Motorcycle riding under the influence of alcohol: Results from the SARTRE-4 survey

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Abstract

Riding a motorcycle under the influence of alcohol is a dangerous activity, especially considering the high vulnerability of motorcyclists. The present research investigates the factors that affect the declared frequency of drink-riding among motorcyclists in Europe and explores regional differences. Data were collected from the SARTRE-4 (Social Attitudes to Road Traffic Risk in Europe) survey, which was conducted in 19 countries. A total sample of 4,483 motorcyclists was interviewed by using a face-to-face questionnaire. The data was analysed by means of multilevel ordered logit models. The results revealed significant regional differences (between Northern, Eastern and Southern European countries) in drink-riding frequencies in Europe. In general, declared drinking and riding was positively associated with gender (males), increased exposure, underestimation of risk, friends' behaviour, past accidents and alcohol ticket experience. On the other hand, it was negatively associated with underestimation of the amount of alcohol allowed before driving, and support for more severe penalties.

Key words: Motorcyclists; Attitudes; Behaviour; Alcohol; Ordered logit model

1. Background and objectives

Motorcyclists are a particularly vulnerable group of road users. Their risk of being severely injured is much higher than that of car occupants (Zambon & Hasselberg, 2006; Aare & von Holst, 2003). In 2011, 6114 moped and motorcycle riders were killed on European Union roads. Moreover, despite the efforts to decrease fatalities of motorcyclists, the proportion of moped and motorcycle rider fatalities in the EU have shown a steady rise in the last decade in several countries (European Road Safety Observatory [ERSO], 2011)[2]. One reason for the high number and share of

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[2] In fact, some countries recorded some decrease between 2000 and 2008 for motorcyclists fatalities (Germany, -30%; Netherlands, -25%; Austria, -19%; France, -15%), but some other countries

motorcycle fatalities and injuries is the lower motorcyclists' mass and protection in their interaction with other vehicles. However, this is not always the major factor for increased accident risk or severity; accidents and injuries may occur due to motorcyclists' road safety perceptions and attitudes, risky behaviours, errors or violations (Haworth, Greig, & Nielson, 2009).

Several rider behavioural factors have been associated with accidents in the international literature (e.g. speeding, inappropriate overtaking, other traffic violations, alcohol and drugs consumption). Particularly motorcyclists' alcohol consumption has received somewhat less emphasis so far, although several studies have associated alcohol consumption with road accident risk (Ahlm et al., 2009). For example, Preusser et al. (1995) found that alcohol consumption was a very common factor associated with fatal motorcycle accident involvement. Lin and colleagues (2003) examined risk factors for motorcycle crashes among junior college students in Taiwan and alcohol consumption was found to significantly increase the risk of being involved in a crash.

Kasantikul et al. (2005) argued that drunk-riders were the primary cause in three-fourths of motorcycle accidents and the only cause in one-third. Huang and Lai (2011) used data from two different government departments in Taiwan and found that 40% of motorcycle fatalities involved alcohol consumption. Moreover, 24% of killed motorcyclists in France in 2010 were under the influence of alcohol, with a BAC higher than 0.5g/l (Observatoire National Interministériel de la Sécurité Routière [ONISR], 2010) and 27% of killed motorcyclists in 2005 in the US were under the influence of alcohol, with a BAC higher than 0.8g/l (National Highway Traffic Safety Administration [NHTSA], 2008).

Alcohol seems to have important effect on riders' skills. Creaser et al. (2009) found that intoxicated riders had longer response times and were prone to task performance errors. Existing research suggests that motorcyclists are more sensible to the effects of alcohol than car drivers while driving (Lin & Kraus, 2009). This is confirmed by the fact that they are involved in fatal crashes with lower levels of alcohol in their blood than car drivers (Voas et al., 2007; Watson & Garriott, 1992). Alcohol is also associated with more severe accidents (Albalate & Fernández-Villadangos, 2010; Savolainen & Mannering, 2007).

Motorcyclists appear to be aware of their increased road accident risk while drink-riding, and may often choose their car rather than their motorcycle when they know that they are going to drink alcohol - however, this "adaptation" attempt appears to be reserved to heavy drinking situations (Syner & Vegega, 2000).

There is a lack of detailed data concerning alcohol and motorcycle/moped use in general. Moreover, attitudes of motorcyclists towards the various aspects of alcohol and riding (e.g. attitudes towards legal Blood Alcohol Content (BAC) limits, frequency of drink-riding, perceptions of alcohol related risk, etc.) are not sufficiently explored in the literature. However, in order to target specific attitudes and behaviours in different countries and overall, by means of appropriately selected

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registered increases (Finland, +260%; Hungary, +75%; Poland, +47%; Italy, +41%; Sweden, +31%; Spain, +26%).

countermeasures, it is important to further understand the factors that affect the drink-riding behaviour of motorcyclists, and the link between drink-riding and attitudes towards alcohol.

These factors are likely to vary in different countries, given that European countries exhibit important differences in terms of motorcycles ownership and use, as well as in terms of the magnitude of the motorcycle safety problem. For instance, in Italy there are 156 Powered Two-Wheelers (PTW) per 1000 inhabitants, whereas in Ireland there are 9 PTW/1000 inhabitants (Association des Constructeurs Européens de Motorcycles [ACEM], 2011). In addition, moped and motorcycle fatalities are also variable across Europe (European Road Safety Observatory [ERSO], 2011).

In this context, the present research aims to investigate the factors that affect the frequency of drink-riding among motorcyclists, and their attitudes and perceptions towards alcohol related riding. Moreover, it aims to identify and analyse country and regional differences in Europe with respect to drink-riding behaviour, alcohol-related attitudes and perceptions. For this purpose, data from the SARTRE-4 (Social Attitudes to Road Traffic Risk in Europe) European survey (Cestac & Delhomme, 2012) were used.

Based on previous researches that explored the variables linked to drink driving, we selected the following factors as potential predictors of drink driving among motorcyclists.

- Drinking and riding is expected to be more pronounced in younger riders (see for example, Elliot et al., 2009), male riders (see for example Tsai, Anderson, & Vaca, 2010), and more frequent riders (for the link between exposure and accident see Jiménez-Mejías et al., 2013);
- Riders who perceive a lower risk associated with drinking and riding are expected to present higher frequency of drinking and riding (Dionne, Fluet, & Desjardin, 2007);
- Riders with a higher perceived level of police enforcement and risk of apprehension would be less likely to drink and ride (Drew et al., 2010);
- Riders who overestimate or are not aware of legal limits would be more likely to drink and ride (Assailly, 1995);
- Riders who support stronger penalties for drink-driving would be less likely to drink and ride;
- A previous fine for alcohol or previous accident involvement would be associated with more frequent drinking and riding (Maxwell, Freeman & Davey, 2007);
- Riders may be influenced by friends' attitudes and behaviour (see for example, Jaccard, Blanton, & Dodge, 2005); We thus expect that people whose friends would drink and ride a motorcycle would be more likely to drink and ride themselves.

