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Should I ride or not?: A conjoint study on young riders' nighttime e-scooter use after drinking☆

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ABSTRACT

Alcohol-impaired riding is a leading contributor to e-scooter crashes and injuries, especially among young adults during nighttime hours. Yet, research on the decision-making processes underlying this risky behavior remains limited. Based on a stated preference approach, this study quantifies the situational factors influencing young people's likelihood of riding e-scooters after drinking alcohol at night. An online conjoint experiment was conducted with 717 participants aged 16–35 from Switzerland, Germany, and Denmark. Respondents evaluated realistic scenarios varying five attributes: type and availability of transport alternatives, e-scooter availability, peer influence, and perceived security. Hierarchical Bayes modeling and choice simulations revealed peer influence and the presence of viable transport alternatives as the most decisive factors, each accounting for over a third of the decision weight. Scenarios where peers opted for safer alternatives or where public transport was directly available significantly reduced the likelihood of alcohol-impaired e-scooter use. Men and frequent e-scooter users showed higher risk propensity, and more permissive attitudes toward drunk riding associated with both past behavior and higher scenario-based e-scooter riding likelihoods after drinking alcohol. Implications include the need for social-norms campaigns leveraging peer dynamics, improved late-night transport provision, and restricted e-scooter availability in nightlife hotspots.

1. Introduction

Please imagine the following scenario: It is a Friday evening. Tim and Amy, both 19 years old, are on a night out. After having a drink or two at their favorite bar, they got a message from their friends, asking them to join them at a club a few kilometers away in 15 min. Now, they have to spontaneously decide on how to get there. While Tim is an experienced e-scooter rider, Amy checks the next public transport connections on her phone, as this is her go-to option. But then, she eventually joins her friend, who is already unlocking an e-scooter parked nearby. This situation could be a scenario in which young people choose to ride an e-scooter, even while being intoxicated.

Riding under the influence of alcohol is a considerable risk in e-scooter riding, being one of the leading causes of crashes worldwide, as reported by police and hospital statistics, especially in single-user incidents (Blomberg et al., 2019; Harbrecht et al., 2022; Janikian et al., 2024; Linhart et al., 2024; Murros et al., 2023; Osti et al., 2023; Raubenheimer et al., 2023). In Switzerland, for 38% of all e-scooter single-vehicle crashes and 8% of all e-scooter collisions, alcohol was registered as the main cause (Hertach et al., 2024). Also, official statistics from Germany show that, besides incorrect use of the road or sidewalks, alcohol-impaired riding was the second most common type of misconduct, found in 18% of e-scooter crashes recorded by the police in 2022 (Statistisches Bundesamt, 2023). In Denmark, hospital-based data show that injured e-scooter riders are primarily young men riding under the influence of alcohol when the crash happened (Blomberg et al., 2019). These findings underline the importance of riding after drinking alcohol as a major issue in e-scooter-related crashes (e.g., Linhart et al., 2024;

Abbreviation: E-Scooter, Electric scooter.
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Toofany et al., 2021).

Studies often showed that riding an e-scooter at night is associated with increased crash risk, also in combination with alcohol (Liu et al., 2025). Nearly half (46%) of all e-scooter-related crashes in Switzerland happen at dawn or night (Hertach et al., 2024). Similarly, a study in Munich on e-scooter use and crash data indicated a share of 48% dawn or nighttime e-scooter crashes. The same study found that most alcohol-related crashes happen between 11 pm and 3 am (Schreier et al., 2022). While these figures imply that about half of all crashes occur during the day, focusing on nighttime impaired riding is justified. The crash risk is disproportionately higher when controlling for exposure, as e-scooter use decreases significantly towards nighttime (Siebert, 2025; Tremmel et al., 2025). Research by Shah and Cherry (2022) shows, for example, that the crash rate per trip is significantly higher at night compared to the day, when controlling for the number of trips taken, to account for the chance of an e-scooter rider being struck by a car.

The characteristics of the main e-scooter user group further compound the problem of nighttime riding after drinking. Young males constitute the majority of riders and, therefore, of those involved in crashes (Hertach et al., 2024; Janikian et al., 2024). This demographic group tends to exhibit higher levels of risk-taking behavior, which may be influenced by a combination of factors, including peer pressure, social norms, and increased thrill-seeking (Asgharpour et al., 2025; Gheorghiu et al., 2015; Leadbeater et al., 2008; Simons-Morton et al., 2012). Cubells et al. (2023) also showed that men take longer detours when riding e-scooters than women. According to the Swiss health survey, about one-third of young males aged between 15 and 24 get drunk at least once a month, compared to only one-fifth of females in the same age group (Storni et al., 2023). A Norwegian study showed that, next to frequent e-scooter riders, individuals with low education, people with lower perceived crash risk, and younger people were more likely to report a higher number of alcohol units perceived to be safe before riding e-scooter (Mehdizadeh et al., 2023).

With riding under the influence of alcohol at night and young users being more prone to risks and social influences, the stage is already set for an increased crash risk. But how do these rides come about in the first place? Currently, we know very little about the decision-making process and the determining factors when riders decide to use an e-scooter after drinking alcohol. To derive policy implications or develop suitable campaigns, it is important to understand the situational and individual factors that drive, or protect against, young people's decision to ride an e-scooter after drinking alcohol at night. While previous studies have documented the prevalence and risks of alcohol-impaired e-scooter riding (Hertach et al., 2024; Janikian et al., 2024; Liu et al., 2025; Toofany et al., 2021; Zube et al., 2022), less is known about the specific decision-making processes underlying these choices.

This is where the present study sets off, asking: How do specific factors contribute to young riders' decision-making about riding an e-scooter after drinking alcohol at night? And how do changes in those factors affect this decision? To answer these questions, we applied a stated-preference approach, conducting an online conjoint study with samples from Switzerland, Germany, and Denmark.

2. Literature review and research aims

The situation of riding an e-scooter or not under the influence of alcohol is a decision situation in which individual and situational factors come into play. The individual factors cover aspects of the users themselves, such as age and gender, as well as constructs related to these (e.g., attitude towards riding under the influence). In addition, situational aspects like the availability of other transport options and time of day influence the likelihood of riding an e-scooter under the influence of alcohol. To cover the theoretical background of both aspects, we first present research on individual factors, and secondly, on situational factors, and how they might relate to the decision to ride an e-scooter after drinking.

2.1. Individual factors

Alcohol limits for e-scooter riding are the same as for driving a car, with 0.5 per mille blood alcohol in Switzerland (Verkehrsregelnverordnung, 2025), Germany (eKFV, 2019), and Denmark (SikkerTrafik, 2025). In Switzerland, to ride an e-scooter, you must be at least 16 years old (or have an additional license when aged 14-16), in Germany, 14 years, and in Denmark, 15 years. The age and alcohol limits resemble the e-scooter legislation throughout the European Union (Kamphuis and van Schagen, 2020; Ringhand et al., 2021). Alcohol impairs coordination and spontaneous reflexes (Gan-El et al., 2022), reaction time, and judgment, making riders more susceptible to crashes. As shown on a test track, even small BAC[2] levels can negatively impact the riding performance with an e-scooter (Zube et al., 2022). While these physiological effects of alcohol increase the risk and severity of crashes when riding an e-scooter (Liu et al., 2025; Mehdizadeh et al., 2023; Zube, 2024; Zube et al., 2022), it is important to recognize that these immediate impairments do not solely determine the decision to ride under the influence.

