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Risk perception, worry, and pedestrian behaviour in the Norwegian population

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ABSTRACT

The aim of the study was to investigate the association between pedestrians' risk perception and worry, and how worry influence pedestrians' behaviour. Worry is regarded as a feeling that emerges as a result of an individual's cognitive assessment of risk. The study was based on a questionnaire survey carried out among a representative sample (n = 2000) of the Norwegian population. The results showed differences in how people perceived risk and how worried they were about being exposed to different hazards (traffic accident, harassment, theft, and terror) as a pedestrian during night-time and daytime. As expected, pedestrians perceived their risk as higher and were more worried being exposed to hazards during night-time than in daytime. Structural equation modelling (SEM) revealed that risk perception was a significant predictor variable for worry during both night-time and daytime. Additionally, worry was found to influence pedestrian behaviour. Worry was moderately associated with walking frequency during night-time, and how often individuals walked alone outdoors during night-time. These associations were stronger for people without access to a private car. No associations were found between worry and walking frequency during daytime. The results of the study contribute to the understanding of the association between pedestrians' risk perceptions and worry, and how worry influence walking frequency. From both a pro-environmental and a health promoting perspective, it is important that people choose to walk or cycle for their daily travels.

1. Introduction

In traffic safety research, pedestrians are defined as vulnerable road users, in common with cyclists and motorcyclists, because they have the highest risk in traffic compared with all other road users (Peden et al., 2004). Nevertheless, active travel, such as walking and cycling, is given high priority in European transport policy. Active travel is seen as a key solution to solve health problems in the population and to reduce environmental problems, both local air pollution and carbon dioxide emissions due to fossil fuel usage. Due to the risk factors and the aim to increase the numbers of people using active transport, priority should be given to examining pedestrians' risk perception and worry. Consequently, the aim of the present study was to investigate what worried pedestrians, the association between their perceived risk and worry, and whether worry is associated with the decision to walk for daily travels.

1.1. Aims of the study

The specific aims of the study were as follows: (1) to examine differences in worry and risk perception related to being a pedestrian during night-time and daytime; (2) to examine the direct and indirect associations between risk perception, risk protection, risk tolerance, previous accidents and assault experiences, and worry being a pedestrian; (3) to compare the role of risk perception in worry about being involved in an accident, and/or experiencing harassment, theft, and terrorism; (4) to examine the association between worry and walking frequency as a pedestrian during night-time.

1.2. Risk perception and worry

Social cognition theory and models have dominated risk perception research and there is a need for more studies that include a focus on the role of emotions in perceived risk as well as in decisions under uncertainty. According to Breakwell (2007), 'an analysis of risk perception and decision-making that fails to consider the affect attached to a hazard, or the emotional state of the individual, is inevitably flawed.' To have a full understanding of individuals' risk assessment, both cognition and emotions should be included in research.

Affective processes have received increased attention in risk

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perception research. The risk-as-feeling approach highlights the role of emotions, e.g. worry, in risk decisions (Loewenstein et al., 2001). This approach distinguishes between two types of emotions that are important for risk perception: anticipatory and anticipated emotions. Anticipatory emotions are immediate visceral reactions to risk, such as worry, fear, anxiety, and dread. Anticipated emotions are those that the individual expects to feel as a consequence of a decision. There are two types of anticipatory emotions: integral emotions and incidental emotions. Integral emotions are caused by the decision problem itself, whereas incidental emotions are caused by other factors, such as mood (Loewenstein and Lerner, 2003).

It is well recognized that hazards often engender worry. Worry is an emotional state that is stimulated by the anticipation of a negative outcome that is uncertain and may happen in the future. According to Breakwell (2007) worry is by definition associated with risk. In this article, worry is conceived as an anticipatory emotion and integral to the decision problem, which implies that worry is defined as a feeling that emerges as a reaction to the individual's cognitive assessment of risk. Accordingly, in this article, we aim to examine the association between people's perceived risk and anticipatory feelings of worry as pedestrians.

Risk perception and worry are primarily interesting because they may be related to people's behavioural choices. According to the risk-as-feeling approach, behaviour is influenced by the interplay between cognitive evaluations of risk and feelings. Further, emotions often produce behavioural responses that differ from the individual's cognitive assessment of the best course of action. When such divergence occurs, it appears that behaviour is driven by emotional reactions, not by the cognitive assessment (Loewenstein et al., 2001). Loewenstein et al. (2001) argue that in contrast to cognitive evaluations, anticipatory emotions such as worry and fear are largely insensitive to changes in probabilities. To illustrate this, they refer to different experiments in which subjects were given information about probability estimates for winning a lottery, receiving an electric shock, or investing money. The results of the experiments showed that changes in probability estimates did not influence the emotional state of the research subjects. This effect is known as the certainty effect, and it supports the risk-as-feeling hypothesis, which suggests that people will be less insensitive to probability variations in emotional outcomes than other outcomes.

In contrast to the findings of Loewenstein et al. (2001); Baron et al. (2000) found that worry was largely affected by probability judgements, especially among laypersons, and that the desire for action was mainly determined by worry and probability judgements. Their study included 32 different risk sources, each of which was defined in terms of a cause and outcome (e.g. injury or death from an automobile accident). For each risk, the respondent was asked (among other questions) to give probability estimates, to estimate the badness of the outcome, number of persons affected, and evaluate how much he or she worried about the risk. Accordingly, in the present study, we investigated the role of the probability assessments, the assessments of severity of the consequences and the feeling of worry.

