



Research

Hauliers' perceptions and attitudes towards farm animal welfare could influence the operational and logistics practices in sheep transport



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ABSTRACT

A survey of Mexico-based sheep hauliers was conducted in order to investigate perceptions and attitudes toward farm animal welfare (FAW) and their influence on operational and logistic practices (OLPs) in sheep transportation. The statistical analysis consisted in the application of 2-factor analyses (OLP and animal welfare attitudes), additionally a cluster analysis; the latter allowed a segmentation of hauliers according to their attitudes and OLP. The factor analysis gave 3 OLP factors: logistic issues, economic losses, and welfare losses. In the case of factor analyses about animal welfare attitudes, we obtained 4 factors: training and regulations, animal needs, welfare improvement, and sensibility. The cluster analysis of this study showed the existence of 3 haulier profiles; these were “efficient and concerned,” “efficient and not concerned,” and “not efficient and concerned.” Our results showed that hauliers' perceptions had a clear influence on the performance of their operative and logistic activities during the sheep transportation. This study highlights the individual hauliers' risk factors which can be considered to improve not only animal welfare but also indicates the need to consider the transportation as a whole because of potential factor combinations and confusions. The attitudes of sheep hauliers toward FAW are a strategic component that requires being considered when hauliers are trained. If it can be shown that modifying hauliers' attitudes leads to improved OLP, then there is an opportunity to develop specific training programs to modify certain haulier's animal welfare attitudes, with a subsequent improvement of sheep welfare.

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Introduction

The improvement of farm animal welfare (FAW) is a joint responsibility and challenge for many stakeholders within the agro-food chain (Verbeke, 2009). In recent years, survey-based research about perceptions and attitudes to FAW of stakeholders of livestock industry has increased (Phillips et al., 2009) but mostly limited to veterinarians (Wu et al., 2015; Ventura et al., 2016), farmers (Kılıç and Bozkurt, 2013; Wilson et al., 2014; Diez et al., 2015; Vanhonacker et al., 2016), retailers (Miranda-de la Lama

et al., 2013), and consumers (Hoeksma et al., 2017; Miranda-de la Lama et al., 2017). The nature of stakeholder's involvement with the livestock industry has been associated with differing attitudes to animal welfare. For example, discord in attitudes toward animal welfare exists in Europe among farmers, who reported satisfactory levels of FAW, and the public, who described the current state of FAW as “problematic” (Vanhonacker et al., 2008). This highlights the importance of understanding and improving the attitudes to the animal welfare of each key stakeholder group within the livestock industry (Sinclair et al., 2017). While on-farm factors, such as housing and husbandry of farm animals are arguable issues for many people, there is an increasing community that is concerned about the treatment of farm animals' postfarm gate, particularly during transportation and preslaughter operations (Hemsworth et al., 2011).

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During transport operations even under favorable conditions, livestock is exposed to a range of potential stressors which may compromise their welfare including increased handling and human contact, driving haulier style, transportation, loading and lairage, unfamiliar environments, food and water deprivation, alterations in weather conditions, and also changes in social structure through separation, mixing, and crowding, and noise and environmental pollutants (Miranda-de la Lama et al., 2014). These stressors will originate a cascade of reactions in the organism, with activation of the nervous sympathetic adrenomedullary system and the hypothalamic–pituitary–adrenocortical axis, causing an increase in levels of catecholamines and glucocorticoids, respectively (Eriksen et al., 2013). Improper preslaughter handling and transportation clearly result in even greater emotional reactivity, morbidity, mortality, live weight losses, meat quality defects, such as shrinking of the carcass, higher pH, dark meat, and damage of the carcass through bruising (Paranhos da Costa et al., 2012). The logistic chain of sheep transport is a strategic activity in the meat sheep industry and includes diverse risk factors such as loading animals at the farm, transport from farm to the abattoir, and unloading of animals at the abattoir (Miranda-de la Lama et al., 2010). Consequently, animal welfare during transport depends greatly on the attitudes and training of handlers and hauliers and on the availability of appropriate facilities. Much has been investigated about stress during transport, but less attention has been paid for identifying and correcting risks factors from the point of view of personal interactions with the animals, partly because they vary widely both nationally and internationally (Marahrens et al., 2011).