Beyond these physiological effects, the decision to ride after drinking is also shaped by attitudes and social acceptance, as consistently shown by research on cycling under the influence of alcohol (CUI), much of which draws on the Theory of Planned Behavior (Ajzen, 1991). Notably, cyclists often hold seemingly contradictory views: while the vast majority acknowledge that alcohol impairs riding ability, a considerable share still consider it acceptable to ride, or actually do ride, when intoxicated (Johnson et al., 2013). Wallén Warner (2021) helps explain this gap by showing that cyclists perceive clear advantages in riding while mildly intoxicated (e.g., being practical, free, and preferable to driving a car) while downplaying or not considering the associated risks. In line with this, permissive attitudes and social norms have repeatedly emerged as central correlates of CUI. In Germany, a permissive attitude predicted the number of CUI trips, whereas deterrence-related factors did not (Huemer, 2018). Among Norwegian cyclists, permissive attitudes, most pronounced among young adults and males, together with having friends who either accept or engage in CUI themselves, were associated with more frequent riding under the influence (Vestgård et al., 2021). These attitudinal and peer-related patterns are likely transferable to the decision to ride an e-scooter after drinking.

These attitudinal and social influences are not evenly distributed among riders but are especially pronounced among young adults, particularly young males (Vestgård et al., 2021). Because self-regulatory capacities are still developing during this period, younger people may be more prone to impulsive, reward-oriented, and overly confident decisions, which can contribute to underestimating the risks of riding an e-scooter after drinking alcohol (Harré et al., 2005; Steinberg, 2007). Risk proneness is also notably higher among young people, and this tendency is particularly strong in young males (Borghans et al., 2009; Chapple & Johnson, 2007). Research consistently shows that men are more likely to engage in risky behaviors, including substance use and dangerous driving/riding (Bates et al., 2024; Byrnes et al., 1999). This combination may increase the likelihood of alcohol-impaired e-scooter riding, as also suggested by Phipps and Hamilton (2024).

A further, highly individual factor relevant to the present study is prior e-scooter riding experience (Pobudzei et al., 2024). Regular users may develop a pattern of choosing e-scooters for short trips due to familiarity and comfort (Kazemzadeh & Sprei, 2024). In this sense, previous use may reinforce a preference for e-scooters over time, even when alternatives are available.

Perhaps most significantly, the influence of peers is particularly strong during adolescence and young adulthood (Wang et al., 2024).

[2] Blood Alcohol Concentration

The presence of friends or acquaintances can substantially increase the likelihood of engaging in risky behaviors, including in traffic contexts (Gheorghiu et al., 2015; Leadbeater et al., 2008; Sutherland et al., 2022; Williams et al., 2007). Studies have shown that young people are more likely to take risks when peers are present, as social acceptance and the desire to fit in become especially salient during this developmental stage. According to a review study, social influence from peers is particularly strong among young people, with both negative and positive effects on their behavior (Molleman et al., 2022). Besides peer presence, peer pressure can directly encourage risky actions and indirectly lower inhibitions, making it more difficult for individuals to make safe choices in group settings. The descriptive norm of others already engaging in a risky behavior, like riding the e-scooter under the influence, can enhance feelings of behavioral pressure (Phipps & Hamilton, 2024). While peer influence can be viewed as a situational factor reflecting the external social environment, there is robust empirical support for treating susceptibility to peer influence as an individual factor (Oyibo & Vassileva, 2019). Research suggests that the extent to which an individual is influenced by peers is partly shaped by stable personal characteristics, including personality-related dispositions and developmental stage (Oyibo & Vassileva, 2019; Steinberg, 2007). These differences are especially relevant to young people, making susceptibility to peer influence a trait-like, person-specific variable (Gheorghiu et al., 2015; Leadbeater et al., 2008; Sutherland et al., 2022; Wang et al., 2024).

Taken together, these developmental, psychological, and social factors within a person could help explain why young people, particularly male users, are disproportionately likely to ride e-scooters under the influence of alcohol.

2.2. Situational factors

Since e-scooter riding under the influence at night is associated with increased crash risk, one countermeasure is to make potential riders choose other modes of transport during nighttime hours. This requires understanding why people choose the e-scooter out of all the available modes of transport in the first place. The decision to use an e-scooter as a mode of transport, rather than alternatives such as walking, cycling, or public transit, is influenced not only by individual factors, but also by various factors specific to the decision situation, which will be presented below.

A central situational factor is the availability of other modes of transport, which is a central predictor of mode choice (Schneider, 2013). In urban areas, especially during off-peak hours or in locations with limited public transport services, e-scooter sharing is often a more readily accessible option than, e.g., public buses. Their widespread presence in densely populated areas and the ease of locating and renting them make them a convenient alternative when other modes of transport are less available (Khan et al., 2025). At the same time, there is a relation between the presence of public transport transit stations and e-scooter usage, presumably as e-scooters are used to cover a first-/ last-mile link towards those stations (Jiao & Bai, 2020; Khan et al., 2025), with studies finding that younger road users have an increased preference for using micromobility devices for these connections (Li et al., 2024; Oeschger et al., 2023). Moreover, the question is not solely about whether other modes of transport are offered, but also how directly or easily they are available. E-scooter sharing services can be station-based, but they are often operated as free-floating, where potential users might find a 'free' vehicle in the direct vicinity. In contrast, most public transport lines have designated stops. E-scooters are perceived as a good alternative for short to medium distances, particularly for urban distances where walking might be too slow, and public transit might involve walking to the next station, waiting times, and indirect routes (Wallgren et al., 2023). The flexibility of e-scooter rentals, which do not require planning or adherence to fixed schedules as with public transportation, might enhance their perceived utility for spontaneous or short trips (Ahmad et al., 2025; Badia & Jenelius, 2023), similar to bike sharing.

Another situational factor is the perceived security of the available options, i.e., the security from crime. At night, this might depend not only on the transport option itself, but also on the surrounding environment. E-scooters might, in some situations, be perceived as a relatively secure option because they can be unlocked and used immediately, without waiting at a stop or sharing space with unfamiliar passengers. At the same time, environmental features such as poor lighting and the absence of other people might increase fear of crime and thereby influence transport decisions. Research in the public transport sector points in this direction, showing that women report greater safety concerns than men and feel less safe at night than during the day (Alfaro et al., 2025; King et al., 2025). In addition, Chaney et al. (2024) showed that women have very different visual search patterns in nighttime scenarios than men, focusing also on areas outside the walking path, such as bushes and dark areas, which might reflect heightened safety concerns. These findings suggest that both the characteristics of the transport option and the perceived security of the nighttime setting might shape the decision to use or avoid an e-scooter.

Overall, the literature suggests that the decision to ride an e-scooter after drinking alcohol at night is shaped by both situational and individual influences.