Several studies of parental worry about children as pedestrians have been conducted (Peterson et al., 1990; Salmon et al., 2007; Mammen et al., 2012). Mammen et al. (2012) investigated differences in parental worry about children's school travel. They found out that parents who escorted their children to school worried more than other parents about the possibility of strangers and bullies approaching their child and the traffic volume around the school. Salmon et al. (2007) found an association between the child's use of active transport to school and parents' concern that their child may be injured in a road accident. Peterson et al. (1990) investigated parents' feelings of worry about different types of injury, including their children being injured by a motor vehicle when walking. Overall, the results showed that parents reported low feelings of worry about injuries.

Rosenbloom et al. (2011) investigated risk perception in relation to the possibility of sustaining an injury when crossing the road while in a fatigued state compared with a non-fatigued state. They divided their sample randomly into two groups, and participants in one group were asked one question about their perceived risk of being involved in a road accident after a sleepless night. Participants in the other group had the same question but without the last part of the sentence, 'after a sleepless night'. No differences in perceived risk were found between the two groups.

In contrast to studies that have examined road crashes, few studies have focused on the association between built environments and perceived risk. In their study, Kononov et al. (2007) argued for using data about road users perceived risk, as well as calculated risk in transport planning. They found that crash data only provided accident frequency and allowed for severity comparisons, but did not provide any information about the nature of the studied safety problem. Cho et al. (2009) examined how perceived risk and accident rates are related to each other, to built-environment characteristics, and to pedestrians' and cyclists' safety. Their results showed that residents who lived in low density-single residential neighborhoods were more likely to perceive their neighborhood as dangerous relative to residents of compact, mixed-use neighborhoods, even though the latter exhibited higher actual crash rates. Painter (1996) studied pedestrians' feelings of fear and about street use after dark. She found that street lightning might lead to a reduction in fears of crime and might increase pedestrians' use of streets after dark. Rankavat and Tiwari (2016) examined pedestrians' perception of convenience and safety while crossing the road in Delhi. Their study showed the use of zebra crossings were positively correlated with convenience perception and not correlated with safety perception.

Several previous studies have examined risk perception and worry related to accidents in relation to travel mode. For instance, Moen and Rundmo (2006); Oltedal and Rundmo (2007) and Roche-Cerasi et al. (2013) included walking as well as other travel modes when investigating perceptions of risk and worry. Both Moen and Rundmo (2006) and Oltedal and Rundmo (2007) found that their respondents reported they were less worried about being in an accident as a pedestrian compared with using other private travel modes. The respondents also perceived the probability of being in an accident as the lowest as a pedestrian compared with the other private transport modes about which they were asked (car, motorcycle, scooter, bicycle). Another interesting finding from the two aforementioned studies was that the respondents reported that the consequences of being in an accident were greater when walking than when cycling, but still lower than when using motorized transport modes. Roche-Cerasi et al. (2013) also included respondents' risk perception of and worry about experiencing a terrorist attack and experiencing physical assault, as well as accidents. They compared differences in risk perception and worry regarding the use of private travel modes (including pedestrians) and public travel modes, and did not solely examine pedestrians. The results of the study showed that the respondents perceived the probability as higher and the consequences if being involved in an accident as greater, and were more worried about being involved in an accident when using private travel modes than when using public modes of transport. The respondents were more worried about experiencing violence when using public travel modes than when using private travel modes. Kummeneje et al. (2019) have studied risk perception and worry when cycling, and seasonal cycling behaviour. They found that risk perception and worry were strong predictors of cycling frequency during wintertime. To the authors of the present article's knowledge, no studies to date have solely investigated worry and risk perception among pedestrians, and the associations between worry, risk perception and pedestrian behaviour.

1.3. Risk tolerance, risk protection, and previous experiences

It is important to investigate how risk is tolerated by individuals, and to what extent they think they can protect themselves against the

risk. Individuals may differ in their thresholds for the degree of risk they find acceptable. The original impetus for the psychometric paradigm came from Starr (1969), in his effort to answer the question 'How safe is safe enough?' He measured the level of risk that individuals found acceptable for different activities, and found that activities that were voluntary and perceived as beneficial were tolerated more than other activities. In a study conducted by Fischhoff et al. (1978), respondents were asked to judge the acceptable level of risk associated with different activities or technologies. The researchers found that risk was less tolerated when the activities were associated with dread. Fischhoff et al. (1978) also found that higher risk levels were tolerated for voluntary activities with well-known and immediate consequences.

Risk protection refers to how the individual considers the possibility to protect himself or herself against risk. The perceived controllability of the risk has previously found important for individuals' perception of risk (Higgins et al., 1997), and people tend to rate a risk as lower when they think they have control over it. Previous experience of accidents and assaults can influence the individual's perceived risk and feeling of worry. This was found in a study that we conducted out recently (Kummeneje and Rundmo, 2018). Kummeneje and Rundmo (2018) found that individuals that had experienced an accident as a cyclist perceived the risk of being in an accident as higher than did the other individuals. They also tended to be more worried about being involved in an accident when cycling. Accordingly, in this article, we hypothesize that risk tolerance, risk protection, and previous negative experiences are associated with risk perception and worry.

2. Methods

2.1. Sample

The study was based on a telephone questionnaire survey carried out among a randomly selected sample of the Norwegian population aged 15 years or older. The data collection was carried out in spring 2017. The final sample was a representative sample of the Norwegian public and included 2000 respondents. The response rate was 27%. There were 43% females and 57% males in the sample. The respondents' age was in the ranged from 15 years to 88 years (mean = 45.38, standard deviation = 17.56). A total of 28% of the respondents reported they had more than three years of university education, 29% had three years or less of university education, 35% had received their highest level of education at upper secondary school, and 9% had primary or secondary school as their highest level of education. A total of 62% reported that they were employed or self-employed, and 10% were students. The remaining respondents were pensioners, benefit recipients, or homemakers. A total of 10% of the respondents reported that they did not have a driving license, and 13% did not have access to a car or other motorized vehicle.

