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Understanding traffic crash under-reporting: Linking police and medical records to individual and crash characteristics

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ABSTRACT

Objective. This study aligns to the body of research dedicated to estimating the under-reporting of road crash injuries and adds the perspective of understanding individual and crash factors contributing to the decision to report a crash to the police, the hospital, or both.

Method. This study focuses on road crash injuries that occurred in the province of Funen (Denmark) between 2003 and 2007 and were registered in the police, the hospital, or both authorities. Under-reporting rates are computed with the capture-recapture method, and the probability for road crash injuries in police records to appear in hospital records (and vice versa) is estimated with joint binary logit models.

Results. The capture-recapture analysis shows high under-reporting rates of road crash injuries in Denmark, and the growth of under-reporting not only with the decrease of injury severity, but also with the involvement of cyclists (reporting rates about 14% for serious injuries and 7% for slight injuries) and motorcyclists (reporting rates about 35% for serious injuries and 10% for slight injuries). Model estimates show that the likelihood of appearing in both datasets is positively related to helmet and seat-belt use, number of motor vehicles involved, alcohol involvement, higher speed limit, and females being injured.

Conclusions. This study adds significantly to the literature about under-reporting by recognizing that understanding the heterogeneity in the reporting rate of a road crash may lead to devising policy measures aimed at increasing the reporting rate by targeting specific road user groups (e.g., males, young road users) or specific situational factors (e.g., slight injuries, arm injuries, leg injuries, weekend).

Keywords: Crash Under-Reporting; Police Reports; Hospital Reports; Capture-Recapture Method; Joint Model Estimation.

INTRODUCTION

The estimation of the number of road crash injuries and the analysis of their severity have received a lot of attention in recent years, but their reliance on police reports makes them subject to bias because of the severe under-reporting (e.g., Elvik and Misen 1999; Farmer 2003; McDonald et al. 2009). A meta-analysis of studies about crash under-reporting showed that the official road crash statistics in Denmark contain only 21% of the hospital crash injuries, a staggering result when compared to rates between 25% and 88% for other countries included in the meta-analysis and between 25% and 57% in other European countries (Elvik and Mysen, 1999). Under-reporting rates vary considerably with the injury severity level and the road user type (e.g., Elvik and Mysen 1999; Farmer 2003; McDonald et al. 2009), and comparing police and hospital records in Denmark revealed that the police reports 97% of the fatalities, but only 48% of car occupant injuries and 10% of cyclist injuries (Elvik and Mysen 1999).

Under-reporting rates are traditionally computed with the capture-recapture method that estimates the share of overlapping records in two different samples not representing the full population, while assuming sampling independence and homogeneity. The method has been criticized because of the inevitable violation of the two assumptions when computing road crash injuries: (i) sampling dependency occurs when the police calls emergency medical services and causes road crash injury under-estimation; (ii) sampling heterogeneity motivates stratification by injury severity level and road user type and causes road crash injury over-estimation (Jarvis et al. 2007). Accordingly, most studies focused on subgroups of road crashes involving children or adolescents (Roberts and Scragg 1994; Morrison and Stone 2000; Dhillon et al. 2001), pedestrians or cyclists (Roberts and Scragg 1994; Dhillon et al. 2001; Tin et al. 2013), heavy vehicles (Meuleners et al. 2006), work-related vehicles (Thomas et al. 2012), and alcohol (Miller et al. 2012). Several studies focused only on fatalities (Lateef et al. 2010; Kudryatsev et al. 2013) or serious injuries (Amoros et al. 2007), and only a few studies covered all injury and road user types (Aptel et al. 1999; Tercero and Andersson 2004; Abegaz et al. 2014; Yannis et al. 2014; Watson et al. 2015). While modeling approaches have tackled sampling heterogeneity by analyzing the probability of hospital records being reported to the police (Yannis et al., 2014; Watson et al., 2015), the probability of police records being reported to hospitals has not been analyzed.