2.3. Aim

Building on this, the present study aimed to quantify the protective and increasing effects of the five attributes: type of transport alternative, availability of transport alternative, availability of e-scooters, influence of peers, and perceived security on the likelihood of young people's decision to ride an e-scooter at night under the influence of alcohol. Further, this study set out to explore whether and how these attributes relate to respondents' gender, age, riding frequency, and drunk riding attitudes. To ensure that the findings apply to multiple countries, samples come from Denmark, Germany, and Switzerland. Three countries in which shared and private e-scooters are prevalent and controversially discussed due to their increased injury risk (Anke et al., 2022; Cloud et al., 2023; Huemer et al., 2022; Siebert et al., 2023).

3. Methods

We conducted an online conjoint study to investigate the effects of different factors on young people's decisions about riding e-scooters at night. A conjoint study asks respondents to make decisions, e.g., about purchasing a product with specific features (Orme, 2020). Employing a conjoint study to investigate the preferences of people to drive a car under the influence of alcohol has already been successfully utilized by Yao et al. (2014) and Yao et al. (2021). As our study aims to shed light on the decision-making process of young people on a night out, choosing or dismissing the e-scooter as a transport mode, utilizing a conjoint experiment entails getting as close as possible to the actual real-world decision-making. Hence, in this online study, participants were repeatedly presented nighttime scenarios for which they were asked how likely they would use an e-scooter. The stated preference data of the conjoint study were supplemented by examining the attitude towards and, as a measure of revealed preference, previous drunk riding.

3.1. Study design, conjoint, and variables

A conjoint value analysis setup was used to present the different nighttime scenarios. The characteristics of the scenarios varied according to the five studied attributes (independent variables) and their 2 to 4 categories, as shown in Table 1.

The combinations of attribute categories (scenarios) evaluated by the participants were generated using Lighthouse Studio (Sawtooth Software, 2024b), which ensured a symmetrical orthogonal design. To

Table 1
Conjoint study design.

Attribute	Categories
Transport alternative	Bus/ Bike Sharing/ Walking
Availability of alternative	Direct/ 5 min away (Bike Sharing/ Bus)[1]
E-scooter availability	Direct/ 5 min away
Peers	Not present/ Undecided/ Prefer e-scooter/ Prefer transport alternative
Security	Low/ High

Note. [1] No meaningful combination possible with walking.

limit participant strain, 20 scenarios (D-efficiency[3] = 0.916) from a possible set of 80 were used in the study,[4] and participants were randomly assigned to one of two versions each containing 10 scenarios. A detailed description of the attributes and their category combinations is given in the next section 3.2. As dependent variables, we measured participants' ratings of their likelihood to choose the e-scooter for each scenario and whether they would also opt for the e-scooter under the influence of alcohol (wording 'after a drink or two'), with the second question forming the core focus of the present study. Respondents answered on a 6-point Likert scale from 1-would definitely not choose an e-scooter to 6-would definitely choose an e-scooter.

3.2. Material and images

To support participants in putting themselves in the situation, we presented the attribute category combinations as images generated with traffic visualization software.[5] All created images had the core characteristics of picturing a night scene in a city, including bars, a cinema, residential buildings, and the opportunity to depict mobility options such as a bike-sharing station, an e-scooter parking area, and a bus stop. The perspective for the images was chosen to mimic the ego perspective of a person standing on the sidewalk, looking at the scene while vieweing the mobility options presented on a smartphone, including the time (11 pm). An example image is shown in Fig. 1.

Depending on the attribute categories, elements were added or removed from the images:

(1) If the bus was an alternative mode option, the bus stop was pictured. The same applied to removing or adding a bike/e-scooter sharing station. (2) Regarding the availability of a transport alternative, the vehicles (bus, bike sharing, e–scooter sharing) were either present or not, and the smartphone app showed the respective details. A peculiarity was the option to walk, which meant waiting was never necessary. (3) The peers, two people in green shirts, were placed close to the ego perspective, being either present or not. Speech bubbles were added to the peers to underline their decision-making. (4) Security was varied by having many other traffic participants (car drivers, cyclists, pedestrians) for the high security condition and full lighting of the promotional sign of the cinema and all lanterns. In the low security condition, only one car was present. At the same time, all other traffic participants were removed, the lighting of the promotional sign was reduced, and only every other lantern was lit. All 20 images are provided in the supplementary material.

[3] D-efficiency: $1/(n|\ (X'X)^{-1}\ |^{\ 1/p})$ is derived as determinant of the information matrix, with 1 representing the most statistically efficient (perfectly orthogonal) design Rao (2026).

[4] The full set of possible combinations comprised 96 scenarios. However, 16 unrealistic scenarios were excluded, namely those in which walking was not directly available as an alternative but only after a five-minute wait.

[5] VICOM Editor, a software from TÜV | DEKRA arge tp 21 GbR, Dresden, https://www.vicomeditor.de, was used to create the media.

3.3. Pretesting and language versions

The online study was first pretested with 16 people from a convenience sample. Whether the participants recognized the relevant attributes and categories of the created scenario images was checked. Feedback and improvement suggestions on the survey were manifold (peers were perceived as being too distant; smartphone display was not large enough; available transport options were not correctly understood; instruction should clearly focus on ego perspective; clock in the scenery was too small; bus station should only be present in scenarios with having bus as a transport option; it was not understood that walking shouldn't be always possible; having a taxi/uber as a transport alternative is not convincing). Subsequently, adjustments were made to the images, such as enlarging the smartphone display, including the time, and providing concrete illustrations of available transport options, and revising the instructions. It was found that no additional textual description was required to supplement the images.

To avoid local biases, the study was designed to be conducted in multiple countries to enhance the external validity of the results. Therefore, the study was conducted in Denmark, Germany, and Switzerland, all of which feature well-established urban transport systems, high e-scooter adoption rates, and substantial technological infrastructure. Despite these shared characteristics, differences exist between these countries. Germany has one of Europe's largest e-scooter markets, Denmark is a sustainability leader with innovative mobility policies, and Switzerland offers unique insights due to its regulatory and topographical challenges. By selecting these three countries, the study aims to gain a more detailed understanding of the factors shaping micromobility trends in Europe. The choice also ensured that the findings are relevant to diverse urban and regulatory contexts, enhancing their applicability beyond the selected countries. To consider the differences among the three countries, the illustrations used in the study had their lane markings and vehicle license plates changed accordingly to present a Danish, German, or Swiss context. Language translations were made by native speakers, building on the English survey version (see annex). Further pretesting of the three language survey versions – Swiss German, German, and Danish – was made to ensure good readability and avoid spelling errors.

3.4. Structure of the online study

The survey items and structure are given in the annex. The survey started with filter questions on age, country of residence, and alcohol consumption. In addition, respondents were screened for general openness to riding an e-scooter. Participants who indicated that they were not open to riding an e-scooter were excluded from the survey, so the final sample represents young adults who were at least generally open to e-scooter use. If the participants stated that in general they do drink alcohol, the subsequent question on the likelihood of choosing an e-scooter 'after a drink or two' per scenario was shown. Participants' ages were restricted to 16 to 35 years, and residency in Switzerland, Denmark, or Germany. After these initial questions, the instructions and introductions to the conjoint followed, including a scenario image example. Two attention checks requesting a specific answering format interrupted the conjoint questions. Participants were excluded from data collection if they did not pass the check twice.

After completing the conjoint study part, participants were surveyed on various aspects, including age, gender, e-scooter usage frequency, prior drunk e-scooter riding, and risk-taking attitudes (see annex for details). This data was used to describe the sample and to form sample subgroups for the analysis of the conjoint data.

