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Predictors of perceived road collision/incident risk among horse users: A survey study from Norway

Özlem Simsekoglu *, Eva B. Dalland, Kåre Robertsen

Road Traffic Section, Nord University Business School, Stjørdal, Norway

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ABSTRACT

Although horse users in traffic are a vulnerable road user group, traffic safety problems among them are scantly examined by previous research. The main aim of the present study was to examine the role of some demographic variables, traffic safety attitudes, and level of knowledge about rules and regulations applying to horse use in traffic for predicting perceived road collision/incident risk in a sample of horse users in Norway. An online survey was conducted to collect data from a total of 1733 horse users including horse riders and drivers of horse-drawn sulky, wagon or sled. The respondents accessed the survey via a link put to the website of the Norwegian Horse Centre, which is in contact with many different horse user environments in Norway. The majority of the respondents were female and between the ages of 18–30. A multiple regression analysis was conducted to examine the predictors of the perceived collision/incident risk involving other motor vehicles. Results showed that traffic safety attitudes among horse users were the strongest predictor of the perceived collision/incident risk. In particular, horse users reported a negative attitude towards the other road users (e.g. drivers) indicating that they perceive the other road users' actions and approaches as the biggest source of risk in road traffic. The level of knowledge about the rules and regulations applying to horse use, especially in walking and cycling lane, was relatively low among the respondents. However, knowledge about rules and regulations did not appear as a strong predictor of the perceived collision/incident risk. Results indicate the need to increase road users, especially drivers', awareness about the problems and needs of horse users in traffic.

1. Introduction

Riding a horse for different purposes has been an important activity for people throughout history. There has been a shift in the use of horses with increased industrialization of the societies. In western societies, horses started to be used more for recreational and sport purposes starting with the second half of the 20th century, whereas in earlier times they were used more as a means of transportation and in agricultural activities (Endenburg, 1999). Although the role of horses has changed and the number of people using horses has declined by time, there are still many people riding a horse in modern societies and some of them ride their horses in traffic environments. This makes traffic safety among horse riders an important issue to consider. Previous research points out horse riders are a vulnerable road user group and they are involved in a considerable amount of road collisions, incidents, and near misses (e.g., Chapman & Musselwhite, 2011; Thompson & Matthews,

* Corresponding author.
E-mail address: ozlem.s.nordfjarn@nord.no (Ö. Simsekoglu).

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2015; Trump & Parkin, 2020). Road collisions involving horse users occur when horses collide with a motor vehicle or road user (e.g. cyclists, pedestrians), whereas road incidents involving horses might occur without a collision with a motor vehicle or road user yet might lead to personal injury/horse injury or damage to the horse-drawn wagon. A horse rider falling from the horse since the horse got spooked by a close passing vehicle can be an example of a road incident involving horses. According to one recent study from the UK (Trump & Parkin, 2020), out of 1976 equestrians participating in a survey, 79.1% reported a near miss, while 15.6% reported a collision and 7.7% reported a collision involving a personal injury. Another survey study from Australia shows that 52% of the respondents reported having experienced at least one near miss or collision involving horses in the last twelve months before the survey (Thompson & Matthews, 2015). In Sweden, during the period between 1997 and 2005, 3 horse users were killed, and on average 4 people were severely injured and 10 people were lightly injured per year in road collisions and incidents involving horse users (Pinzke & Elgåker, 2008). International studies about horse-related road collisions and incidents point out that especially the percentage of people having a near miss while riding or driving a horse is quite high, although the percentages of people having a horse-related road collision are relatively low.

Despite being a vulnerable road user group, horse users have not attracted enough attention both from the researchers and transport policymakers. There is a need to focus on traffic safety problems experienced among horse users. The focus of the present study is to examine traffic safety attitudes, knowledge about rules and regulations regarding horse use, and perceived collision/incident risk in a Norwegian sample of horse users, including horse riders and drivers of sulky (i.e. a light two-wheeled horse-drawn vehicle for one person), wagon, or sled.

1.1. Horse use in Norway

Horse use has been an important activity in Norwegian society historically. There are about 125,000 horses and 50,000 horse owners in Norway and horses have multiple roles, as 72% of the horses are used in hobby or recreation- activities, and 32% are trot-horses (Vik & Farstad, 2012). Changes in Norwegian society have led to a great change in the horses' role in society during the last fifty years. Traditionally, horses were used for farming, forestry, transport, and military purposes (Ministry of Agriculture and Food. (2018), 2018). During the years from 1949 to 1969, there was a great reduction in the number of horses from 200,000 to 38,000 in Norway due to the technological developments, such as the emerging use of tractors, agricultural and forestry machines that decreased the need for horses (Central Bureau of Statistics, 1949, 1961, 1971a, 1971b, 1979). There was a big increase in the number of motor vehicles between 1959 and 1970, from 356,883 in 1960 to 1,116,528 in 1970 (Central Bureau of Statistics, 1961, 1971b), while at the same time, number of horses in the official statistics went down from 200,000 in 1949 to only 20,000 in 1969. Motor vehicles mostly undertook the role of horses in work and transport areas (Dahle, 2009). In historical memories, this period is called the "Horse Death" (Weseth, 2007).

After the 1970s, the number of horses has gradually expanded, and the horses' role has changed. Horses have started to be used more like leisure-, health- and sport-activity, and in competitions, horse-racing and tourist transport rather than being used in farming and forestry (Econ Pöyry, 2009; Ministry of Agriculture and Food, 2018). Besides, horses started to be used more in urban areas and road traffic. When riding a horse or driving a horse-drawn wagon or sulky, horse users often move in a road traffic environment, which causes risky situations due to poor interactions between horse users and other road users.