This study proposes the computation of under-reporting rates in Denmark from police and hospital records and analyzes the determinants of reporting to the police, the hospital, or both. This study hypothesizes that under-reporting exists in both sources and hence extends existing literature by looking at police records not reported to hospitals alongside hospital records not reported to the police. Data consist of police reports maintained by the Danish Road Directorate and hospital reports collected in the Danish province of Funen between 2003 and 2007. As the hospitals are under the national healthcare system and the national police operate in all Danish regions, the under-reporting rates in Funen are a reliable estimate of the rates in Denmark. The under-reporting rate of road crash injuries is computed with the capture-recapture method from police and hospital records matched according to a (pseudo) civil registration number from the Danish Bureau of Statistics. The likelihood of reporting road crashes to the police and hospitals is investigated with a joint binary logit model as a function of individual and crash characteristics and not only trauma type and severity. Model estimation allows comprehending the reasons for road crash injuries appearing in the hospital and/or police records, and understanding the heterogeneity in the reporting to the two authorities is essential for devising policy measures aimed at increasing the reporting rate by targeting specific road user groups or situational factors.

METHODS

Data

There were 27,199 road crash injuries reported to the hospitals or the police in Funen in the years 2003 to 2007: 12,637 appeared in the police records, 18,896 appeared in the hospital records, and only 4,334 appeared in both. Crashes involving motorized vehicles as well as solo cyclist crashes were included: of the latter, 4,963 were reported to the hospital, 92 to the police, and 132 to both.The police records were obtained from the Danish Road Directorate, which is the governmental agency that collects police reports on road crashes in Denmark. Police reports include crash characteristics (e.g., roadway characteristics, surface conditions, weather conditions, speed limits), crash location (e.g., intersection, section, municipality), vehicles involved (e.g., make, model), and road users involved (e.g., civil registration number, injury degree, age, gender, residence). The hospital records were collected at three hospitals covering all of Funen (Odense, Svendborg and Middelfart). Hospital records include an AIS (Abbreviated Injury Scale) code with diagnosis codes related to trauma type, crash characteristics (e.g., number of vehicles involved, the involvement of vulnerable road users, crash location) and personal information of the patients (e.g., civil registration number, age, gender). Notably, road users can voluntarily report to the police or the hospital any road crash defined as an incident that happened on a road or place used by regular traffic and where at least one of the involved road users is a car driver, motorcyclist or cyclist. When called, police officers report the crash when there are injuries or material damage exceeding 7500 USD per vehicle. When admitted to hospitals, medical personnel reports the crash also for suspected injuries. As the Danish healthcare system is public, hospital compile records from both self-admittance and general physician referral and hence merging multiple hospital sources (Watson et al. 2015) is not required.

Injury severity levels are coded differently in the two databases. The police uses a 4-step scale where no injuries correspond to property damage and bruises, slight injuries require medical treatment, severe injuries result in temporary or permanent incapacity, and fatalities occur within 30 days from the crash. The hospital uses a 6-step AIS scale (Leth and Ibsen 2010). Accordingly, the end result of the hospitalization is transformed into a 4-step injury scale to mimic the police scale and include injury severity in the analysis: ISS 1 was assigned to “no (or minor) injury”, ISS 2 to 4 were assigned to “slight injury”, and ISS over 5 was assigned to “severe injury” (Abay, 2015).

Records are linked between the two databases via the individual (pseudo) civil registration number of the person involved in the road crash as recorded by the Danish Bureau of Statistics. This procedure obviates possible biases introduced by matching characteristics (e.g., date, gender, age) between police and hospital records (e.g., Amoros et al. 2006; Meuleners et al. 2006; Lateef et al. 2010; Thomas et al. 2012) that could imply false positive identification of matching records when they are highly similar but do not derive from the same road crash. Also, both databases are complete and accurate since police officers attend regular training courses for crash reports and follow strict reporting guidelines, while hospital personnel has specific training in classifying injuries and screening for suicides and sudden deaths before the road crash.

Capture-recapture method

Under-reporting rates are estimated with the capture-recapture method commonly used in ecology to estimate animal population size and in epidemiology to estimate disease spread. The method estimates the share of overlapping records in two independent samples (see Figure I) while assuming that (i) the population is finite and closed, (ii) common records are unambiguously identified, (iii) records are independent, and (iv) records are homogeneously catchable.

