



## Alcohol-impaired Walking in 16 Countries: A Theory-Based Investigation

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### ABSTRACT

Alcohol is a global risk factor for road trauma. Although drink driving has received most of the scholarly attention, there is growing evidence of the risks of alcohol-impaired walking. Alcohol-impaired pedestrians are over-represented in fatal crashes compared to non-impaired pedestrians. Additionally, empirical evidence shows that alcohol intoxication impairs road-crossing judgements. Besides some limited early research, much is unknown about the global prevalence and determinants of alcohol-impaired walking. Understanding alcohol-impaired walking will support health promotion initiatives and injury prevention. The present investigation has three aims: (1) compare the prevalence of alcohol-impaired walking across countries; (2) identify international groups of pedestrians based on psychosocial factors (i.e., Theory of Planned Behaviour (TPB) and perceptions of risk); and (3) investigate how segments of pedestrians form their intention for alcohol-impaired walking using the extended TPB (i.e. subjective norm, attitudes, perceived control, and perceived risk). A cross-

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sectional design was applied. The target behaviour question was “have you been a pedestrian when your thinking or physical ability (balance/strength) is affected by alcohol?” to ensure comparability across countries. Cluster analysis based on the extended TPB was used to identify groups of countries. Finally, regressions were used to predict pedestrians’ intentions per group. A total of 6,166 respondents (Age  $M(SD) = 29.4 (14.2)$ ; Males = 39.2%) completed the questionnaire, ranging from 12.6% from Russia to 2.2% from Finland. The proportion of participants who reported never engaging in alcohol-impaired walking in the last three months ranged from 30.1% (Spain) to 83.1% (Turkey). Four groups of countries were identified: group-1 (Czech Republic, Spain, and Australia), group-2 (Russia and Finland), group-3 (Japan), and group-4 (final ten countries including Colombia, China, and Romania). Pedestrian intentions to engage in alcohol-impaired walking are predicted by perceptions of risk and TPB-psychosocial factors in group-1 and group-4. Favourable TPB-beliefs and low perceived risk increased alcohol-impaired walking intentions. Conversely, subjective norms were not significant in group-2 and only perceived risk predicted intention in group-3. The willingness of pedestrians to walk when alcohol-impaired differs significantly across the countries in this study. Perceived risk was the only common predictor among the 16 countries.

## 1. Introduction

### 1.1. Background

Pedestrians are the most vulnerable road users and are at risk of injury, disability, and death due to road crashes (Hashemiparast et al., 2017; Rod et al., 2021). According to the World Health Organization, global deaths from traffic crashes are around 1.35 million per year and more than half of these people are not travelling in a car (World Health Organization (WHO), 2018). Globally, pedestrians and cyclists account for 26% and motorcycle riders and passengers account for 28% of all road traffic deaths (World Health Organization (WHO), 2019). While eighty percent of road traffic deaths occur in low-to-middle-income countries, one factor affecting all countries’ road transport systems is human behaviour (McIlroy et al., 2020a; World Health Organization (WHO), 2018). To date very limited research (e.g. McIlroy et al., 2020b) has attempted to study pedestrian behaviour using a multi-country perspective, including the influence of alcohol consumption and intoxication on pedestrian behaviour and associated decision-making processes.

Alcohol is an important risk factor influencing both the risk of a road crash occurring, as well as the increase in severity of the injuries that result from crashes (Pawłowski et al., 2019). Much of the attention of alcohol as a risk factor for road crashes has been given to its effects on driver behaviour. Alcohol is responsible for traffic accidents due to its pharmacological action on the central nervous system, affecting driver’s vision, awareness, perception, reaction time and the ability to concentrate (Behnood & Mannering, 2017). Alcohol consumption also results in a decreased ability to estimate space and distance, increased levels of self-confidence, and a generally impaired ability to safely operate a vehicle (Chen et al., 2016). Drivers who have been drinking have a higher risk of involvement in crashes than those not intoxicated (World Health Organization (WHO), 2018).

Alcohol intoxication is not only a risk factor among users of motor vehicles, but is also significant and meaningful among pedestrians (Lang et al., 2003; Törő et al., 2005). Alcohol-impaired pedestrians are more likely to display behaviours that are unsafe such as crossing the street when the signal is red or crossing roads where there is no pedestrian crossing (Dultz & Frangos, 2013) as well as sitting or lying on the road (Hutchison et al., 2010). Impairments resulting from alcohol intoxication among pedestrians contribute to decreased cognitive functioning and potentially poor decision making (Eichelberger et al., 2018). Alcohol was associated with 58% of fatalities among pedestrians in South Africa and 48% of pedestrian fatalities in the United Kingdom (World Health Organization (WHO), 2018). Another study using data from 2014 to 2016 in the US reported that 75% of all pedestrian fatalities involved alcohol (Thomas et al., 2019). Additionally, Lasota et al (2019) found the presence of alcohol in the blood, muscle and vitreous body in 72% of a sample of pedestrian fatalities in Warsaw. In another Polish study, victims of road crashes who were under the influence of

alcohol were predominantly young males (Pawłowski et al., 2019). Another study found that fatally injured pedestrians who had positive alcohol screens had a higher incidence of severe abdominal injuries (Demetriades et al., 2004). This suggests that alcohol is not only a clear contributor to traffic crashes but also presents a risk factor leading to a higher level of severe outcomes in pedestrian road traffic incidents as well as a generally higher incidence of injury severity (Živković et al., 2016).

The limited number of theory-based studies examining alcohol-impaired walking has hindered the development of interventions worldwide. Although interventions have been established to address general pedestrian crash risk; interventions for alcohol-impaired walking are virtually non-existent (Gannon et al., 2014; Haque et al., 2012; McGhie et al., 2012). The lack of evidence-based interventions presents a clear gap in literature and practice, and to find suitable interventions we need to evaluate the suitability of theories in cross-cultural contexts. Investigating the cross-cultural differences in intentions to walk when alcohol-impaired could lead to better theoretical basis for countermeasures which are more globally useful. Given the increase in interest in global health initiatives (Adams et al., 2016), increasing understanding of cultural differences in intention to walk when alcohol-impaired is an important addition to the literature.