3.5. Sample and data collection

The data was collected from 05.11.24 to 30.11.24 via the online survey software Lighthouse Studio (Sawtooth Sawtooth Software,

Fig. 1. *Illustration being used in the conjoint experiment. Note.* Swiss version of the combination of (1) bus as transport alternative, (2) being directly available, (3) having an e-scooter directly available, (4) with your peers present, having decided on the e-scooter, and (5) in a low security setting. Swiss German wording: 'Steht bereit' – 'Ready to go'; 'Abfahrt jetzt' – 'Departure now'; 'Wir nehmen das E-Trotti. ' – 'We'll take the e-scooter.'.

2024a) in Switzerland, Germany, and Denmark. For this purpose, the link to the study was sent via the Bilendi panels in Switzerland, Germany, and Denmark to people who were at least 16 years old and no more than 35 years old. Care was also taken to ensure that the age distribution of participants above and under 25 was balanced. Mean age of the overall sample was $M = 27.0$ ($SD = 5.2$, $n = 717$); Switzerland $M = 27.1$ ($SD = 5.2$, $n = 230$); Germany $M = 27.4$ ($SD = 5.0$, $n = 260$), Denmark $M = 26.4$ ($SD = 5.5$, $n = 227$). Further sample characteristics are shown in Table 2. The age distribution, analyzed with the Kruskal-Wallis test, showed no differences between the three samples, $H(2) = 3.44$, $p = 0.179$. A chi-square test of independence was conducted to examine the relationship between gender and country (Switzerland, Germany, Denmark), yielding a significant result, $\chi^2(2) = 13.14$, $p < 0.001$. Cramer's V was 0.14, indicating a small effect size. Examination of standardized residuals revealed that the Danish sample had more female and fewer male respondents than expected. There is a statistically significant difference in the distribution of e-scooter usage frequency across the three countries, Chi-square test of independence, $\chi^2(8) = 24.21$, $p = 0.002$, with respondents from Denmark showing the lowest rate of regular use. However, the effect size is very small (Cramer's $V = 0.09$), indicating that while differences are statistically significant, they are not large in magnitude.

When asked about the frequency of e-scooter riding after drinking alcohol ("How often do you ride an e-scooter while under the influence of alcohol?"), 18.8% of respondents stated that they do so at least occasionally (including 5.9% often and 2.1% very often). With 20.8%, around one-fifth at least once rode an e-scooter under the influence, which makes a total of around 40% with past alcoholized e-scooter rides. More than half of respondents (60.4%) reported having never ridden an e-scooter after drinking.

3.6. Data analysis

During data preparation, data records were deleted if the attention check was not passed twice, if the survey was completed in less than 4 min (so-called speeders), and if there was no variation in responses (respondents who provided the same answer to each question) in the CVA tasks. The adjusted data set used for the following analyses comprised $N = 717$ participants (see Table 2 for details).

A Hierarchical Bayes (HB) model was developed using Lighthouse Studio (Sawtooth Software, 2024a) to estimate the part-worth utilities for each attribute category. HB models can be applied to conjoint data as they estimate part-worth utilities (beta weights) not across all respondents but within each respondent. Thus, HB models are superior to traditional regression approaches, as they yield more precise individual-level estimates by allowing parameters to vary across respondents (Allenby et al., 1998; Liechty et al., 2008). The estimated part-worth utilities reflect the direction and strength of each attribute category on the e-scooter riding decision. They are scaled to sum up to zero per attribute and therefore not directly comparable across attributes. Thus, attribute importance is derived by calculating the range of part-worths within each attribute, normalizing these ranges across all attributes, and expressing them as percentages. This provides a ratio-scaled measure of each attribute's influence on the e-scooter riding decision, ensuring that attribute importance is interpretable, standardized, and directly reflects the structure of the conjoint experiment (Orme, 2020).

In addition, choice simulations (sensitivity analysis) were conducted utilizing the respondent-level HB part-worth utilities estimated in Lighthouse Studio. Specifically, predictions were generated for all possible scenarios (all combinations of attribute categories), rather than only for the 10 scenarios evaluated by each respondent. The simulator was run with the *Purchase Likelihood* method, which estimates the stated likelihood for each specified scenario independently (Sawtooth Software., n.d.). To ensure that all possible combinations were evaluated, *Exhaustive Search* was applied (Sawtooth Software., n.d.). For each simulated scenario, the relevant attribute-level part-worths were combined at the individual level and converted into a predicted e-scooter riding likelihood. The reported scenario likelihoods therefore represent model-based predictions averaged across respondents, following the general simulation logic described by Yao et al. (2014). To examine the isolated effect of each attribute, we then defined a base-case scenario and conducted choice simulations in *Sequential mode*, in which one attribute was varied across its categories while all remaining attributes were held constant at the base-case categories (Sawtooth Software., n.d.). This procedure yields changes in predicted riding likelihood relative to the base-case scenario, rather than raw observed percentages from the conjoint tasks.

Sample subgroups based on gender (male, female), age (16-25, 26-35), e-scooter ridership (riders, non-riders), and attitude towards e-scooter riding after drinking (permissive, neutral, dismissive) were analyzed for inter-group differences of attribute importance values utilizing Kruskal-Wallis H tests and respective pairwise comparisons. Moreover, differences within the subgroups in the average likelihood of all 80 scenarios (including the simulated data) were analyzed by applying independent samples t-tests, Welch's F-test, and Games-Howell

Table 2
Sample characteristics for overall and subsamples.

Variable	Switzerland		Germany		Denmark		Total sample	
	%	*n*	%	*n*	%	*n*	%	*n*
Gender								
Female	53.9	124	43.8	114	59.5	135	52.0	373
Male	45.7	105	55.8	145	39.2	89	47.3	339
Non-binary	0.4	1	0.4	1	1.3	3	0.7	5
What kind of place do you live in?								
Rural area	31.7	73	20.0	52	14.5	33	22.0	158
Small town	32.6	75	17.3	45	15.4	35	21.6	155
Medium-sized town	19.6	45	15.8	41	28.6	65	21.1	151
Big city	13.5	31	17.7	46	24.7	56	18.5	133
Small metropolis	1.3	3	11.5	30	5.7	13	6.4	46
Big metropolis	1.3	3	17.7	46	11.0	25	10.3	75
Do you have a public transport subscription ticket or travel pass/card?								
Yes – with unlimited travel	37.4	86	38.1	99	28.6	65	34.9	250
Yes – reduced prices for ticket purchase	32.6	75	10.0	26	32.6	74	24.4	175
No	30.0	69	51.9	135	38.8	88	40.7	292
Driver's license or learner's permit								
Yes	89.6	206	85.8	223	72.2	164	82.7	593
No	10.4	24	14.2	37	27.8	63	17.3	124
What is your main mode of transport for your everyday journeys?								
Walking	12.2	28	15.4	40	11.9	27	13.2	95
Public transport (bus, train, tram)	37.8	87	21.2	55	11.9	27	23.6	169
E-scooter	2.2	5	4.2	11	4.0	9	3.5	25
Bicycle/e-bike/ pedelec	13.5	31	7.7	20	20.7	47	13.7	98
Car (driver or passenger)	28.3	65	45.0	117	39.6	90	37.9	272
PTW	0.9	2	1.0	5	0.9	2	1.3	9
Other	0.4	1	0.4	1	1.3	3	6.1	5
Usually, combine several modes of transport	4.8	11	4.2	11	9.7	22		44
How often do you go out with friends to bars, clubs, or discos?								
More than 2 times a week	1.3	3	4.2	11	0.9	2	2.2	16
1–2 times a week	11.3	26	12.3	32	8.8	20	10.9	78
1–2 times a month	48.7	112	37.3	97	33.9	77	39.9	286
Less than monthly	30.0	68	29.6	77	36.6	83	31.9	229
Never	8.7	20	16.5	43	19.8	45	15.1	108
When you go out with your friends, which is your default travel mode to switch between locations (e.g., from club A to B or to reach the next transport hub)?								
Walking	26.1	60	20.0	52	41.4	94	28.7	206
Public transport (bus, train, tram)	44.8	103	36.5	95	22.5	51	34.7	249
E-scooter	4.8	11	5.4	14	5.3	12	5.2	37
Bicycle/e-bike/ pedelec	5.2	12	3.5	9	11.0	25	6.4	46
Car (driver or passenger)	12.6	29	28.5	74	13.2	30	18.5	133
PTW	1.3	3	1.5	4	0.0	0	1.0	7
Other	0.9	2	0.8	2	0.0	0	0.6	4
Usually, combine several modes of transport	4.3	10	3.8	10	6.6	15	4.9	35