Rapid progress toward animal welfare may arise due to stakeholder's initiatives to adopt welfare friendly practices with respect to animal transport (De Witte, 2009). Although hauliers are likely to be interested in making profits and prevent the losses, hauliers are not simply rational profit maximizers and are likely to have emotional reactions to their animals that also influence decision-making (O'Kane et al., 2017). The willingness to change current operating practices throughout the logistic chain will depend upon the hauliers' perception about this issue which is crucial for an improvement in animal welfare (Vimiso et al., 2012). Through a social approach, researchers can capture the social aspects of a phenomenon to improve the understanding of how hauliers perceive the relationships between attitudes and perceptions of hauliers and their impact in operational and logistic practices (OLPs) and the welfare of transported animals (Burnard et al., 2015). The results of this study will help to identify "at-risk" groups of hauliers that can be targeted for training programs on animal welfare, good OLP, and empathy for animals. The study is based on the hypothesis that animal welfare perceptions directly influence the performance and usual OLP of hauliers. Therefore, the purpose of this study was to analyze the perceptions and attitudes of commercial hauliers toward animal welfare and their influence on operational and logistics practices in sheep transport. The second aim of this research was to identify the potential areas for further research, development, and improvements in the worldwide livestock transport sector.

Material and methods

The study was carried out in the municipality of Capulhuac (19°12'N 99°28'W; 2700 masl) in the State of Mexico (central plateau of Mexico). The survey period was from May to September 2016. The slaughter of sheep and their industrialization for meat and by-products in Mexico is concentrated in the center of the country. This focus is mostly motivated by a higher demand for sheep meat in the central plateau of Mexico, Hidalgo, and Mexico City, which are traditional consumers of sheep meat in the form of a traditional dish named "barbacoa." Capulhuac municipality is the largest meat sheep

producer in the country with around 400,000 heads per year slaughtered, and approximately 300 sheep meat retailers operating in the area. There are 350 feedlots, 700 sheep meat processors, and approximately 115 professional hauliers. At this municipality, there are 8 specialized abattoirs, and 60% of the animals are slaughtered in small abattoirs and even at homes. The transported animals come from different origins of the Mexican Republic like the North through long journeys—more than 8 hours (Chihuahua, San Luis Potosi, Zacatecas, Coahuila, and Durango); Northwest–Central Mexico with medium journeys—between 4 and 8 hours (Aguascalientes, Jalisco, Queretaro, and Guanajuato); Central Mexico with short journeys—less than 4 hours (State of Mexico, Morelos, and Michoacan); and Southeast Mexico with long journeys (Guerrero and Oaxaca).

Study description

In the study, a nonprobability sampling method was used following the sampling strategy proposed by Girma et al. (2011). A multistage sampling method was used to identify the farmers' sample. First, the Capulhuac municipality (State of Mexico) was selected purposively because it is the largest meat sheep retailer in the country. Second, this municipality has the Sheep Dealers and Hauliers Association of Capulhuac which is the most representative association of sheep hauliers of the country. Third, respondent hauliers from the association were identified using a systematic random sampling procedure. The sample size was determined based on the project time and the willingness of hauliers to provide information. A face-to-face survey was carried out with 57 male professional hauliers aged between 18 and 62 years (mean = 40, standard deviation = 10.7 years old) because there were no women hauliers in this activity. For this purpose, the members' list of the association was used. The hauliers of this association had participated in previous studies related to the same sector, due to the credibility of the information given. To minimize the bias, we ensure that the participant hauliers did not know the main objectives of the study (Daros et al., 2017). The interested hauliers in the study were informed that: "participation will be voluntary, the information collected will be confidential, and if they finally did not participate or if the participants decided to leave the study, their future employment conditions won't be affected." No financial remuneration was offered to the participants. The participants had a heavy-lorry driving license, and they were working as professional hauliers driving sheep lorries. The interviews were conducted individually at the assembly center, classification center, or haulier offices (working context). In the last 20 years in Mexico, professional hauliers have displaced the occasional livestock lorry drivers, representing 80% of the livestock drivers in the country (J. Martinez, personal communication).