### 1.2. A theory-based approach to alcohol-impaired walking

Human behaviours are difficult to predict, and evidence-based theories are required for a holistic understanding of decision-making processes, particularly in relation to risk behaviours, where it has been demonstrated that knowledge of negative consequences itself is commonly not sufficient to cease or change behaviours (Egger et al., 2013). The TPB (Ajzen, 1991), an extension of the Theory of Reasoned Action (Fishbein and Ajzen., 1975), has become one of the most frequently cited and influential models explaining the determinants of human social behaviour in social psychology and consumer decision making (Ajzen, 2011). According to the TPB, the proximal determinant of behaviour is the intention to engage in a particular behaviour. Behavioural intentions are assumed to be a function of an (1) *attitude* (i.e., favourable or unfavourable beliefs), (2) *subjective norms* (i.e., perceptions that important others would approve of), and (3) *perceived behavioural control* (PBC) (i.e., ease or difficulty of performing that behaviour) (Ajzen, 1991; Kaye et al., 2020; Oviedo-Trespalcacios et al., 2020). Thus, the model consists of the three previous standard constructs, the strength of which determine the strength of one’s intentions toward engaging in the behaviour, which are then regarded as proxies for whether people will actually engage in the behaviour (Ajzen, 1991, 2011). In this research, the TPB was selected to seek a greater insight into the factors influencing, and motivations underpinning, pedestrian alcohol-impaired walking at an international level. Intentions are used as dependent variables as they show how likely a pedestrian is to engage or continue engaging in alcohol-impaired walking. The TPB is a well-

**Table 1**  
Demographics separated by country.

| Country                  | Age                                      | Gender  |
|--------------------------|--|---|
| Australia (n = 713)      | (M = 41.00; SD = 19.87)<br>17 - 88 years | Male: 245; Female: 457; Other: 11             |
| Brazil (n = 202)         | (M = 31.00; SD = 13.83)<br>16 - 73 years | Male: 64; Female: 134; Other: 1; Missing: 3   |
| Chile (n = 309)          | (M = 34.78; SD = 13.24)<br>18 - 76 years | Male: 133; Female: 175; Other: 1              |
| China (n = 280)          | (M = 28.77; SD = 9.66) 17 - 78 years     | Male: 189; Female: 91; Other: 0               |
| Colombia (n = 773)       | (M = 25.32; SD = 10.57)<br>16 - 78 years | Male: 326; Female: 447; Other: 0              |
| Czech Republic (n = 318) | (M = 33.56; SD = 12.90)<br>18 - 75 years | Male: 91; Female: 222; Other: 2; Missing: 3   |
| Finland (n = 135)        | (M = 34.37; SD = 12.69)<br>18 - 75 years | Male: 51; Female: 84; Other: 0                |
| Japan (n = 282)          | (M = 19.07; SD = 1.00)<br>18 - 23 years  | Male: 218; Female: 64; Other: 0               |
| Malaysia (n = 315)       | (M = 21.84; SD = 5.85)<br>17 - 49 years  | Male: 146; Female: 167; Other: 2              |
| Mexico (n = 311)         | (M = 28.12; SD = 11.22)<br>17 - 77 years | Male: 112; Female: 199; Other: 0              |
| Peru (n = 329)           | (M = 23.59; SD = 5.64)<br>18 - 53 years  | Male: 71; Female: 255; Other: 3               |
| Portugal (n = 512)       | (M = 39.90; SD = 16.79)<br>16 - 83 years | Male: 258; Female: 252; Other: 2              |
| Romania (n = 299)        | (M = 28.99; SD = 10.44)<br>20 - 64 years | Male: 75; Female: 224; Other: 0               |
| Russia (n = 777)         | (M = 22.16; SD = 8.90)<br>16 - 70 years  | Male: 232; Female: 531; Other: 0; Missing: 14 |
| Spain (n = 356)          | (M = 22.72; SD = 8.23)<br>16 - 66 years  | Male: 80; Female: 276; Other: 0               |
| Turkey (n = 255)         | (M = 35.78; SD = 13.00)<br>18 - 73 years | Male: 118; Female: 137; Other: 0              |

validated decision-making model, which has been used in recent road-safety studies to explain or predict risky behaviours on the roads such as distraction, speeding, and seat belt non-use (Lennon et al., 2017; Oviedo-Trespalcacios et al., 2019).

Several studies have used TPB constructs, or extended versions of it, to explain alcohol-impaired behaviours. For instance, Conner et al. (1999) examined the predictive power of the TPB explaining alcohol consumption in three prospective samples of students. The results showed that attitude, subjective norms and perceived behavioural control explain between 12 and 50% of the variability in intentions. The researchers also found that past engagement in alcohol consumption was a significant, positive predictor of intentions and subsequent drinking behaviour (Conner et al., 1999). In a more recent study, Moan & Rise (2011) determined to what extent the theory of planned behaviour (TPB) extended with moral norms and descriptive norms were able to predict intentions not to drink and drive. The results showed that the extended TPB model accounted for a small amount of the variance in intentions in the sample as a whole. However, the model was better suited to predict intentions not to drink and drive among men and drivers aged 35 years and younger than women and drivers aged above 35 years (Moan & Rise, 2011). Haydon, Obst, & Lewis (2018) applied an extended TPB, including self-identity, to examine women's intentions to consume alcohol. The results showed the importance of the standard TPB constructs in influencing women's intentions to drink frequently or binge drink. Specifically, attitude and perceived behavioural control were significantly associated with intentions to binge and drink frequently for women of all age cohorts (Haydon et al., 2018).

