ELSEVIER

Accident Analysis and Prevention 37 (2005) 391–397

ACCIDENT ANALYSIS & PREVENTION

www.elsevier.com/locate/aap

Drink driving in Belgium: results from the third and improved roadside survey

W. Vanlaar

Belgisch Instituut voor de Verkeersveiligheid, Haachtsesteenweg 1405, 1130 Brussel, Belgium

Received 7 July 2004; received in revised form 17 November 2004; accepted 2 December 2004

Abstract

In 2003, the Belgian Road Safety Institute organised the third national roadside survey to estimate the proportion of drink drivers and their profile. The objective of this initiative is to gather data as a basis to formulate theory- and research-based recommendations to policymakers with the intention of decreasing the number of alcohol related accidents and victims on Belgian roads.

Almost all Belgian police forces agreed to participate in a stratified two-stage cluster sample. First stage of the survey consisted of randomly selecting road sites ($m = 449$) in each region using a Geographical Information System (Arcview). Second stage of the survey consisted of randomly stopping drivers of personal cars ($n = 12{,}891$) during October and November 2003. All stopped drivers were asked by the police to perform an alcohol breath test. In addition, the police invited all sampled drivers to participate in a short questionnaire with individual variables (gender, age, etc.). Questionnaires with aggregated variables for road sites (traffic flow, intensity of stopping drivers, etc.) were also completed.

The percentage of drivers who were found to have a blood alcohol concentration at or above the legal limit of 0.5 g/l during weekend nights (7.68%) is significantly higher than all other time spans. These percentages for the remaining time spans do not differ significantly (weekdays: 1.76%; weekday nights: 2.99%; weekend days: 2.98%). A multilevel logistic model for Belgium was successfully fitted.

Keywords: Drink driving; Roadside survey; Stratified two-stage cluster sample; Multilevel modelling

1. Introduction

1.1. The general assembly on road safety

In 2003 the Belgian Road Safety Institute organised the third national roadside survey to estimate the proportion of drink drivers and their profile. This initiative, that was originally conducted in 1998 and repeated in 2000, was consolidated by the general assembly on road safety (a large-scale official consultation on road safety, involving all relevant partners), set up by the Council of Ministers on May 18, 2001 as a response to the poor level of road safety on Belgian roads. The official consolidation of the initiative made it possible to improve the methodology of the roadside survey substantially.

1.2. Objectives of the roadside survey

The objective of this initiative is to gather data as a basis to formulate theory- and research-based recommendations to policymakers with the intention of decreasing the number of alcohol related accidents and victims on Belgian roads. This roadside survey will be repeated every 2 years to study trends in drink driving.

1.3. Overview of other relevant indicators

According to the official statistics of 2001 (BIVV, 2002) 8.4% (4002) of all injury accidents were alcohol-related, whereas 10.0% (870) of all accidents with fatally and seriously injured persons were alcohol-related. However,

0001-4575/$ – see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2004.12.001

accident figures are always an underestimation of the real dimensions of the problem because not all accidents are taken into consideration and persons involved are not always tested for alcohol (for instance because they were taken to the hospital). The Belgian Toxicology and Trauma Study estimated that 28% of the drivers who entered the emergency room after an injury accident had a blood alcohol concentration (BAC) at or above the legal limit. During weekend nights, this percentage increases from 28% to 50% (BESEDIM et al., 1997).

There exists a positive correlation between the consumption per capita and drink driving (Mann and Anglin, 1990). In 2002 the Belgian consumption per capita equals 7.9 l of pure alcohol. On a world scale Belgium occupies the 12th place (Commissie Gedistilleerd, 2004).

In 1998 and in 2000 (Vanlaar, 2002), the Belgian Road Safety Institute carried out a roadside survey on Saturday nights to determine the amount of drink drivers and their profile. In 2000 the percentage of drink drivers with a BAC at or above the legal limit was 8.4% while in 1998 this percentage was 8.9.