Questionnaire and measurement scales

Before using the final questionnaire, a pilot study was carried out in May 2016 using draft questions and applied to 10 sheep hauliers (these participants were excluded from subsequent analyses), then the results were used for the development of the final questionnaire that contained 2 sections. The first section considered OLPs during transport; the operational part considered the time to unload animals, vehicle load capacity, number of kilometers of the journey, transportation time in a journey, number of inspections carried out during the transport of sheep in a journey, loading time of sheep, transportation cost per sheep, body weight loss of sheep during the journey, percentages of sheep dead, or injured. The logistic chain of sheep transport considered the following questions: origin of the journey (north, northwest center, center and/or Southeast, described previously), vehicle type used (potbelly, lorry of 10 t, lorry of 3.5 t, and/or pick-up), methods used

by hauliers for: minimizing sleepiness, sheep classification during preloading, sheep handling during loading and unloading, aggressive handling (shouting and hit or electric prod use).

The second section regarded perceptions and attitudes toward animal welfare, and the responses were based on 5-point Likert scale (Miranda-de la Lama et al., 2017). Questions in this section included perceptions of hauliers toward animal welfare teaching in schools and whether new animal welfare laws are required to prevent animal abuses during transport operations. The information was obtained by the statement “Do you think that...” and measured with an ordinal scale of 5 points (1 = surely not, 2 = probably not, 3 = it does not matter to me, 4 = probably yes, and 5 = definitely yes). In the same section, the participants were asked about their perception about 5 aspects of animal welfare based on a literature review (animal pain, animal emotion, and animal fear).

Specifications of statistical model

Univariate analyses were carried out on all the variables included in the study to observe their individual behavior and to detect outliers. Two multivariate statistical techniques were used, factor analysis, and cluster analysis. The factor analysis was used to reduce and summarize the information of OLP, hauliers' perceptions, and attitudes toward animal welfare (Likert scale) because the assumptions of linearity and normality in the variables can be obviated; however, this analysis requires 50 observations minimum (Sepúlveda et al., 2010). Unlike other data-reducing techniques such as the nonlinear principal components analysis, which is based on the use of qualitative variables, we opted to use the factor analysis because it is easier to identify the relationships between variables and the components to be retained. However, given the differences that exist among hauliers' OLP and attitudes toward animal welfare, the factor analyses were performed separately between blocks of questions, as conceptually this would be of little validity.

The principal components method was used to extract factors, and the Kaiser–Meyer–Olkin (KM) index and Bartlett's Test of Sphericity were used to measure the correlation between variables. Those variables with a low communality ($h < 0.6$) were not included in the factor analyses because indicated that those variables were not correlated with the new factors. The selected factors were those that presented eigenvalues ≥ 1 . To gain a better understanding of the new factors, an orthogonal rotation (Varimax method) was carried out. The factor scores were estimated by the regression method, and they were consequently saved as new variables to be used in the cluster analysis.

After factor analysis, a cluster analysis was carried out to identify haulier profiles in accordance with their attitudes toward animal welfare and their OLP during transport. The 2-step method was used as the conglomeration method. The distance measurement was the maximum likelihood, using the factors related to attitudes obtained in the previous step, and the number of conglomerates was identified. Once the clusters were defined, they were then characterized based on their orientation toward performance in the logistic chain, sociodemographic variables (studies, age, and lorry type), factors related to attitudes toward animal welfare, and factors related to OLP. Finally, analysis of variance and chi-squared tests (both of bivariate type) were used to identify the significant variables that allowed discrimination among clusters. The SPSS statistical package version 21.0 was used.

Results

Factor analyses

The participants responded to all questions in the questionnaire; thus, there were no missing data on the measured variables of the

Table 1

Sociodemographic characterization of Mexican hauliers included in the study (n = 57)

Haulier	n (%)
Age (years old)	
18–28	7 (12.3)
29–38	16 (28.1)
39–48	20 (35.1)
>48	14 (24.6)
Education level	
Elementary school	11 (19.3)
Junior high school	27 (47.4)
High school	12 (21.1)
Higher education	7 (12.3)
Work status	
Owner	37 (65.0)
Employee	20 (35.0)
Vehicle type	
Potbelly	16 (28.1)
Lorry 10–16 t	23 (40.4)
Lorry 3.5 t	10 (15.8)
Pick-ups	8 (14.0)

study. Table 1 reports the sociodemographic characteristics of the sheep's hauliers. No women were found working as sheep truck drivers. Three factors were extracted that explained 63.5% of the total variance, whereas the KM = 0.682 and the Bartlett's test ($P = 0.001$) suggested a high correlation among variables. The parameters loaded high on the 3 factors (Table 2). The first factor accounted for 26.8% of the total variance and was characterized by 6 out of 10 variables used. The first factor indicated logistic operations during transportation and was labeled as the “logistic issues factor.” The second factor accounted for 22.7% of the total variance and was characterized by 2 out of 10 variables. Since this factor included the body weight losses as a consequence of transportation and transportation cost per animal, it was labeled as the “economic losses factor.” The last factor accounted for 14% of the total variance and was characterized by 2 out of 10 variables (percentages of injured animals and transport mortality). Since this factor included an animal welfare aspect, it was called the “welfare losses factor.”