The TPB and extended version of the TPB have been implemented to understand the determinants of alcohol-impaired walking intentions. For example, McGhie et al. (2012) examined the influence of psychosocial factors upon individuals' intentions to walk when alcohol-impaired, indicating that an individuals' intentions are stronger when an individual was walking with others than when alone. Haque

et al. (2012) offered some support for the utility of the Theory of Planned Behaviour (TPB) framework in explaining young peoples (aged 17–25 years) intentions to drink alcohol and walk. Another study (Gannon, et al., 2014) explored the role of TPB, normative influences and perceived risk in predicting young people's self-reported intentions to walk after alcohol consumption. The results found that males, when compared with females, had higher intentions to drink and walk and lower perceptions of risk regarding walking after alcohol consumption. Especially younger males have consistently been found to be less risk averse than females and more likely to take part in risky activities (Byrnes et al., 1999), particularly under the influence of alcohol and other drugs (Kim & Kim, 2012). In the context of alcohol-impaired walking, it could be expected that a person who anticipates risky behaviour or feelings of regret for their behaviour would be less likely to walk when alcohol-impaired. For instance, Haque et al. (2012) showed perceived behavioural control, anticipated regret, and past behaviour were predictors of young pedestrians' (aged 17–25 years) intentions to walk after alcohol consumption (Haque et al., 2012). Previous research has also found that the construct of perceived risk is a significant predictor of road users' intentions as well as alcohol related behaviours (Lang et al., 2003). Thus, it is expected that psychosocial factors as defined in the TPB extended with perceived risk could be used to predict intentions to walk when alcohol-impaired across countries. However, what underlies the differences in intentions to walk when alcohol-impaired across countries needs significant further research. The extended TPB has not been extensively tested among diverse groups of pedestrians with diverse socio-cultural perceptions of risk and alcohol use.

### 1.3. The current study

Understanding the prevalence, intentions and perceptions of walking when alcohol-impaired is an under researched global road safety issue.

The limited body of research on alcohol-impaired walking does not provide a strong enough evidence base to create health behaviour messaging and little is known about how these frameworks perform at an international level across different socio-cultural perceptions of risk and alcohol use (most of the psychosocial research on alcohol-impaired walking has been conducted in Australia). To address this gap, the present investigation has three aims:

(1) compare the prevalence of alcohol-impaired walking across 16 countries;

(2) identify international groups of pedestrians based on psychosocial factors (i.e., Theory of Planned Behaviour (TPB) and perceptions of risk); and

(3) investigate how segments of pedestrians form their intention for alcohol-impaired walking using the extended TPB (social norm, attitudes, perceived control, and perceived risk).

To enable a cross-cultural comparison between such diverse countries and cultures in this study, alcohol-impaired walking was described to participants as walk or cross the road “when your thinking or physical ability (balance, strength) was affected by alcohol”. This definition was agreed upon as one that is cross-culturally understandable after a systematic discussion amongst experienced alcohol related harm researchers at the Centre for Accident Research and Road Safety-Queensland (CARRS-Q). Previous research in alcohol-impaired walking has asked about walking following a given number of standard drinks or having a blood alcohol concentration (BAC) above 0.05 mg/ml (McGhie et al., 2012). However, types of alcohol, knowledge of BAC, and alcohol content of particular drinks is not globally uniform, and a more human-centred approach was needed to measure alcohol-impaired walking behaviour in such a diverse group of countries. Additionally, some countries such as Colombia have a strong culture of artisanal/homemade alcoholic beverages which are not standardised which made the use of the number of alcoholic drinks or BAC less desirable for this research. Furthermore, such a binary approach may limit recall bias that more complex measurements may be more prone to, particularly across different cultures.

## 2. Methods

### 2.1. Participants

A total of 6166 participants from 16 different countries were recruited to take part in this study 12.6% from Russia, 12.5% from Colombia, 11.6% from Australia, 8.3% from Portugal, 5.8% from Spain, 5.3% from Peru, 5.2% from Czech Republic, 5.1% from Malaysia, 5.0% from Mexico, 5.0% from Chile, 4.8% from Romania, 4.6% from Japan, 4.5% from China, 4.2% from Turkey, 3.3% from Brazil and 2.2% from

Finland. Participants' age ranged from 18 to 88 years ( $M = 29.4$ ,  $SD = 14.2$ ; 39.2% males). Table 1 presents the demographic information by country.

### 2.2. Data collection

To enable this study to take place, researchers from all 16 countries were involved. Researchers from each country were responsible for either translating the survey (using back-translation) into their native language or if there was already a translated version of the survey, they were responsible for modifying the relevant survey to ensure it was suitable for their country's language idiosyncrasies. Researchers were also responsible for participant recruitment in their own countries. All researchers involved were affiliated with a university in their respective countries and were therefore able to disseminate the survey through university classrooms, affiliated social media platforms or web pages. Some participants were offered small incentives such as course credit. Most collaborators used the Qualtrics online survey platform ( $n = 8$ ), with Google forms the next most popular platform ( $n = 4$ ). Ethical approval for the study was granted by Queensland University of Technology Human Research Ethics Committee (approval no. 1800001243).

Participant recruitment for all countries ran from March to December 2019 with researchers choosing appropriate dates for recruitment within that time frame. Of the 16 countries involved in this research only Romania and China exclusively used paper-based surveys. Students from Romania received course credit while some students in China received an incentive payment of CNY 20. Eight countries used the online Qualtrics survey platform licensed to Queensland University of Technology (QUT), including Australia, Chile, Colombia, Finland, Mexico, Portugal, Spain and Turkey. These countries all used a combination of methods for participant recruitment including advertisement through classrooms, university affiliated social media platforms and in Portugal, regional radio stations and websites of Parish Councils. Of the eight countries that used Qualtrics, only student participants from Australia, Mexico, Portugal and Turkey received course credit. No incentives were offered to any non-student participants.

The remaining seven countries used different survey platforms with only Japan offering their students course credit. Survey Monkey was used in Brazil with the survey advertised through open social media platforms. The Japanese, Malaysian, Peruvian and Russian surveys used the Google forms online platform. The Czechia survey was conducted using a Czech online survey platform (vypInto.cz) and was advertised to Palacky University staff and students through emails and on the university's website.