According to Norwegian regulations, a horse user is defined as a driver, both when riding a horse, driving a wagon and leading the horse, and should follow the same traffic rules as the drivers of vehicles (Ministry of Transport, 2019, RTR §2). Although both horse users and cyclists have to follow the rules like drivers, cyclists are allowed to use walking and cycling lanes by the law (Ministry of Transport, 2019, RTR §18). However, horse users are not allowed to use the same lanes (Ministry of Transport, 2019, RTR §4). In addition, there are no official regulations regarding a driver- or riding license or age limit for using a horse in traffic. Therefore, to reduce ambiguous and conflicting situations in road traffic and improve traffic safety among horse users, some amendments need to be made in the rules and regulations regarding horse use in road traffic.

Earlier in the history horse users were approached as a protected road user group by the Norwegian traffic law, stating that the drivers of motor vehicles and cyclists had to act very carefully both when meeting and when they wanted to pass a horse wagon driver or the person who was riding or leading a horse (Ministry of Labour, 1926, p. 451). Those concrete road traffic rules aimed to protect horse users in road traffic are removed by time. Currently, there is no specific rule concerning horse user's safety but instead, there is a more wide and general rule about being considerate and careful towards different road users, which can also be applied to horse users (Ministry of Transport, 2019). Building a road safety culture has been an important vision for Norwegian traffic safety authorities. Norwegian government created a white paper titled "The National Transport Plan (2002–2011)", which presented the Vision Zero, a road safety approach outlining an official vision for a future without road traffic fatalities and serious injuries (Ministry of Transport and Communications, 1999). This vision is mostly achieved as Norway has the lowest number of road fatalities per million inhabitants in the world (Adminaite, Calinescu, Jost, Stipdonk, & Ward, 2018). Despite this road safety focus in Norwegian society, there is not enough attention given to traffic safety issues among the horse users. Several problems make it difficult to focus on traffic safety among horse users. First, currently there is no official registration system for all horses in Norway, which makes it difficult to follow the number of horse users in Norway (Vik & Farstad, 2012). Horse-organizations have a system for registration of their members' horses and sometimes it is obligatory to do so, however, they do not include all the horses, and the registrations are connected

to different horse environments and horse organizations. Another problem is that it is not possible to know the exact number of injuries of horses and horse users within the current registration systems. In statistics from insurance companies, collisions between motor vehicles and horse users are described and reported to authorities as a crash with an *animal*, which can be a wild animal, as well. Those statistics do not differentiate if the animal is a horse with a rider on its back or a moose. In official statistics, fatal collisions involving horses and horse users are also put into the group "other kind of collisions" (Directorate of Public Roads, 2015; Statistics Norway, 2015). Thus, it is difficult to know the scope of the traffic safety problems experienced by horse users in Norway as the statistics about road collisions and incidents involving horse users are unclear and incomplete.

1.2. Traffic safety attitudes and knowledge about rules and regulations among the horse users

Road safety attitudes have an important role in understanding and explaining various road user behaviors. Previous research has shown that road user attitudes are significantly related with road user behaviors and behavioral intentions in different topics, such as speeding, drinking and driving and seat belt use (e.g. Chan, Wu, & Hung, 2010; Elliott, Armitage, & Baughan, 2003; Şimşekoğlu & Lajunen, 2008). This line of research indicates that as the road users have a safe attitude towards a certain traffic behavior, they are more likely to behave in a safer way. Although road safety attitudes have been widely examined among different road user groups, such as drivers, cyclists, and pedestrians, there is a lack of studies focusing on horse users' attitudes and their interaction with other road users. One previous study (Chapman & Musselwhite, 2011) focusing on attitudes and risk perception among horse riders and drivers indicates that risk awareness and attitudes towards different situations in traffic show differences between the horse riders and the drivers, which leads to dangerous situations and increases risk in traffic. In order to reduce risky situations and collisions involving horses and horse users, more research aiming at understanding attitudes, perspective, and risk perception among both horse users and other road users is needed.

How accurately horse users and other road users know the rules and regulations related to horse use in traffic and apply them is another important factor for horse users' safety. Lack of knowledge and misunderstanding the rules and regulations applying to horse users in traffic appear as common problems among road users. One previous study from Australia (Thompson & Matthews, 2015) reports that misunderstanding of road rules and rider hand signals are among the factors contributing to road collisions/incidents and near misses involving horse riders. Although in Norway there is no previous research about horse users' safety in road traffic, preliminary results from an ongoing research project (Hest i Trafikk) by the authors of the present paper indicate that road users, especially drivers, ignore or do not respect horse users' hand signs. On the other hand, there are no clearly described rules about hand signs of horse users in the law.

1.3. Perceived risks in traffic among horse users

In addition to attitudes, traffic risk perception, which can be defined as the subjective experience of risk in potential traffic hazards (Deery, 1999), is another important psychological construct that is related to road user behaviors. Road users tend to report an increased risk in traffic as they perceive the probability of a collision/crash high and the consequences to be severe (e.g. Nordfjærn & Rundmo, 2010). When it comes to the perceived risks related to horses in traffic, it appears that there is a divergence in risk perception between horse riders and drivers due to different perspectives and mutual misunderstandings (Chapman & Musselwhite, 2011; Thompson & Matthews, 2015; Trump & Parkin, 2020). Hence, what is risky for horse riders might not be perceived as risky by drivers and vice versa. Most of the drivers are not familiar with horses and do not know how the horses would react in different situations in traffic; therefore, they behave in ways that would increase the risk for horse users. For example, not being sure what is the appropriate speed when overtaking a horse seems like a common problem among the drivers encountering a horse on the road. According to one recent study from the UK (Trump & Parkin, 2020), cars' overtaking too close was the biggest contributory factor for the collisions involving equestrians. Similar to previous findings, preliminary results from the ongoing research project (Hest i Trafikk) by the authors of the present paper also points out that in Norway drivers cause some risky situations for the horse users by showing some inconsiderate behaviors around the horses, such as driving with high speed and passing the horses too closely.