2. Method

2.1. Survey participants and procedure

The SARTRE-4 survey, co-funded by the European Commission, was conducted mainly in Europe. 19 countries participated in the project, namely 17 EU Member

States (Austria, Belgium, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Slovenia, Spain, Sweden), Serbia and Israel. A total sample of 4,483 motorcyclists was interviewed, at least 200 in each country, on the basis of simple random sampling, by using a common questionnaire, with questions on road safety attitudes, perceptions, beliefs, motives etc. In each country, participants were recruited following a quota method according to gender, age categories, occupation, the NUTS (Nomenclature of Units for Territorial Statistics) and the rural or urban location.

The SARTRE-4 database, developed from the coding of the questionnaire responses, involved various common questions (CO) that all road users had to fill, followed by a separate section for each category of road user (car drivers - CD, motorcyclists - MC and other road users - ORU). For details on the questionnaire design and selection of questions the reader is referred to the final SARTRE-4 report (Cestac & Delhomme, 2012).

2.2. Measures

The frequency of drink-driving is defined as a discrete variable expressed by question MC11 of the motorcycle part of the questionnaire: 'Over the last month, how often have you driven a motorcycle after having drunk even a small amount of alcohol?' The values of the dependent variable are: never, rarely, sometimes, often, very often and always.

Table 1 summarizes the explanatory variables that were examined in this research and their values. These variables include:

- motorcyclists' characteristics (i.e. age and gender) and travel habits (i.e. motorcycle engine size, exposure).
- perceived risk of drink-riding (i.e. 'you can drink and ride if you do it carefully');
- perceived level of alcohol enforcement and risk of apprehension (i.e. likelihood of being checked for alcohol)
- ability to correctly estimate the alcohol consumed in order to comply with the legal BAC limits;
- attitudes towards penalties for drink-driving (i.e. 'penalties for drink-driving should be more severe');
- declared past history fines and accidents;
- friends' behaviour with respect to drink-riding (i.e. 'most of my friends would drink and drive').

Table 1 to be inserted here

Finally, another variable that deserves particular emphasis is country. In order to explore the regional differences in the frequency of riding under the influence of alcohol, and attitudes towards alcohol in general, a standard regional distribution of European countries is considered, as summarised in Table 2. This grouping into Southern, Eastern and Northern European countries has been proposed in several existing studies on regional differences in Europe in terms of both road safety culture and road safety performance (Avenoso and Beckmann, 2005; Cauzard, 2004).

Table 2 to be inserted here

2.3. Data analysis

The dependent variable has multiple (six) ordered categories, namely from 'never' to 'always'.

An ordered logit model specification is commonly used for this type of dependent variable, as in the following equation (1):

$$y_i^* = \beta_{0(n)} + \Sigma\beta_i x_i + \varepsilon_i \qquad (1)$$

Where, y_i^* is the latent (unobserved) variable measuring the response of motorcyclist i, x_i is a (m x 1) vector of observed non-stochastic explanatory variables measuring the attributes of the respondent (i), β_i is a (m x 1) vector of unknown fixed parameters and ε_i is a random error term.

In this case, the actual dependent variable y_i^* is unobserved and therefore standard regression techniques cannot be performed. Instead, the observed variable y_i is included in the data, as the ordered variable described previously. The typical relationship between the observed and the actual dependent variable is formalized as follows:

$$y = \begin{cases} 0, \text{ if } y^* \leq \beta_{01} \\ 1, \text{ if } \beta_{01} < y^* \leq \beta_{02} \\ \quad ... \\ n, \text{ if } \beta_{0n} < y^* \end{cases} \qquad (2)$$

Where the threshold values β_{01}, β_{02}… β_{0n} are unknown parameters to be estimated. The notation used in Equation (2) indicates that each response category has a different intercept value (i.e. it is the only term of the model to which the n subscript for categories is assigned). These intercepts or "thresholds" for the response categories must be understood as the average cumulative log-odds for each category. A typical attribute of all logistic regression models are the odds ratios. Odds ratios for discrete variables are calculated as the exponential of the coefficient β_i of this variable [$\exp(\beta_i)$]. They can thus be interpreted as the ratio of the probability of an observation falling into category n or below to the probability of the observation falling into an upper category, when all predictors are set to 0. This series of intercepts accounts for the order of proportional odds, and is what confers the model a cumulative nature (Goldstein, 2003; Dupont & Martensen, 2007).

In the present research, an extension of this model is examined, namely referring to the family of hierarchical (or multilevel, or variance components) models. These models may take into account various data structures (e.g. hierarchical data structures, nested data structures, repeated observations etc.) resulting in correlated observations, and violating one of the main assumptions of most linear models (Goldstein, 2003; Huang and Abdel-Aty, 2010; Dupont et al, 2013). This may have important consequences on the results, not only in terms of the parameter estimates interpretation, but also as regards their statistical significance: in fact, failure to

account for such correlations may lead to underestimation of the standard errors of the parameter estimates, yielding erroneous statistical significances.

The SARTRE-4 data present a hierarchical structure, given that respondents come from 19 different countries, and consequently it is not possible to assume that the responses are independent observations. Furthermore, countries being closer to one another may share common characteristics (e.g. cultural or other contextual elements), so that the responses between such countries may be more similar compared to responses from countries which are further apart. In this research, it is assumed that a regional pattern (i.e. North / South / East) is involved in motorcyclists' drink-driving behaviour.

In order to account for these unobserved country and region effects, a hierarchical structure is considered for the data, in which respondents (i) are nested into 19 countries (j), and countries (j) are in turn nested into 3 regions (k) (see Figure 1).