Participation in the survey was anonymous, and voluntary. All participants were made aware of this through the participants information

**Table 2**  
Prevalence of alcohol-impaired walking

| Country   | Never       | Rarely-Sometimes | Frequently-Every Time |
|-----------|-------------|------------------|-----------------------|
| Australia | 404 (56.6%) | 257 (36%)        | 52 (7.2%)             |
| Brazil    | 111 (54.9%) | 60 (29.7%)       | 31 (15.3%)            |
| Chile     | 174 (56.3%) | 117 (37.8%)      | 18 (5.8%)             |
| China     | 175 (62.5%) | 99 (35.3%)       | 6 (2.1%)              |
| Colombia  | 486 (62.8%) | 248 (32%)        | 39 (5%)               |
| Czech R.  | 154 (48.4%) | 130 (40.8%)      | 34 (10.6%)            |
| Finland   | 57 (42.2%)  | 71 (52.5%)       | 7 (5.1%)              |
| Japan     | 207 (73.4%) | 61 (21.6%)       | 14 (4.9%)             |
| Malaysia  | 206 (65.3%) | 97 (30.7%)       | 12 (3.8%)             |
| Mexico    | 202 (64.9%) | 96 (30.8%)       | 13 (4.1%)             |
| Peru      | 180 (54.7%) | 131 (39.8%)      | 18 (5.4%)             |
| Portugal  | 336 (65.6%) | 143 (27.9%)      | 33 (6.4%)             |
| Romania   | 244 (81.6%) | 49 (16.3%)       | 6 (2%)                |
| Russia    | 510 (65.6%) | 208 (26.7%)      | 59 (7.5%)             |
| Spain     | 107 (30%)   | 195 (54.7%)      | 54 (15.1%)            |
| Turkey    | 212 (83.1%) | 32 (12.5%)       | 11 (4.4%)             |
| Total     | 3765 (61%)  | 1994 (32.3%)     | 407 (6.6%)            |

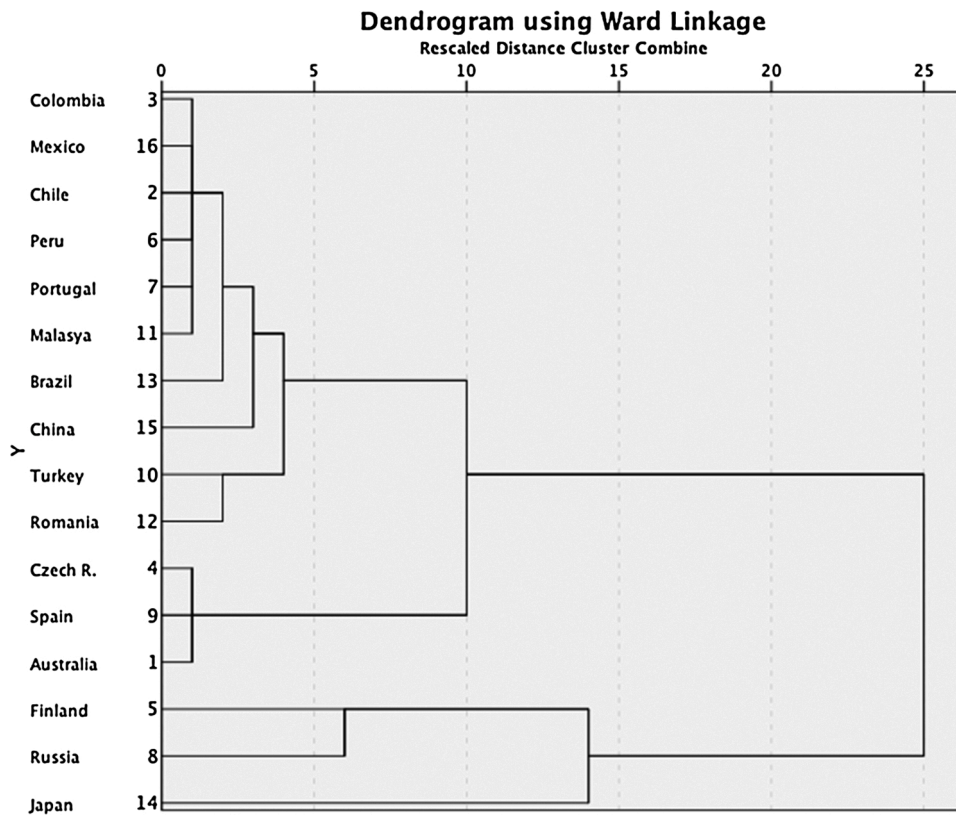


Fig. 1. Dendrogram.