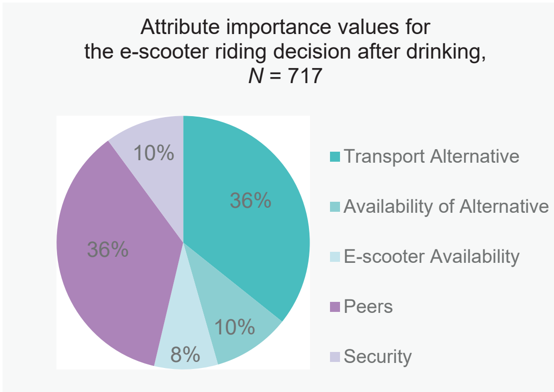
post hoc analysis. For this, e-scooter riders and non-riders were differentiated based on the items "How often do you ride an e-scooter during the day?" and "How often do you ride an e-scooter during the night?" (see annex for details), with respondents selecting "never ridden before" for both items being coded as non-riders. Similarly, respondents who disagreed or strongly disagreed with the statement "I think it is acceptable to ride an e-scooter after having a drink or two" were labeled "Disagree with drunk riding" (dismissive attitude), those who neither agreed nor disagreed were labeled "Undecided about drunk riding" (neutral attitude). Those agreeing or strongly agreeing were labeled as "Agree with drunk riding" (permissive attitude). To analyze associations between attitude towards and previous drunk e-scooter riding, ordinal regression was used.

4. Results

4.1. Attribute importance

The average importance indicates the relative impact of each attribute on the e-scooter riding decision (see 3.6 for details). The importance values of all attributes add up to 100% and are illustrated in Fig. 2. The results show that, for the respondents, *peers* and the *transport alternative*, were nearly equally the most significant contributors to their e-scooter riding decision after drinking alcohol. When taken together, around 72% of relative importance, both attributes greatly impacted the riding decision. The attributes of *alternative availability*, *e-scooter availability*, and *security* played a minor role in the likelihood of riding an e-scooter.

A comparison of the attribute importance values across different respondent subgroups showed that, regardless of respondents' age, gender, or e-scooter usage frequency, the same pattern of attribute importance values, as described above, emerges (Fig. 3). For the most influential attributes (peers and transport alternatives), the most considerable descriptive differences within the groups appeared for the gender and attitude comparison. While females attached slightly more importance to the *transport alternative*, males placed greater weight on their *peers* in the e-scooter riding decision. However, a Kruskal-Wallis H test showed no statistically significant differences in the attribute importance of peers, $H(1) = 3.06$, $p = 0.080$, or transport alternatives, $H(1) = 1.84$, $p = 0.176$, between women and men. Regarding the attitude towards drunk riding (see 3.6 Data analysis), respondents with no clear attitude (neutral) placed the highest importance on the *peer* attribute, while for respondents who were not ok with drunk e-scooter riding, the *transport alternative* was most important. The Kruskal-Wallis H test



Attribute	Importance	SD	Lower 95% CI	Upper 95% CI
Transport alternative	35.71	13.68	34.71	36.71
Alternative availability	9.86	6.84	9.36	10.36
E-scooter availability	8.13	7.18	7.60	8.65
Peers	36.19	13.18	35.23	37.16
Security	10.11	7.47	9.56	10.66

Fig. 2. Attribute importance values in percent.

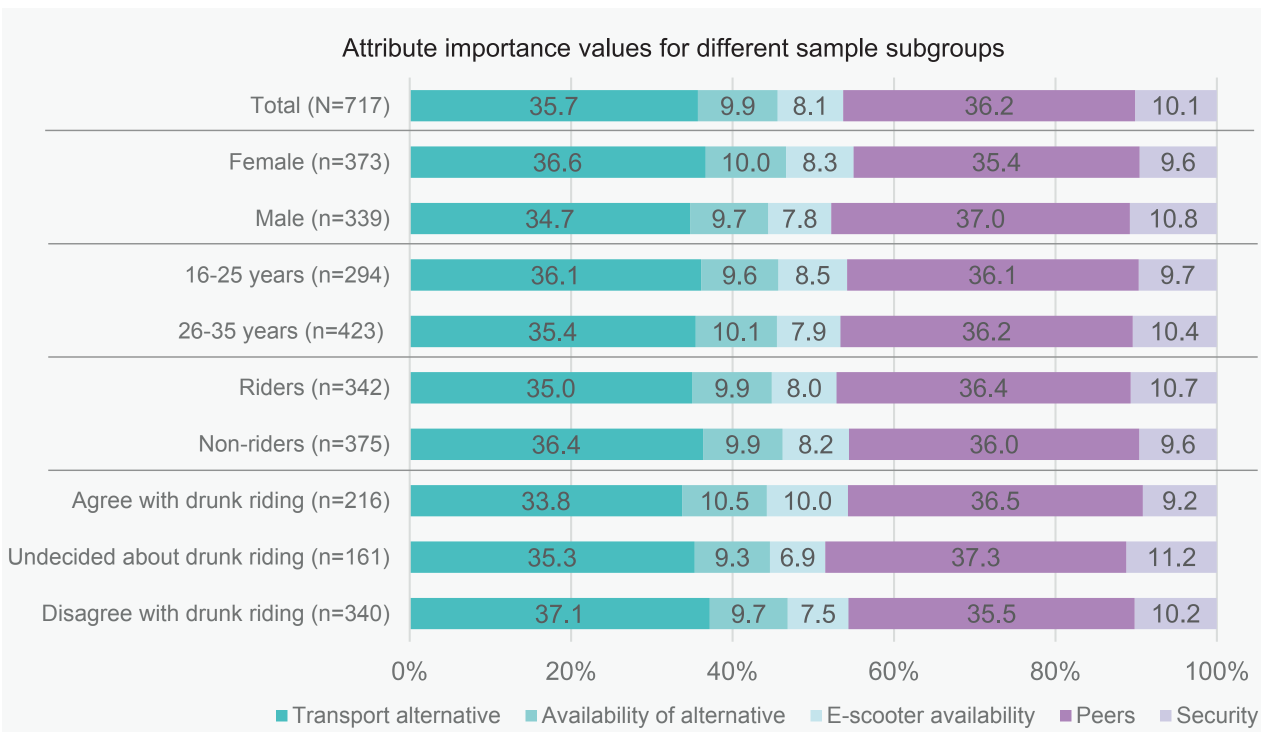


Fig. 3. Attribute importance values for the e-scooter riding decision after drinking for different subgroups in percent.

