recorded measures related to travel conditions is reported in Table 4. In approximately 90% of cases, a tarpaulin was covering one side of the truck at the arrival of the vehicle and was then removed prior to the start of unloading.

Eleven horses over eight months of age were not wearing a halter. Inadequate (eg made of rope) or absence of halter was recorded for 34% of the animals. In addition, 2.6% of the animals were attached with too short ropes during travel. Overall, 58 horses (foals) were transported in groups while all the others were transported in single stalls. Deck height was adequate in all trucks except one, where the height above the withers of the highest horse was less than 75 cm. All the horses housed in single stalls were transported with an orientation of 90° to the direction of travel, with the head toward the right side of the truck. The mean area per horse was 1.64 m^2. Partitions to stall horses individually were present in all inspected trucks but one; 14% of these had a higher portion in the front part. Potentially harmful openings were present in 4% of cases. Bedding quantity in the lorry was sufficient in the vast majority of transports. Straw was the most common bedding material, followed by wood-shavings. The assessors detected presence of sharp edges inside the truck in three transports. Water storage was either completely or partly empty. When drinkers were present they were mainly mobile ones. Temperature monitoring systems were not present on approximately half of the lorries but, when present, they were functioning correctly. Horses were always transported on the same deck.

No animals were found dead, unable to move without assistance or severely injured on arrival, while one animal showed severe lameness. Body Condition Score (BCS) was mostly between 2 and 4, with two horses considered as too poor (0–1) and three considered as too fat/obese (5). Signs of sweating were observed on 11.3% of animals. Diarrhoea was recorded in four transports with coughing in one. On the total number of horses inspected after unloading, in the resting pens, two were found to be severely lame. No signs of hampered respiration, exhaustion, increased respiration rate or abdominal discomfort were recorded.

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Table 4 Prevalence of recorded measures related to travel conditions. In cases of binomial scoring(eg yes/no) only one of the prevalence is provided while if more options were foreseen the scoring for all categories is listed.

Measure	Score	Percentage
Truck covering	Yes	90.0
Halters	Adequate	53.4
Deck height	Adequate	98
Dead on arrival	Number/total assessed	0
Direction of travel	90°	100
Adjacent stalls	Yes	0
Holes in partitions	Yes	3.9
Sharp edges in the truck	Yes	5.9
Individual stalls	Yes	93.7
Truck bedding type	Straw	90.2
Truck bedding type	Wood-shaving	9.8
Truck bedding quantity	Sufficient	82.4
Water supply: drinkers type	Through	9.2
Water supply: drinkers type	Mobile	39.2
Water supply: drinkers type	Absent	51.0
Water supply: drinkers type	Through	9.2
Water supply: tank	Full	0
Water supply: tank	Partially empty	51.0
Water supply: tank	Completely empty	49.0
Temperature monitoring and control systems	Functioning	50.0
Severe lameness	Yes	0.1
Body Condition Score	Poor	0.2
Body Condition Score	Obese	0.3
Sweating	Number/total assessed	11.3
Severe injuries	Number/total assessed	0
Coughing	Truck with coughing	2
Diarrhoea	Truck with signs of diarrhoea	7.8
Dead in resting pen	Number/total assessed	0
Several lame in resting pen	Number/total assessed	0.2
Hampered respiration in resting pen	Number/total assessed	0
Exhaustion in resting pen	Number/total assessed	0
Abdominal discomfort in resting pen	Number/total assessed	0
Increased respiratory rate in resting pen	Number/total assessed	0
Other severe health problem	Number/total assessed	0

Table 5 Prevalence of recorded measures related to unloading conditions. In cases of binomial scoring (eg yes/no) only one of the prevalence is provided while if more options were foreseen the scoring for all categories is listed.