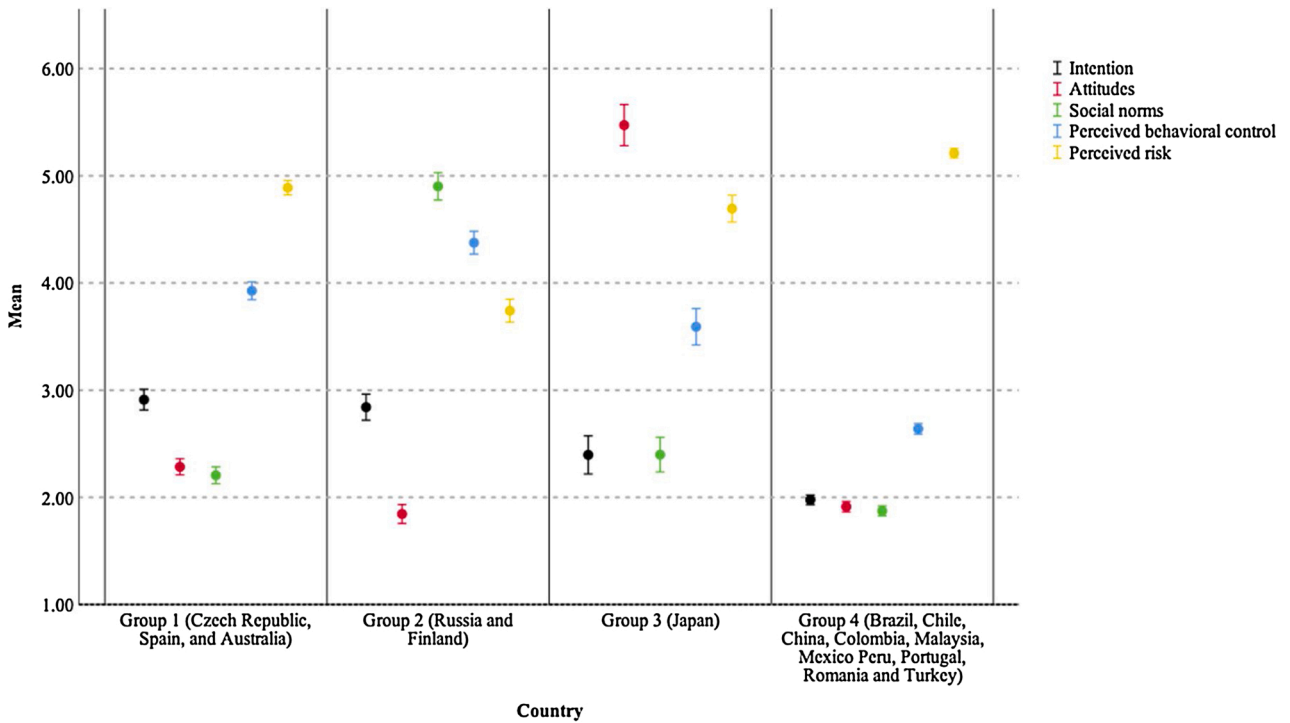


Fig. 2. Cluster descriptives.





with participants in Turkey reporting the lowest level of alcohol-impaired walking (16.9%). More information on the self-reported behaviour is presented in Table 2.

### 3.2. Cluster analysis to identify international groups of pedestrians based on psychosocial factors

Four clusters that maximised the difference between clusters but minimized differences within clusters were delineated: group-1 (Czech Republic, Spain, and Australia), group-2 (Russia and Finland), group-3 (Japan), and group-4 (final ten countries including Colombia, China, and Romania). Fig. 1 shows a dendrogram which represents the activity pattern similarity of the 16 countries. The dendrogram shows the distance or similarity between lifestyle and risky behaviours, as a result of clustering. The axis “rescaled distance cluster combine” shows the distance at which the clusters combine.

Pedestrians in Group 1 and Group 2, that contain mostly European high-income countries, seemed to have collectively the highest intention of alcohol-impaired walking. Also, Russia and Finland have the largest scores in terms of perceived control and social norm but the lowest for perceived risk. Japan is the country with the most favourable attitudes related alcohol-impaired walking, Fig. 2. shows the values of the extended TPB variables per cluster.

### 3.3. Prediction of intention for alcohol-impaired walking using the extended TPB by international groups of pedestrians

To examine the relationship between the TPB variables and pedestrians intention to engage in alcohol-impaired walking, hierarchical regression with intention as the dependent variable of interest was conducted. The first variables included were basic demographics such as age and gender. The standard TPB construct of attitude, subjective norms and perceived behavioural control were entered at the second step. Finally, the third step investigated the influence of perceived risk as a moderator of behaviour. Four regressions were performed given the differences shown in the sample, the first for Group-1 that include Czech Republic, Spain, and Australia, the second for Group-2 that included Russia and Finland, the third for Group-3 that only included Japan, and the fourth for Group-4 with final ten countries including Colombia, China, and Romania. Table 3 displays the results for all the groups.

#### 3.3.1. Group 1 (Czech Republic, Spain, and Australia)

The regression model for this group significantly predicted intentions for alcohol-impaired walking,  $F = 248.004$ ,  $p < 0.001$  (see Table 3). Age and gender were entered at Step 1, these variables were significant and accounted for 9.9% variance in intention ( $R^2$  adj = 0.099). When entered into Step 2, attitude, subjective norms and perceived behavioural control resulted in a significant increase in the variance of intention,  $R^2$  adj = 0.517,  $F = 295.622$ ,  $p < 0.001$ . At Step 2, gender was not significant. In the final model, there were five statistically significant predictors: age, attitude, subjective norms, perceived behavioural control and perceived risk. Attitude was by far the strongest predictor of intention in terms of beta weights and accounted for 37.8% of unique variance. Subjective norms were the next strongest predictor (21.1%), followed by perceived behavioural control (20.2%).

#### 3.3.2. Group 2 (Russia and Finland)

Patterns of important predictors were somewhat different in this group. The regression model significantly predicted intentions for alcohol-impaired walking,  $F = 88.840$ ,  $p < 0.001$  (see Table 3). In Step 1,

gender was the only significant variable and accounted for 2.40% variance in intention ( $R^2$  adj = 0.024). However, in Step 2, the standard TPB measures together explained 35.3% of the variance in intentions ( $R^2$  adj = 0.353). Of these, gender, attitude and perceived behavioural control were significant. When entered into Step 3, attitude, perceived behavioural control and perceived risk were significant ( $R^2$  adj = 0.370). Attitude was by far the strongest predictor of intention in terms of beta weights, and accounted for 35.9% of unique variance, followed by perceived behavioural control (33.6%).

#### 3.3.3. Group 3 (Japan)

The regression model significantly predicted intentions for alcohol-impaired walking in this group,  $F = 4.164$ ,  $p < 0.001$  (see Table 3). Age and gender were entered at Step 1, these variables were not significant. In Step 2, attitude, subjective norms and perceived behavioural control resulted in a significant decrease in the variance of intention,  $R^2$  adj = 0.005,  $F = 1.288$ ,  $p = 0.269$ . No variable was significant in this step. However, in the final model, there were three statistically significant predictors: age, gender and perceived risk ( $R^2$  adj = 0.063).