Figure 1 to be inserted here

In the resulting hierarchical modelling framework, random intercept terms are considered, expressing random variations between countries and group of countries, as in equation (3):

$$y_{ijk}^{*} = \beta_{0(n)jk} + \Sigma\beta_{jk}x_{ijk} + \varepsilon_{ijk} \qquad (3)$$
$$\beta_{0(n)jk} = \beta_{0(n)} + u_{jk} + u_{k}$$

where $\beta_{0(n)jk}$ is the model intercept, consisting of a fixed intercept $\beta_{0(n)}$ as in equation (1), a random variation $u_{jk}\,[0, \sigma_{jk}^{2}]$ of this intercept across countries and a random variation $u_{k}\,[0, \sigma_{k}^{2}]$ of this intercept across groups of countries. This corresponds to a three-level hierarchical model. For instance, a significant random country intercept suggests that differences between responses are due to unobserved country differences, and not to differences between respondents. Moreover, the countries and country groups at the higher levels of the hierarchy are considered themselves a sample from a general population (of countries and groups of countries respectively). It is therefore possible to partition or structure the total variation of the model into the different levels (Dupont et al. 2013; Lord & Mannering, 2010).

The model thus specifies different intercepts for the response categories, but one estimate for the random variation of these intercepts at. Indeed, allowing each different category intercept to vary randomly would render the interpretation of the results quite difficult, and the model most costly to estimate. All the components of the proportional model - except the intercepts - are defined as being common to the different response categories, reflecting a fundamental assumption of the proportional model: all the effects (both fixed and random) are assumed to be independent from the particular category considered.

A detailed presentation of hierarchical or multilevel models, and of their ordered logit form in particular, is beyond the scope of this paper, and the reader is referred to Dupont & Martensen (2007) and Dupont et al. (2013).

3. Results

3.1. Descriptive statistics

A descriptive analysis of the questionnaire responses was carried out to in order to provide some first insight on motorcyclists' attitudes, perceptions and behaviour as regards drink-riding, with some focus on country and regional comparisons.

Most motorcyclists interviewed live in rural areas (48.9%) or in large towns (39.4%), while the minority live in the outskirts of cities or suburban areas (11.7%).

Figure 2 summarise the responses with respect to the dependent variable of this research, namely the reported frequency of drink-riding (even after a small amount). The results suggest that the majority of respondents do not report frequent drink-riding. The 'never' responses reach their maximum in Poland (97.2%), Finland (96.7%) and Hungary (93.1%). The lowest percentage of abstinent riders can be found in southern countries e.g. Cyprus (29.9%), Italy (51%) and Spain (56.1%). The frequency of riding under the influence of alcohol (sometimes, often, very often or always) may range from less than 1% of riders in Finland to 44% in Cyprus.

Figure 2 to be inserted here

The mean percentage of "sometimes / often / very often / always" replies to the frequency of drink-riding is 4.1%, 3.2% and 20.7% in Eastern, Northern and Southern countries respectively. A one-way non-parametric ANOVA (namely the Kruskal-Wallis test) confirmed lead to reject the null hypothesis that the drink-driving distributions of the three groups of countries are the same, confirming the regional differences detected in the data.

Table 3 to be inserted here

As would be expected (see Table 3), the majority of motorcyclists interviewed are males. The highest percentages of male motorcyclists were observed in Serbia, Hungary and Slovenia (96.7%, 95.6% and 93.7% respectively). On the other hand, Italy (69.6%) and France (77%) have the lowest percentages of male motorcyclists.

Motorcycling seems to attract individuals from all age categories. As would be expected, the minority of motorcyclists are elderly (>65 years old). The highest percentage of elderly motorcyclists can be found in Italy and Germany (11.3% and 10.3% respectively). On the contrary, the highest percentages of young motorcyclists (<35 years old) were observed in Israel, Serbia, Cyprus and Estonia (77.2%, 76.3%, 65.5% and 60.1% respectively).

As expected the highest exposure can be found in Southern countries (see Table 3), possibly due to more favourable climate and a stronger motorcycling culture overall. For example, Greece, Israel and Italy have very high percentages of more than 6 months riding per year (98 %, 96 % and 92 % respectively).

Overall, engine size seems evenly distributed overall. However, only 38.1% of southern riders have engine size higher than 500cc, while this number in northern

countries is 70.6%. This may be considered to reveal a higher proportion of recreational motorcycling in Northern countries, and a higher proportion of motorcycles being the main travel mode in the Southern countries.
Northern European countries are characterised by more positive attitudes towards penalties and more awareness of the risks of drinking and riding (see Table 4). The opposite seemed to be the case for Southern European countries, while Central and Eastern European countries showed a larger dispersion in the related responses.

Table 4 to be inserted here

The percentage of motorcyclists who believe that they can drink and ride if they do it carefully is non negligible in several countries. Italy and Cyprus have the highest percentages of under-estimation of perceived risk of drink-riding (i.e. 'drink-driving is allowed if done carefully').

The majority of the riders interviewed support more severe penalties by agreeing or strongly agreeing (see Table 4). However, a noticeable variation among countries is observed. The strongest supporters of stronger penalties for alcohol can be found in Finland, Sweden, Hungary and Israel. On the other hand, respondents from Italy, Slovenia and Cyprus have the least positive attitude towards more severe penalties for drink-riding.

About half of all participants indicate that their friends would drink and ride a motorcycle. In this case, there is also considerable variation in the responses. Greece, Cyprus and Italy have the lowest response 'not at all' (28.7%, 19.6% and 9.8% respectively). Finland and Sweden showed very low percentages in positive responses to this question (0.9% and 1% respectively).

3.2. Multilevel ordered logit models development

In order to establish the relationships between the drink-riding related variables and the riders' characteristics, multilevel ordered logit models were developed, with the question "frequency of driving a motorcycle after having drunk even a small amount of alcohol" as dependant variable.

The first step concerned the fitting of 'empty' multilevel models, in order to test whether random variation between countries and between groups of countries are a significant part of the total variation between responses. The results are summarised in Table 5.

Table 5 to be inserted here

This analysis revealed one model for each category of the dependent variable except for the last category which is omitted (reference case). Therefore, three sub-models are expected in each case. These models differ from each other in terms of the initial threshold value (i.e. constant term).

A multilevel model with fixed country group effect was tested, revealing that the effect of country group is statistically significant. Given these results, as well as the descriptive analysis and the Kruskal-Wallis test suggest important differences

between the three groups of countries in terms of motorcyclists drink-driving, we proceeded in the estimation of three separate ordered logit modes, one for each group of countries, each one including a random country effect.

The results in Table 5 show that the country variation within each group of countries is non significant. It may also be noticed that the category-specific intercepts are different in the three models. There are significant differences between countries overall, and between the three groups overall (given by the ANOVA). Moreover, there are no significant country differences within each one of the three groups of countries. These results further suggest that each country group are homogenous., but.

Given these results, it was decided to fit a multilevel ordered logit model for all countries, and separate (non multilevel) ordered logit models for the three groups of countries. The next step is to include explanatory variables in these models.