2.2. Questionnaire and measure instruments

The questionnaire (see Appendix A) asked the respondents to evaluate their perception of risk and worry about being involved in an accident, as well as non-accidental risks (theft, harassment, and acts of terrorism) as a pedestrian during night-time and daytime. Additionally, they were asked about how they tolerated being exposed to risk (risk tolerance) as a pedestrian, and to what extent they thought it was possible to protect themselves against the risk (risk protection). The questionnaire also contained questions about the respondents' age, gender, employment status, highest level of completed education, driving licence, motorized vehicles at their disposal, walking frequency, and their accident and assault experiences as a pedestrian.

To measure risk perception, the respondents were asked to assess their probability of experiencing four different hazards (accident, theft, harassment, or acts of terrorism), and to judge the severity of the consequences if such an event were to take place. The scale for measuring the probability assessments was a five-point evaluation scale ranging from 'not at all probable' to 'very probable'. For the judgement of severity of the consequences, the scale ranged from 'not at all serious' to 'very serious'. To measure worry, the respondents were asked to rate how worried they were about experiencing each of the four hazards as a pedestrian, and the measurement scale ranged from 'not at all worried' to 'very worried'. To measure risk tolerance, the respondents were asked: 'To what extent do you tolerate being exposed to risk as a pedestrian?' The five-point evaluation scale ranged from 'tolerate the risk absolutely' to 'do not tolerate any risk'. To measure risk protection, the respondents were asked: 'To what extent do you think it is possible to protect yourself against risk as a pedestrian?' The five-point scale ranged from 'very possible' to 'not at all possible'.

To measure walking frequency, the respondents were asked how often they walk outside during night-time and daytime each season (winter, spring, summer, and autumn). For this measurement, a six-point evaluation scale was applied: 5 or more times per week; 3–4 times per week; 1–2 times per week; Monthly; Rarely; and Never. Previous studies have found the same measure appropriate (Kummeneje and Tretvik, 2015; Kummeneje and Rundmo, 2018; Kummeneje et al., 2019). The respondents that answered that they more than monthly walk outside during night-time, were further asked if they walk alone (without a family member, friend or dog). A three-point evaluation scale was applied: Often; Sometimes; and Never.

To measure accident experience, the respondents were asked whether they had been involved in an accident as a pedestrian during the last two years, including single accidents (i.e. accidents with no other road users involved). If they reported being in an accident, they were further asked whether other road users (e.g. cyclist, pedestrian, motorized vehicle) were involved and whether they needed medical treatment after the accident. To measure assault experiences, the respondents were asked whether they had experienced being physically assaulted as a pedestrian during the last two years. If they answered 'yes' to this question, they were further asked whether they had needed medical treatment after the experience.

2.3. Statistical analysis

Paired sample t-tests were used to compare the respondents' risk perception (perceived probability and severity of consequence) and worry as a pedestrian during night-time and daytime. Structural equation modelling (SEM) was done to predict worry about being a pedestrian during night-time and daytime. To examine the fit of the model to the data, the Root Mean Square Error of Approximation (RMSEA), the Standardized Root Mean Square Residual (SRMR), and a comparative fit index (CFI) were used. In addition, the Chi-square degrees of freedom ratio were calculated (χ^2/df). A RMSEA of 0.07 or less was considered to indicate a satisfactory fit between the model and the data. For SRMR, a value below .08 is considered a good fit. A CFI above 0.90 was considered indicative of a satisfactory fit. The same was the case for an X^2/df ratio of 4:1. Eight multiple regression analyses were used to predict worry as a pedestrian during night-time and daytime for each of the four different hazards (accident, theft, harassment, and acts of terrorism). The multiple regression analyses are used as exploratory analyses for further research. In the multiple regression analysis, all the variables that originally was hypnotized as predictor variables are reported. The predictor variables were entered into the models with an enter procedure. The calculation of the contribution of each predictor to the R-square value was as follows:

$$R^2 \cdot 100\% = \sum_{i=1}^{6} \beta \cdot r \cdot 100\%$$

β is the standardized beta coefficients, r is the Pearson's r correlation.

The variables measuring worry about the four different hazards were summarized to one variable for daytime and another variable for night-time. These variables were used to examine the association

Table 1a
Worry experienced as a pedestrian during night-time and daytime (%), Worried, high (5-3), Worried, low (2), Not worried (1), n = 2000.

	Accident		Theft			Harassment		Terrorism	
	Night	Day	Night	Day		Night	Day	Night	Day
Worried, high	22	9	20	5	19	6	14	7	
Worried, low	26	13	24	11	21	10	12	9	
Not worried	53	78	55	84	59	84	74	84	

between worry and behaviour. Four different ANOVAs (analyses of variance) were conducted to examine the association between worry and walking frequency during night-time in different seasons of the year. An additional ANOVA analysis was conducted to find the association between worry and how often the respondents walked alone during night-time.

3. Results

3.1. Worry as a pedestrian during night-time and daytime

The results presented in Table 1a show differences in how worried the respondents were about being a pedestrian during night-time and daytime. They were more worried about experiencing an accident, theft, harassment, and terrorism as a pedestrian during night-time than in daytime. The majority of the respondents (78–84%) reported they were not worried about being exposed to a hazard as a pedestrian during daytime. By contrast, between 53–74% of the respondents reported they were not worried about the hazards as a pedestrian during night-time.