#### 3.3.4. Group 4 (Brazil, Chile, China, Colombia, Malaysia, Mexico, Peru, Portugal, Romania, and Turkey)

Patterns of predictors were different in this group. The regression model significantly predicted intentions for alcohol-impaired walking,  $F = 422.293$ ,  $p < 0.001$  (see Table 3). In Step 1, age and gender were significant and accounted for 2.90% variance in intention. When entered into Step 2, attitude, subjective norms and perceived behavioural control resulted in a significant increase in the variance of intention,  $R^2$  adj = 0.411,  $F = 498.627$ ,  $p < 0.001$ . All the variables were significant. In the final model, there were six statistically significant predictors: age, gender, TPB variables and perceived risk. Perceived behavioural control was by far the strongest predictor of intention in terms of beta weights and accounted for 34.2% of unique variance. Attitude was the next strongest predictor (23.2%), followed by subjective norms (20.8%)

## 4. Discussion

The present study shows that alcohol-impaired walking is a common behaviour among pedestrians. Our study considered a more pedestrian-centred approach to measure alcohol impairment asking specifically about walking when impairment was important, i.e. when thinking or physical ability (balance, strength) was affected by alcohol. It is therefore likely that this figure does not consider those individuals who consume alcohol but do not perceive that this significantly affects their functional ability. Therefore, the prevalence values of alcohol-impaired walking reported in this paper are conservative. This is evident when comparing our findings with previous research from Australia. While this study found that 56.6% of participants reported never engaging in alcohol-impaired walking (when thinking or physical ability was affected by alcohol), Gannon et al. (2014) found that 18.6% participants reported never engaging in “drink walking” while under the influence of alcohol with a blood alcohol concentration level (BAC) of .05 or more in the last six months. It is important to state that the absence of walking when impaired through alcohol, does not necessarily mean that decisions made will result in safe transport choices. For example, it is likely that some participants may drive or use personal mobility devices (e-scooters) which would result in an increased risk of injury.

Although previous studies have found that walking under the influence of alcohol is one of the least self-reported risky behaviours commonly performed by pedestrians (Useche et al., 2020), the results of

this study suggest that it remains a considerably prevalent issue. The large prevalence of alcohol-impaired walking is important considering that alcohol has been associated with higher risk of falls (Afshar et al., 2015; Afshar et al., 2016; Chen & Yoon, 2017), and pedestrian injury associated with traffic crashes (Wagner et al., 2020). Additionally, pedestrians involved in collisions with vehicles while walking under the influence of alcohol have higher levels of injury severity and hospital admission rates than pedestrians not walking under the influence of alcohol (Bradbury, 1991; Hezaveh and Cherry, 2018; Jehle & Cottingham, 1988). Furthermore, alcohol-related harm, including injuries associated with alcohol-impaired walking, presents a burden on the health care systems with up to ten percent of emergency department presentations in some countries (Egerton-Warburton et al., 2018; Rehm et al., 2010). Although it is unknown what proportion of these injuries is actually related to crashes or falls in the road traffic environment, a reduction of these presentations could have a positive impact on the health systems.

Using a cluster analysis, international groups of pedestrians were identified based on psychosocial factors. Some obvious groups were formed such as Group 2 including Russia and Finland and Group 4 including all five Latin American countries. This is not surprising given that the geographical closeness and shared histories could result in similar lifestyle and socio-cultural norms and perceptions. For instance, Finland and Russia are neighbouring countries that share a long history together as Finland was part of the Russian Empire during most of the 19th century before its independence in 1917. Moreover, the largest share of foreign citizens in Finland are Russian. Thus, it seems to make sense that the two countries formed one cluster. However, this is also surprising as alcohol consumption is rather different between Finland and Russia (Laatikainen et al., 2002). The litres per capita consumed are 8.4 in Finland and 11.2 in Russia in 2018 (OECD, 2021). Thus, the Finnish alcohol consumption is closer to the mid-European levels, whereas the Russian level is one of the highest of OECD countries (OECD, 2021). Yet, a study on alcohol use of adolescents found similarities between Finnish and Russian adolescents (Soellner et al., 2014). Moreover, a recent study on value priorities in seven European countries, including Finland and Russia, found that certain value priorities were more consistent between younger adults across countries than between younger and older adults within countries (Tulviste et al., 2017). The participants from Finland and Russia were dominantly younger, which might explain the similarities found between Finns and Russians. Another important case that further confirms this is that Latin American countries such as Brazil, Chile, Colombia, Mexico, and Peru appeared in the same cluster, with these countries sharing similar histories and a large number of cultural similarities. Previous research on traffic behaviour have found that Latin American countries such as Argentina, Mexico and Colombia present similar risky behaviours when on the roads (Tosi et al., 2020). These results warrant for further research to increase understanding of how the values and attitudes related to alcohol consumption, and the behaviour under the influence of alcohol might cause risky behaviour regardless of the levels of alcohol consumed in different countries.

Interestingly, participants from Japan seemed to be the most distinct sample in the study. As the Japanese sample was predominantly males (77%), it would be expected that the self-reports and intentions of alcohol-impaired walking would have been higher. However, this was not the case. A potential explanation for this is that the sample was composed mostly by young people who are in university setting and they could potentially be more cautious concerning the risk of heavy driving. There has been reports that heavy drunkenness (or heroic drinking) in Japan is largely associated with salary men engaging in socialisation

(Partanen, 2006). The identification of groups provides a framework to consider similarities and differences across jurisdiction. This research shows the importance of studying local characteristics before proposing behaviour change initiatives.

The present study used the Theory of Planned Behaviour (TPB) extended with perceptions of risk to understand alcohol-impaired walking intentions. Previous work by Gannon et al. (2014) and Haque et al. (2012), using the TPB in Australia to study alcohol-impaired walking was adapted. As expected, given the high reliability of the TPB in these previous studies, the results showed that the questionnaire developed for this study showed high reliability as Cronbach's alpha was satisfactory for the total scale (>0.7). Across groups, pedestrians with favourable attitudes, perceived social norms, and perceived control tended to have higher intentions to engage in alcohol-impaired walking. This is consistent with the theoretical expectations drawn from the TPB and past research using TPB in the alcohol-impaired-walking context (Haque et al., 2012).