According to the official statistics on police enforcement 6% of all tested drivers were at or above the legal limit (BIVV, 2002). This result corresponds to the results from the SARTRE survey (2004): 6% of fully licensed, active Belgian car drivers report they may have been driving during 1 or more days in the past week while over the legal limit for drinking and driving. The first percentage, however, is based on a non-representative sample as a result of a selective way of sampling drivers. Therefore, it is impossible to generalise this result to the Belgian population of car drivers as a whole. The second percentage most probably suffers from a bias due to social desirability.

2. Methodology

2.1. The legal limit in Belgium

The legal drink driving limit in Belgium is expressed in milligrams of alcohol per litre of exhaled alveolar air and is abbreviated as BrAC (Breath Alcohol Concentration). It is proportional to the BAC, expressed in grams of alcohol per litre blood, by a factor of 2.2727. So the legal BrAC limit of 0.22 mg/l corresponds to a BAC of 0.5 g/l and the BrAC limit of 0.35 mg/l (the point from which on sentences are much more severe) corresponds to 0.8 g/l. Although the Belgian legal limit is expressed as a BrAC, BAC is used throughout this article. Driving with a BAC at or above the legal limit of 0.5 g/l is illegal in Belgium and we refer to that as drink driving.

2.2. The sampling design

An improved methodology was successfully tested in a pilot project (see Vanlaar, 2003). Due to the success of this project, almost all Belgian police forces agreed to participate in a stratified two-stage cluster sample (Cochran, 1963; Kish, 1965; Levy and Lemeshow, 1999).

First stage of the roadside survey consisted of randomly selecting road sites (primary sampling units; PSUs) in each region using a Geographical Information System (Arcview). Policemen decided whether or not a road site had to be replaced for reasons of efficiency or security based on their expertise of the field. PSUs that did not qualify according to the policemen were replaced by other randomly selected PSUs. The sample of PSUs consisted of $m = 449$ road sites, stratified per region.

Once the sampling of road sites was completed, each site was randomly linked to one out of four possible time spans (weekdays: Monday, Tuesday, Wednesday, Thursday, Friday from 8 am–10 pm, $n = 4709$; weekday nights: Monday, Tuesday, Wednesday, Thursday from 10 pm–8 am, $n = 2164$; weekend days: Saturday, Sunday from 8 am–10 pm, $n = 3249$; weekend nights: Friday, Saturday, Sunday from 10 pm–8 am, $n = 2702$). Therefore, the sampling design is not only stratified in space (per region) but also in time.

The traffic flow was counted and this result was used to calculate weights (Billiet, 1996; StataCorp., 2001).

Second stage of the roadside survey consisted of randomly stopping drivers. Once stopped, they were asked by the police to perform an alcohol breath test. Randomly stopping drivers has been achieved by stopping as many drivers as possible and testing all of them, without making any distinction based on observable criteria. In total the sample consists of $n = 12,891$ drivers.

Agreements were made with police forces that had an important impact on the representativeness of the data (e.g., to control during 1 h at the same road site; to intercept drivers who try to escape; etc.).

2.3. Data collection

During October and November 2003 data of drivers of personal cars (except for minibuses and vans) were collected. Besides the collection of breath samples by means of an Alcotest 7410 PAF 4 from Dräger, the police invited all sampled drivers to participate in a short questionnaire with individual variables. The police officers also completed a questionnaire with aggregated variables for road sites.

The outcome variable of interest is a binary variable based on the BAC of each driver. For the purpose of the multilevel analysis it has been recoded with 0 representing those drivers with a BAC below the legal limit and 1 representing those drivers with a BAC at or above the legal limit.

The individual explanatory variables (level 1 explanatory variables) are *gender*, *age* (a categorical variable consisting of the following age groups: 16–25, 26–39, 40–54, 55+), *previously* (a binary variable distinguishing between drivers who previously have been stopped and tested at a road site at least once and drivers who have never been stopped and tested at a road site before) and *probability* (a categorical variable representing the driver's perception of the probability of being tested for drink driving; drivers could answer: very low, low, medium, high, very high).