As a preliminary analysis, all explanatory variables had to be tested for potential correlations in order to evaluate their independence. Spearman correlation coefficients between explanatory variables, although statistically significant, were in their majority very low ($r < 0.2$) and therefore no multicollinearity issues are expected in the statistical analysis.

The results, in terms of parameter estimates (B), their statistical significance and their odds ratios, as well as model's fit, are summarised in Table 6. All the models are quite satisfactory in terms of performance, with good fit .

Table 6 to be inserted here

All intercepts are statistically significant. The ascending order of the intercepts for each model reflects the natural order of the responses, i.e. the range from 'never' to 'always'. However, one may notice that the actual distance between the intervals of the response as reflected by the constants, are not always equal. This means that the baseline probabilities intervals of drink-riding are not equal i.e. the difference in the probability of 'sometimes' and 'rarely' drink-riding is not equal to the difference in the probability of 'often' and 'sometimes' drink-riding, and so on.

As was the case in the 'empty' models, a significant random country effect, and a significant fixed country group effect was found in the model for all countries, while no significant random country effect was found in the models for the three country groups.

The monthly/year exposure is statistically significant in almost all groups of countries and overall. The odds ratios revealed that as exposure rises, it is more likely that motorcyclists are in higher response categories: motorcyclists who were using more frequently their motorcycle were almost 50% more likely (i.e. 1/0.68=1.47) to self-report more often drinking and riding, confirming our initial hypothesis that exposure would increase inappropriate behaviours.

Another influential factor in the analysis was the gender of the motorcyclists. Overall, male riders are more likely to report drinking and riding more often than females. Indeed, males are 2.7 times more likely to report drinking and riding more often than

females overall, and 3.2 times more likely in southern countries, while no significant gender difference was detected in eastern countries – in which the proportion of female motorcyclists in the sample was generally smaller.

The motorcycle engine size was not found to significantly affect the frequency of drinking and riding neither in the whole sample, nor at regional level. The data suggest that, as the size of the engine increases, riders appear to report less frequent drink-riding (see Table 3), but this could not be statistically validated. However, it should be considered that engine size distribution differs depending on European regions. Indeed, mean engine size is higher ($F(2.4371) = 200$, with $p < .001$) in Northern (747 cc) and Eastern countries (575 cc) than in Southern countries (454 cc), it is therefore possible that the regional differences also express the effect of engine size.

Contrary to our expectation, age was not found to be a statistically significant predictor in the whole sample and also in particular regions, although it was tested both as a discrete (age groups) and as a continuous variable.

Another important predictor of drink-riding was the perception that individuals can drink if they drive carefully. The signs in all models indicate that the more a motorcyclist believes that one can drink and drive if done carefully, the more likely he or she is to report more frequent drinking and riding. This relationship remained significant overall and for each group of countries. For example, in the whole sample, those who respond that it is 'not much' or 'fairly/very' acceptable are 2.8 times and 5.3 times more likely to report more frequent drink-riding than those who respond that it is 'not at all' acceptable. Motorcyclists who report that it is 'fairly/very' acceptable to drink and ride if careful are 4.2, 5.4 and 7.4 times more likely to report more frequent drinking and riding in Southern, Eastern and Northern countries respectively.

Friends' drink-riding was also a significant predictor of motorcyclists' drink-riding behaviour in all regions. More specifically, it was found that motorcyclists who very or fairly agree that most of their friends would drink and ride, are 3.4 times more likely to report drink and riding more often (3.1, 4.3 and 2.8 in east, south and north countries respectively), compared to those who not at all agree that most of their friends would drink and ride. Even for those motorcyclists who agree 'not much' that most of their friends drink and ride, the odds ratios of drinking and riding more often are higher than 2 in all European regions.

There was some variation in the models regarding the attitudes towards drink driving penalties. It was a significant predictor in the whole sample and in northern countries, but not in eastern or southern countries. When significant, there is a tendency that stronger agreement with more severe drink driving penalties is associated with less often (declared) drinking and riding, compared to stronger disagreement with more severe penalties for alcohol.

Regarding the ability of riders to accurately estimate the amount of alcohol they can consume in order to stay in the legal limit, it was found that underestimation or accurate estimation of the legal BAC limit are associated with less often drinking and riding in the whole sample and in the eastern region. More specifically, overall, riders who underestimate the legal BAC limit are more than 2 times (i.e., 1/0.40=2.45) less

likely to report drinking and riding, compared to those who overestimate it. In Northern countries the relationship was significant only for those who underestimate the BAC limits, while in Eastern countries the effect was significant both for those who underestimate it (more than 9 times less likely to report drink-riding) and for those who accurately estimate it. It is also noted that several eastern countries have more strict BAC limits than other countries.

The perceived probability of being checked for alcohol was found to affect drinking and riding overall and in country groups.

In this sample, alcohol checks experienced are rare, but those who have received a fine for drinking and riding in the past are 4.4 times (i.e. 1/0.225=4.44) more likely to report more frequent drinking and riding, suggesting that there is some recidivism among alcohol impaired riders; this effect was significant in all country groups. Similarly, past history crash involvement was linked with 55% (i.e. 1/0.647=1.55) more frequent declared drinking and driving a motorcycle, in contrast to our initial hypothesis that past accident involvement would result in less frequent drink-riding. This effect is stronger than the average in Northern countries (2.4 more frequent drinking and riding).

4. Discussion

This study aims to investigate the factors that affect the frequency of drink-riding as stated by motorcyclists and also to identify any regional differences in Europe regarding Eastern, Southern and Northern countries. For that purpose, data from the SARTRE-4 project were used and multilevel ordered logit models were developed. Overall, the effects of the various predictors were consistent between the different groups of countries. However, the differences identified appear to be more striking in the Southern countries, somewhat less pronounced in the Eastern countries and smaller in the Northern countries, a pattern that is in accordance with the overall magnitude of the motorcycle safety problem in these groups of countries.

Drink-riding frequency depend on riding frequency. Those who use their motorcycle daily are less likely to seek for another transportation option while alcohol impaired, but on the other hand, those who use their motorcycle exceptionally may decide in advance not to use it when they know that they will drink alcohol (Syner & Vegega, 2000). In general, motivations and relationship with the motorcycle use are very different between those who use it daily and those who use it scarcely.

The motorcycle engine size was not found to significantly affect the frequency of drinking and riding neither in the whole sample, nor for each region. On the other hand, the SARTRE-4 survey revealed a significant difference between regions regarding engine sizes. More specifically, in Southern countries there are many < 500 cc motorcycles (and more frequent drinking and riding), whereas in Northern countries there are more > 500cc motorcycles (and less frequent drinking and riding) (Cestac & Delhomme, 2012). It is therefore possible that the overall engine size effect may be included in these regional differences.