Measure	Score	%
Ramp flooring	Anti-slip corrugated	88.2
Ramp flooring	Rubber mat	9.8
Ramp flooring	Smooth metal	2.0
Ramp floor condition: holes	Yes	3.8
Ramp floor condition: slip areas	Yes	11.8
Ramp floor condition: sharp edges	Yes	5.9
Foot battens	Yes	96
Ramp covering	Total	3.9
Ramp covering	Partial	56.9
Ramp covering	None	39.2
Ramp lateral protection	Yes	76.5
Ramp lateral protection: openings	Yes	23.5
Ramp lateral protection: sharp edges	Yes	9.8
Gaps or steps: truck-ramp	Yes	9.8
Gaps or steps: ramp-lateral protection	Yes	49.0
Gaps or steps: ramp-floor	Yes	19.6
Ramp slope	< 20°	58.0
Blocking zones	Yes	15.7
Lighting for orientation	Adequate	87.0
Lighting for handling	Adequate	83.0
Reluctance to move	Truck with reluctant horses	9.6
Falling	Truck with falling horses	1.2
Fast gait	Truck with horses moving at fast gait	15.2
Slipping	Truck with slipping horses	36.7
Handler moving excitedly	Yes	15.69
Handler making loud noises	Yes	17.65
Handler slapping	Yes	29.41
Appropriate handling	Yes	70.59
Handler performing forbidden practice	Yes	3.92

Unloading conditions

The prevalence of the recorded measures related to unloading conditions is reported in Table 5. Holes, sharp edges, and slipping areas on the ramps were rarely recorded (two, three and six transports, respectively). Ramp coverage with straw was present during unloading in the majority of cases, but only partially covering the ramp in 57% of cases. In 39% of cases, no ramp covering was present. One-fifth of the transports used no lateral protection on the ramp while unloading. Lateral protections, when present, showed dangerous openings on 23.5% of cases and sharp edges on 9.8%. Gaps between the lorry floor and the ramp were observed in 10% of trucks, gaps between truck and lateral protection on half of them and gaps between the end of the ramp and the floor in 20% of cases. In more than half of the trucks the ramp slope was compliant with the EC Regulation, while it was steeper than 20° (maximum recommended height) in the remaining ones. Foot battens were present in almost all cases. On 16% of the unloadings, blocking zones were present on the ground (eg shadows, holes in the ground), possibly delaying the passage of animals. The light was adequate for the animals' orientation and for handling in 87 and 83% of cases, respectively.

Slipping was recorded in 36.7% and reluctance to move on 9.6% of the animals. Fourteen horses fell during unloading and 141 approached the ramp at a fast gait (galloping or jumping). Slipping events differed between ramp floor types. Since 'smooth metal floor' was recorded only once, analysis was carried out comparing 'anti-slip corrugated floor' with 'rubber-mat floor': horses slipped significantly less when the ramp had rubber-mat floor ($W = 208$; $P = 0.002$). A significant positive correlation emerged between falling and ramp slope ($R = 0.39$; $P = 0.005$). A higher percentage of animals showed fast gait (gallop or jump) when there was no gap between the ramp and the floor ($W = 308.5$; $P = 0.014$).

Appropriate handling during unloading was recorded on most transports (70%). Nevertheless, in two transports forbidden practices, as defined by Council Regulation (EC) 1/2005, were performed. Also, handlers were moving excitedly during eight unloadings, making loud noises in nine transports and slapping the animals for no obvious reason in 15 unloadings.

A higher percentage of inappropriate handling (ie moving excitedly [tendency] [$W = 92$; $P = 0.04$]; slapping/hitting [$W = 119.5$; $P = 0.002$]) was recorded when animals showed reluctance to move. In parallel, less reluctance to move was associated to appropriate handling ($W = 389$; $P = 0.003$). Also, a higher percentage of animals showed fast gait when handlers were performing loud noise during unloading procedures (tendency $W = 108.5$; $P = 0.05$).

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Discussion

Welfare assessment of horses, transported on one truck, using the current protocol took, on average, one hour and was found to be feasible and straightforward to perform under commercial conditions. All the assessments were performed with the consent of operators, making the choice of the location for data collection non-randomised. Nevertheless, all consignments arriving at the three participating facilities in the time-frame of the study were inspected. Hence, the data collected are likely to be representative of normal conditions for these three facilities.