The aggregated explanatory variables (level 2 explanatory variables) are *Traffic count* (a continuous variable indicating the total number of vehicles driving by the road site during the police check) and *Intensity* (a continuous variable calculated by dividing the number of policemen per road site by traffic count for that road site).

2.4. Quality assurance procedure

The following procedure was adhered to in order to assure the quality of data collection. A coordinator was appointed for each participating police district. As a liaison, the coordinator was responsible for transferring the information from and to the IBSR. They also had to organise the drink driving police checks according to the IBSR's instructions. The IBSR's staff participated in some of the police checks to respond to any problems that might occur.

2.5. Data analysis

Using the software package Stata (Statacorp., 2001) weighted point estimates, standard errors, 95%-confidence intervals and *p*-values were calculated, taking into account the complex sampling design (Cochran, 1963; Kish, 1965; Levy and Lemeshow, 1999).

In order to compensate for chance capitalisation Sidak's adjustment formula for multiple testing was used when evaluating the significance of differences between the percentages of drivers at or above the legal limit per time span and per region ($\gamma = 1 - (1 - \alpha)^n$); with α the *p*-value for one test, γ the *p*-value for the simultaneous test and n the number of single tests that make up the simultaneous test; Sidak, 1967).

Data resulting from this research design–known as multilevel designs (Kreft and de Leeuw, 2002; Goldstein, 2003)–were analysed by means of the software package MLwiN (Rasbash et al., 2000). In analysing the data estimates were derived from a variance components model for which the variance of the response is the sum of a level 1 and a level 2 variance (Goldstein, 2003). A two-level binomial model was fit with drivers at level 1 ($n = 11{,}186$) and road sites (the PSU's) at level 2 ($m = 413$). To model the relationship between the binary response and the set of explanatory variables, the logit function was used, meaning a multilevel logistic regression was performed (Rice, 2001). To interpret the relationship between the binary response and an explanatory variable, logit coefficients were transformed into odds ratios using the exponential transformation. These odds ratios compare the odds for drink driving of a certain category of a variable to the reference category of that variable.

Estimation was performed using the restricted iterative generalised least squares (RIGLS) method, more precisely via a second order penalised quasi likelihood (second order PQL) estimation (Rodriguez and Goldman, 1995; Goldstein and Rasbash, 1996).

3. Results

3.1. The extent of the phenomenon

3.1.1. The 2003 results

The results of the total sample of 12,891 drivers are shown in Table 1. In Table 2 the refusals (10) and the drivers who were not able to provide a breath sample (57) are disregarded; then 96.69% of 12,824 drivers had a BAC lower than the legal limit. 3.31% of all drivers had a BAC at or above the legal limit. Most of these drivers (2.26%) even had a BAC at or above 0.8 g/l, which is significantly more than the percentage of drink drivers below 0.8 g/l (1.05%).

Table 3 cross-tabulates the frequency and percentage of drink drivers per time span. This table also contains the standard errors and 95%-confidence intervals. Further analysis using a *t*-test and Sidak's adjustment formula for multiple testing revealed that the percentage of drink drivers during weekend nights (7.68%) is significantly higher than all other time spans. These percentages for the remaining time spans do not differ significantly (weekdays: 1.76%; weekday nights: 2.99%; weekend days: 2.98%).