Comparatively more respondents felt worried about being involved in an accident as a pedestrian than about experiencing the other three hazards (theft, harassment, and terrorism), both in night-time (48%) and daytime (22%). There were small differences in their worry about experiencing theft (16%), harassment (16%), or terrorism (16%) during daytime. By contrast, for night-time, the results showed that 44% of the respondents felt worried about experiencing theft, 40% about harassment, and 26% about terrorism. It is interesting to note that for night-time, the respondents reported they were least worried about experiencing acts of terrorism. After accidents, daytime acts of terrorism worried them the most. Table 1b shows the mean values in the respondents' assessment of risk and worry being a pedestrian during daytime and night-time.

The paired sampled *t*-test showed significant differences in the respondents' perceived risk and worry for all four hazards. The respondents perceived the risk associated with being a pedestrian during night-time as greater than during daytime. This was the case for both the subjective assessment of the probability and the respondents' judgement of the severity of consequences. Further, the results revealed that the judgement of the severity of consequences had relatively high scores compared with the probability assessments. This was the case for all four hazards. The incident with the highest perceived probability was being involved in a traffic accident during night-time, while experiencing acts of terrorism during daytime was perceived as least probable. The severity of consequences was judged as most serious for experiencing acts of terrorism during night-time, and least serious for being harassed during day-time. The standard deviations for all of the variables were relatively high and revealed variations in the respondents' perceived risk and worry. With regard to worry and the probability assessment scores, the variations were higher for daytime than for night-time.

Table 1b
Differences in worry and risk perception as a pedestrian during night-time and daytime, scales form 1 to 5, 1 = not at all worried; 5 = very worried / 1 = not at all probable; 5 = very probable / 1 = not at all serious; 5 = very serious, n = 2000.

		Worry		Probability		Consequence	
		Mean	SD	Mean	SD	Mean	SD
Accident	Night	1.82	1.036	2.16	1.015	2.99	1.252
	Day	1.37	.788	1.68	.928	2.90	1.270
	t-value	−24.450		−22.817		−4.109	
	(sig. 2-tailed)						
Theft	Night	1.77	1.010	1.98	1.040	2.64	1.218
	Day	1.26	.670	1.40	.750	2.26	1.150
	t-value	−27.683		−28.616		−17.860	
	(sig. 2-tailed)						
Harassment	Night	1.74	1.038	1.94	1.103	2.50	1.279
	Day	1.26	.665	1.42	.786	2.05	1.136
	t-value	−25.819		−26.217		−23.103	
	(sig. 2-tailed)						
Terrorism	Night	1.51	1.000	1.41	.814	3.20	1.648
	Day	1.29	.761	1.24	.634	3.10	1.686
	t-value	−13.337		−11.731		−5.122	
	(sig. 2-tailed)						

*p < .05 **p < .01, ***p < .001.

3.2. Model for predicting worry about being a pedestrian during night-time and daytime

Next, we examined a model for predicting worry about being a pedestrian during night-time and daytime (Fig. 3), which included both direct and indirect associations between risk perception, worry, previous experiences, risk protection, and risk tolerance. Demographics contributed very little to the explained variance and were not included in the model. Overall, the model explained an acceptable proportion of the variance in worry about being a pedestrian during night-time (R^2 = .81) and during daytime (R^2 = .64).

As shown in Fig. 3, risk perception was a strong predictor of worry about being a pedestrian during both night-time and daytime. Risk tolerance, risk protection, accident experience, and assault experience were indirectly associated with worry. The results showed that individuals that had experienced an accident or assault as a pedestrian during the last two years, perceived their risk of being involved in a negative incident as higher than did the other individuals. Both accident experience (night-time β = .10; daytime β = .07) and assault experience (night-time β = .11; daytime β = .14) significantly influenced the perceived risk being a pedestrian during night-time and daytime. Risk protection and risk tolerance were found to be significantly related to perceived risk when being a pedestrian during night-time and daytime. The perceived risk increased when the respondent assessed the possibility of protecting himself or herself against the risk as small (night-time β = -.20; daytime β = -.18). The more the respondent tolerated being exposed to risk, the lower they perceived the risk when exposed to hazards as a pedestrian (night-time β = -.18; daytime β = -.16). The associations between risk tolerance and risk protection were found to be significant, which indicates that people who experience that they can protect themselves against risk will tolerate more risk. There was also a significant association between accident experience and assault experience, which indicates that people who have been involved in an accident as a pedestrian have more often also experienced assault as a pedestrian than have others. The fit of the model to the data was acceptable both for night-time (χ^2/df = 3.994, RMSEA = .039, CFI = .991, SRMR = .019) and daytime (χ^2/df = 4.366,

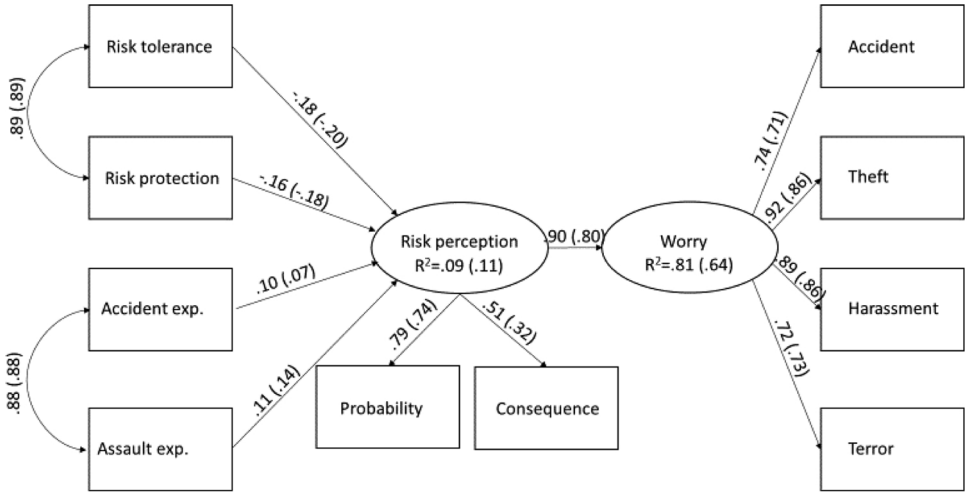

Fig. 1. Heuristic path model for predicting worry as a pedestrian during night-time (daytime), n = 2000.
χ^2/df = 3.994, RMSEA = .039, CFI = .991, SRMR = .019.
(χ^2/df = 4.366, RMSEA = .041, CFI = .986, SRMR = .023).