In the case of factor analyses related to perceptions of hauliers toward attitudes and animal welfare, 4 factors were extracted that explained 71.2% of the total variance, whereas the KM = 0.465 and the Bartlett test ($P = 0.003$) suggested a high correlation among variables (Table 3). The first factor accounted for 19.2% of the total variance and was characterized by 2 out of 8 variables used. This factor was described by hauliers' needs about new laws and training toward animal welfare and was labeled as the “training and

Table 2

Factorial analysis of variables that classify operational and logistics practices of Mexican hauliers (n = 57)

Variables	Factors		
	Logistic issues	Economic losses	Welfare losses
Time to download animals	0.722		
Vehicle load capacity	0.684		
Length of journey (km)	0.679		
Transportation time in a journey	0.672		
Sheep inspections along the journey	0.664		
Loading time of sheep	0.628		
Transportation cost per sheep		0.913	
Body weight loss during transporting sheep		0.873	
Percentage of injured sheep			0.788
Percentage of dead sheep			0.655
Explained variance (%)	26.8	22.7	14.0

Table 3

Factorial analysis of Mexican hauliers of attitudes and perceptions towards farm animal welfare (n = 56)

"Do you think that ...?"	Factors			
	Training and regulations	Animal needs	Welfare improvements	Sensibility
New regulations are required in order to avoid abuses during operations in a journey	0.890			
Hauliers should receive animal welfare training	0.671			
The farm's animals should be able of expressing their natural behavior		0.805		
The animals in the farms should be well fed, properly sheltered, and healthy.		0.783		
The animal welfare should improve in Mexico			0.780	
In Mexico, there is enough information about animal welfare during animal transportation			-0.730	
The animals feel positive or negative emotions during transportation				0.867
The animals feel pain during transportation				0.647
Explained variance (%)	19.2	17.7	17.3	17.0

regulation factor." The second factor accounted for 17.7% of the total variance and was characterized by 2 out of 8 variables. Since this factor included the hauliers' opinion about the importance of animals well fed, well sheltered healthy, and the expression of their natural behavior, it was labeled as the "animal needs factor." The third factor accounted for 17.3% of the total variance and was

characterized by 2 out of 8 variables (necessity of improvements in animal welfare in the country and more information about transport and logistics). Since this factor included an animal welfare aspect, it was called the "welfare improvements factor." Finally, the fourth factor accounted for the remaining 17% of the total variance and was characterized by 2 out of 10 variables (the transported

Table 4

Hauliers' profiles based on OLP, perceptions and attitudes towards animal welfare and sociodemographic features (n = 57)