1.4. The present study

This study is conducted as part of a research project called "Hest i Trafikk" (*Horse in Traffic*). The project aims to address traffic safety issues among horse users by examining the risky situations arising from the interactions between horse users and the other road users in traffic by conducting both a survey and interviews. It should be noted that this article is based on a part of the survey conducted within the project. The aims of the present study are to examine traffic safety attitudes, perceived collision/incident risk, and level of knowledge related to rules and regulations applying to horse users in a Norwegian sample. There is a lack of research focusing on traffic safety issues among horse users both in Norway and other countries. In order to reduce road collisions and risky traffic situations experienced by horse users, it is important to understand both horse users and other road users' (e.g. drivers, bicyclists) perspectives. However, understanding horse users' views regarding traffic safety problems seem more urgent as they are a vulnerable road user group and many of the traffic risks experienced by them are unknown to other road user groups. Thus, in the present study, we aim to examine factors important for traffic

safety among horse users. Moreover, providing findings that might be useful for interventions aiming to decrease traffic risks among horses and horse users is another important goal of the present study. The specific aims of the study are listed below:

1) To examine traffic safety attitudes, perceived road collision/incident risk and level of knowledge related to rules and regulations applying horse use in traffic among horse users
2) To test whether the traffic safety attitudes, collision risk, and knowledge show differences according to some demographic variables (e.g. gender and age) and year of experience in horse use
3) To examine the role of demographic variables, traffic safety attitudes and the knowledge about rules and regulations for predicting the perceived collision/incident risk among the horse users

2. Method

2.1. Data collection

A web-survey was used to collect the data in 2019 spring. The selection criteria for the participants were being above 16 years old and having experience of using a horse in traffic either as a horse rider or driver of horse-drawn sulky, wagon or sled. The link of the survey was put to the website of the Norwegian Horse Centre, which is an umbrella organization for many different horse user environments in Norway. There was a high interest in the survey resulting in a high number of respondents. Before starting the data collection, the project was approved by the Norwegian Centre for Research Data (NSD) in terms of the ethical considerations required for data collection.

2.2. Sample characteristics

The present sample includes 1733 horse users who responded to the survey. The sample characteristics can be seen in Table 2. The vast majority of the respondents were females, and most of them were between the ages of 18–30 years old and used horses in traffic for seven years or more. It should also be noted that most of the respondents in the present study reported that they use a horse as a hobby or recreational activity. Using a horse for hobby and recreational purposes are way more common among females than males in Norway, except in harness racing, where males still are the dominating group (Econ Pöyry, 2009; Morset, 2019; Vik & Farstad, 2012) This might explain the high proportion of females in the present sample. Most of the respondents were using a horse either as a rider or driver of a horse-drawn wagon. Almost 60% of them reported riding a horse and 20% of them reported driving a horse-drawn wagon in traffic several times a week. Moreover, they reported that they ride or drive a horse especially in rural environments with asphalt and gravel roads, while a small amount reported that they use their horses in more densely populated urban environments, such as cities.

2.3. Measures

An online questionnaire was used to collect the data. The questionnaire included items about the demographic characteristics of the respondents (gender and age), the year of experience with using a horse in traffic, knowledge about rules and regulations applying to horse use in traffic, attitudes towards risks related to horse use in traffic, perceived road collision/incident risk and finally collision/incident history.

Knowledge about the rules and regulations were measured in two sections. The first section included six items related to the use of walking and cycling lanes. There were both true and false statements regarding the walking and cycling lane sign (see Appendix) (e.g. "*It is not allowed to use a horse in the walking and cycling lane*"). The second section included nine items related to different situations involving interaction between horse users and other road users (e.g. "*Drivers should give way to horse users in the pedestrian crossings*"). The respondents replied to the knowledge items using three option categories, which were "true", "false" and "I do not know". Two total knowledge scores were calculated by adding the number of correct answers for both knowledge scales separately.

Traffic safety attitudes among the horse users were measured using twelve items. Some of these items were related to the risks experienced with the horse (e.g. "*I avoid riding a horse in traffic because it is difficult to control my horse due to distractions, such as approaching cars and sounds*") and the general road collision/incident risk in traffic (e.g. "*I avoid riding my horse in traffic due to high risk of collision/incident*"). Whereas, some items were related to the risks arising from the interaction with the other road users (e.g. "*It is risky riding a horse in traffic because the other road users do not know about the traffic rules related to horses in traffic well*"). The respondents rated the items using a 5-point Likert type scale (1 = completely agree, 5 = completely disagree).

The perceived road collision/incident risk was measured by two questions. The first question was asking about the probability of having a collision/incident involving a vehicle or another road user while using a horse (1 = very unlikely, 5 = very likely), while the second question was asking about how severe it would be the consequences of such a collision/incident for the user (1 = no injury, 5 = serious injury). A single perceived collision/incident risk score was calculated by multiplying the scores from these two questions.

The final section of the questionnaire included items related to collisions/incidents and near misses experienced by horse users. They were asked if they had a collision/incident or a near miss while using a horse in traffic (Yes, No). Also, they were asked to report the number of near misses.