Motorcyclists who believe that drinking and riding can be performed if done carefully, are more likely to report more frequent drink-riding. This finding appears to

link attitudes towards alcohol related risk and actual behaviour. The feeling of control could be a central factor in the drink-riding behaviour: some motorcyclists think that they can drive safely if they compensate the increased risk by more careful driving (Trimpop, 1994). Moreover, they are more likely to have driven several times under the influence of alcohol without damage, and these experiences could reinforce their feeling of control and decrease their perceived probability of crash (Fuller, 1991). Nevertheless, in contrast to our initial assumption, the data showed that motorcyclists who reported more frequently to drink and ride also reported more accidents, suggesting that the risk awareness of drinking and riding is low among motorcyclists.

Results indicated that motorcyclists whose friends would very/fairly often drink and ride are far more likely to report drink-riding more often. This result confirms the importance of the social influence by peers. Individuals tend to adopt the norms of their group and also select their friends according to these norms (Arnett et al., 1997; Doherty et al. 1998; Jaccard, Blanton, & Dodge, 2005).

It was also found that motorcyclists who have not had any alcohol ticket experience are less likely to report drink-riding than those who had such experience. There are two different ways of analyzing this link. The first one is that alcohol controls are efficient because they capture motorcyclists who reported the more frequent drinking and riding. The second one is that those who were already caught and fined are still more likely to report drinking and riding. Unfortunately, the second option seems more credible as it has been found that fines alone may not be efficient for preventing alcohol recidivism (Ahlin et al., 2011; Yu, 2000). Moreover, the lowest support for stronger measures found among drink-drivers could indicate that they are aware of their violations and fully conscious of doing something illegal. This would dismiss the common explanation given by violators to policemen that they didn't realize they were above the BAC threshold.

Another related question (accuracy of legal limits estimation), showed that riders who overestimated the number of alcohol they can consume while remaining under the legal BAC threshold were those who reported the most frequent drink-riding behaviours. This reveals an important issue of road safety: motorcyclists, as others, are expected to comply with a maximum BAC level before they drive, but some of them are unable to accurately estimate their BAC when needed (Assailly, 1995). This lack of knowledge about the effects of alcohol for some riders contribute to leading them to drink and ride. This problem could be addressed by information campaigns.

Despite the fact that many studies in international literature have shown that younger adults generally tend to drink and drive a car more frequently and are more involved in road traffic crashes (Elliot et al., 2009; Holubowycz & McLean, 1995), age was not found to be a statistically significant predictor of riding a motorcycle under the influence of alcohol; this may be explained by a difference between car drivers and powered two-wheelers regarding this particular point.

The results per country group appear to confirm the known regional patterns as regards road safety in Europe (Avenoso & Beckmann, 2005; Özkan et al. 2006). Motorcyclists in Southern countries report more often drinking and riding, and are more prone to related negative attitudes and beliefs. Eastern countries follow, and the lowest rates of drinking and riding, together with more positive attitudes, are observed

in Northern countries. The differences in general background and road safety culture in particular may be an additional major determinant of these regional differences. It is noted that similar regional differences have been identified in other road users' groups (e.g. car drivers, pedestrians etc.) and in other road safety issues (e.g. speeding) within the SARTRE-4 data analyses (Cestac & Delhomme, 2012), suggesting a consistent regional pattern in Europe.

5. Conclusions

The present research aimed to shed some light on drink-riding behaviours, attitudes and beliefs among motorcyclists in Europe, a topic which had not received much emphasis in the existing literature. The results revealed several significant predictors of drink-riding, as well as important regional differences. This may influence countermeasure programs which should probably be set up in a different way in each country depending on the respective general attitudinal trends.

The fact that motorcyclists with past drink-driving penalties are likely to report drink and driving, implies that these riders either do not believe that they will be checked (and punished) again or they are prone to alcohol use and driving. This raises the need for serious law enforcement efforts to discourage drink-driving particularly by focusing on increasing the check probability rather than imposing more severe penalties. Training programmes should also raise alcohol awareness and its effects on riding performance for example, by carrying out different training scenarios under the influence of alcohol.

However, when considering potential countermeasures for motorcyclists' drink-driving behaviour, one has to keep in mind that, according to the SARTRE-4 data, the majority of motorcyclists are also car drivers. Driving under the influence of alcohol appears to be a bigger problem for driving a motorcycle than a passenger car, however effective measures should address drink-driving globally, by increasing awareness and understanding of all the risks, and not lead intoxicated individuals 'shifting' from riding their motorcycle to driving their car instead.

The study indicated no significant effects of rider age on declared drinking and driving. This has to be investigated further. Further research is certainly needed regarding other issues, particularly in linking attitudes/perceptions towards alcohol and risk in general with the actual behaviour of motorcyclists and identify potential differences. Moreover, riding a motorcycle under the influence of drugs, medication or fatigue have received even less attention from researchers. Finally, another direction for further research could be to investigate how motorcyclists' attitudes and behaviour towards alcohol or medication have evolved over time.

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Table 1. Summary of explanatory variables

Question Code	Question	Values	Abbreviation
SQ2	Gender	1-male, 2-female	Gender
SQ3	Age	1-17-34, 3-35-65, 6->65	Age
CO08b	Do you agree that penalties for drink-driving offences should be much more severe?	1-strongly agree, 2-agree, 3-neither, 4-disagree, 5-strongly disagree	Attitude to drink-driving penalty
MC19	In the last 3 years how many accidents have you been involved in, as a driver of a motorcycle, in which someone, including yourself, was injured and received medical attention?	0-no accidents, 1-one or more accidents	Number of reported accidents
MC17	On a typical journey, how likely is it that you will be checked for alcohol?	1-never, 2-rarely, 3-sometimes, 4-often, 5-very often, 6-always	Perceived check probability
MC16b	In the past 3 years, have you been fined or punished in any other way for driving a motorcycle under the influence of alcohol?	1-no, 2-yes	Reported alcohol ticket experience
MC27	What engine size is the motorcycle you usually drive?	0- lower than 501cc, 1-more than 501cc	Engine size
MC30	In an average year, how many months do you use a motorcycle?	0-less than 6months/year, 1-more than 6 months/years	Exposure
MC10a	You can drink and drive if you drive carefully. How much do you agree?	1-very, 2-fairly, 3-not much, 4-not at all	Attitude to drink-driving if carefully
MC10d	Most of your motorcycle-driving friends would drink and drive a motorcycle. How much do you agree?	1-very, 2-fairly, 3-not much, 4-not at all	Friends estimated probability
Max_units_diff_CAT	Accuracy of legal units estimation	1-underestimate, 2-accurate, 3-overestimate	Accuracy of legal units estimation

Table 2. Regional distribution of SARTRE-4 countries

Eastern region	Northern region	Southern region
Czech Rep.	Austria	Cyprus
Estonia	Belgium	France
Hungary	Finland	Greece
Poland	Germany	Israel
Serbia	Ireland	Italy
Slovenia	Netherlands	Spain
	Sweden	

Table 3. Percentage distribution of responses on motorcyclists' attitudes and perceptions towards drinking and riding as well as other attributes.