Table 1
Results (frequency and percentage) of breath testing, expressed as BAC; refusals and drivers unable to deliver a breath sample are included

	Frequency	Percentage
Refusal	10	0.08
Not able	57	0.44
BAC < 0.5 g/l	12400	96.19
0.5 g/l ≤ BAC <0.8 g/l	134	1.04
BAC ≥ 0.8 g/l	290	2.25
Total	12891	100.00

Table 2
Results (frequency and percentage) of breath testing, expressed as BAC; refusals and drivers unable to deliver a breath sample are excluded

	Frequency	Percentage
BAC < 0.5 g/l	12400	96.69
0.5 g/l ≤ BAC < 0.8 g/l	134	1.05
BAC ≥ 0.8 g/l	290	2.26
Total	12824	100.00

Table 3
Frequency of all drivers per time span and weighed percentage, S.E. and 95%-confidence intervals of drink drivers at or above the legal limit (BAC = 0.5 g/l) per time span

Time span	Frequency	Percentage	S.E.	95%-confidence interval
Weekday	4696	1.76	0.38	1.01–2.50
Weekday night	2123	2.99	0.63	1.75–4.22
Weekend day	3144	2.98	0.51	1.97–3.98
Weekend night	2589	7.68	1.09	5.53–9.82
Saturday night	1169	5.40	1.53	2.38–8.42

Table 4
Frequency, weighed percentage, S.E. of drink drivers at or above 0.5 g/l but below 0.8 g/l and at or above 0.8 g/l per time span

Time span	Frequency	Percentage	S.E.
Weekday			
0.5 g/l ≤ BAC < 0.8 g/l	18	0.42	0.13
BAC ≥ 0.8g/l	54	1.33	0.36
Weekday night			
0.5 g/l ≤ BAC < 0.8 g/l	35	1.06	0.27
BAC ≥ 0.8 g/l	51	1.93	0.48
Weekend day			
0.5 g/l ≤ BAC < 0.8 g/l	25	0.86	0.34
BAC ≥ 0.8 g/l	54	2.11	0.34
Weekend night			
0.5 g/l ≤ BAC < 0.8 g/l	52	2.46	0.64
BAC ≥ 0.8 g/l	113	5.22	0.94
Saturday nights			
0.5 g/l ≤ BAC < 0.8 g/l	21	1.73	0.62
BAC ≥ 0.8 g/l	39	3.67	1.09

Also studied was the distribution of drink drivers below the threshold of 0.8 g/l and at or above this threshold. Table 4[1] contains this distribution per time span. The percentage of drink drivers at or above 0.8 g/l was found to be significantly higher in each time span than the percentage of drink drivers below this limit, except for weekday nights.

3.1.2. Trends in drink driving.

Data from the two previous editions of this survey were only collected during Saturday nights from 10 pm until 4 am but during the same period of the year. A 95%-confidence interval for drink driving on Saturday nights between 10 pm and 4 am in 2003 is [2.38%, 8.42%] and the point estimate equals 5.40% (see Table 3). In 1998 this percentage corresponded to 8.90% on a total of $n = 13{,}411$ drivers and in 2000 to 8.40% on a total sample of $n = 10{,}112$ drivers.

3.2. The profile of drink drivers in Belgium

The influence of the independent variables on the outcome variable is interpreted based on the exponential coefficients (i.e. odds ratios) of the binomial model in Table 5.

There is a negative relationship between *Traffic count* and the odds of drink driving when controlling for intensity of stopping drivers and for the other independent variables. For each additional car at a road site the odds of drink driving are multiplied by a factor of 0.998. This means that the odds of drink driving decrease by 0.2%, or, per 100 extra cars on a site, the odds are multiplied by a factor of 0.819 ($\exp(-0.002 \times 100)$), meaning that the odds of drink driving decrease by 18.1%.

The odds of drink driving for women in comparison with men (*Female*) are multiplied by a factor of 0.253, meaning that women's odds for drink driving decrease by 74.7% compared to men.

The odds of drink driving for drivers who previously have been stopped and tested at a road site at least once in comparison with drivers who have never been stopped and tested (*Previously*) are multiplied by a factor of 1.505. This means that the former drivers have a 50.5% higher risk for drink driving than the latter drivers.