2.4. Statistical analyses

First, to identify the dimensional structure of the attitude scale a principal component analysis (PCA) using iteration and Varimax rotation was conducted. Kaiser's "eigenvalue > 1" criterion and a scree plot were used to decide the number of dimensions. In the second step, a Mann-Whitney *U* test was conducted to see whether there are significant gender differences in the variables of the study. Since the gender distribution of the sample was too skewed a non-parametric analysis approach was used to test the gender differences. Also, several one-way between-subjects ANOVA tests were conducted to examine whether the attitudes, perceived collision/incident risk, and level of knowledge related to the rules and regulations show differences according to the age. Finally, a hierarchical multiple regression analysis was conducted to examine the predictors of the perceived road collision/incident risk among the horse user. Gender and years of experience as a horse user were entered to the model in the first step, having a collision/incident or near miss in the past (yes, no) and the number of near misses was entered in the second step, attitudes were entered in the third step, and total knowledge scores were entered in the final step as the predictor variables. Perceived road collision/incident risk was entered as the dependent variable.

3. Results

3.1. Traffic safety attitudes among horse users

According to the PCA, two dimensions were obtained from the attitude scale. The first dimension was labeled as *"attitudes towards risks related to horse use in traffic*" and the second dimension was labeled as *"attitudes towards the other road users*". Items, factor loadings for the items, explained variance and the reliability scores for the two dimensions can be seen in Table 1. Both dimensions have an alpha value above 0.70 indicating high reliability.

3.2. Descriptive characteristics for the variables of the study

Descriptive information (Mean, SD, and percentages) for the variables of the study can be seen in Table 2. The total number of correct answers for the knowledge scores indicate that the level of knowledge about the rules and regulations applying to horse use, especially regarding the use of walking and cycling lane, is low. Almost half of the items were responded either wrongly or as "I do not know", which indicates that there is a gap or confusion among the horse users regarding the use of

Table 1
Dimensions of the traffic safety attitudes among the horse users.

Items	Dimensions	
	Attitudes towards risks related to horse use in traffic	*Attitudes towards other road users*
I avoid riding my horse in traffic due to the high risk of having a collision/incident.	0.53	
I enjoy riding a horse in traffic.*	0.74	
I avoid riding my horse in traffic because the traffic environment is in general not horse friendly.	0.73	
I avoid riding a horse in traffic because it is difficult to control my horse due to distractions, such as approaching cars and sounds.	0.80	
The unpredictable nature of horses makes it irresponsible to ride a horse on a motorway.	0.82	
I think riding a horse in traffic is risky because horses can be scared by the other road users.	0.55	
It is risky riding a horse in traffic risky because the other road users (e.g. drivers, pedestrians, cyclists) do not know about the traffic rules related to horses in traffic well.		0.50
I think drivers of motor vehicles perceive horses and horse riders as less prioritized in traffic because they slow down the traffic.		0.71
When I ride a horse in traffic, I worry because I think the other road users do not pay enough attention to me.		0.78
Drivers of motor vehicles have a poor understanding of how horses can behave and react in traffic.		0.75
I think the traffic environment in Norway is well organized for riding a horse.*		0.49
There are many drivers who do not approach horse riders in safe way in traffic.		0.69
Explained variance (%)	25.8	24.8
Reliability (α)	0.82	0.75

* These items are recoded so that higher scores indicate more positive attitudes.

Table 2
Descriptive characteristics of the variables of the study.

Variable	%	Mean	SD
Gender			
Male	5		
Female	95		
Age			
17 years and below	6.9		
Between 18 and 30 years old	42.3		
Between 31 and 50 years old	38.6		
51 years old and above	12.2		
Driving a car			
Yes	91.3		
No	8.7		
Experience in traffic as a horse rider			
2 years and below	1.4		
Between 3 and 6 years	11.8		
7 years and above	86.8		
Knowledge about rules and regulations			
Knowledge about the rules related to use of walking and cycling lane[1]		3.2	1.9
Knowledge about rules related to different traffic situations with horse users[2]		6.0	1.9
Traffic safety attitudes			
Attitudes towards risks related to horse use in traffic		3.1	0.9
Attitudes towards other road users		1.7	0.6
Perceived road collision/incident risk			
Probability of having a road collision/incident while riding a horse		2.9	0.9
Severity of the consequences of the collision/incident		4.2	0.9
Road collision/incident in the last 10 years			
Yes	22.1		
No	77.9		
Near miss			
Yes	82.9		
No	17.1		
Number of near misses		5.5	3.7

[1] Total number of correct answers out of 6 items.
[2] Total number of correct answers out of 9 items.

walking and cycling lane. In terms of the traffic safety attitudes among the horse users, it appears that horse users' attitudes towards the other road users are much more negative than their attitudes towards risks in traffic related to horse use, which indicates that horse users perceive other road users' behaviors and approaches as the biggest source of risk in traffic. For the perceived collision/incident risk, the mean scores show that the severity of the consequences of a collision while using a horse is rated much higher compared to the probability of the collision/incident. It is also worth mentioning that 22% of the horse users reported having a road collision/incident in the last 10 years, and the majority of them reported that they had a near miss, which indicates that traffic collision/incident risk among the horse users is considerably high.

3.3. Gender and age differences in the variables of the study

Results of the Mann-Whitney *U* test show that there is a significant gender difference only in the perceived road collision/incident risk ($U = 47046.5$, $p = 0.000$). The mean rank value for perceived risk among female horse users was 881.9, compared to 584.8 for male horse users, indicating that perceived road collision/incident risk is significantly higher among the female horse users compared to the male horse users.