	Over the last month, How often have you driven a motorcycle after having drunk even a small amount of alcohol?				Gender		Age			Exposure in months/year		Engine size	
Country	never	rarely	sometimes	often/very often/always	male	female	17-35	35-65	>65	<6months	>6months	<500cc	>500cc
Austria	88.0	10.0	2.0	0.0	86.0	14.0	32.0	64.0	5.0	58.0	42.0	43.0	57.0
Belgium	68.0	21.5	7.0	3.5	90.0	10.0	26.0	70.0	4.0	32.0	68.0	30.7	69.3
Cyprus	29.9	25.5	24.0	19.6	85.8	14.2	65.5	33.5	1.0	9.8	90.2	39.9	60.1
Cæch Rep	85.6	10.9	2.0	1.0	83.2	16.8	54.0	42.6	3.5	53.2	46.8	63.9	36.1
Estonia	90.2	7.5	1.7	0.6	91.6	8.4	60.1	38.7	1.2	49.7	50.3	15.6	84.4
Finland	96.7	3.3	0.0	0.0	88.6	11.4	33.6	62.6	3.8	84.3	15.7	14.6	85.4
France	69.9	19.1	7.7	3.3	77.0	23.0	38.8	58.9	2.4	28.2	71.8	48.8	51.2
Germany	80.9	15.7	3.4	0.0	87.7	12.3	29.4	60.3	10.3	36.8	63.2	36.0	64.0
Greece	56.4	24.3	13.9	5.4	87.1	12.9	42.6	56.4	1.0	1.6	98.4	68.7	31.3
Hungary	93.1	5.4	0.5	1.0	95.6	4.4	44.1	52.0	3.9	43.8	56.2	57.3	42.7
Ireland	83.5	13.0	1.5	1.5	93.5	6.5	38.5	57.5	4.0	12.5	87.5	40.5	59.5
Israel	60.9	22.3	9.4	6.9	85.1	14.9	77.2	22.8	0.0	4.1	95.9	93.8	6.3
Italy	51.0	20.1	22.7	6.2	69.6	30.4	30.9	57.7	11.3	7.8	92.2	49.5	50.5
Netherlands	85.6	9.6	2.9	1.9	74.0	26.0	25.5	71.6	2.9	59.6	40.4	27.9	72.1
Poland	97.2	1.1	0.4	0.0	93.2	6.8	29.2	65.9	5.0	66.7	33.3	47.9	52.1
Serbia	58.6	28.9	8.6	3.9	96.1	3.9	76.3	22.4	1.3	51.2	48.8	53.5	46.5
Slovenia	73.7	19.0	4.9	2.4	93.7	6.3	42.4	54.1	3.4	62.3	37.7	33.8	66.2
Spain	56.1	25.3	15.9	2.0	80.6	19.4	31.8	64.1	4.0	21.0	79.0	67.1	32.9
Sweden	93.0	5.5	0.5	0.5	81.4	18.6	32.7	63.8	3.5	76.9	23.1	14.1	85.9
Total	76.3	14.1	6.5	2.8	86.7	13.3	41.3	54.9	3.7	41.6	58.4	44.7	55.3
Northern countries	85.2	11.2	2.5	1.1	85.9	14.1	31.1	64.3	4.6	51.7	48.3	29.4	70.6
Eastern countries	87.4	8.9	2.2	1.0	92.3	7.7	46.5	50.2	3.3	56.7	43.3	43.1	56.9
Southern countries	54.4	23.1	15.6	6.5	80.9	19.1	45.7	51.0	3.3	13.6	86.4	61.9	38.1

Table 4. Percentage distribution of responses on motorcyclists' attitudes and perceptions towards drinking and riding.

					Do you agree that:								
	Over the last month, How often have you driven a motorcycle after having drunk even a small amount of alcohol?				You can drink and drive if you do it carefully?			Penalties for drink-driving should be more severe?			Most of your friends would drink and ride?		
Country	Never	Rarely	Sometimes	Often/Very often/Always	Very/Fairly	Not much	Not at all	Strongly agree/agree	Neither	Disagree/ strongly disagree	Very/fairly	Not much	Not at all
Austria	88.0	10.0	2.0	0.0	5.0	22.0	73.0	71.5	14.0	14.5	8.0	33.0	59.0
Belgium	68.0	21.5	7.0	3.5	12.5	27.0	60.0	70.0	13.0	17.0	18.0	39.0	40.5
Cyprus	29.9	25.5	24.0	19.6	18.6	30.9	50.0	65.2	13.2	21.6	41.7	38.2	19.6
Cæch Rep	85.6	10.9	2.0	1.0	9.4	13.9	75.7	82.7	10.9	5.4	9.9	37.1	52.0
Estonia	90.2	7.5	1.7	0.6	5.5	19.4	74.9	84.4	0.0	15.6	11.8	47.1	40.8
Finland	96.7	3.3	0.0	0.0	1.4	1.4	97.2	88.2	10.0	1.9	3.3	5.2	91.5
France	69.9	19.1	7.7	3.3	6.7	15.8	77.5	67.5	15.3	16.3	11.5	27.3	60.8
Germany	80.9	15.7	3.4	0.0	0.5	12.3	86.8	79.4	9.8	10.8	2.0	32.8	64.2
Greece	56.4	24.3	13.9	5.4	1.0	16.3	82.7	73.8	2.0	24.3	26.2	45.0	28.7
Hungary	93.1	5.4	0.5	1.0	3.4	6.4	90.2	92.2	4.4	2.9	3.4	8.3	86.8
Ireland	83.5	13.0	1.5	1.5	2.0	9.0	89.0	80.5	9.0	8.0	9.0	18.0	72.5
Israel	60.9	22.3	9.4	6.9	10.4	22.8	66.3	87.6	5.4	6.4	9.4	29.2	59.9
Italy	51.0	20.1	22.7	6.2	35.1	27.8	37.1	51.5	32.5	16.0	58.8	31.4	9.8
Netherlands	85.6	9.6	2.9	1.9	8.2	17.3	74.5	85.1	11.5	3.4	9.6	31.3	59.1
Poland	97.2	1.1	0.4	0.0	2.2	13.9	83.7	85.0	9.5	5.5	9.2	41.1	49.4
Serbia	58.6	28.9	8.6	3.9	9.2	29.6	61.2	77.6	9.9	12.5	34.9	35.5	29.6
Slovenia	73.7	19.0	4.9	2.4	5.9	16.6	77.6	59.0	20.0	20.5	16.1	30.7	53.2
Spain	56.1	25.3	15.9	2.0	3.3	22.0	74.0	76.0	12.1	11.4	12.1	40.9	45.2
Sweden	93.0	5.5	0.5	0.5	1.0	0.5	98.0	85.9	8.5	5.0	1.0	2.5	96.0
Total	76.3	14.1	6.5	2.8	6.7	17.0	76.1	77.8	10.7	11.2	14.5	31.9	52.9
Northern countries	85.2	11.2	2.5	1.1	4.4	12.8	82.6	80.1	10.8	8.7	7.3	23.1	69.0
Eastern countries	87.4	8.9	2.2	1.0	5.9	16.6	77.2	80.1	9.1	10.4	14.2	33.3	51.9
Southern countries	54.4	23.1	15.6	6.5	12.5	22.6	64.6	70.3	13.4	16.0	26.6	35.4	37.3