[Insert Figure I about here]

A two sampled capture-recapture method estimates the total number N of road crash injuries in Funen by applying the Chapman capture-recapture formulary:

$$N = \frac{(p+1)(h+1)}{(B+1)} - 1 \tag{1}$$

where p are the road crash injuries in the police reports, h are the road crash injuries in the hospital reports, and B are the road crash injuries in both reports. Variance and 95% confidence interval for the estimate of N are calculated as:

$$Var(N) = \frac{(p+1)(h+1)(p-B)(h-B)}{(B+1)^2(B+2)} \tag{2}$$

$$95\%\ CI(N) = N \pm 1.96\sqrt{Var(N)} \tag{3}$$

In this study, the first assumption is plausible, as the records have been approved for release by the police and the hospitals, and the second assumption is met, as the (pseudo) civil registration number unambiguously links the road crash injuries in both databases. The third assumption is likely violated, in the case that the police informs the hospital about a road crash, and the fourth assumption is violated, as under-reporting is not random. This violation motivates the investigation of the heterogeneity in the reporting with a discrete choice model approach.

Joint binary logit model

A binary logit model estimates the probability that a road crash injury n appears in the database M given that the same road crash injury appears in the other database. While previous studies investigated the under-reporting of police records in hospital records (Yannis et al. 2014; Watson et al. 2015), this study examines also the under-reporting of hospital records in police records and hence overcomes the incorrect assumption that either sample represents the entire population.

The probability that a road crash injury n in one database appears in the other is a function of a vector X_{ni}^M of observable variables that include person characteristics, vehicles involved and injury severity (Watson et al. 2015). While repeated involvement of the same road user in multiple crashes could violate the sampling independence assumption, in this study (i) only 2% of road users appeared in multiple crashes, (ii) 80% of these cases occurred over one year apart, (iii) 90% of these cases involved different third parties, and (iv) 99% of these cases had different severity outcomes. Accordingly, the assumption of sampling independence is reasonable. Given the police database P and the hospital database H, the probabilities P_{ni}^P and P_{ni}^H of observing a registration match for road crash injury n are expressed as a function of vectors of observable variables X_{ni}^P and X_{ni}^H and vectors of parameters β_P and β_H:

$$P_{ni}^{P} = \frac{\exp\left(\beta_P X_{ni}^{P}\right)}{\exp\left(\beta_P X_{ni}^{P}\right)+\exp\left(\beta_H X_{ni}^{H}\right)} \qquad (1)$$

$$P_{ni}^{H} = \frac{\exp\left(\beta_P X_{ni}^{H}\right)}{\exp\left(\beta_P X_{ni}^{P}\right)+\exp\left(\beta_H X_{ni}^{H}\right)} \qquad (2)$$

Estimates of the vectors β_P and β_H provides insights into the determinants of police records being registered also in the hospital and vice versa. However, the estimates cannot be compared because their differences could result from differences in utility parameters and scale factors, and hence the scale factors μ^P and μ^H should be estimated with the vectors β_P and β_H. Accordingly, this study considers the two utility functions $U_{ni}{}^P$ and $U_{ni}{}^H$ for the joint estimation of two models:

$$U_{ni}^{P} = V_{ni}^{P} + \varepsilon_{ni}^{P} = \beta X_{ni}^{PH} + \alpha W_{ni}^{P} + \varepsilon_{ni}^{P} \qquad (7)$$

$$U_{ni}^{H} = V_{ni}^{H} + \varepsilon_{ni}^{H} = \beta X_{ni}^{PH} + \gamma Z_{ni}^{H} + \varepsilon_{ni}^{H} \qquad (8)$$

where $X_{ni}{}^{PH}$ is a vector of observable variables common to both databases, $W_{ni}{}^P$ is a vector of observable variables specific to the police database, $Z_{ni}{}^H$ is a vector of observable variables specific to the hospital database, $\varepsilon_{ni}{}^P$ and $\varepsilon_{ni}{}^H$ are vectors of i.i.d. Gumbel error terms, and β, α and γ are vectors of parameters to be estimated.