Although it would have been interesting to perform evaluations both at departure and arrival to be sure of assessing the effect of the transport itself, the choice of focusing on the point of arrival was taken for several reasons. Firstly, it would have been complicated logistically to assess both departure and arrival, not only at research level, but also in the future application of the protocol, making the hypothesis of its future routine applications during commercial transports more unlikely. Moreover, inspection of the truck at departure may have biased the composition of the horse groups before loading (ie farmers/transporters influenced on truck preparation because of the presence of the assessors) or their travelling conditions.

Training of the assessors

Six outcome measures were evaluated for inter-observer agreement and accuracy with the reference score. Inter-observer agreement was moderate to almost perfect and significantly above the level of chance for all assessed measures. When testing accuracy, one of the observers had moderate and fair values when scoring appropriate handling, fast gait and slipping behaviours. The horses' unloading procedure from the truck is very fast, and experience and practice can play an important role in improving the level of accuracy of the assessors. The trainers assisted the assessors during the two practice field exercises to make sure that they were confident with the protocol. Initially, all outcome measures were meant to be included in the training exercises. However, the very low prevalence of some measures (eg coughing and dead on arrival) recorded during the three transports assessed for the feasibility test, made it impossible to prepare appropriate training material for these measures. Detecting good inter-observer agreement is difficult when the population under investigation is near-homogenous, since the probability of agreeing by chance is very high (Burn *et al* 2009). Nevertheless, these measures were explained in detail with examples and pictures, were considered easy to score, and therefore were included in the protocol in order to understand the prevalence in a larger sample.

Welfare assessment — travel

Travel duration at the time of the assessments was, on average, 24 h, although in some cases it exceeded the time limits imposed by Council Regulation (EC) 1/2005. This limit was infringed fairly regularly, but a number of these were caused by adverse weather conditions. Hence, additional care should be taken when planning transport of horses over long journeys, in order to guarantee compliance with the Council Regulation (EC) 1/2005 on travel times.

Most horses assessed had an acceptable BCS, supporting the idea that the animals were bred for slaughter rather than other purposes and then sent to the abattoir when they became worn-out (eg due to age).

Nearly all inspected trucks had one side covered with a tarpaulin which may have affected ventilation in the truck. Providing some support for this hypothesis, signs of sweating were observed in several horses, despite all assessments being performed during winter. Yet coughing was observed very rarely, indicating that the air quality inside the truck was still acceptable in most cases. On the other hand, since sweating is one of the main causes of dehydration in transported horses (Weeks *et al* 2012), it can be argued that the presence of the tarpaulin might have had serious consequences if used in warmer climatic conditions. This study does not provide evidence about the use of the tarpaulin in other seasons and this requires further investigation.

On arrival, no major welfare issues were observed in any of the 51 trucks with no dead or downers recorded. Injuries as a result of the journey have been reported frequently in horse transports, partly due to fighting between the animals, particularly in the breeding season, when transporting stallions together with other stallions or adult mares (Weeks *et al* 2012). Panic triggered by a loss of balance and insufficient space to adopt a stable position have also been found to result in injuries during transport (Tasker 1990). For our purposes it was important to develop a feasible protocol that would not slow down unloading practices, therefore during unloading only severely injured animals could be recorded easily. In our study, although the transport of stallions adjacent to other stallions or mares was relatively frequent, no severely injured horses were observed. The separation of the horses into single stalls and, in some cases, having partitions presenting a taller portion on the side where the head of the animal was positioned, may have lowered the risk of fights. In addition, the presence of bedding (which provides more grip) on almost all trucks, may have reduced incidence of loss of balance, and subsequent injuries during travel. Severe lameness was recorded in a very low number of animals. This is in contrast to the findings of Marlin *et al* (2011), where 23% of the horses being off-loaded in Italy had at least one acute injury and 10% were severely lame. The low number or absence of severely lame and severely injured animals in the present study may be partly explained by an *a priori* selection of animals being fit for transport. In accordance with the Council Regulation (EC) 1/2005 only severely lame animals could be considered as being not fit for travel at the time of unloading. This contrasts strongly with the findings of Marlin *et al* (2011), in which 37% of the horses being unloaded in Italy were deemed unfit to travel. For the majority of the horses in that study, a lack of fitness to travel was due to clinical signs, such as nasal discharge, sweating, congested mucous membranes and elevated respiratory rate. In the present study, not all of these measures were assessed due to lack of feasibility. Nevertheless, some potential hazards were identified in some trucks (eg sharp edges on truck walls), but they did not seem to have affected horse condition onboard. This may be related to the