Table 5. Multilevel ordered logit models on motorcyclists' drink-driving behaviour ('over the last month, how often have you driven a motorcycle after having drunk even a small amount of alcohol?) – 'empty' models

Dependent variable:	Over the last month, how often have you driven a motorcycle after having drunk even a small amount of alcohol? *	ALL COUNTRIES - random country and country group effects			ALL COUNTRIES - random country effect and fixed country group effect)			EASTERN COUNTRIES - random country effect			NORTHERN COUNTRIES - random country effect			SOUTHERN COUNTRIES - random country effect		
Fixed effects	**Label**	**B**	**St. error**	**p-value**	**B**	**St. error**	**p-value**	**B**	**St. error**	**p-value**	**B**	**St. error**	**p-value**	**B**	**St. error**	**p-value**
intercept	never	1.353	0.622	0.030	0.106	0.226	0.639	2.015	0.491	0.000	1.912	0.286	0.000	0.151	0.213	0.479
intercept	rarely	2.646	0.623	0.000	1.400	0.251	0.000	3.575	0.483	0.000	3.520	0.367	0.000	1.280	0.243	0.000
intercept	sometimes	4.035	0.628	0.000	2.789	0.316	0.000	4.765	0.498	0.000	4.765	0.445	0.000	2.740	0.354	0.000
intercept	often / very often / always	0[a]	-	-	0[a]	-	-	0[a]	-	-	0[a]	-	-	0[a]	-	-
Region=1	East	-	-	-	-1.908	0.529	0.000	-	-	-	-	-	-	-	-	-
Region=2	North	-	-	-	-1.829	0.366	0.000	-	-	-	-	-	-	-	-	-
Region=3	South	-	-	-	0[a]	-	-	-	-	-	-	-	-	-	-	-
Random effects																
Country group	variance of intercept (σ^2_k)	1.021	0.887	0.380	-	-	-	-	-	-	-	-	-	-	-	-
Country	variance of intercept (σ^2_{ik})	0.841	0.319	0.008	0.845	0.320	0.008	1.684	1.109	0.129	0.631	0.405	0.119	0.348	0.232	0.133

"0"[a]: indicates the reference category of an explanatory variable (B=0)

Table 6. Multilevel ordered logit models on motorcyclists' drink-driving behaviour ('over the last month, how often have you driven a motorcycle after having drunk even a small amount of alcohol?) – models with explanatory variables

Dependent variable:	Over the last month, how often have you driven a motorcycle after having drunk even a small amount of alcohol? *	ALL COUNTRIES				EASTERN COUNTRIES				NORTHERN COUNTRIES				SOUTHERN COUNTRIES			
Fixed effects	**Label**	**B**	**St. error**	**p-value**	**odds ratio**	**B**	**St. error**	**p-value**	**odds ratio**	**B**	**St. error**	**p-value**	**odds ratio**	**B**	**St. error**	**p-value**	**odds ratio**
intercept	never	-0.631	0.354	0.075	-	1.348	0.434	0.002	-	0.640	0.241	0.008	-	1.000	0.593	0.092	-
intercept	rarely	0.973	0.346	0.005	-	3.227	0.401	0.000	-	2.509	0.256	0.000	-	2.418	0.585	0.000	-
intercept	sometimes	2.613	0.409	0.000	-	4.505	0.387	0.000	-	3.888	0.337	0.000	-	4.142	0.472	0.000	-
intercept	often / very often / always	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-
Region=1	East	-1.738	0.539	0.001	0.176	-	-	-	-	-	-	-	-	-	-	-	-
Region=2	North	-1.137	0.225	0.000	0.321	-	-	-	-	-	-	-	-	-	-	-	-
Region=3	South	0[a]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MC30=0	exposure less than 6 months/year	-0.385	0.110	0.000	0.680	n.s.	-	-	-	-0.395	0.029	0.000	0.674	-0.676	0.299	0.024	0.509
MC30=1	exposure more than 6 months/year	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-
MC10a=1	drink and drive if carefully=very/fairly	1.667	0.112	0.000	5.296	1.692	0.288	0.000	5.430	2.004	0.151	0.000	7.419	1.437	0.199	0.000	4.208
MC10a=3	drink and drive if carefully=not much	1.030	0.099	0.000	2.801	1.172	0.348	0.001	3.228	1.139	0.177	0.000	3.124	0.927	0.098	0.000	2.527
MC10a=4	drink and drive if carefully=not at all	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-
MC10d=1	friends estimated drink driving=very/fairly	1.232	0.159	0.000	3.428	1.142	0.255	0.000	3.133	1.025	0.327	0.002	2.787	1.466	0.149	0.000	4.332
MC10d=3	friends estimated drink driving=not much	0.952	0.104	0.000	2.591	0.867	0.334	0.009	2.380	0.882	0.164	0.000	2.416	1.067	0.078	0.000	2.907
MC10d=4	friends estimated drink driving=not at all	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-
SQ2=1	gender=male	0.981	0.179	0.000	2.667	n.s.	-	-	-	1.041	0.194	0.000	2.832	1.161	0.185	0.000	3.193
SQ2=2	genrder=female	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-
CO08b=1	attitude to drink driving penalty=strongly agree/agree	-0.309	0.096	0.001	0.734	n.s.	-	-	-	-0.523	0.238	0.029	0.593	n.s.	-	-	-
CO08b=3	attitude to drink driving penalty=neither	n.s.	-	-	-	n.s.	-	-	-	n.s.	-	-	-	n.s.	-	-	-
CO08b=4	attitude to drink driving penalty=disagree/strongly disagree	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-
Max_units_diff_CAT=1	accuracy of legal units estimation=underestimate	-0.899	0.185		0.407	-2.265	0.229	0.000	0.102	-0.792	0.229	0.001	0.453	n.s.	-	-	-
Max_units_diff_CAT=2	accuracy of legal units estimation=accurate	n.s.	-	-	-	-0.881	0.265	0.001	0.414	n.s.	-	-	-	n.s.	-	-	-
Max_units_diff_CAT=3	accuracy of legal units estimation=overestimate	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-
MC16b=1	alcohol ticket experience=no	-1.490	0.184	0.000	0.225	-1.195	0.330	0.000	0.303	-0.945	0.254	0.000	0.389	-1.554	0.354	0.000	0.211
MC16b=2	alcohol ticket experience=yes	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-
MC19=0	number of reported accidents=no accident	-0.435	0.117	0.000	0.647	n.s.	-	-	-	-0.884	0.158	0.000	0.413	n.s.	-	-	-
MC19=1	number of reported accidents=one or more accidents	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-	0[a]	-	-	-
Random effects																	
Country	variance of intercept (σ^2_{u0})	0.558	0.230	0.015	-	n.s.	-	-	-	n.s.	-		-	n.s.	-	-	-
Model's fit	**Likelihood ratio test**	771.3				2723.9				1080.1				1806.4			
	Degrees of freedom	df=12				df=7				df=10				df=17			