The estimation of the joint binary logit models provides insight into the differences between the scale factors μ^P and μ^H whose ratio is estimated by normalizing the variance of the error ε^P to unity and identifying the relative variance or scale for the error ε^H (Hensher et al., 1999). Estimation is performed by maximum likelihood and produces the estimates of the elements of vectors β, α, and γ, as well as the scalar μ^P.

RESULTS

Capture-Recapture Computation

Table 1 presents the results of the application of the capture-recapture method in order to estimate the total number of road crash injuries or suspected injuries in Funen for each of the years from 2003 to 2007. Material damage only crashes from the police were included, as some of the road users involved in those actually were also included in the hospital records.

[*Insert Table I about here*]

Table 2 presents the results of the capture-recapture method when road crash injuries are differentiated according to the degree of injury severity. The number of road fatalities in Funen varies between 25 and 39 in the period from 2003 to 2007, while the number of severe injuries varies between 1,190 in 2006 and 1,408 in 2003, and the number of slight injuries varies from 2,142 in 2006 to 2,317 in 2007. Expectedly, the under-reporting in the police records is significantly higher than the one in the hospital records.

[*Insert Table II about here*]

Table 3 illustrates the reporting rate recorded by the police for each transport mode. The results show that the police reports only about 6-7% of all slightly injured cyclists and 14-15% of all severely injured cyclists involved in a road crash in Funen. The problem is common to other vulnerable road users, as the police records only about 6-10% of the slightly injured and 27-44% of the seriously injured motorcyclists. Interestingly, the police records between 0% and 13% of the slight injuries and between 6% and 18% of the severe injuries on buses.

[*Insert Table III about here*]

Joint Model Estimation

Table 4 presents the estimation of the joint binary logit models expressing the likelihood that a road user involved in a road crash reported to the police appears also in the hospital records, and vice versa. Given missing information, only 26,052 road users were considered for model estimation, with 18,263 in the hospital records, 12,062 in the police records, and 4,273 in both databases.

[*Insert Table IV about here*]

The estimates uncover similarities in the matching likelihood. The probability of being recorded in both datasets is lower for males and higher for people under 18 years old. The likelihood for road crash injuries to appear in both datasets increases for severe crashes, seatbelt and helmet use, and morning peak crashes. Moreover, comparable seasonal effects are observed, as reporting from police to hospital and vice versa seems more likely in the summer with respect to colder seasons.

Interestingly, the estimates reveal differences in the matching likelihood. With respect to car occupants, pedestrians are more likely to appear in both databases and cyclists are more likely to appear in either database regardless of analysing the reporting to the police or the hospitals. With respect to car occupants however, moped riders and motorcyclists are under-reported when checking whether police records appear in the hospital database, and over-reported when controlling whether hospital records appear in the police database. When considering the number of parties involved, both models express the same tendence but the likelihood of hospital records appearing in the police ones appears higher. In the hospital records, injuries to head, thorax and spine are more likely to be related to an increase in the probability of the crashes being also in the police records, in particular when spinal injuries are recorded. In the police records, there is not a significant effect of the level of education of the road user in reporting the crash also to the hospital, while larger roads and higher speed limits have an effect on the likelihood of reporting the police record also to the hospital.

Lastly, the estimation of the scale factor μ^P with respect to the normalized scale factor μ^H is significantly lower than 1 and indicates higher variance of the error term ε^P , which in turns shows that the police dataset contains more noise than the hospital dataset.

DISCUSSION AND CONCLUSIONS

This study computed the total number of road crash injuries with the capture-recapture method, and then estimated the likelihood that a road crash injury reported to the hospital will be reported also to the police, and vice versa.

The total number of road crash injuries in Funen in the study period is estimated to be 4-6 times higher than the number reported in the hospital and police records. The highest under-reporting rates were registered among cyclists and motorcyclists, in line with recent studies (Yannis et al. 2014; Watson et al. 2015), and in bus-related crashes. Expectedly, reporting rates increase with injury severity.