RMSEA = .041, CFI = .986, SRMR = .023).

3.3. Predictors of worry about being involved in an accident or incidents of harassment, theft, or terrorism

Exploratory analyses were conducted to investigate the contribution of the six predictor variables previously included in the SEM (see Fig. 1). Worry was entered into the analyses as a latent exogenous variable. Eight multiple regression analysis were carried out in order to examine the explained variance related to worry about each of the four types of hazards (accident, harassment, theft, and terrorism) separately. The first four analyses (see Fig. 2) aimed at predicting worry being a pedestrian during night-time. The last four analyses (see Fig. 3) aimed at predicting worry being a pedestrian during daytime. The figures show the contribution of each predictor to the R-square value. All eight models explained an acceptable amount of variance in worry (R^2 between .33 and .23).

The model was better for predicting worry about being a pedestrian during night-time than during daytime. The model explained the largest amount of the variance in worry about experiencing harassment during

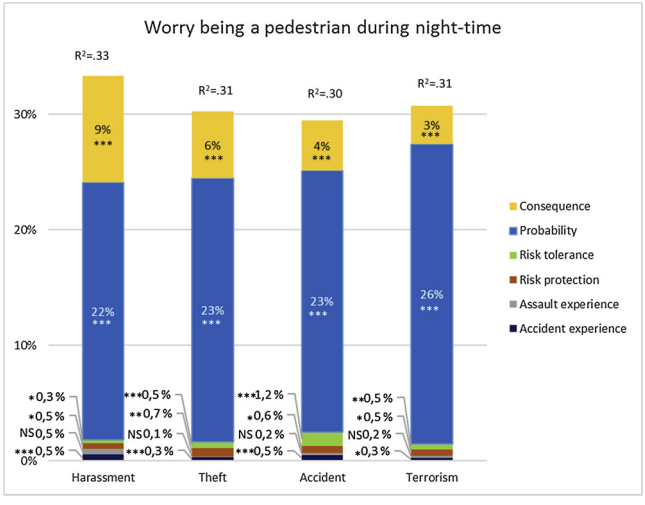

Fig. 2. Predictors of worry about being involved in incidents of harassment, theft, traffic accident, and terrorism as a pedestrian during night-time, the contribution of each predictor to the R-square value, n = 2000.
*p < .05 **p < .01, ***p < .001, NS = non-significant.

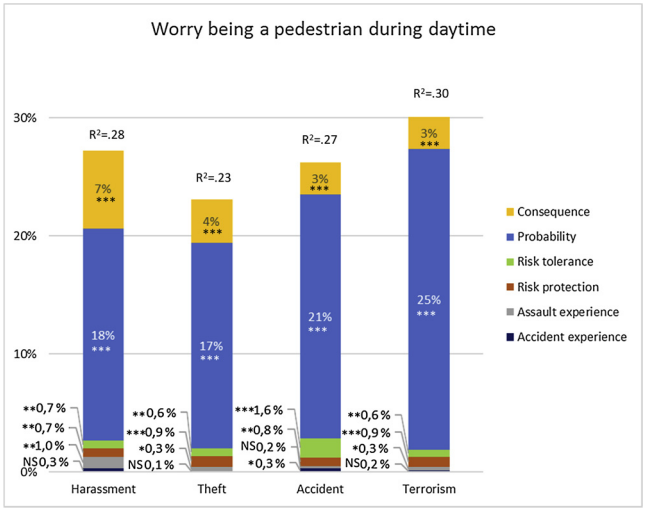

Fig. 3. Predictors of worry about being involved in incident of harassment, theft, traffic accident, and terrorism as a pedestrian during daytime, the contribution of each predictor to the R-square value, n = 2000.
*p < .05 **p < .01, ***p < .001, NS = non-significant.

night-time (R^2 = .33), and the model was least successful in explaining worry about theft during daytime (R^2 = .23).

The assessment of the probability of being involved in an adverse event was found to be the most important predictor of worry in all of the models. The probability estimates explained between 17% (theft during daytime) and 26% (terrorism during night-time) of the variance in worry. The judgment of severity of consequences was the second most important predictor of worry in the models. Severity of consequences was most important for predicting worry about harassment during both night-time (9%) and daytime (7%), and least important for predicting worry about being exposed to acts of terrorism during night-time (3%) and daytime (3%).

Further, the results showed that risk protection and risk tolerance were related to worry. For all four hazards, there were small differences in the influence of risk protection and risk tolerance between night-time and daytime. Risk tolerance was a more important predictor of worry about being involved in an accident (1% during night-time, 2% during daytime) compared with experiencing the other three hazards. For all of the hazards, risk protection was shown to be a more important predictor of worry about being a pedestrian during daytime (0.7–0.9%)

than during night-time (0.5–0.7%).

Additionally, previous experiences influenced worry, but were less important than were the other predictors. Accident experience was a more important predictor of worry about being a pedestrian during night-time compared with during daytime, especially with regard to being involved in an accident (0.5% during night-time, 0.3% during daytime) or experiencing harassment (0.5% during night-time, 0.3% during daytime). Assault experience was associated with worry about being harassed during daytime (0.5% during night-time, 1.0% during daytime), but was only to a low degree important for worry about experiencing or being involved in other types of hazards.