Importantly, attitudes, perceived control, and social norms were not associated with the intention of walking when alcohol-impaired among pedestrians in Japan. This suggests that a more culturally appropriate theory may be needed to investigate alcohol-impaired walking in Japan. Previous qualitative research has highlighted differences regarding alcohol consumption between the Japan and the West. Partanen (2006) explains that other people's reactions to drunken behaviour are generally positive and tolerated with some scholars calling Japan a "drunkard's paradise". Perhaps, these cultural differences and the social aspects of alcohol are influencing the lack of significance of the psychosocial constructs proposed by the TPB. Additionally, it has been suggested that the use of western-based constructs to study behaviour in non-western cultures may not be as effective (Hendricks and Moghaddam, 2020) despite the successful use of the TPB in other Asian countries such as Taiwan (Hung et al., 2019). Research on the application of psychosocial models in non-Western and/or low and middle-income countries is still needed, and it is an on-going focus of concern among researchers (Hendricks et al., 2019). Nonetheless, the results of the present study suggest that targeting pedestrians' personal attitudes, their perceptions of pressure to walk while intoxicated and perceived control may be useful strategies to reduce this risky behaviour in the other 15 countries. By building knowledge regarding levels of current and intended use of alcohol, and factors influencing alcohol-impaired walking across countries, lessons may be learned as to what factors may typically increase intentions. Although cultural adaptation is still needed (Taylor, 2019), targeting intentions has been demonstrated to be an important part of the success of alcohol interventions (Kelly et al., 2016; Cooke et al., 2016).

An important consideration when using the TPB is that participants may not perceive that a particular risky behaviour such as alcohol-impaired walking is fully under their voluntary control. Intoxication may reduce an individual's capabilities and may lead to a misjudgement of environmental restrictions (Ajzen, 1988). Conversely, intoxication may also lead to a temporarily increased confidence in people's own capabilities, increasing perceived behavioural control over the situation and efficacy to engage in the behaviour, while impacting on risk perception and impulsivity control, particularly among young people (Ryb et al., 2006; Proestakis et al., 2013). Finally, alcohol consumption in young people often takes place in a group context. This group context is commonly associated with an increased intake of alcohol which may lead to heightened levels of, and susceptibility to peer-pressure, resulting in increased engagement in risky behaviours, particularly in young people (McCoy et al., 2019; Sela-Shayovitz, 2008).

Perceived risk was the common variable that influenced intention



across all the groups of pedestrians. Pedestrians who perceived risk when engaging in impaired walking have lower intentions to engage in this behaviour. Previous research has argued that as perceived risk increases, risky and illegal behaviour among road users declines (Homel, 1993; Nguyen-Phuoc et al., 2020a, 2020b). This perceived risk may be limited while alcohol-impaired as pedestrians may no longer be able to process information on speed and distance in traffic situations in a timely manner within specific and concrete situations (Dultz & Frangos, 2013; Oxley et al., 2006). However, the consistency of this variable still suggests that generalised risk perception could be a universal target for educational campaigns and prevention initiatives with the potential to impact a wide range of groups. Global media initiatives are now common especially when considering social media connectivity and digital resources. Importantly, psychosocial factors as conceptualised in the TPB seem to have a stronger influence on pedestrians with certain characteristics, e.g., age, gender, personality, etc. This is potentially a consequence of cultural differences, which need to be considered in the design of multi-jurisdiction interventions.

Age was negatively associated with the intention of alcohol-impaired walking in this study. There are key age-based differences: for instance, younger participants are more willing to take the risk of walking while intoxicated. This is in line with research showing that younger people have psychosocial characteristics that make them more prone to risk-taking in the road traffic environment (Scott-Parker and Oviedo-Trespalcacios, 2017; Lennon et al., 2017; Oviedo-Trespalcacios et al., 2018; Truelove et al., 2021). However, this may be partially explained by the lack of accessibility to motor vehicles or other forms of transport such as taxis due to cost. It is important to consider that although more adult pedestrians have less intention to walk while intoxicated, this could also result in drink driving in some jurisdictions (Jiang et al., 2020). This outcome is just one of the dimensions of the problem and further work is needed to fully comprehend the interactions between impaired walking and driving.

Gender was only a significant in Group 2 (*Russia and Finland*) and 4 (*Brazil, Chile, China, Colombia, Malaysia, Mexico, Peru, Portugal, Romania, and Turkey*) with having significantly less intentions of alcohol-impaired walking. A potential explanation for this is that women generally have less intentions of walking than males due to security risks such as sexual harassment. However, it is also a possibility that the differences on the proportion of females across clusters could have influenced the sensitivity of the models. For example, group 1 (*Czech Republic, Spain, and Australia*) and 2 (*Russia and Finland*) have a higher number of females by more than double, whereas in group 4 (*Brazil, Chile, China, Colombia, Malaysia, Mexico, Peru, Portugal, Romania, and Turkey*) the ratio is more balanced. Future research is needed to understand gender-based determinants of risky walking behaviours such as alcohol-impaired walking.”

The best-practices for the development of interventions against alcohol-impaired walking are largely unknown. Generally, some lessons can be learned from previous experience regulating other risky behaviours associated with public intoxication which indirectly have an impact on traffic-related injuries. Such policies include limiting trading hours of licensed venues and criminalising public intoxication as a part of a response to alcohol-fuelled violence, and general misconduct, particularly noise pollution, with limited or no reference of alcohol-impaired walking beyond mentioning road injuries in general. The summary offence of ‘public intoxication’ exists in several countries including the United Kingdom and some states and territories in Australia and Canada (Room, 2020). Although there is some evidence that lock-out laws and similar trading hour restrictions were associated

with a reduction in emergency department presentations, this reduction can partly be explained by reduced foot traffic (exposure to walking) in entertainment precincts and lower levels of intoxication (Holmes et al., 2018). However, these policies have been found to be unsustainable due to the falling public support and growing public resistance (Livingston et al., 2019). Therefore, we foresee that a prohibitive approach to address alcohol-impaired walking may be insufficient and ineffective, which highlights the need for interventions seeking to minimise harm as well as involving stakeholders across the transport, health, and judicial systems. As highlighted by Hutchison et al. (2010) traffic engineering that is safer for all pedestrians will be safer for intoxicated pedestrians. As part of a safe systems approach to road safety, lowering speed limits in built up areas, especially around pubs and clubs should be a priority.