Variables	Efficient and concerned, E&C (n = 21)	Efficient and not concerned, E&N (n = 26)	Not efficient and concerned, N&C (n = 10)	P value
Factors related to operational and logistic practices				
Factor of logistic issues	-0.662	0.585	-0.132	0.000
Factor of economic losses	-0.485	0.242	0.391	0.016
Factor of injured and mortality	-0.225	-0.217	1.036	0.001
Factors related to perceptions and attitudes toward animal welfare				
Factor of training and regulation ^a	0.513	-0.142	-0.709	0.003
Factor of animal needs ^a	0.583	-0.731	0.676	0.000
Factor of welfare improvements ^a	-0.104	-0.229	0.816	0.013
Factor of sensibility ^a	0.472	-0.033	-0.905	0.001
Age of haulier ^b				
18-28 years	9.5%	11.5%	20.0%	Ns
29-38 years	28.6%	26.9%	30.0%	
39-48 years	38.1%	26.9%	50.0%	
≥48 years	23.8%	34.6%	0.0%	
Academic qualifications ^b				
Basic	23.8%	11.5%	30.0%	Ns
Secondary school	38.1%	50.0%	60.0%	
High school	23.8%	26.9%	0.0%	
University degree	14.3%	11.5%	10.0%	
Work status				
Owner	71.4%	65.4%	50.0%	Ns
Employee	28.6%	34.6%	50.0%	
Common routes from "origin point of animals" to State of Mexico (Capulhuac)				
North (yes) ^b	28.6%	73.1%	60.0%	0.01
West and north central (yes) ^b	47.6%	38.5%	30.0%	Ns
Center (yes) ^b	38.1%	3.8%	10.0%	0.01
South (yes) ^b	9.5%	0.0%	0.0%	Ns
Vehicle type				
Potbelly	4.8%	53.8%	11.1%	0.001
Lorry 10-16 t	38.1%	38.5%	55.6%	
Lorry 3.5 t	28.6%	0.0%	33.3%	
Pick-ups	28.6%	7.7%	0.0%	
Countermeasure for sleepiness				
Cigarettes (yes) ^b	47.6%	84.6%	80.0%	0.017
Energy drinks (yes) ^b	4.8%	7.7%	10.0%	Ns
Soft drinks (yes) ^b	66.7%	88.5%	80.0%	Ns
Coffee (yes) ^b	52.4%	76.9%	90.0%	Ns
Animal-handling procedures during loading and unloading ^b				
Separation or selection of sheep during preloading (yes) ^b	55.0%	92.3%	60.0%	0.011
Shouting	52.4%	53.8%	80.0%	Ns
Physical aggression (by hits or electric prod)	47.6%	46.2%	20.0%	

ANOVA, analysis of variance.

The bold numbers are positive values that indicate that the profile is highly related to the characteristic described by the factor.

Ns = $P \geq 0.05$.^a Corresponds to an ANOVA, and therefore, the values of each cluster for each variable are the mean value.^b Relates to development of a chi-square test, and therefore, the values included for each cluster are percentages.

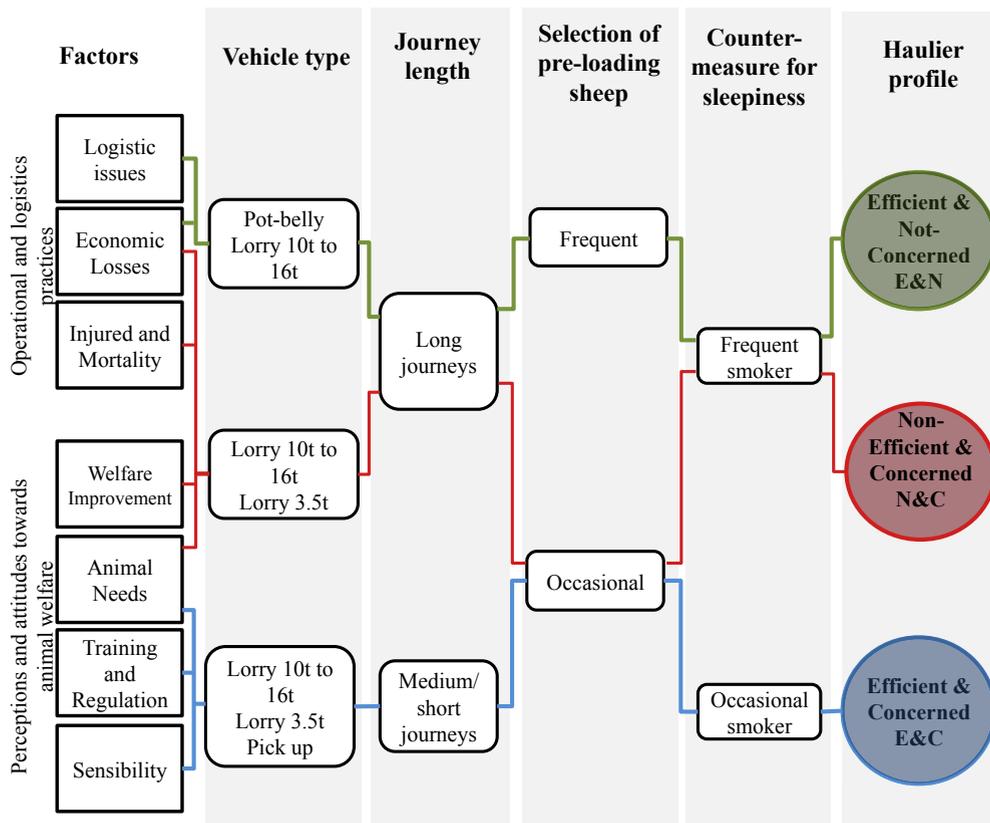


Figure. Simplified illustration of the model flow about hauliers' profiling based on farm animal welfare attitudes and their relation with OLP in Mexico ($n = 57$).

animals feel pain and the transported animals feel positive or negative emotions). Since this factor was recognized by hauliers as animals could feel emotions and pain, it was labeled as the “sensitivity factor.”