presence of head ties for the vast majority of the horses. These are used in order to avoid turning attempts by the horses during transport (Weeks *et al* 2012).

The Council Regulations (EC) 1/2005 requires no unbroken horses to be transported over long journeys. Fitting a halter on horses is considered as a routine handling procedure and the ease of doing so is dependent on preceding handling experiences (Heird *et al* 1986; Mal & McCall 1996). The flight response in horses that have yet to habituate to humans can lead to traumatic injuries (Weeks *et al* 2012). Although, in the present study, all horses that were penned singularly were fitted with halters, whether or not this should be perceived as 'broken' remains undetermined. Moreover, since not all of the group-housed foals wore halters, it may be possible that these foals had not been handled at all prior to loading. For safer practices, and without compromising the horses' welfare, the interpretation of the Council Regulation (EC) 1/2005 regarding 'no unbroken horses should be transported over long journeys' needs further clarification and a reliable method of assessment developed.

Space allowance was compliant with the legal requirements in almost all trucks, with the exception of those transporting group-housed foals. Horses were always loaded onto a single deck, but in one case the height of the truck was insufficient to allow the animals to stand in a natural position. Moreover, where present, the halter and the length of the rope were assessed and not always found to be appropriate for horses in transit. In order to remain upright, horses make certain postural adjustments, adopting a 'bracing' posture (Waran & Cuddeford 1995) that allows them to compensate for the changing accelerative forces imposed by the motion of the vehicle. Loss of balance and subsequent panic has been described where horses were given insufficient space or rope length to adopt the bracing stance (Tasker 1990). When the rope is too short, horses have to maintain their heads in an elevated position, which runs the risk of introducing normal pharyngeal flora into the lower respiratory tract. Raidal *et al* (1995) showed that a break of at least 8 h was required to clear the secretions that accumulated after maintaining an elevated head position for 24 h. When horses have their heads restrained, the restricted head movement can compromise their ability both to balance during travel and avoid respiratory disease (Stull & Rodiek 2002).

Signs of diarrhoea were recorded in a number of the trucks. Nevertheless, scoring the consistency of faeces proved to be difficult when horses had been standing in the stalls and straw was moved during the unloading phase. Therefore, this measure requires further revision in order to be suitable for use in field conditions. One suggestion may be to assess signs of diarrhoea after unloading by assessing the animals' hindquarters.

Hydration of horses during travel, especially during warm seasons, is a major issue. Dehydration is thought to contribute to horses' weight loss during long journeys (Smith *et al* 1996). Horses transported over long distances during hot weather lost 8% of their bodyweight after being transported for 24 h (Friend *et al* 1998) and 8% after being transported for 30 h when the nights were relatively cool (Stull 1999) and 10.3% when transported for 30 h under hot and humid conditions (Friend 2000). However, horses often reject water from unfamiliar sources (Weeks *et al* 2012) and may be reluctant to drink when inside a moving vehicle, since it necessitates them adopting a vulnerable position, such as risking banging into the drinkers with their mouth and lips (McGreevy 2004). Furthermore, providing water in moving trucks may cause floor spillage, making it slippery, thus increasing the risk to horse welfare. Thus, water provision during stops is preferable. In the current study, it was not feasible to reliably monitor water consumption. It is recommended that a reliable tool to monitor water consumption is developed, especially for warmer seasons.