In preliminary analyses, we controlled for demographic variables. Gender was shown to be the most important predictor among the demographic variables for worry about being a pedestrian (1–2% of the explained variance). Education level was shown to be associated with worry about experiencing terror attack (0.9% during night-time, 0.6% during daytime), but was not as important as for the other three types of hazard. Age was most important for worry about being involved in an accident (0.8%) and experiencing theft (0.9%) during night-time, and not as important as for other types of hazards. Overall, the results showed that demographic variables to a little extent contributed to the explained variance in worry and demographics were not included in the final models (Figs. 2 and 3).

To summarize, the results showed that risk perception was strongly related to worry for all four hazards (accident, harassment, theft, and terrorism), both during night-time and daytime. Especially, the probability estimates were important for worry about being a pedestrian, but the perceived severity of consequences was as well highly important for worry about being a pedestrian.

3.4. The association between worry and behaviour

According the results from the SEM models, worry about 'accidents', 'harassment', 'theft', and 'terrorism' could be seen as part of the same factor. All of the four variables have strong factor loadings. Accordingly, the variables measuring worry about the four different hazards were summarized to one variable for daytime and another variable for night-time. Worry was shown to be associated with how often the respondents chose to walk to their travel destinations during night-time, and whether they chose to walk alone. We did not find the same correlation between worry and walking frequency during daytime. Table 2 shows the association between worry and walking frequency during night-time for the different seasons of the year. The whole sample is included in the results. The more worried the respondents were, the less frequently they walked.

Table 2 shows that worry was weakly to moderately associated with walking frequency during night-time for all four seasons. Worry was most important for walking frequency during winter and least important for walking frequency during summer. Table 3 shows the association between worry and walking frequency during night-time for respondents who did not have access to a car.

Worry was more important for walking frequency for respondents without a car, and the correlations were stronger for all four seasons compared with respondents who had a car at their disposal. Those who reported that they walked outdoors during night-time were further asked whether they walked alone. The results for all who responded 'yes' to walking alone and who did not have an access to a car are presented in Table 4.

Worry about being a pedestrian was important for respondents who chose to walk alone during night-time. When all respondents were included in the analysis, the correlations were significant but weak. For individuals without an access to a car the correlations between worry and never walking alone during night-time were moderate to strong.

Table 2
Worry about being a pedestrian during night-time, and walking frequency, scale from 4 to 20, 4 = not at all worried of any of the four hazards; 5 = very worried about all four hazards, n = 2000.

		Worry, night-time			Cohen's d		
		Mean	SD	N	1-2	1-3	2-3
Winter	1 Daily	5.91	3.031	264	−.21	−.41	−.22
	2 Weekly	6.57	3.197	1159			
	3 Rarely	7.35	3.996	577			
	F (sig.)	18.341					
Spring	1 Daily	6.07	3.067	359	−.20	−.31	−.13
	2 Weekly	6.72	3.329	1211			
	3 Rarely	7.18	3.998	430			
	F (sig.)	10.288					
Summer	1 Daily	6.40	3.307	486	−.10	−.19	−.10
	2 Weekly	6.73	3.367	1208			
	3 Rarely	7.09	3.967	306			
	F (sig.)	3.896					
Autumn	1 Daily	6.05	3.113	324	−.20	−.33	−.15
	2 Weekly	6.69	3.309	1260			
	3 Rarely	7.26	4.019	416			
	F (sig.)	11.252					

*p < .05 **p < .01, ***p < .001.

Table 3
Worry about being a pedestrian during night-time, and walking frequency (no car), scale from 4 to 20, 4 = not at all worried of any of the four hazards; 20 = very worried about all four hazards, n = 297.

		Worry, night-time			Cohen's d		
		Mean	SD	N	1-2	1-3	2-3
Winter	1 Daily	6.67	3.42576	54	−.24	−.59	−.40
	2 Weekly	7.48	3.42835	186			
	3 Rarely	9.16	4.92729	57			
	F (sig.)	6.624					
Spring	1 Daily	6.78	3.43643	72	−.23	−.62	−.43
	2 Weekly	7.59	3.52246	184			
	3 Rarely	9.49	5.09962	41			
	F (sig.)	6.872					
Summer	1 Daily	7.27	3.70838	104	−.08	−.49	−.43
	2 Weekly	7.56	3.53473	163			
	3 Rarely	9.47	5.21095	30			
	F (sig.)	4.008					
Autumn	1 Daily	6.98	3.57012	64	−.15	−.56	−.44
	2 Weekly	7.53	3.51033	196			
	3 Rarely	9.49	5.22080	37			
	F (sig.)	5.483					

*p < .05 **p < .01, ***p < .001.

Table 4
Worry about being a pedestrian during night-time, and walking alone, scale from 4 to 20, 4 = not at all worried of any of the four hazards; 20 = very worried about all four hazards.

		Worry, night-time			Cohen's d		
		Mean	SD	N	1-2	1-3	2-3
All n = 1845	1 Often	6.36	3.217	907	−.13	−.27	−.17
	2 Some times	6.78	3.246	681			
	3 Never	7.41	4.087	257			
	F (sig.)	10.504					
No car n = 283	1 Often	7.30	3.653	160	−.07	−.63	−.58
	2 Some times	7.55	3.444	98			
	3 Never	9.92	4.600	25			
	F (sig.)	5.308					

*p < .05 **p < .01, ***p < .001.