While the capture-recapture method is currently the best-practice approach to under-reporting estimation, results should be taken with caution. Model estimates reveal heterogeneity in the likelihood of reporting with respect to injury type, injury severity, road user, individual characteristics, and crash location. The likelihood of finding hospital records in police records is greater for: (i) children and adolescents under 18 years old; (ii) females; (iii) severe and fatal injuries, (iv) pedestrians, mortorcyclists and van occupants; (v) head, thorax and spine injuries; (vi) recorded seat-belt or helmet use; (vii) morning peak hours and summer time. The likelihood of finding police records in hospital records is greater for: (i) children and adolescents under 18 years old; (ii) females; (iii) severe and fatal injuries; (iv) pedestrians and van occupants; (v) recorded seat-belt or helmet use; (vi) involvement of other parties; (vii) roads with high speed limits and multiple lanes; (viii) morning peak hours and weekdays. The model estimates for the scale factors reveal that the police dataset contains more noise than the hospital dataset, and in general the loss of information in the police records confirms that road safety analysis relying on police data might be biased (e.g., Farmer, 2003; Abay, 2015).

The estimation results from the model analyzing not only under-reporting to the hospital, but also under-reporting to the police, suggest a dependence of the police and hospital records in the case of severe injuries, injuries affecting consciousness and movements, and injuries that occur on high-speed multi-lane roads, which require inviting various emergency forces to the crash scene. Model estimation results also show heterogeneity in the injury reporting to both the police and the hospitals because of the road user individual characteristics, thus not only because of the road user type and injury severity outcome. These results confirm and extend previous findings (e.g. Amoros et al. 2007; Watson et al. 2015), and allow agreeing with the conclusion that "injured people are not goldfish" (Jarvis et al. 2000), namely that dependence and heterogeneity need to be accommodated in the estimation of the phenomenon of under-reporting.

A limitation of the study, and in general of police and hospital records, is that while the model estimates reveal that the reporting to the police and the hospital can be explained by individual characteristics, the data lack information about the reasons for under-reporting. Further research efforts should be directed to investigating the behavioural reasons for under-reporting to a specific authority by focusing on behavioral theories and service management approaches.

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REFERENCES

Abay K. Investigating the nature and impact of reporting bias in road crash data. *Transport Res A-Pol* 2015;71:31-45.

Abegaz T, Berhane Y, Worku A, Assrat A, Assefa A. Road traffic deaths and injuries are under-reported in Ethiopia: A capture-recapture method. *PloS One* 2014;9:e103001.

Amoros E, Martin J, Laumon B. Estimating non-fatal road casualties in a large French County, using the capture-recapture method. *Accident Anal Prev* 2007;39:483-490.

Aptel I, Salmi LR, Masson F, Bourdé A, Hanrion G, Erny P. Road accident statistics: discrepancies between police and hospital data in a French island. *Accident Anal Prev* 1999;31:101-108.

Dhillon PK, Lightstone AS, Peek-Asa C, Kraus JF. Assessment of hospital and police ascertainment of automobile versus childhood pedestrian and bicyclist collisions. *Accident Anal Prev* 2001;33:529-537.

Elvik R, Mysen AB. Incomplete accident reporting: meta-analysis of studies made in 13 countries. *Transport Res Rec* 1999;1665:33-140.

Farmer CM. Reliability of police-reported information for determining crash and injury severity. *Traffic Inj Prev* 2003;4:38–44.

Hensher DA, Louviere J, Swait J. Combining sources of preference data. *J Econometrics* 1999;89:197-221.

Jarvis, S.N., Lowe, P.J., Avery,A., Levene,S., Cormack R.M. Children are not goldfish—mark/recapture techniques and their application to injury data. *Injury Prevention* 2000;6:46–50.

Khoso AK, Ekman DS, Bhatti JA. Comparison of highway crash reporting in Pakistan with the World Health Organization injury surveillance guidelines. *Traffic Inj Prev* 2011;12:279-282.

Kudryavtsev AV, Kleshchinov N, Ermolina M, Lund J, Grjibovski AM, Nilssen O, Ytterstad B. Road traffic fatalities in Arkhangelsk, Russia in 2005-2010: reliability of police and healthcare data. *Accident Anal Prev* 2013;53:46-54.

Lateef MU. Estimation of fatalities due to road traffic crashes in Karachi, Pakistan, using capture-recapture method. *Asia Pac J Public He* 2010;22:332-341.