The reference category for the following variable (*Probability*) is the category of drivers who answered that they perceive the probability of being tested to be very low. The odds of drink driving for drivers who answered they perceive the probability of being tested as low in comparison with the reference category are multiplied by a factor of 1.711, meaning the odds of drink driving increase by 71.1% compared to the reference category. The odds of those who answered they perceive the probability of being tested medium in comparison with the reference category are multiplied by a factor of 2.104, so the odds increase by 110.4% compared to the reference category. The odds of those drivers who answered they perceive the probability of being tested high in comparison with the reference category are multiplied by a factor of 1.366 and thus are 36.6% higher than the reference category's odds (but this dummy variable is not significant). Finally, the odds of drink driving of those drivers who answered they perceive the probability of being tested as very high in comparison with the reference category are multiplied by a factor of 4.187; in other words, those odds increase by 318.7%.

The reference category for the variable *Age* is the category of drivers in the age group 16–25. The odds of drink driving for drivers with an age in the range of 26–39 in comparison with the reference category are multiplied by 2.034. This means that drivers with an age in the range of 26–39 have 103.4% more chance to be a drink driver than drivers with an age in the range of 16–25. The odds of drink driving for drivers with an age in the interval 40–54 in comparison with the reference category are multiplied by 3.721 and thus those odds increase by 272.1%. Finally, the odds of drivers aged 55 or older in comparison with the reference category are multiplied by a factor of 2.370; those odds increase by 137.0%.

The final model fits the data well, which can be derived from the model diagnostic $\Omega_e = 0.712$ in the extra binomial model; i.e. a model that does not constrain the level 1 variance to be equal to unity. Since this parameter is rather close to 1 – which actually means there is little or no evidence that our model exhibits extra binomial variance, more precisely under dispersion – the binomial distribution holds. Table 5 contains the results for the different parameters of both the extra binomial and the binomial model. The strength and the direction of all relationships remain unchanged between both models.

The intraclass correlation coefficient for the multilevel logistic model – a coefficient that indicates "whether a given

[1] The differences between Tables 3 and 4 (e.g. weekday in Table 4: 1.33% + 0.42% = 1.75% differs from 1.76% in Table 3) are explained by the weighting and/or rounding errors.

Table 5
Logit and exponential coefficients for the fixed and random effects of the extra binomial and the binomial 2 level multilevel logistic model; significant coefficients are printed in italic

Parameter	Extra binomial model		Binomial model	
	Logit coefficients (S.E.)	Exponential coefficients	Logit coefficients (S.E.)	Exponential coefficients
Fixed parameters				
Intercept	−4.981 (0.265)		−4.757 (0.285)	
Traffic count	−0.001 (0.000)	0.999	−0.002 (0.000)	0.998
Intensity	0.746 (0.407)	2.109	0.896 (0.383)	2.450
Female	−1.395 (0.177)	0.248	−1.375 (0.207)	0.253
Previously	0.467 (0.126)	1.595	0.409 (0.141)	1.505
Probability low	0.565 (0.144)	1.759	0.537 (0.167)	1.711
Probability medium	0.769 (0.146)	2.158	0.744 (0.169)	2.104
Probability high	0.304 (0.239)	1.355	0.312 (0.278)	1.366
Probability very high	1.445 (0.254)	4.242	1.432 (0.290)	4.187
Age 26–39	0.749 (0.206)	2.115	0.710 (0.242)	2.034
Age 40–54	1.382 (0.200)	3.983	1.314 (0.234)	3.721
Age 55+	0.948 (0.233)	2.581	0.863 (0.272)	2.370
Random parameters				
Level 2 variance, (Ω_u)	1.569 (0.229)		0.991 (0.197)	
Level 1 variance (Ω_e)	0.712 (0.010)		1.000 (0.000)	

nesting structure in a data set calls for multilevel analysis” (Snijders and Bosker, 1999: p. 22) – is $\rho = \Omega_u/(\Omega_u + \pi^2/3)$. In our case the intraclass correlation coefficient, while controlling for the explanatory variables, is 0.231. This means 23.1% of the total variance is level 2 variance, which justifies modelling the data according to a multilevel structure.