## 5. Limitations and future research

The present study is not without limitations. The definition of alcohol-impaired walking used in this research, “when your thinking or physical ability (balance and strength) was affected by alcohol”, does not cover all aspects of alcohol impairment. Nor does the definition of alcohol-impaired walking given to participants in the present study allow us to understand how different levels of alcohol impairment influence different behaviours or intentions measured by this study. For instance, a participant may recall being mildly alcohol impaired, felt that their thinking and or physical ability was affected by alcohol, but be very willing to walk back home. If, however, the participant recalls being severely alcohol impaired, with their thinking and physical ability severely affected, they may not be willing to walk back home. In both cases the participant’s thinking and physical ability was affected but we have not measured different levels of impairment and the influence different levels have on behaviour or intentions. This issue is also present in previous research that used blood alcohol concentration (BAC) above 0.05 mg/ml as the measure of alcohol impairment (McGhie et al., 2012). Moreover, at 0.05 mg/ml BAC, the level of impairment is not necessarily consistent across individuals. These issues are further complicated by the fact that an individual is not necessarily aware of the level of impairment and/or blood alcohol concentration, which brings a great deal of subjectivity to the measurement of alcohol impaired walking. Further research is warranted to improve our understanding of different levels of alcohol-related impairment on pedestrian behaviour.

The sample sizes were comparatively large for such a study, however, there are differences in samples between countries which must be acknowledged as a limitation. For example, the sample in Japan was relatively younger than the other countries and there were fewer reports of alcohol-impaired walking. This could have resulted in the country being clustered so distinctively from the other jurisdictions. Unfortunately, the lack of research and population level information regarding alcohol consumption prevents the generalisation of the findings presented in this paper. Future research including replication of the present study is needed to understand these differences and strengthen the results from this research.

Although participation was anonymous, as with all self-reported measures, participants may give more socially desirable answers compared to their observable behaviour. Common Method Biases (CMBs) may emerge, especially when topics related to participants’ social and safety behaviours are addressed in the questionnaire. Such a tendency may be more influential in some countries more than others. For instance, in countries where alcohol use is socially undesirable, admitting to alcohol-impaired walking would be more challenging compared to societies where alcohol use is high. Alcohol use and

abstinence also differs markedly in different countries, as does poly substance use (illegal substances such as cannabis or cocaine) (Canfield et al., 2017). This study did not, however, ask participants if they abstained or used other illegal or legal substances that may impair their ability to walk safely.

### 6. Conclusion

The present manuscript provides a unique and nearly global perspective regarding attitudes and intentions of pedestrians to engage in alcohol-impaired walking. The countries included in this project are diverse, but patterns of engagement in problematic pedestrian behaviour of alcohol-impaired walking were found. The Extended TPB was applied, and as found in past research, perceived risk influences intention of walking when impaired by alcohol. This is an important finding given the increased risk for alcohol-impaired pedestrians globally. Additionally, this paper shows that walking while intoxicated by alcohol is a common behaviour in need of targeted countermeasures such as policy and education. Alcohol-related harm and injuries resulting from alcohol-impaired walking need further attention to reduce the burden of disease including a stronger consideration for these issues in public policy as well as health promotion campaigns.

### CRedit authorship contribution statement

The authors confirm contribution to the paper as follows: study conception and design: **Oscar Oviedo-Trespalcacios, Elisabeth Rubie, and Mark King**; data collection: **Oscar Oviedo-Trespalcacios, Ali Kemal Çelik, Ana Marti-Belda, Anna Włodarczyk, Elisabeth Rubie, Erkan Oktay, Gabriel Dorantes Argandar, J.E. Rod, Jean Carlos Natividade, Joonha Park, Jorge Tiago Bastos, Laura Martínez-**

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### Declaration of Competing Interest

The authors report no declarations of interest.

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### Appendix A

Table A1

**Table A1**  
Theory Planned Behaviour (TPB) questionnaire used in the study (Adapted from Gannon et al. (2014) and Haque et al. (2012))

| Constructs                    | Number of items | Items   | Scale                                      |
|-------------------------------|-----------------|---|--|
| Original TPB questions        |                 |   |  |
| Intention                     | 4               | I plan...<br>I intend...<br>It is likely...<br>I would be willing... (to walk or cross the road when my thinking or physical ability (balance and strength) is affected by alcohol)   | 1 strongly disagree to 7 strongly agree    |
| Perceived behavioural control | 4               | I am confident...<br>If I wanted to...<br>I have complete control...<br>It is entirely up to me... (whether I cross the road when my thinking or physical ability (balance and strength) was affected by alcohol)   | 1 strongly disagree to 7 strongly agree    |
| Subjective norms              | 4               | Those people who are important to me think that I should be a pedestrian when my thinking or physical ability (balance, strength) is affected by alcohol<br>Those people who are important to me think that being a pedestrian when my thinking or physical ability (balance, strength) is affected by alcohol would be a good thing to do<br>Most people whose opinions I value, approve of me being a pedestrian when my thinking or physical ability (balance, strength) is affected by alcohol<br>People who are important to me want me to be a pedestrian when my thinking or physical ability (balance, strength) is affected by alcohol | 1 strongly disagree to 7 strongly agree    |
| Extended TPB measures         |                 |   |  |
| Perceived risk                | 4               | How likely is it that you will be hurt or injured...<br>How likely is it that you will be seriously injured or killed...<br>How likely is it that other people of similar age to you...<br>How likely is it that other people of similar age to you will be seriously injured or killed... (in a road crash as a pedestrian if thinking or physical ability (balance, strength) was affected by alcohol)  | 1 extremely unlikely to 7 extremely likely |

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