Leth PM, Ibsen M. Abbreviated injury scale scoring in traffic fatalities: comparison of computerized tomography and autopsy. *J Trauma Acute Care Surg* 2010;68:1413-1416.

McDonald G, Davie G, Langley J. Validity of police-reported information on injury severity for those hospitalized from motor vehicle traffic crashes. *Traffic Inj Prev* 2009;10:184-190.

Meuleners LB, Lee AH, Cercarelli LR, Legge M. Estimating crashes involving heavy vehicles in Western Australia, 1999-2000: A capture-recapture method. *Accident Anal Prev* 2006;38:170-174.

Miller TR, Gibson R, Zaloshnja E, Blincoe LJ, Kindelberger J, Strashny A, Thomas A, Ho S, Bauer M, Sperry S, Peng J, Singleton M, Smith TJ, Zhang Y. Underreporting of driver alcohol involvement in United States police and hospital records: capture-recapture estimates. *Ann Adv Automot Med* 2012;56:87-96.

Morrison A, Stone DH. Capture-recapture: a useful methodological tool for counting traffic related injuries? *Inj Prev* 2000;6:299-304.

Roberts I, Scragg R. Application of Capture-Recapture methodology to estimate the completeness of child injury surveillance. *Child Health* 1994;30:513-514.

Tercero F, Andersson R. Measuring transport injuries in a developing country: an application of the capture-recapture method. *Accident Anal Prev* 2004;36:13-20.

Thomas AM, Thygerson SM, Merrill RM, Cook LJ. Identifying work-related motor vehicle crashes in multiple databases. *Traffic Inj Prev* 2012;13:348-354.

Tin ST, Woodward A, Ameratunga S. Completeness and accuracy of crash outcome data in a cohort of cyclists: a validation study. *BMC Public Health* 2013;13:420.

Watson, A., Watson, B., Vallmuur, K. Estimating under-reporting of road crash injuries to police using multiple linked data collections. *Accident Anal Prev* 2015;83:18-25.

Yannis G, Papadimitriou E, Chaziris A, Broughton J. Modeling road accident injury under-reporting in Europe, *Eur Transport Res Rev* 2014;6,425-438.

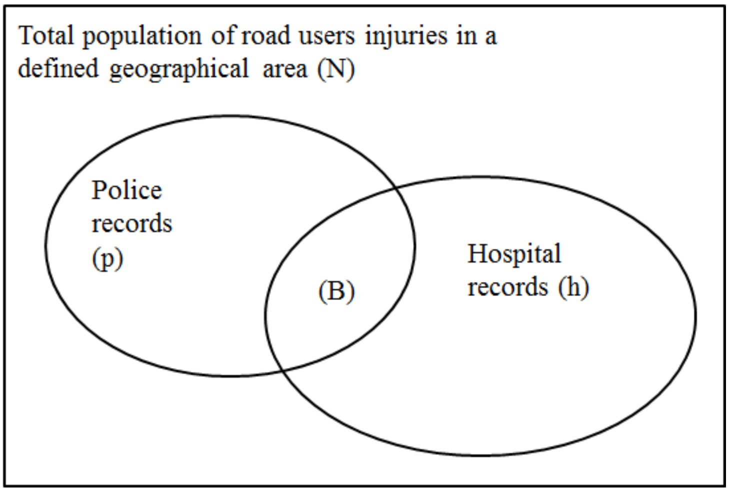

Figure I The capture-recapture method

Table I Number of road users involved in a road crash by year

Year	Matched	Unmatched in police data	Unmatched in ER data	Capture (95% CI)
2003	927	1,812	2,927	11,381 (10,863-11,900)
2004	848	1,631	3,033	11,339 (10,729-11,885)
2005	778	1,499	2,872	10,675 (10,136-11,215)
2006	876	1,558	2,769	10,122 (9,655-10,589)
2007	905	1,803	2,961	11,562 (11,024-12,099)

Table II Number of road users involved in a road crash by year, divided by degree of injury severity, transport mode