4. Conclusion

In general the number of drink drivers in Belgium during the months of October and November 2003 is low: 96.69% of all drivers are below the legal limit, thus only 3.31% of all drivers are drink drivers. 1.05% are at or above the legal limit but below 0.8 g/l, while 2.26% are at or above 0.8 g/l. The difference between these two percentages is significant: there are significantly more drink drivers at or above 0.8 g/l then at or above the legal limit but below 0.8 g/l. Since drinking behaviour and drink driving behaviour is dependent on time of day and week, the frequency of drink driving was cross-tabulated with time span. This cross-tabulation revealed that the problem mainly manifests itself during weekend nights with a 95%-confidence interval of [5.53%; 9.82%]. The point estimate is significantly higher than the point estimates of all other time spans. However, the problem of drink driving also reaches considerable dimensions during weekdays [1.01%; 2.50%], weekday nights [1.75%; 4.22%] and weekend days [1.97%; 3.98%]. The point estimates of these three time spans are not significantly different from each other. It is surprising, however, that the number of drink drivers during weekday nights is not significantly higher than during weekdays and weekend days because, based on a pilot project in one province, it was expected that night time spans would be problematic, rather than day time spans. In each time span there are significantly more drink drivers at or above 0.8 g/l than below this threshold, except for weekday nights.

Further analysis shows that the percentage of drink drivers on Saturday nights decreased from 8.9% in 1998 to 8.4% in 2000 and continued to decline to 5.4% in 2003.

A multilevel logistic regression model for Belgium was successfully fitted. No substantial evidence for extra binomial variance was found. The results of the multilevel model are surprising at least for some independent variables.

5. Discussion

5.1. The methodology

Whereas the previous national roadside surveys suffered from some methodological shortcomings (Vanlaar, 2002), the methodology of the third survey is substantially improved. Strong points of the methodology of this roadside survey are the random selection of road sites and drivers; the stratification in space and in time; the use of weights based on traffic counts; the uniform way of data collection; the QA procedure and the used methods to analyse the data.

Important agreements were made with police forces that had an impact on the representativeness of the data. If police officers continue to check drivers for drink driving for more than an hour at the same road site then the final sample of drivers drawn on that road site will most likely be biased. Drivers who have been subjected to the police check might warn others, which will lead to changed behaviour. Actually the sample would no longer be the result of an unobtrusive observation and we would expect an underestimation of the real proportion of drink drivers as a result. However, changing to another road site much sooner than after an hour could lead to a very small sample at that road site and there would be no way to guarantee that it represents the road site well. It would also be very unpractical from an organisational point of view if police officers would have to change to another location every 15 or 30 min.

Finally our methodology did not ignore the multilevel structure of the sampling design. It was shown that the dataset called for a multilevel analysis. Ignoring such a structure has important consequences, for example “ignored clustering will generally cause standard errors of regression coefficients to be underestimated” (Rasbash et al., 2000: p. 8). Multilevel analysis did not only enable us to model these clustering effects but made it also possible to calculate the influence of explanatory aggregated variables (such as traffic flow) and explanatory individual variables (such as gender and age) on the individual outcome variable (probability of drink driving).

5.2. The results

The problem of drink driving has taken on considerable dimensions in Belgium and calls for countermeasures. There is clear evidence that a balanced combination of enforcement and mass media campaigns leads to a decrease in the number of drink drivers (Delhomme et al., 2000; Delaney et al., 2004). Alternatives like driver improvement courses (Wells-Parker et al., 1995) and alcohol ignition interlocks (Beirness et al., 2003) are also very promising.