In terms of age differences, ANOVA results show that attitudes towards risks related to horse use in traffic [$F(3, 1729) = 4.38$, $p = 0.004$], knowledge about the use of walking and cycling lane [$F(3, 1729) = 44.68$, $p = 0.000$], and rules related to different traffic situations with horse users [$F(3, 1729) = 57.04$, $p = 0.000$], and perceived collision/incident risk [$F(3, 1729) = 9.58$, $p = 0.000$] differ significantly by age. Comparison of the mean scores shows that the total correct answer in the knowledge scales increases with increasing age, whereas attitudes towards risks related to horse use in traffic get more negative with the increasing age. In addition, the lowest perceived collision/incident risk was reported by the respondents aged 51 and over, while the highest perceived collision/incident risk was reported by the respondents aged between 18 and 30 years old.

3.4. Predictors of the perceived road collision/incident risk among the horse users

The results of the regression analysis can be seen in Table 3. Being male was negatively and significantly related to the perceived collision/incident risk indicating that compared to female horse users, male horse users reported a lower perceived

Table 3
Predictors of the perceived road collision/incident risk among the horse users.

Step	Variable	R^2	R^2 change	F	d.f.	β	p-value
1		0.01	0.01	5.43	3		
	Gender (male)					−0.08	**0.001**
	Years of experience with horse use						
	2 years and below					0.03	0.249
	7 years and more					−0.04	0.089
2		0.10	0.09	31.45	5		
	Road collisions/incidents in the last ten years					−0.04	0.092
	Number of near misses					0.22	**0.000**
3		0.17	0.07	43.26	7		
	Attitudes towards risks related to horse use in traffic					−0.09	**0.000**
	Attitudes towards the other road users					−0.24	**0.000**
4		0.18	0.01	34.05	9		
	Knowledge about the rules related to use of walking and cycling lane					0.03	0.242
	Knowledge about rules related to different traffic situations with horse users					0.02	0.482

collision/incident risk. The number of near misses was positively and significantly related to the perceived collision/incident risk showing that perceived risk increases as the number of near misses experienced by the horse users in the past increases. Both attitudes towards risky situations in traffic and other road users were negatively associated with the perceived collision/incident risk indicating that as the horse users report more negative attitudes towards risky situations in traffic and other road users they tend to have a higher perceived collision/incident risk. Attitudes appear as the strongest predictors of the perceived collision/incident risk among horse users.

4. Discussion

Horse riders and drivers of horse-drawn vehicles are at a higher risk in traffic as they are a vulnerable road user group. Although the absolute number of road collisions and injuries involving horse users is low, previous research shows that the number of near misses experienced and feeling unsafe in traffic are quite common among horse users (Chapman & Musselwhite, 2011; Thompson & Matthews, 2015; Trump & Parkin, 2020). Underreporting of collision and injury statistics involving horse users appears as a common problem both in Norway and in some other countries (e.g. Samferdselsdepartementet, 2017; Trump & Parkin, 2020). Thus, it should be noted that official statistics about road collisions involving horse users might not reflect the scope of the problem accurately. There is a limited number of international studies examining traffic safety issues among horse users. In order to reduce the number of road collisions and risky situations involving horses and horse users, more research focusing on the factors related to collision/incident risk among horse users is needed. Horse users currently constitute a substantial road user group in Norway. The main aim of the present study was to examine the role of some demographic factors, traffic safety attitudes and knowledge related to rules and regulations regarding horse use in traffic for predicting the perceived collision/incident risk in a sample of horse users in Norway.

Findings of the present study regarding the traffic safety attitudes show that horse users have more negative attitudes towards the other road users in traffic compared to their attitudes towards the general risks related to horse use in traffic (e.g. risk arising from the unpredictable nature of the horse). This indicates that horse users perceive other road users' risky behaviors and approaches (e.g. drivers do not choose the appropriate speed when passing a horse) as the biggest source of risk for their safety. This finding is in line with the previous findings showing that drivers' perception of seeing horse riders as less prioritized in traffic and mutual misunderstandings between the horse riders and drivers are the common sources of risk regarding horse riders' traffic safety (Chapman & Musselwhite, 2011; Thompson & Matthews, 2015; Trump & Parkin, 2020). In addition, the present findings show that both the attitudes towards risks related to horse use and other road users in traffic were significant predictors of the perceived collision/incident risk among the horse users. Particularly attitudes towards the other road users were the strongest predictor of the perceived road collision/incident risk among the horse users. These findings support the previous research findings showing a close link between traffic safety attitudes and perceived road collision/incident risk among different road user groups (e.g. Nordfjærn, Jørgensen, & Rundmo, 2011; Şimşekoğlu et al., 2012; Ulleberg & Rundmo, 2003). Risk perception has been traditionally measured using the psychometric model, which has a cognitive approach assuming that risk perception is multi-dimensional and can be measured by scales reflecting the unique qualities of different risk sources (Slovic, 1992). In accordance with the psychometric model, in the present study perceived risk related to horse use was based on the perceived probability of having a collision/incident while using a horse and severity of consequences. Although the psychometric model has been the dominant approach to explain perceived risk, a newer model proposing attitudes, risk sensitivity, and fear as the explanatory variables were shown to be more successful explaining the perceived risk (Sjöberg, 2000), especially attitude was an important predictor of the perceived risk. The present findings showing road safety attitudes as the strongest predictors of the perceived road collision/incident risk among the horse users support this newer model about risk perception (Sjöberg, 2000).