	Year	Matched	Unmatched in police data	Unmatched in ER data	Capture (95% CI)
Fatal	2003	19	9	1	29 (28-31)
	2004	19	8	0	27 (27-27)
	2005	18	7	0	25 (25-25)
	2006	28	3	1	32 (31-33)
	2007	27	8	3	39 (37-41)
Severe	2003	448	111	681	1,408 (1,363-1,453)
	2004	398	68	743	1,336 (1,295-1,376)
	2005	362	68	683	1,241 (1,200-1,282)
	2006	410	61	626	1,190 (1,158-1,222)
	2007	433	88	640	1,291 (1,252-1,329)
Slight/ Suspected injury	2003	460	113	2,244	3,367 (3,243-3,491)
	2004	431	95	2,289	3,318 (3,197-3,440)
	2005	398	73	2,189	3,060 (2,952-3,169)
	2006	438	83	2,142	3,068 (2,964-3,172)
	2007	445	100	2,317	3,382 (3,259-3,504)

Table III Number of road users involved in a road crash by year, divided by degree of injury severity, transport mode and police report rate

		Fatal		Severe		Slight/ Suspected injury	
Transport mode	Year	Capture (95% CI)	Police catch rate (%)	Capture (95% CI)	Police catch rate (%)	Capture (95% CI)	Police catch rate (%)
Pedestrian	2003	1 (1-1)	100	65 (57-73)	60	130 (101-158)	22
	2004	2 (2-2)	100	83 (73-93)	52	111 (96-125)	32
	2005	6 (6-6)	100	50 (46-55)	46	90 (73-108)	18
	2006	3 (3-3)	100	65 (58-72)	60	101 (80-122)	26
	2007	5 (5-5)	100	66 (60-73)	62	120 (93-146)	23
Cyclist	2003	6 (6-6)	83	669 (609-739)	15	1,712 (1,559-1,865)	6
	2004	9 (9-9)	100	637 (688-686)	14	1,562 (1,446-1,679)	6
	2005	4 (4-4)	100	612 (557-668)	14	1,478 (1,376-1,579)	7
	2006	4 (4-4)	100	490 (457-524)	14	1,344 (1,252-1,435)	6
	2007	3 (3-3)	100	582 (522-642)	14	1,459 (1,334-1,585)	7
Moped	2003	4 (4-4)	100	192 (175-209)	52	291 (253-329)	23
	2004	6 (6-6)	100	212 (190-233)	40	292 (253-331)	23
	2005	2 (2-2)	100	172 (157-187)	41	276 (236-315)	20
	2006	6 (6-6)	100	179 (164-195)	47	321 (279-363)	22
	2007	6 (6-6)	100	201 (186-217)	48	330 (297-363)	26
Motor-	2003	2 (2-2)	100	68 (60-76)	35	116 (92-140)	10
Cyclist	2004	0 (0-0)	N/A	74 (63-84)	27	154 (115-194)	6
	2005	0 (0-0)	N/A	70 (58-83)	38	131 (99-164)	10
	2006	5 (5-5)	100	61 (54-68)	44	162 (92-232)	7
	2007	3 (3-3)	100	77 (67-87)	44	118 (93-143)	7
Car	2003	15 (15-15)	100	361 (351-371)	73	982 (945-1,018)	31
	2004	8 (8-8)	100	291 (285-297)	67	1,018 (976-1,060)	28
	2005	12 (12-12)	100	293 (284-302)	67	907 (871-942)	27
	2006	10 (9-11)	89	320 (313-326)	66	997 (964-1,030)	28
	2007	19 (17-21)	85	349 (340-358)	68	1,159 (1,113-1,204)	25
Bus	2003	0 (0-0)	N/A	14(6-22)	14	40 (27-52)	13
	2004	0 (0-0)	N/A	10 (10-10)	10	49 (17-80)	4
	2005	0 (0-0)	N/A	17 (17-17)	6	39 (39-39)	5
	2006	0 (0-0)	N/A	12 (12-12)	17	28 (28-28)	11

	2007	1 (1-1)	0	11 (11-11)	18	47 (47-47)	0
Other*	2003	1 (1-1)	100	42 (38-45)	72	78 (70-87)	56
	2004	2 (2-2)	100	38 (36-40)	79	48 (45-52)	41
	2005	1 (1-1)	100	39 (37-42)	74	78 (71-84)	45
	2006	4 (4-4)	100	45 (43-47)	81	71 (64-78)	49
	2007	2 (2-2)	100	31 (29-32)	82	78 (67-90)	36

* Include road users of van, tractor and truck.