The reduction in drink driving in 2003 (5.4%) compared to the results of the previous roadside surveys in 1998 (8.9%) and 2000 (8.4%) is probably partly the result of the higher level of enforcement and awareness raising following the general assembly on road safety. However, in our view, the major decline from 2000 to 2003 is not entirely explained by a real decrease in the proportion of drink drivers but also by the improvement of the methodology. As discussed before in a previous paragraph the 2003 sample is less biased than the samples from 1998 and 2000 and this could have easily artificially increased the proportion of drink drivers in the samples of 1998 and 2000, making the gap between 2003 and 2000 unreasonably large. Time will tell whether there is a real downward trend in the number of drink drivers in Belgium.

An interesting relationship was identified between traffic count and odds for drink driving indicating that drink drivers tend to avoid places with higher traffic counts. In practice this means that police officers should not restrict their enforcement activities to sites where the frequency of vehicle traffic is high. One could argue that this relationship is of a spurious nature caused by the fact that drink driving takes place primarily on weekend nights with low traffic while there are less drink drivers during the day when there is much more traffic. Therefore, another series of analyses per time span was performed to rule out this explanation. The result confirmed our findings regarding the negative relationship between traffic count and odds for drink driving. A more sophisticated way to investigate this relationship is by extending the two level model to a three level model by including the variable time as an extra level. Locations would then be at level 3, time at level 2 and drivers at level 1. Further research will allow for such an extension of the multilevel model.

We found evidence that drivers who have been tested and provided a breath sample in the past at least once are more likely to drink drive than drivers who have never been tested before. This result seems to be in contradiction with the SORC-model, explained in the GADGET-project, stating that past experiences with law enforcement–as one aspect of the objective risk of getting caught–lead to obedience (Christ et al., 1999). It can however, be explained by the selective way in which police checks in general are carried out in Belgium. Normally police officers focus on drivers who are more likely to be drink driving based on observable criteria like gender. This eventually results in a population of drivers consisting of drink drivers who, relatively speaking, have been tested for drink driving more often than the non-drinking drivers. The evidence we found in this roadside survey is based on a random sampling mechanism that allocates equal probabilities for selection to drink drivers and non-drinking drivers, reflecting the result of the selective way in which police checks are carried out in general. This rationale is of course conditional on the assumption that drink drivers in general are recidivists who will continue to drink drive even if they have been caught and sentenced before. In other words, the explanation for the evidence we found could simply be the nature of the group of drink drivers which might be composed for the largest part by hard core drink drivers (Simpson et al., 2004) for whom this SORC-model does not hold.

Another strange result was identified regarding the perception of drivers of being stopped and tested on an average trip–the subjective risk of getting caught. The data clearly support a positive relationship, meaning that drivers who estimate the likelihood of getting tested as very high, are at the highest risk for drink driving. Based on the same model as before, one would expect the opposite. A possible explanation is that the perception of drivers who are caught on the spot is influenced by this event. An alternative explanation could be related to a selective memory bias for alcohol cues (Franken et al., 2003).

Acknowledgements

I acknowledge the helpful suggestions of Mr. René Mathijssen, senior researcher at the SWOV Institute for Road Safety Research in Leidschendam, the Netherlands and Ms. Min Yang, visiting fellow and senior researcher at the Centre for Multilevel Modelling Information in London, UK. I also thank my colleagues from the Behaviour and Policy Department for their interesting feedback.

References

Beirness, D.J., Simpson, H.M., Robertson, R.D., 2003. International Symposium on Enhancing the Effectiveness of Alcohol Ignition Interlock Programs. Traffic Injury Prevention, pp. 1–4.

BESEDIM, BLT, BIVV, 1997. Belgian Toxicology and Trauma Study. BIVV, Brussels.

Billiet, J.B., 1996. Methoden van Sociaal-Wetenschappelijk Onderzoek: Ontwerp en dataverzameling. Acco, Leuven.

BIVV, 2002. Verkeersveiligheid Statistieken 2001. BIVV, Brussel.

Christ, R., Delhomme, P., Kaba, A., Makinen, T., Sagberg, F., Schulze, H., Siegrist, S., 1999. GADGET, guarding automobile drivers through guidance education and technology. Final Report, Kuratorium für Verkehrssicherheit (KfV), Vienna.