In terms of the rules and regulations applying to horse use, the present findings show that the level of knowledge especially related to the rules for the use of walking and cycling lane is quite low. It should be noted that based on the present findings we cannot argue that horse users' knowledge related to rules and regulations is lower compared to the other road user groups, such as drivers or cyclists. However, some preliminary findings from the interviews made with the horse users within our project indicate that some horse users know and interpret the rules correctly but ignore them because of their safety. For example, although they are not allowed to use walking and cyclist lanes, some of them still ride or lead their horses on these lanes because it feels safer compared to the road. Thus, it seems like when it comes to practical situations horse users' knowledge and application of some rules differ from the actual meaning in the rules due to some safety concerns and practical reasons. This indicates a need for adjusting the rules in a more clear way with consideration of horse users' needs in various traffic situations. Regression analysis results indicate that the overall level of knowledge related to rules applying to horse use has a weak role in explaining the perceived road collision/incident risk. People often cannot evaluate objectively how much they know about a topic thus it is not surprising that the level of knowledge about the rules was weakly related to the perceived collision/incident risk.

Present findings also show that there are some demographic differences in the variables of the study. Previous studies have shown that perceived risk and worry in traffic shows some differences according to gender (e.g. DeJoy, 1992; Glendon, Dorn, Davies, Matthews, & Taylor, 1996; Kummeneje, Ryeng, & Rundmo, 2019; Moen & Rundmo, 2006), therefore, in the present study gender difference in road collision/incident risk among the horse users was also examined. Results show that compared to the male respondents, female respondents in the present study reported a significantly higher collision/incident risk. This is in line with the previous findings showing that females tend to report a higher perceived collision/incident risk and worry related to risky traffic situations compared to males (e.g. DeJoy, 1992; Glendon et al., 1996; Kummeneje et al., 2019; Moen & Rundmo, 2006). It should be noted that findings related to gender differences in the present study need to be interpreted with caution since the vast majority of respondents were females. Today horse-husbandry often is mentioned as a "female leisure activity" in Norway since most of the horse owners are females, although the environment of the harness is still male-dominated (Morset, 2019; Vik & Farstad, 2012). Thus, our sample reflects a realistic gender distribution among horse users in Norway.

Regarding age differences, results show that the level of knowledge related to rules and regulations increased with age, which might be explained by the increased experience with horse use that comes with the increased age. Also, attitudes towards risks related to horse use in traffic get more negative with the increasing age. It is likely that with the increasing age horse users gain more experience in traffic and consequently be more exposed to various risky situations in traffic, which leads to more negative attitudes. Finally, it is worth to mention that the highest perceived collision/incident risk was reported by the respondents aged between 18 and 30 years old. This might be explained by the frequency of horse use and level of experience in this age group. Respondents in that age group are likely to use horses more actively and frequently, which leads to increased exposure to risky situations. At the same time, due to their relatively young age, they may not have so much experience with how to manage risky situations related to horse use. Therefore, due to these reasons, they might perceive a higher collision/incident risk.

The present study has some implications that might be useful for traffic safety interventions and measures aiming to improve traffic safety among horse users. Results indicate that horse users perceive other road users' approaches and behaviors as the biggest source of risk in traffic. Although we only focused on the horse users' perspective in this study, the present findings support the argument by some previous studies that the gap in the expectations and perceptions between the horse users and other road users, especially drivers, constitute a risk for horse users' traffic safety. Increasing awareness about the problems and needs of horse users in traffic among other road user groups might be an important step towards reducing the amount of risk perceived by the horse users. Addressing the problems and needs of horse users in traffic during the driving education programs might help to improve traffic safety among horse users. Currently, there is not enough attention given to horse users' safety in Norwegian driving education. However, traffic safety risks experienced by the horse users and how to reduce these risks by interacting with them in a more considerate and safe way in traffic could be included as a topic in the Norwegian driving education program, which is a comprehensive program with a great focus on safety for all road user groups. Also, forming positive attitudes towards horse users is crucial since especially some drivers tend to perceive horse users as less prioritized and legitimate in traffic. It should be noted that the sources of the problems for horse users are not only related to the other road users but they are rather related to the interaction and mutual misunderstandings between the horse users and other road users. Therefore, training horse users about how to move in traffic safely and what to expect from other road users are also very essential. Today in Norway there is a lack of regulations and requirements for training people to use a horse in road traffic; however, like driving other vehicles in traffic, riding a horse or driving a horse-drawn sulky, sled, etc. in traffic could also require a certain amount of training and age limit. This could be an important step towards increasing traffic safety among horse users. Another important implication of the study is to rearrange the traffic rules and regulations applying to horse use in traffic so that they are clearly understood by all road users without ambiguity. In addition, the level of knowledge about the rules and regulations applying to horse use in traffic should be increased both among the horse users and other road users. This could also be achieved during the driving education process.

It should be noted that this study presents results related to horse user safety specifically from the Norwegian context thus when applying the present findings to other country contexts differences in road traffic cultures, education and laws

should be taken into consideration. Norwegian road traffic culture is characterized by an inclusive attitude and high respect towards all types of road users. In Norway, there are rules/regulations and road safety campaigns that encourage road users to share the road, and it is common to see traffic signs along the roads for sharing the roads. This principle is rooted in road user training starting from the very beginning of learning to walk (primary school 1–4 steps) or cycling on the road (primary school 5–7 steps). Using a horse especially as a recreational/hobby activity or training purposes is quite common and highly accepted in Norwegian society. Often horse users need to use some parts of the motorized roads when they try to reach the recreational or training areas. Thus, it is not uncommon to see horse users on motorized roads where they have to interact with the other road users. However, it should be noted that in some other countries horse use on motorized roads may be restricted by the law or maybe less common.