revealed significant differences in the attribute importance of transport alternatives, $H(2) = 8.42$, $p = 0.015$, between attitude groups. Post hoc pairwise comparisons showed that, among respondents with a permissive attitude, the transport alternative is more important than for respondents with a dismissive attitude ($p = 0.004$, Bonferroni-corrected). The attribute importance of *peers* did not differ significantly among the three attitude groups, $H(2) = 2.82$, $p = 0.24$.

4.2. Choice simulations

Based on the conjoint study data, simulated, model-based predicted likelihoods of riding an e-scooter after drinking alcohol were calculated for all possible attribute-category combinations (80 scenarios in total), using the Lighthouse Studio choice simulator and the respondent-level HB utilities described in 3.6. Our base-case scenario, shown in Fig. 4, which served as a reference, was the scenario identified as having the highest predicted likelihood of riding an e-scooter after drinking alcohol (47.7%) among all possible scenarios. In this base-case scenario, the transport alternative was a rental bike parked 5 min away. At the same time, an e-scooter was directly available, and the peers were already set on e-scooter riding. Starting from this scenario, one attribute at a time was varied across its categories to assess each category's isolated impact on the e-scooter riding decision through holding all other attribute categories constant. These simulations made it possible to determine the attribute categories with the most deterrent/protective and increasing effect on the riding likelihood.

The results of the choice simulations (Fig. 5) showed that the peers' decision for the transport alternative and the transport alternative of a bus connection can lower the e-scooter riding likelihood by 11.0%, respectively, 9.6%. Hence, the *peers* and the *transport alternative* can have the most significant effect on the e-scooter riding likelihood after drinking alcohol. On the other hand, this also implies that these attributes,can increase the likelihood of e-scooter riding, i.e., if there is no public transport option and peers opt for the e-scooter.

As expected, the direct *availability of a transport alternative* (bus, bike sharing) could decrease the riding rate by 3.7%. Along the same lines,

Fig. 4. Base-case scenario for the choice simulations.

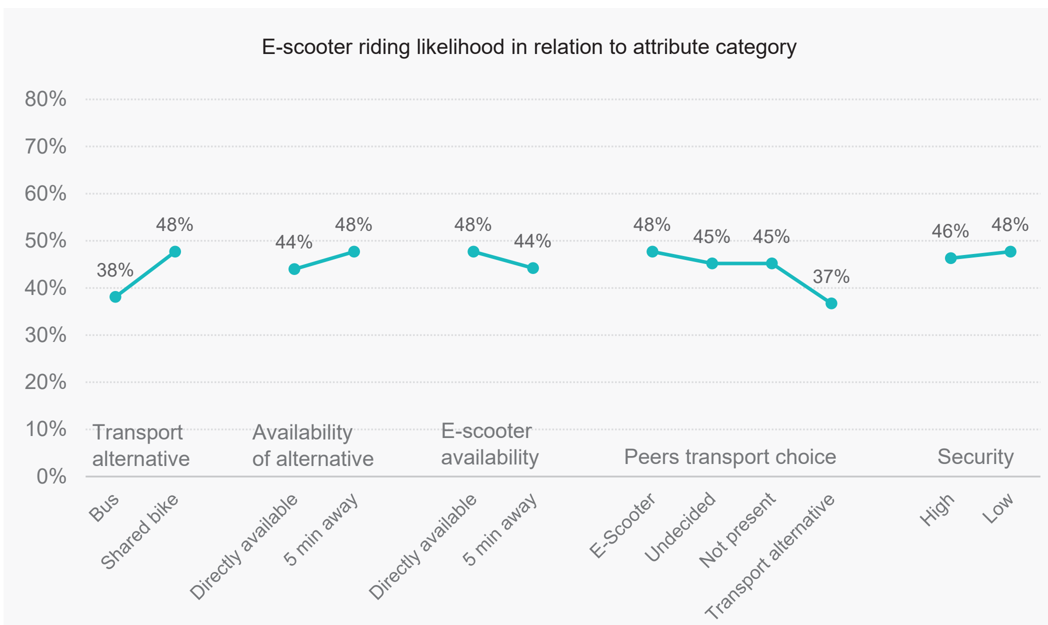


Fig. 5. Alcohol-impaired e-scooter riding likelihood for all attribute categories, in reference to the base-case scenario (purple dots).

lowering the *e-scooter availability*, e.g., with the next sharing station a 5-minute walk away, in our study, decreased the riding rate by 3.5%. Security features through which we operationalized *security from crime* in a nighttime traffic scene, such as the number of people around and how well the scene was lit, had little impact on the likelihood of riding. If more people were around and more lighting was on, the riding rate was slightly decreased (-1.4%).

4.3. E-scooter riding likelihood by subgroups

Over the 80 scenarios, the average likelihood to ride an e-scooter after drinking alcohol was 34.5%, ranging from 20.3% to 47.7%. For the aforementioned sample subgroups by gender, age, e-scooter usage, and drunk-riding attitude, we checked for inter-group differences in the average likelihood of these 80 scenarios (Fig. 6).

With 38.0% (SD = 6.1%), men showed an around 6.5% higher average likelihood to ride an e-scooter after drinking alcohol than women, who showed an average likelihood over all scenarios of 31.6% (SD = 6.8%). This gender difference[6] was statistically significant with a large effect size, $t(158) = -6.359$, $p < 0.001$, Cohen's $d = -1.005$, indicating that men are more likely to choose an e-scooter than women, independent of scenario variations. With a mean average riding likelihood over all 80 scenarios of 34.5% (SD = 6.7%) for respondents aged 16-25 years and 34.7% (SD = 6.35%) for respondents aged 26-35 years, the riding likelihood did not differ between the studied age groups, $t(158) = -0.196$, $p = 0.556$, Cohen's $d = 0.031$.

E-scooter riders were around 10% more likely to ride an e–scooter after drinking alcohol than non-riders who have never used an e-scooter (M = 39.9%, SD = 6.4% vs. M = 29.8%, SD = 6.5% average riding rate over all scenarios). The e-scooter riding likelihood differed significantly for riders and non-riders with a large effect, $t(158) = 9.890$, $p < 0.001$, Cohen's $d = 1.564$.

[6] As there were only 5 non-binary respondents in the sample, they could not be considered for statistical analyses.