Cochran, W.G., 1963. Sampling Techniques, 2nd ed. Wiley, New York.

Commissie Gedistilleerd, 2004. WARC World Drink Trends, 2004, http://www.pgd.nl/frameset.php?goto=publicaties.

Delaney, A., Lough, B., Whelan, M., Cameron, M., 2004. A Review of Mass Media Campaigns in Road Safety. Monash University, Accident Research Centre, Victoria, Australia.

Delhomme, P., Vaa, T., Meyer, T., Harland, G., Goldenbeld, C., Järmark, S., Christie, N., Rhenova, V., 2000. Evaluated Road Safety Media Campaigns: An Overview of 265 Evaluated Campaigns and Some Meta-analysis on Accidents. GADGET Project, INRETS, France.

Franken, I.H.A., Rosso, M., van Honk, J., 2003. Selective memory for alcohol cues in alcoholics and its relation to craving. Cogn. Therapy Res. 27 (4), 481–488.

Goldstein, H., 2003. Multilevel Statistical Models. Arnold, London.

Goldstein, H., Rasbash, J., 1996. Improved approximations for multilevel models with binary responses. J. Roy. Stat. Soc. A 159, 505–513.

Kish, L., 1965. Survey Sampling. Wiley, New York.

Kreft, I., de Leeuw, J., 2002. Introducing Multilevel Modelling, 2nd ed. Sage Publications, London.

Levy, P.S., Lemeshow, S., 1999. Sampling of Populations. Methods and Applications, 3rd ed. Wiley, New York.

Mann, R.E., Anglin, L., 1990. Alcohol availability, consumption, and the alcohol-crash problem. In: Wilson, R.J., Mann, R.E. (Eds.), Drinking and Driving. Advances in Research and Prevention. The Guilford Press, New York, pp. 216–225.

Rasbash, J., Browne, W., Goldstein, H., Yang, M., Plewis, I., Healy, M., Woodhouse, G., Draper, D., Langford, I., Lewis, T., 2000. A User's Guide to MLwiN. Version 2.1c. Centre for Multilevel Modelling, Institute of Education, University of London, UK.

Rice, N., 2001. Binomial regression. In: Leyland, A.H., Goldstein, H. (Eds.), Multilevel Modelling of Health Statistics. Wiley, New York, pp. 27–43.

Rodriguez, G., Goldman, N., 1995. An assessment of estimation procedure for multilevel models with binary responses. J. Roy. Stat. Soc. A 158, 73–89.

SARTRE, 2004. European Drivers and Road Risk. Part 1: Principal Analyses. INRETS, Paris.

Sidak, Z., 1967. Rectangular confidence regions for the means of multivariate normal distributions. J. Am. Stat. Assoc. 62, 626–633.

Simpson, H.M., Beirness, D.J., Robertson, R.D., Mayhew, D.R., Hedlund, J.H., 2004. Hard core drinking drivers. Traffic Injury Prevention 5 (3), 261–269.

Snijders, T., Bosker, R., 1999. Multilevel Analysis. An Introduction to Basic and Advanced Multilevel Modelling. Sage Publications, London.

StataCorp., 2001. Stata Statistical Software: Release 7.0. Stata Corporation, College station, TX.

Vanlaar, W., 2002. Results of the Belgian drink driving roadside survey. In: Proceedings of the 16th International Conference on Alcohol, Drugs and Traffic Safety, Montreal, Canada.

Vanlaar, W., 2003. Rijden onder invloed van alcohol in de provincie Limburg. Resultaten van de gedragsmeting uitgevoerd in 2002. BIVV, Brussel.

Wells-Parker, E., Bangert-Drowns, R., McMillen, R., Williams, M., 1995. Final results from a meta-analysis of remedial interventions with drink/drive offenders. Addiction 90, 907–926.