Cluster analysis

The cluster analysis suggested the existence of 3 clusters' or hauliers' profiles that explained the association between animal welfare attitudes and OLP (Figure). The 4 factors corresponding to attitudes toward animal welfare showed differences among groups. Given the associations that were found in each cluster and according to the attitudes about FAW and OLP used for each profile (Table 4), cluster 1 was labeled as “efficient and concerned (E&C),” cluster 2 “efficient and not concerned (E&N),” and cluster 3 “not efficient and concerned (N&C).” Most of the respondents (45.6%) were classified in cluster 2 or E&N hauliers, whereas 36.8% were in cluster 1 (E&C) and only 17.5% in cluster 3 (N&C). The E&C hauliers were respondents who had negative values for the 4 factors related to OLP and positive values for 3 out of 4 factors about perceptions toward animal welfare. Their profile included an age between 39 and 48 years old, with secondary school education, they transported animals from West and North Central region to Capulhuac using typically a lorry with 10–16 t capacity and during preloading operations shouted and applied physical aggression to the sheep. The E&N hauliers had high values for the 2 factors related to OLP and negative values in the factor of perceptions toward animal welfare. The E&N included hauliers of more than 48 years old, with secondary studies mainly, they transported animals from the North region of Mexico (long journeys) to Capulhuac using typically a potbelly vehicle, and most of them shouted and applied physical aggression to the sheep during preloading operations. The N&C

hauliers had high values in 2 variables of the factors of OLP (economic losses, injured, and mortality), and in 2 variables of the factors about attitudes and perceptions toward animal welfare (animal needs and welfare improvements); they showed a range from 39 to 48 years old, with secondary studies, transported animals from North region to Capulhuac using typically a lorry with a capacity of 10–16 t, and only half of them shouted to the animals during preloading operations. Finally, there were no significant ($P = 0.051$) differences between the possibility of being an employee or being the owner of the truck.

Discussion

A growing body of research in the last decade has emphasized the role of attitudes of stakeholders of livestock industry on work performance and emotional issues about perceptions referring to farm animal emotions, pain, and suffering (Coleman et al., 2003; Kılıç and Bozkurt, 2013; Burnard et al., 2015; Cardoso et al., 2016; O'Kane et al., 2017). Recently, some studies used the multivariate perspective to understand the role of attitudes and personality on the behavior of farmers and animal welfare (Kielland et al., 2010). Whereby, there is an increasing interest in understanding haulier's attitude with respect to management of the transported livestock. According to our knowledge, this is one of the first studies to analyze the haulier perception and attitude toward animal welfare and their influence on OLP in the animal transport.

Overview

The present study was motivated by the goal of a better understanding of the effects of attitudes and perceptions of the sheep hauliers toward animal welfare during operations and provides an

empirical basis for the logistic chain of sheep transport interventions and design of proper training programs in the context of road livestock transport. In recent years, the demand for meat in Mexico has been grown exponentially due to the population growth (cities with more than 2 million per km²). This has increased the number of transported animals per journey and the distances in a journey; therefore, forcing the sheep hauliers to configure a logistic chain of sheep transport. In this context, FAW in Mexico is attracting the attention from organizations, consumers, policymakers, civil societies, livestock producers, and meat industry for several reasons, ranging from concerns with trade and sustainable production schemes, to the implementation of shared value strategies (Miranda-de la Lama et al., 2017).