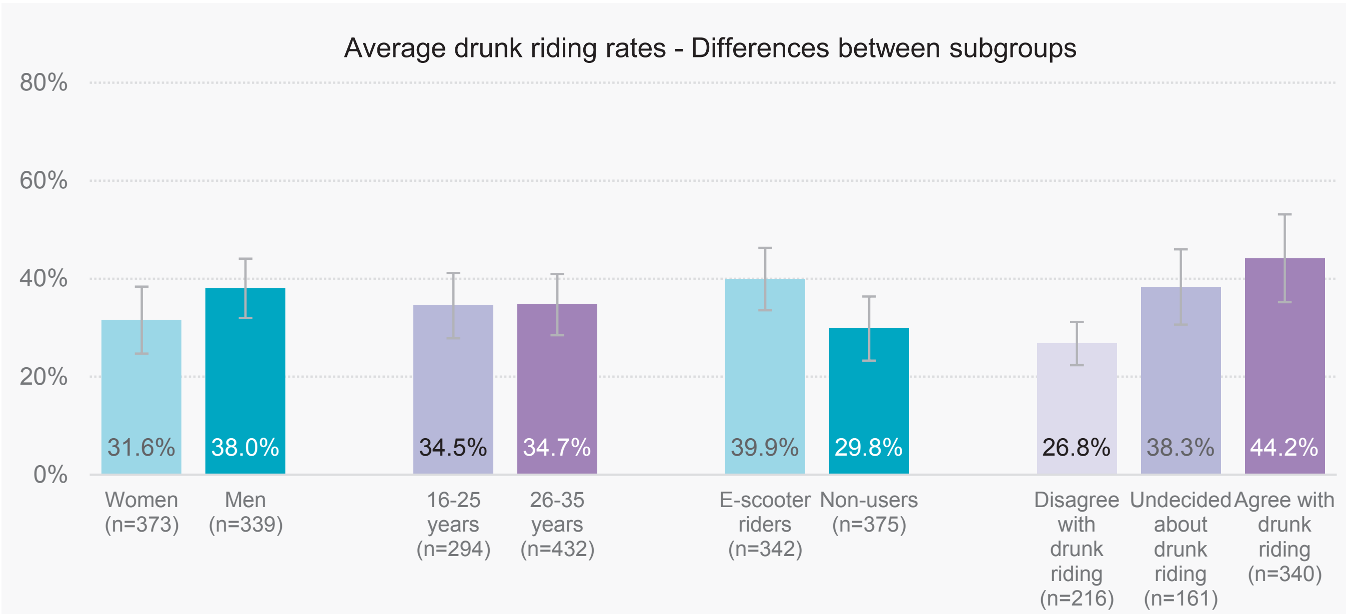


Fig. 6. Mean differences in indicated e-scooter riding likelihood after drinking alcohol between sample subgroups over all possible 80 scenarios.

The average likelihood to ride an e–scooter after drinking over all scenarios decreased from the positive drunk riding attitude subgroup (ok, to ride after drinking, M = 44.2%, SD = 9.0%), to the neutral attitude subgroup (M = 38.3%, SD = 7.7%) to the negative drunk riding attitude subgroup (not ok, to ride after drinking, M = 26.8%, SD = 4.4%). The likelihood of e-scooter riding differed significantly for the three attitude groups, Welch's F(2, 143.14) = 156.22, $p < 0.001$. Games-Howell post-hoc analysis revealed a significant difference ($p < 0.001$) for the indicated e-scooter riding likelihood between all attitude groups. Average riding likelihood decreased from positive drunk riding attitude to neutral attitude (-5.9%, 95%-CI[-8.97, -2.73]), from neutral to negative attitude (-11.6%, 95%-CI[-13.90, -9.20]), and from positive to negative attitude (-17.4%, 95%-CI[-20.05, -14.75]).

Additionally, in conjunction with the stated preference conjoint data, collected revealed preference data on past drunk e-scooter rides were checked for associations between attitude towards drunk riding and past drunk e-scooter riding. Ordinal regression showed that more permissive attitudes are associated with higher odds of more frequent drunk riding in the past, $\chi^2(4) = 294.87$, $p < 0.001$. The model fits the data well (Pearson $\chi^2(12) = 18.31$, $p = 0.107$; Deviance $\chi^2(12) = 19.94$, $p = 0.068$) and explains a moderate proportion of variance (Nagelkerke's pseudo $R^2 = 0.31$). Compared to participants who “strongly agree” with risk-taking attitudes, those who “strongly disagree” had significantly lower odds of reporting more frequent riding under the influence of alcohol in the past ($OR = 0.012$, 95% CI [0.005, 0.027], $p < 0.001$). Similarly, “disagreeing” ($OR = 0.093$, 95% CI [0.049, 0.177], $p < 0.001$), being “neutral” ($OR = 0.247$, 95% CI [0.133, 0.459], $p < 0.001$), and “agreeing” ($OR = 0.535$, 95% CI [0.292, 0.980], $p = 0.043$) were all associated with lower odds of past riding under the influence compared to strong agreement.

5. Discussion

The presented study sought to provide insights into the extent to which the situational factors: type of transport alternative, availability of alternative, e-scooter availability, peers, and security contribute to young people's decision to ride an e-scooter after drinking alcohol at nighttime. Moreover, the protective and increasing effects of changes in those factors were investigated. The outcomes of this study showed that peer influence and the transport alternative are the most important factors, with no differences by age groups, genders, riders versus non-riders, or per drunk riding attitude. More specifically, our results indicate that the peers' decision to go for an alternative to e-scooter riding has the most significant potential to decrease the likelihood of alcohol-impaired riding. However, this also implies the peer influence as the most critical pull factor in case the peers decide to go for e-scooter riding, even under the influence of alcohol. That the peers emerged as such an important factor for the riding decision underpins their significance for the young user group to engage in risky behaviors, as already documented by other research (Gheorghiu et al., 2015; Leadbeater et al., 2008; Sutherland et al., 2022; Wang et al., 2024), also applies to nighttime e-scooter riding after drinking. In line with research on mode choice (e.g., Schneider, 2013), the type of transport alternative emerged as the second most crucial factor in the riding decision. The conducted choice simulations demonstrated how important the interplay between the factors is, showing that peers deciding on available e-scooter sharing, and worst case, at the same time with no public transport option available, riding after drinking alcohol is highly likely.

These results confirm that e-scooters offer a convenient alternative because they provide more direct access than public transport options that often involve waiting or walking to a station (Khan et al., 2025; Wallgren et al., 2023). This highlights the importance of tightly scheduled public transport services, even at night, to compete with the flexibility of e-scooter rental schemes (Badia & Jenelius, 2023), and to help prevent e-scooter riding under the influence of alcohol. From the opposite perspective, this can also indicate that, at least in districts popular with young people for going out, e-scooter availability should be restricted so that the e-scooter is not the most natural option. This is also supported by studies showing that e-scooter use is related to how far or close the next device is located (Badia & Jenelius, 2023). Such timely and local restrictions at night, e.g., through geofencing, already proved successful in reducing e-scooter related injuries (Pakarinen et al., 2023), e.g., in the context of preventing drunk rides during the Munich Oktoberfest (Müller et al., 2024). A study conducted in Zurich provides indications of how such restrictions could be set up, showing that riders accept a maximum walking distance to e-scooter sharing of 210 m (average accepted distance: 60 m, Reck et al., 2021). Along the same lines, a positive effect of more restrictive e-scooter parking, as currently planned, for example, in the amendment to the e-scooter legislation in Germany (BMDV, 2024), on nighttime e-scooter riding under the influence of alcohol can be expected.