"0[a] ": indicates the reference category of an explanatory variable (B=0)

"n.s.": indicates a non significant effect at 90%

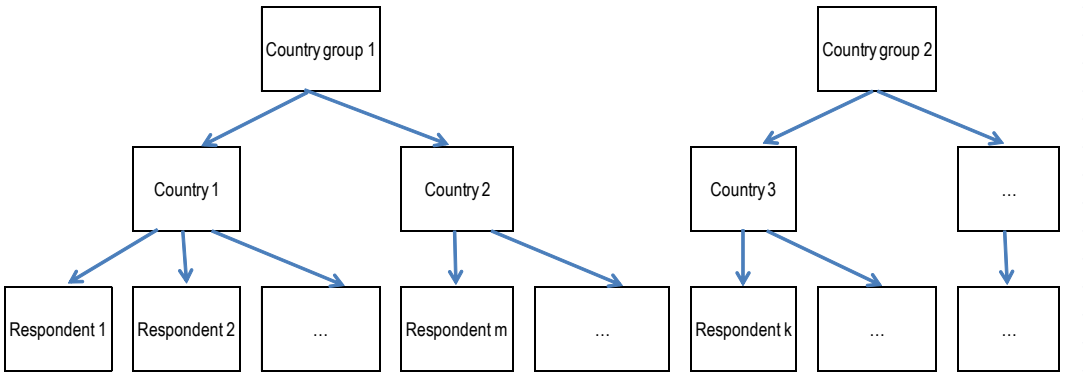

Figure 1. Hierarchical structure of the SARTRE-4 data

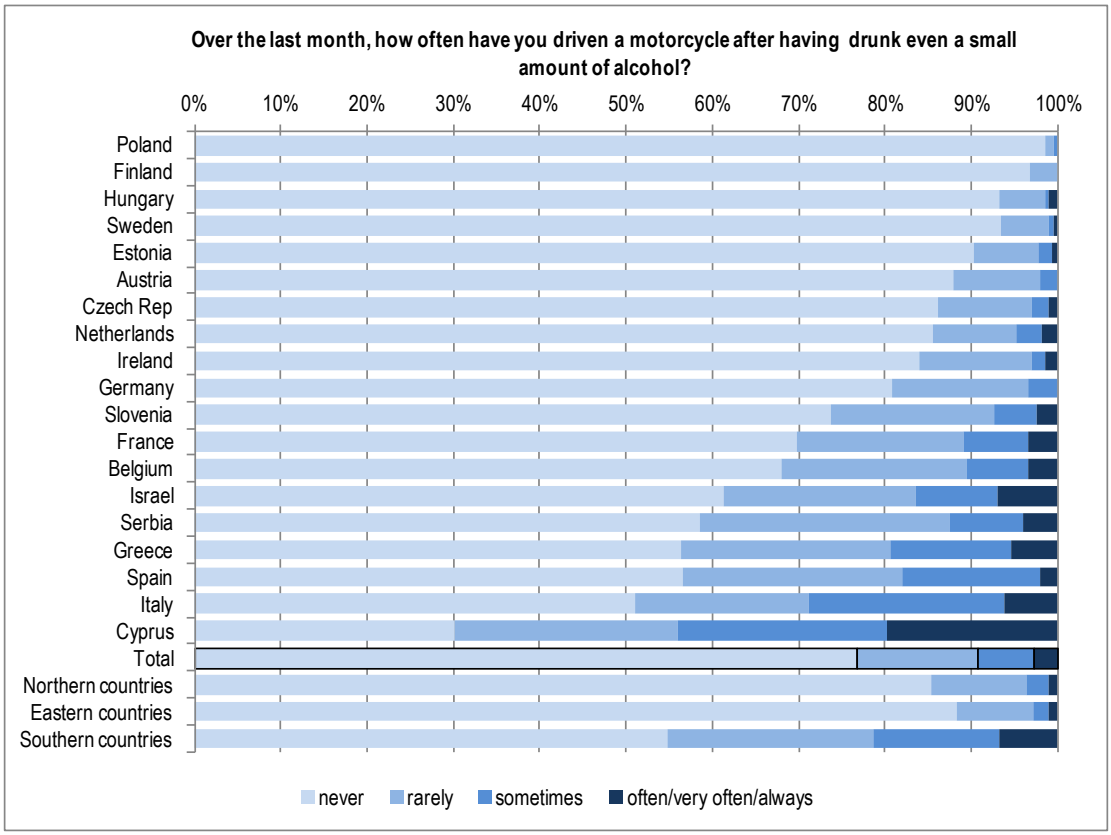

Figure 2: Percentage of responses per country and region on the dependent variable "Over the last month, how often have you driven a motorcycle after having drunk even a small amount of alcohol?".