The professional livestock hauliers are required to deliver live and healthy animals on time; they are under pressure to drive for long periods and on irregular driving schedules (Asaoka et al., 2012). In this context, hauliers are exposed to long shifts, fatigue, sleep restrictions, postural fatigue, exposure to noise vibration, sedentary lifestyle, unhealthy diet, exposure to diesel exhaust fumes, handling for load/unload animals, and other occupational stressors, which can increase the risk of road accidents (Miranda de la Lama et al., 2011). In our study, women hauliers were not found because transportation of sheep is a specific task of men in the country. However, participation of women in this activity is expected to increase within the next 10 years. It is possible that the presence of women in the logistics chain as haulier's improves sheep welfare, because women have more moral and ecological concerns about animal welfare than men (Miranda-de la Lama et al., 2013). Herzog (2007), reviewed gender differences in human–animal interactions and found that women are more sympathetic in their work with animals than are men. The reasons for this gender difference are unclear, but differences in empathy may be linked to both gender and gender role-femininity. The differences must be considered in the recruitment procedures and training programs.

Hauliers' profiles

The results of this study suggested the existence of 3 hauliers' profiles (clusters) as “E&C,” “E&N,” and “N&C” that explained the association between animal welfare attitudes and OLP. Factor analyses and subsequent cluster technique showed detailed information within each individual response when hauliers were grouped per attitudes and perceptions about animal welfare and OLP. Our study has delimited 2 main characteristics that defined a profile like efficient (or not) during transport operations and the worries for animal welfare (or not). The efficiency of the hauliers in their activity could be determined by the worries of animal welfare (E&C cluster) or by the economic profitability and logistic planning (E&N cluster). The efficiency as strategy in the first 2 clusters could be highly influenced by the sheep meat prices in the market compared to other animal species and by the visible effects in the product quality that has characterized to the hauliers who are frequently partners with the retailers and industrializers. The third cluster (N&C) showed low efficiency (animals with injuries and animal deaths during transportation) although they declared to be worried for animals' biological necessities and the improvements of actual animal welfare. It is probable that captive markets are more worried about for animals' weight than meat quality, and therefore, this captive markets will not exert pressure about changes during the OLP.

Surprisingly, we did not find a profile referred to “not efficient and not concerned” as it was expected. It is possible that the growing demand and high sale prices of sheep meat motivate to the industry and to their different actors to be more efficient,

competitive, and to gain a better reputation. It is clear that economic losses motivate to the industry to make important changes in their OLP, although the latter shows the importance of making aware to the hauliers during training programs about animal welfare. The economic losses are the result of animal suffering and sheep stress during preslaughter operations. In the same way, the fact that being a truck owner or an employee does not influence neither OLP nor perceptions toward animal welfare suggesting that hauliers have notions of animal welfare that persist and is independent of their labor status opening the possibility of designing training programs even with economic incentives in the meat industry with lower bruises, animal mortality, and declared injuries.

The industrialized sheep chain in Mexico is still young, the ages observed in this study showed a low participation of hauliers lower than 29 years old, and in the case of N&C, the age of 48 years was absent. Our results indicated that age and academic qualifications were not an important effect on the perceptions toward animal welfare and their possible effects on the OLP. A possible explanation could be that most of the hauliers in the clusters were more than 29 years old, suggesting that experience and personality could have had a stronger influence on the criteria and beliefs than age and education. Our results showed a relationship between the type of lorry and the places where animals came from. Clusters E&N and N&C had a marked trend of increasing the time and distance of the journey due to the demand of meat sheep in the center of the country and the incapacity of the region to meet the market's demand, and therefore, the north and northwest region have included the sheep meat production in their activities to supply meat to the market, meanwhile E&C cluster was specialized in short and intermediate journeys which showed lower animal mortality and declared injuries.

Regional specialization in sheep production in Mexico has increased trade markets and transport demand as the locations of production and consumption have separated. The abattoirs are localized usually in the center of the country where the meat is industrialized and distributed to other big cities. The latter has shown a trend in the acquisition of specialized trailers with higher loading capacity such as the not-articulated ones (capacity of 10–16 t) and the articulated (potbelly). The potbelly trailers are part of the agro-food chain because of the insertion of Mexico (especially in cattle) to the United States and Canada free-trade agreement in the past 30 years, in large part because of its large load capacity, resulting in reduced transportation cost per animal. The sheep meat dealers need to transport animals for long distances, leading to a gradual increase in the use of potbelly trailers that can transport large loads (up to 600 lambs) in a single journey. Ideally, the trailer design should facilitate animal movements to loading and unloading process. It should also encourage the hauliers and/or handlers to optimal actions toward the animals, making it possible to use the animal's flight zones for handling. However, the use of potbelly trailers has been criticized because of the difficult handling at loading and unloading due to steep internal ramps and poor internal climate conditions, resulting in greater animal losses and poor meat quality when compared with other trailer models, both for pigs (Conte et al. 2015) and cattle (Goldhawk et al. 2015). Although less is known about the effects of potbelly trailers on sheep welfare, it is likely to present similar problems as in other species.