There is no previous research study focusing on traffic safety problems among horse users in Norway. Therefore, addressing psychological and individual factors important for the traffic safety of horse users can be considered as a strong and novel aspect of the present study. In addition to Norway, findings of the present study can also contribute to improvement of traffic safety among horse users in other countries, especially in other Scandinavian countries with similar socio-economic and historical profiles to Norway. Despite being an important step towards improving traffic safety among horse users, the present study has also some limitations to mention. The majority of the respondents were female in the present study thus the imbalanced gender distribution might have biased the results in some ways. Since some of the variables measured in the study, such as the perceived collision/incident risk and traffic safety attitudes, show differences according to gender, the results should be interpreted with caution. Although it is understandable that the majority of the respondents were female in the present study as currently horse-owners are female-dominated in Norway, in future studies trying to involve a more balanced number of male and female horse users would be beneficial for improving the representativeness and statistical power of the results. Another limitation might be related to the representativeness of the sample. Respondents for the present study were recruited through the website of the Norwegian Horse Centre, which is an umbrella organization for many different horse user environments in Norway. Thus, the present sample can be considered as fairly representative. Reaching out to a randomly selected sample of horse users from all regions of Norway would give more representative findings; however, this was not possible since there is no central registration system including the contact information for all horse owners in Norway. Finally, the focus of the present study was only horse users; however, in future studies also including other road users to the study would be useful for making comparisons between different road users groups to understand the differences in their perspectives for approaching traffic safety issues related to horse use in traffic.

5. Conclusions

Traffic safety problems among horse users are a neglected topic that needs more attention from traffic safety research. The focus of the present study was to examine the role of some demographic variables, traffic safety attitudes, and level of knowledge about the rules and regulations applying to horse use for predicting the perceived road collision/incident risk in a sample of horse users in Norway. Traffic safety attitudes towards other road users and general risk factors for horse use were the strongest predictors of perceived collision/incident risk among the horse users. Findings indicate that horse users especially perceive other road users' (e.g. drivers, cyclists) actions and approaches towards them as the biggest source of risk for their traffic safety. In addition, results point out that the level of knowledge about rules and regulations applying to horse use, especially related to the use of walking and cycling lane, is quite low among the horse users. There is a need to increase awareness about the problems and needs of horse users among the other road users, especially among the drivers, and to increase knowledge related to rules and regulations applying to horse use in traffic for all road user groups. These issues should be addressed in collaboration between different traffic safety actors, such as traffic safety researchers, driving education authorities, and law- and policy-makers.

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Appendix

Walking and cycling lane sign

The sign indicates that roads are designed for pedestrians and cyclists. The sign also states that the traffic rules provisions for the use of such roads apply.

References

Adminaite, D., Calinescu, T., Jost, G., Stipdonk, H., & Ward, H. (2018). Ranking EU Progress on Road Safety. 12th Road Safety Performance Index Report. Retrieved from https://etsc.eu/wp-content/uploads/PIN_ANNUAL_REPORT_2018_final.pdf.

Chan, D. C. N., Wu, A. M. S., & Hung, E. P. W. (2010). Invulnerability and the intention to drink and drive: An application of the theory of planned behavior. *Accident Analysis & Prevention, 42*(6), 1549–1555. https://doi.org/10.1016/j.aap.2010.03.011.

Chapman, C., & Musselwhite, C. B. (2011). Equine road user safety: Public attitudes, understandings and beliefs from a qualitative study in the United Kingdom. *Accident Analysis & Prevention, 43*(6), 2173–2181.

Central Bureau of Statistics. (1961). Jordbruksteljinga i Noreg 1959. Første hefte. Areal, husdyrhold m.m. [Census of Agriculture in Norway 1959. Volume I. Land Area, Livestock husbandry, etc.]. Retrieved from Oslo: https://www.ssb.no/a/histstat/nos/nos_xii_040.pdf.

Central Bureau of Statistics. (1971a). Jordbruksteljinga 1969, Hefte III Husdyrhald. [Census of Agriculture. Volume III. Livestock husbandry]. Retrieved from Oslo: https://www.ssb.no/a/histstat/nos/nos_a446.pdf.

Central Bureau of Statistics. (1971b). Statistisk årbok 1971 [Statistical yearbook of Norway 1971]. Retrieved from Oslo: https://www.ssb.no/a/histstat/aarbok/1971.pdf.

Central Bureau of Statistics. (1979). Statistisk årbok 1979 [Statistical Yearbook of Norway 1979]. Retrieved from Oslo: https://www.ssb.no/a/histstat/aarbok/1979.pdf.

Central Bureau of Statistics of Norway. (1949). Jordbrukstellingen i Norge. Første hefte. Arealet, husdyrholdet m.v. Herredsvis oppgaver. [Census of Agriculture in Norway. Volume I. Land Area, Livestock husbandry, etc. County by county]. Retrieved from Oslo: https://www.ssb.no/a/histstat/nos/nos_xi_040.pdf.

Dahle, H. K. (2009). Tilbakeblikk [A Retrospect]. In H. K. Dahle (Ed.), *Hesten i vår tid [The Horse in Our Time]*. Oslo: Tun forlag as.

Deery, H. A. (1999). Hazard and risk perception among young novice drivers. *Journal of Safety Research, 30*(4), 225–236.

DeJoy, D. M. (1992). An examination of gender differences in traffic accident risk perception. *Accident Analysis & Prevention, 24*(3), 237–246.

Directorate of Public Roads. (2015). Road Traffic Fatalities. Annual Report 2014. [Drepte i vegtrafikken. Årsrapport 2014]. Retrieved from Oslo: https://www.vegvesen.no/_attachment/471615/binary/1044317?fast_title=%C3%85rsrapport+-+Trafikkulykker+2014.pdf.