4. Discussion

The results showed that worry could be seen as an anticipatory integral emotion caused by the cognitive evaluation of risk. This finding is in accordance with findings by Loewenstein et al. (2001). There was a significant strong association between risk perception and worry. The exploratory regression analysis showed that the perceived probability of being exposed to a hazard was a more important predictor variable of worry than the judgement of the severity of consequences. This finding is in accordance with the finding made by Baron et al. (2000), but in contrast to Loewenstein et al. (2001) that argue that the perceived severity of consequences is a more significant predictor variable for emotions such as worry. However, the role of subjective assessments of probability and severity of consequences may depend on the type of risk source evaluated. Previous studies have not focused on pedestrians, and the association between risk perception and worry among pedestrians has not been examined previously. The results of the present study indicate that the majority of Norwegians perceive the risk of being a pedestrian as low. If the probability estimates are low, it is conceivable that individuals give less attention to their perception of the severity of consequences. This could be a reason for the strong association we found between the probability estimates and worry. Further research should clarify the relationship between probability and severity of consequence estimates, and worry.

In the present study, both risk perception and worry seemed to have been influenced by external factors (accident involvement and assault experience), as expected. This is in accordions with Kummeneje and Rundmo (2018) that found that individuals that had experienced a bicycle accident during the last two years perceived their risk as higher and tended to be more worried about being involved in an accident when cycling than did other individuals. In the present study, it was not asked about the date of the incidents. It is reasonable to assume that the more recent the individual has experienced assault or been involved in an accident, the higher they would perceive the risk of the same incident happening again. These associations were not possible to test in the present study, but would be worth studying in future research.

The results showed a moderate association between worry and behaviour. Worry was measured in relation to accidents and three different security problems (harassment, theft, and terrorism). The type of anticipatory worry that was measured consider these specific factors. On the other side, behaviour was measured as how often the respondents walk in general. With these conditions, strong correlations were not expected. A moderate negative association between worry and walking frequency was found, as expected. In general, the group without access to a car is more worried about being exposed to the risk being as a pedestrian than others. A possible explanation for this may be that people that are more exposed to the risk will be more worried than people that to a little extend are being exposed to the same risk. Individuals without access to a car are also walking more often on their daily travels than others. A further interesting finding was that the association between worry and walking frequency during night-time was stronger for individuals without access to a car. Those who have no car and answered that they rarely walk outdoors during night-time is a group who severely worried about walking at night. This group worry more about hazards being a pedestrian than the general public. Sever worry in this group results in rarely walking outside at night. From the results we cannot conclude that not having access to a car results in more worry in this group because they to a little extend are being exposed to the risk being a pedestrian. The results show that the proportion of the group that answer that they sometimes walk alone at night is bigger in the group that does not have a car compared to the whole sample. Individuals without access to a car are more dependent of safe environment for pedestrians than others because they have no choice about being exposed to risk while on their daily travels. Because they do not have access to a car, most of them have no other choice than walk at night sometimes even though they worry about hazards. There is a need for more research to explain the association between worry as a pedestrian and access to a car.

Worry was found especially important for walking frequency during night-time in winter. Hence, measures such as better street lighting may increase the number of pedestrians in certain areas. Measures that reduce pedestrians' feelings of worry about being involved in an accident could be separate pathways for vulnerable road users. This might reduce pedestrians' perceived probability of being involved in an accident. Earlier research has shown that people perceive themselves as less likely to experience an accident as a pedestrian than people in general (Moen and Rundmo, 2006), and it is therefore reasonable to assume that people will tolerate less risk exposure for persons for whom they are responsible, such as children. Measures that reduce vulnerable road users' perception of risk could also influence where children use active transport modes, and reduce the numbers of parents who drive their children to school.

Two methodological issues should be focused in future research. The first relates to the scales used to measure risk tolerance (risk acceptance) and risk protection. These variables are usually measured on a relative scale where the respondents are asked to compare different types of risks (e.g. risk tolerance or risk protection related to different modes of transport, different types of hazards, or different conditions) (e.g. Moen and Rundmo, 2004; Kummeneje et al., 2019). In the present study the respondents were only asked one question about risk tolerance and one question about risk protection. A one question scale might be more open to interpretation by different respondents than a relative scale. The second methodological issue relates to the measurement of worry. The variables measuring worry about being a pedestrian were measured with Likert-type five-point scales. The use of such scales does not fully satisfy the requirements of criterion variables in multiple regression analysis. However, Likert-type scales with five or more categories are often used as criterion variables in survey research analysing measurements of subjective judgements (Norman, 2010; Sullivan and Artino, 2013). This should be an issue more suitable for basic measurement research than for applied research in the area of transport safety and security.

The response rate of the present study was low (27%). Relatively low response rates are common in transport population studies (e.g. Backer-Grondahl et al., 2009; Castanier et al., 2012; Moan, 2013) probably partially due to the low immediate personal salience of the research topic (Galea and Tracy, 2007). However, low response rates only constitute a methodological problem if the overall sample is not representative of the target population (Krosnick, 1999). Demographic characteristics were compared with the Statistics Norway (2015) registry that showed that there were no serious violations between our sample and the population. The youngest age group (15–29 years) were slightly underrepresented compared with other age groups, and females were underrepresented relative to males. When we compared the study sample with the National Travel Survey (Hjorthol et al., 2014) we found similarities in the demographic characteristics. In the present study, 10% of the respondents reported that they did not have a driving license, and 13% did not have a motorized vehicle at their disposal. This finding is in accordance with the one reported by Hjorthol et al. (2014) that found that 91% of the Norwegian population have a driving license and that 88% of the population have access to a car or other motorized vehicle.