Mexican sheep hauliers normally consume cigarettes, energy drinks, soft drinks, and coffee as conventional countermeasures for minimizing sleepiness. Our results showed that E&N and N&C hauliers had a high preference for smoking, coffee, and energy drinks. The consumption of these drinks is effective at reducing sleepiness because of the caffeine content (Filtness and Naweed, 2017). Several studies have illustrated that administering caffeine to sleepy hauliers have several benefits, reporting reductions in

both subjective measures such as sleepiness and objective measures such as sustained reaction time and driving performance. However, although caffeine is effective in minimizing sleepiness, it can have an adverse impact on subsequent sleep, which is already compromised (Jay et al., 2006). This level of sleep restriction is known to yield cumulative deficits in waking alertness across successive days (Darwent et al., 2012). Therefore, the future training programs of livestock hauliers should include countermeasures for sleepiness such as a rest or mandatory sleep time (8 h/day) and night driving limitation as possible, for both local short- and long-distance journeys (Bunn et al., 2005).

Appropriate transportation, unloading, and handling procedures are vital to the welfare of animals and tremendously impact the marketable product (Nicholson et al., 2013). As the handling of livestock involves people, there is a social component, and it has been documented that attitudes held by hauliers affect the behavior of animals (Burnard et al., 2015). Handling and transport of animals must be supervised to prevent rough treatment (Grandin, 2014). Separation or selection of preloading sheep is a good OLP due to allowing distributing animals by commercial categories or species (sheep or goat) within the lorry. Although this practice benefits animal welfare, the hauliers use it as a strategy to attenuate the economic losses. Therefore, E&N hauliers use this practice mainly versus the other 2 clusters indicating that animal welfare is not always an important factor in the hauliers' awareness mainly in the hauliers with pragmatic personality and motivated by the economic revenues. The plastic sorting paddles and board, electric prods, or flags do not have the same efficiency and the same effects on the welfare of animals during transport and handling operations (Goumon and Faucitano, 2017). Our results indicated the use of shouts, hits, and electric prod which were common management practices in the 3 clusters. A similar relationship between livestock handling by hauliers and high use of electric prods was found in a survey by Nicholson et al. (2013). Hauliers in E&C and E&N allowed the use of these practices for moving animals, being the N&C cluster that presented higher operative costs and mortality; however, they minimized the use of hits and electric shocks.

Conclusions and implications

This study not only highlighted the risk factors of hauliers which can be considered to improve animal welfare but also indicated the need to consider the transportations as a whole because of potential factor combinations and confounds. Although it is widely accepted that transportation is a vital activity in the sheep industry, it is possible that the value of the hauliers had been underestimated for animal welfare and operative and logistic quality. Our results showed that hauliers' perceptions had a clear influence on the performance of their operative and logistic activities during the sheep transport. The hauliers are a key element for animal welfare due to they have great influence on decreasing or increasing a series of factors that causes animal suffering during driving, handling, loading, or unloading operations. It is probable that perception about animal welfare could be a characteristic of personality that could be regulated by the empathy during the journey; this empathy could be a key element to show operative quality and to minimize OLP that causes animal pain and suffering.

A key aspect is to develop new national norms that establishes maximums and minimums for the transport distances and logistics improvements (i.e., rest points), not only to sheep but also to other species like swine, equine and bovine. In addition to encouraging the slaughtering in the producing regions and the sale of carcasses to the meat industry, this would reduce weight loss, mortality, morbidity, and other welfare problems associated with live animal transportation. Likewise, future training programs should be oriented not

only to the improvement of OLP quality but also to the development of positive feelings and empathy toward sheep. A driver with an appropriate training, emphatic, and a positive attitude toward animal welfare will have an effective result in the quality of sheep logistic chain operatively, minimizing the economic losses (i.e., mortality and bruises in carcass), improving the product quality and gives a positive image toward public opinion. Our results indicated that perceptions and attitudes of sheep hauliers toward sheep could be a strategic component that needs to be considered when hauliers are trained.

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Conflict of interest

The authors declare no conflict of interest.

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