Econ Pöyry. (2009). Hest i Norge. Econ-rapport nr. 2009-001 [Horses in Norway. Econ-report no. 2009-001]. Retrieved from Oslo: http://www.hesteforskning.com/wp-content/uploads/2014/07/Hest-i-Norge.pdf.

Elliott, M. A., Armitage, C. J., & Baughan, C. J. (2003). Drivers' compliance with speed limits: An application of the theory of planned behavior. *Journal of Applied Psychology, 88*(5), 964–972. https://doi.org/10.1037/0021-9010.88.5.964.

Endenburg, N. (1999). Perceptions and attitudes towards horses in European societies. *Equine Veterinary Journal, 31*(S28), 38–41.

Glendon, A. I., Dorn, L., Davies, D. R., Matthews, G., & Taylor, R. G. (1996). Age and gender differences in perceived accident likelihood and driver competences. *Risk Analysis, 16*(6), 755–762.

Kummeneje, A. M., Ryeng, E. O., & Rundmo, T. (2019). Seasonal variation in risk perception and travel behaviour among cyclists in a Norwegian urban area. *Accident Analysis & Prevention, 124*, 40–49.

Ministry of Agriculture and Food. (2018). Hesten som ressurs- Lokal næringsutvikling. Nasjonal veileder [The horse as a resource- Local development of industry and commerce. A national guide]. Oslo: Ministry of Agriculture and Food Retrieved from https://www.regjeringen.no/no/dokumenter/hesten-som-resurs—lokal-naringsutvikling2/id2601834/sec1.

Ministry of Labour. (1926). Motorvognloven [Act of Motor Vehicle]. Oslo: Arbeidsdepartementet [Ministry of Lobour].

Ministry of Transport. (2019). Vegtrafikklovgivningen [Road Traffic Act]. Oslo: Cappelen Damm Akademisk.

Ministry of Transport and Communications. (1999). Stortingsmelding nr.46 (1999-2000), Nasjonal transportplan 2002-2011 [White paper no. 46 (1999-2000). The National Transport Plan 2002-2011]. Retrieved from https://www.regjeringen.no/no/dokumenter/stmeld-nr-46-1999-2000-/id193608/.

Moen, B. E., & Rundmo, T. (2006). Perception of transport risk in the Norwegian public. *Risk Management, 8*(1), 43–60.

Morset, R. B. (2019). Historie om hest. Fra maskulin arbeidskamerat til feminin rekreasjons– og hobbydyr. [Horse- story. From being a masculine fellow worker to a feminine recreation– and hobby-animal]. (Master degree). Norwegian University of Science and Technology, Faculty of Humanities, Trondheim. Retrieved from https://ntnuopen.ntnu.no/ntnu-xmlui/handle/11250/2612823.

Nordfjærn, T., Jørgensen, S., & Rundmo, T. (2011). A cross-cultural comparison of road traffic risk perceptions, attitudes towards traffic safety and driver behaviour. *Journal of Risk Research, 14*(6), 657–684.

Nordfjærn, T., & Rundmo, T. (2010). Differences in risk perception, priorities, worry and demand for risk mitigation in transport among Norwegians in 2004 and 2008. *Safety Science, 48*(3), 357–364.

Pinzke, S., & Elgåker, H. (2008). *Trafiksäkerhet till häst*. Alnarp: Lantbrukets arbetsmiljö.

Samferdselsdepartementet. (2017). White Paper no. 33 (2016–2017). The Norwegian National Transport Plan 2018–2029. Oslo: Ministry of Transport and Communications.

Şimşekoğlu, Ö., & Lajunen, T. (2008). Social psychology of seat belt use: A comparison of theory of planned behavior and health belief model. *Transportation Research Part F: Traffic Psychology and Behaviour, 11*(3), 181–191.

Şimşekoğlu, Ö., Nordfjærn, T., & Rundmo, T. (2012). Traffic risk perception, road safety attitudes, and behaviors among road users: A comparison of Turkey and Norway. *Journal of Risk Research, 15*(7), 787–800.

Sjöberg, L. (2000). Factors in risk perception. *Risk analysis, 20*(1), 1–12.

Slovic, P. (1992). Perception of risk: Reflections on the psychometric paradigm.

Statistics Norway. (2015). Road Traffic Accidents with personal injury, 2014. Retrieved from https://www.ssb.no/transport-og-reiseliv/statistikker/vtu/aar/2015-05-29).
Thompson, K., & Matthews, C. (2015). Inroads into equestrian safety: Rider-reported factors contributing to horse-related accidents and near misses on australian roads. *Animals, 5*(3), 592–609.
Trump, D., & Parkin, J. (2020). Equestrian road collisions: An analysis of the collision record, riding behaviours and experiences. *Safety Science, 123* 104523.
Ulleberg, P., & Rundmo, T. (2003). Personality, attitudes and risk perception as predictors of risky driving behaviour among young drivers. *Safety Science, 41*(5), 427–443.
Vik, J., & Farstad, M. (2012). Hest, hestehold og fôring: Status for hesteholdet i Norge. Kommentert frekvensrapport. [Horse, Horse-husbandry and Feeding: Status about the Horse-husbandry in Norway. Annotated frequency report] Retrieved from Trondheim: https://ruralis.brage.unit.no/ruralisxmlui/handle/11250/2367791.
Weseth, G. (2007). Glimt fra mekaniseringen av vårt landbruk 1850-2000 [Focus on the mechanization of our agriculture 1850-2000]. Ås: Norsk landbruksmuseum [The Norwegian Agriculturel Museum].