5. Conclusions

The present study has shown that the respondents perceived their risk as higher and tended to be more worried about hazards (accidents, harassment, theft, and terrorism) as pedestrians during night-time than during daytime. Furthermore, the results showed that previous accident involvement and assault experience had an indirect effect on worry. Respondents who had previous experience of being involved an accident or had experienced assault perceived the risk of walking as higher

than respondents without these experiences, and tended to be more worried being exposed to hazards. Both risk tolerance and risk protection were associated with risk perception, which in turn influenced how worried the respondents felt about being pedestrians. Finally, the results showed that worry influenced how often the respondents walked outdoors during night-time. We did not find the same correlation between worry and walking frequency during day-time as we found for night-time. This association was stronger for individuals without access to a car.

The results of our study contribute to the understanding of the association between risk perceptions of and worry about being a pedestrian, and how worry influences walking frequency. From a pro-environmental perspective as well as a health promoting perspective, it is important that people choose to walk or cycle for their daily travels. The results of our study of worry about being a pedestrian may be important in the work with increasing the frequency of such behaviour. Interventions that aim to include all transport users could be ineffective if they do not take into account that the risk of being exposed to a hazard is perceived differently between different groups in the population. It is especially important to reduce the perceived risk and worry for people without access to a car. People who are dependent on public transport are also dependent on a safe environment for pedestrians.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Questionnaire about risk perception, worry, and travel behaviour among pedestrians

1
- 1 How often do you walk outside during daytime in …
  - a Winter (5 or more times per week; 3–4 times per week; 1–2 times per week; Monthly; Rarely; Never)
  - b Spring (5 or more times per week; 3–4 times per week; 1–2 times per week; Monthly; Rarely; Never)
  - c Summer (5 or more times per week; 3–4 times per week; 1–2 times per week; Monthly; Rarely; Never)
  - d Autumn (5 or more times per week; 3–4 times per week; 1–2 times per week; Monthly; Rarely; Never)
- 2 How often do you walk outside during night-time in …
  - a Winter (5 or more times per week; 3–4 times per week; 1–2 times per week; Monthly; Rarely; Never)
  - b Spring (5 or more times per week; 3–4 times per week; 1–2 times per week; Monthly; Rarely; Never)
  - c Summer (5 or more times per week; 3–4 times per week; 1–2 times per week; Monthly; Rarely; Never)
  - d Autumn (5 or more times per week; 3–4 times per week; 1–2 times per week; Monthly; Rarely; Never)
- 3 The respondents that answered that they more than monthly walk outside during night-time, were further asked: How often do you walk outside during night-time alone (without a family member, friend or dog)? (Often; Sometimes; Never)
- 4 How probable do you think it is that you will experience the following hazards when walking in daytime…
  - a Accident (1 = not at all probable; 5 = very probable)
  - b Theft (1 = not at all probable; 5 = very probable)
  - c Harassment (1 = not at all probable; 5 = very probable)
  - d Acts of terrorism (1 = not at all probable; 5 = very probable)
- 5 How probable do you think it is that you will experience the following hazards when walking in night-time…
  - a Accident (1 = not at all probable; 5 = very probable)
  - b Theft (1 = not at all probable; 5 = very probable)
  - c Harassment (1 = not at all probable; 5 = very probable)
  - d Acts of terrorism (1 = not at all probable; 5 = very probable)
- 6 If you experienced the following hazards, how serious do you think the consequences would be when walking in daytime …
  - a Accident (1 = not at all serious; 5 = very serious)
  - b Theft (1 = not at all serious; 5 = very serious)
  - c Harassment (1 = not at all serious; 5 = very serious)
  - d Acts of terrorism (1 = not at all serious; 5 = very serious)
- 7 If you experienced the following hazards, how serious do you think the consequences would be when walking in night-time …
  - a Accident (1 = not at all serious; 5 = very serious)
  - b Theft (1 = not at all serious; 5 = very serious)
  - c Harassment (1 = not at all serious; 5 = very serious)
  - d Acts of terrorism (1 = not at all serious; 5 = very serious)
- 8 How worried are you being involved in the following hazards when walking in daytime…
  - a Accident (1 = not at all worried; 5 = very worried)
  - b Theft (1 = not at all worried; 5 = very worried)
  - c Harassment (1 = not at all worried; 5 = very worried)
  - d Acts of terrorism (1 = not at all worried; 5 = very worried)
- 9 How worried are you being involved in the following hazards when walking in night-time…
  - a Accident (1 = not at all worried; 5 = very worried)
  - b Theft (1 = not at all worried; 5 = very worried)
  - c Harassment (1 = not at all worried; 5 = very worried)
  - d Acts of terrorism (1 = not at all worried; 5 = very worried)
- 10 To what extent do you tolerate being exposed to risk as a pedestrian? (1 = tolerate the risk absolutely; 5 = do not tolerate any risk)
- 11 To what extent do you think it is possible to protect yourself against risk as a pedestrian? (1 = very possible; 5 = not at all possible)
- 12 Have you been involved in an accident as a pedestrian during the last two years? (yes; no)
  If ‘yes':
  - a Were other road users involved in the accident(s)? (e.g. cyclist, pedestrian, motorized vehicle)
  - b Did you need medical treatment after the accident(s)? (yes; no)
- 13 Have you experienced being physically assaulted as a pedestrian during the last two years? (yes; no)
  If ‘yes':
  - a Did you need medical treatment after the experience(s)? (yes; no)
- 14 Gender? (male; female)
- 15 Year of birth? (year)
- 16 Highest level of education completed? (1 = primary or lower secondary school; 2 = upper secondary school; 3 =three years or less of university education; 4 = more than three years of university education)
- 17 Employment status? (1 = employed; 2 = student; 3 = pensioner; 4 = other)
- 18 Do you have a driving license?? (yes; no)
- 19 Do you have a motorized vehicle at your disposal? (yes; no)

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