The assessments carried out after unloading in the resting pens, did not highlight any particular issues. This may indicate that the welfare conditions of the horses were adequate, but it is also possible that 20 min is an inadequate amount of time to allow the manifestation of the selected symptoms. On the other hand, it may be necessary to include more detailed behaviour recordings over a longer time-period in the resting pen to assess indicators such as exhaustion. During the present study, this was not investigated further due to time restrictions for the observers at the slaughterhouses after unloading. The results of the present study are, to a degree, in contrast with the findings of Marlin *et al* (2011) in similar studies, where numerous welfare infringements among horses were found. Several factors may have produced these different outcomes. Firstly, the protocol used by Marlin *et al* (2011) included a more detailed scoring system (eg not only severe lameness or injuries, but also mild and moderate injuries, and cuts, bruising, chronic and acute injuries were all separately recorded). Another factor influencing results may be the discrepancy between the countries of origin of the animals in our study and those of Marlin *et al*. In fact, while Poland was the main exporter in both cases (86 and 51%, respectively), relevant differences existed in the prevalence of shipments coming from Romania (0 vs 41%). Marlin *et al* found several Romanian horses presented in poor condition at loading and these appeared to be animals not farmed for slaughter but a mixture of animals bred for different purposes.

Welfare assessment — unloading

Loading and unloading are among the most stressful phases of transport for most species, including horses (Nielsen *et al* 2011). In our study, horses were often observed slipping and, in a few cases, falling on the ramp, subjecting them to risk of injury. Several factors emerged which appeared to influence these events. Specifically, the ramp slope, being steeper than the maximum limits specified in the Council Regulation (EC) 1/2005 in 41% of cases, was positively correlated with falling. The type of ramp flooring was associated with slipping events: the rubber mat reduced slipping events significantly more than the corrugated metal. Although both materials were supposed to be 'anti-slip', the rubber mat is preferable as it buffers the hollow sound of the ramp when used (Weeks *et al* 2012). Finally, no gap is preferable, but may lead to faster gait which is undesirable. Fast gait can be a behavioural reaction to a fearful situation

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(eg unloading from the truck) and can be dangerous for the handler leading the animal down the ramp, and for the horse itself. Despite evidence regarding the role of different types of bedding on the ramp in reducing slipperiness in other species (Garcia & McGlone 2014), no evidence of such an effect emerged from this study.

The attitude and behaviour of handlers toward horses is known to be fundamental, especially during transport events (Weeks *et al* 2012). In fact, in our study, inappropriate handling practices in general were associated with reluctance of the horse to move, whilst the instances of loud noise by the operators was associated with the fast gait events, where animals were likely to be frightened.

Unloading problems may also be related to several other factors, such as unfamiliar surroundings, contact with humans and by horses' unwillingness to go downhill (Broom 2008). Additional time given to horses to inspect the ramp at unloading may help them in coping with the situation.

Animal welfare implications

The welfare of horses travelling on fifty-one commercial long journey travels was assessed during unloading in the Northern part of Italy using a protocol which integrated animal-based measures and resource- and management-based measures. After field-testing, the protocol was shown to be feasible for carrying out assessments under practical conditions, the scoring system was easy to standardise and good reliability was found for several measures. However, several issues emerged that will need to be addressed in future studies to fine-tune this tool. Namely, the current study was performed only during winter, therefore an evaluation of horse transport conditions in warmer climates might yield different results. Furthermore, some measures had very low prevalence in the current study. A larger sample size, including different countries of origin and destination could elucidate whether these measures are widely applicable when assessing the welfare of horses during long transport. Finally, some issues emerged in relation to the appropriateness of some measures (how much a measure is fit for the purpose). In future studies these need to be investigated and fine-tuned in order to obtain and validate a definitive list of measures to be included.

In conclusion, we deem that the protocol developed in this study represents a sound basis for the initiation of a practical and much-needed welfare assessment tool for horses travelling over long journeys. The careful and constant application of the protocol would provide stakeholders with an opportunity to track and monitor changes in the industry over time.

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