Concerning the target group of road safety campaigning, the subgroup analysis showed a generally higher likelihood of riding an e-scooter under the influence of alcohol for young male users, which is in line with the higher risk proneness and sensation seeking tendency of this group (Bates et al., 2024; Borghans et al., 2009; Byrnes et al., 1999; Chapple & Johnson, 2007; Phipps & Hamilton, 2024). What also became apparent is the significance of attitude. Our findings show that people with a relatively permissive attitude, for whom it is ok to ride after drinking, are also more likely to have past drunk e-scooter riding experience and a higher average likelihood of drunk riding in the tested scenarios. Here, one approach to road safety campaigning might be to address these permissive drunk-riding attitudes, e.g., by utilizing social media influencers, communicating, or even demonstrating a drunk-ridingdismissive attitude. As young riders are strongly influenced by peers and use social media extensively, a role-model approach on social media platforms might be promising (PIARC, 2012). Our findings thus extend the attitude- and peer-related patterns documented for cycling under the influence to e-scooter riding. The observation that a permissive attitude, rather than deterrence, best predicts impaired cycling (Huemer, 2018) further supports our suggestion to prioritize attitude- and norm-focused campaigning over purely legal or enforcement-based measures.

With regard to the age subgroups investigated, the peers emerged as equally important to the older participant group (25+ years) as to the younger ones (16-25 years). Though the literature on peers in the traffic context predominantly describes the importance of them for young (around 16-25 years) peoples' risky behavior related to car driving (Gheorghiu et al., 2015; Leadbeater et al., 2008; Sutherland et al., 2022), our results showed that, at least, in our setting of being on a night out, the peers' social influence is highly relevant also in the context of e-scooter riding and remains highly relevant also to people above 25 years of age. One possible explanation is that the peer attribute in our conjoint captured not only age-related susceptibility to peer influence, but also the descriptive norm conveyed by peers' transport choice. Moreover, the older group still consisted of relatively young adults in a nightlife context, in which peer-related decision processes might remain highly relevant. A further, less intuitive finding concerns the availability attributes. Although availability is regarded as a central predictor of mode choice (Schneider, 2013), the direct availability of the e-scooter and the alternative contributed less to the riding decision than the peer and transport-type attributes. This suggests that alcohol-impaired e-scooter decisions in a nighttime context are driven more strongly by the social situation and the kind of alternative available than by the purely rational convenience of how readily a transport option is at hand.

This study has some limitations that warrant discussion. The most important limitation of this study is that we created a hypothetical decision scenario that cannot fully resemble the actual situation when going out at night. Nevertheless, the validity of our setting is supported by the finding that people already using e-scooters also showed a higher riding likelihood in our artificial setting, as would be expected if the scenario is realistic enough. Moreover, the study's design and visualization received positive feedback from participants, who left respective entries in the free comment field at the end. Another limitation is that respondents who were not open to riding an e-scooter were excluded from the survey. Thus, the findings apply specifically to young adults open to e-scooter use, and the reported likelihoods should be interpreted with this restriction in mind. A further limitation is the possible effect of the security factor visualization. Here, with the scene's sparse lighting and low traffic volume, a less secure scenario was intended. However, such a scenario might also have implied a lower likelihood of being caught riding under the influence. How the interpretation might have differed between respondents and subsequently impacted the riding likelihood remains unknown, though, across the studied factors, security emerged as the least important factor overall. Indeed, future research could more clearly differentiate between the possible contradictory effects of a fear of crime on the one hand and the likelihood of being nabbed on the other. Another limitation relates to the operationalization of alcohol intoxication in the decision scenarios. "One or two drinks" is a widely used public health heuristic that is readily understood by the general public and frequently used in alcohol prevention efforts. However, the extent of intoxication resulting from this amount can vary considerably depending on several factors such as sex, body weight, beverage type, food intake, and drinking pace. As a result, participants may have envisioned different levels of impairment when responding to the scenarios, potentially influencing risk perceptions and riding decisions and thereby introducing additional variability beyond the experimental conditions. While the present study pooled data from Switzerland, Germany, and Denmark, the observed effects were remarkably consistent across the investigated subgroups. Given the comparable legal treatment of alcohol-impaired e-scooter riding in the three countries, we do not expect regulatory differences to have substantially influenced the identified importance of peers and transport alternatives. However, future research may benefit from explicitly comparing countries with more strongly diverging regulatory frameworks or enforcement practices. Finally, an issue not studied was the knowledge or awareness of public transport options. We demonstrated in our study the importance and, thus, the protective effect a public transport connection might have on e-scooter riding after drinking. On this, we provided explicit information about the next public transport option; thus, an issue of interest for future studies might be the information gap or missing awareness regarding public transport connections and schedules, which might also impact the e-scooter riding decision, as well as the option of other transport options like ride-hailing.

6. Conclusion

Using a conjoint experimental design across Switzerland, Germany, and Denmark, this study quantified the relative impact of key factors, including the type and availability of transport alternatives, e-scooter availability, peer influence, and security, on young people's likelihood of impaired e-scooter riding. Our findings offer several important implications for both research and practice.

First, the data underscore the central role of peer influence and the availability of transport alternatives, such as public transport, walking, and bike sharing, in shaping risky riding decisions. Notably, scenarios in which peers opted for alternatives to e-scooter use, or where attractive public transport options were available, significantly reduced the likelihood of alcohol-impaired e-scooter riding. In contrast, the absence of such alternatives, combined with peer encouragement, markedly increased the likelihood of riding under the influence. This pattern was consistent across demographic subgroups, suggesting a broad applicability of these mechanisms in young urban populations.

Second, our results demonstrate that interventions targeting the social context, particularly through peer-based or normative campaigns, may be especially effective in reducing alcohol-impaired e-scooter use. Campaigns that leverage influential role models or social media figures to promote safer choices could harness the documented power of peer dynamics, particularly among young males, who tend to be more prone to risk-taking andmore susceptible to peer influence.

Third, providing and communicating safe, convenient late-night transport alternatives emerges as a critical protective factor. Urban policy measures such as extending nighttime public transport schedules, and increasing the promotion and availability of alternative modes could meaningfully shift modal choices away from impaired riding. Conversely, targeted restrictions on e-scooter availability may further reduce the convenience advantage of e-scooters in these contexts.

In sum, our study advances the understanding of decision-making processes underlying alcohol-impaired e-scooter riding and identifies actionable levers for injury prevention. Policies and campaigns that simultaneously address social, attitudinal, and infrastructural factors, rather than focusing solely on individual responsibility, are most likely to achieve meaningful reductions in alcohol-related e-scooter incidents.

Future research should continue to explore context-specific mechanisms, including the roles of information access and real-time feedback, to further refine intervention strategies.

CRediT authorship contribution statement

Juliane Anke: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Madlen Ringhand:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Désirée Hagmann:** Writing – review & editing. **Markus Hackenfort:** Writing – review & editing. **Felix Wilhelm Siebert:** Writing – review & editing, Investigation. **Tanja Stoll:** Writing – review & editing. **David Schackmann:** Writing – review & editing, Methodology, Investigation.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used you.com to improve the manuscript's readability and language. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssci.2026.107426

Data availability

Data will be made available on request.

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