** 31 road users in the police registration only are not included in this table because of missing information on the transport mode.

Table IV Estimates of the joint model of the probability that a road user involved in a road crash with injury or suspected injury reported to the hospital appears in the police records, and vice versa

		Reported in H appears in P		Reported in P appears in H	
Variable	Category	Estimate	t-stat	Estimate	t-stat
Gender	Male	-0.603	-14.23	-0.895	-16.88
	Female	-	-	-	-
Age	Less than 18 years old	-	-	-	-
	18-24 years old	-0.872	-13.12	-0.755	-9.10
	25-34 years old	-0.916	-13.18	-0.941	-10.72
	35-44 years old	-0.910	-13.07	-0.979	-11.03
	45-54 years old	-0.855	-11.35	-1.010	-10.59
	55-64 years old	-0.854	-10.32	-0.979	-9.53
	65-74 years old	-0.723	-7.05	-0.740	-5.85
	Over 75 years old	-0.831	-7.17	-0.623	-4.44
Injury severity	Minor	-	-	-	-
	Serious	1.600	30.64	2.510	25.20
	Fatal	5.210	9.72	2.740	10.28
Road user type	Pedestrian	1.270	11.53	0.556	3.68
	Cyclist	-0.345	-5.00	-0.546	-5.66
	Moped	0.870	8.74	-0.883	-6.64
	Motorcyclists	0.263	1.84	-1.280	-6.63
	Car	-	-	-	-
	Van	0.889	4.59	0.819	3.91
	Heavy vehicle	-0.999	-6.02	-0.987	-5.38
Seatbelt	Yes	2.170	34.60	2.090	26.75
	No	-	-	-	-
Helmet	Yes	0.515	6.23	2.010	20.26
	No	-	-	-	-
Family status	Single	-2.650	-35.95	-2.430	-26.91
	Partner	-2.930	-42.02	-2.730	-31.42
	Other status	-	-	-	-
Other parties involved	Zero	-	-	-	-
	One	1.070	18.01	0.253	3.29
	Two	0.863	11.43	0.315	3.03
	Three or more	1.010	12.40	0.572	5.30
Type of injury	Head	1.110	19.08	-	-
	Head and thorax	1.600	9.20	-	-
	Head and upper extremities	1.710	16.92	-	-
	Head and lower extremities	1.980	18.09	-	-
	Head and spine	2.710	16.79	-	-
	Thorax	1.630	13.56	-	-
	Thorax and upper extremities	1.480	7.39	-	-
	Thorax and lower extremities	2.110	11.80	-	-
	Thorax and spine	2.220	9.36	-	-
	Upper extremities	-	-	-	-
	Upper extremities and spine	2.690	11.39	-	-

	Lower extremities	0.880	13.12	-	-
	Lower extremities and spine	3.120	12.86	-	-
	Spine	2.240	19.35	-	-
Education	Low education	-	-	-	-
	Medium education	-	-	0.050	0.34
	High education	-	-	-0.008	-0.13
Speed limit	Less than 70 km/h	-	-	-	-
	70-90 km/h	-	-	1.160	17.11
	100-130 km/h	-	-	1.370	9.84
Number of lanes	One	-	-	-	-
	Two	-	-	3.510	36.96
	Three or more	-	-	3.510	29.57
Type of day	Weekend	-	-	-0.085	-1.62
	Weekday	-	-	-	-
Time of day	Morning peak	0.107	1.78	0.211	3.02
	Other periods	-	-	-	-
Season	Spring	-0.744	-13.10	-0.614	-9.22
	Summer	-	-	-	-
	Autumn	-0.703	-13.00	-0.606	-9.45
	Winter	-0.739	-12.77	-0.539	-8.01
Scale parameter		1.000	-	0.886	-7.73*
Log-likelihood at zero					-33315.148
Log-likelihood at convergence					-15639.149
Adjusted Rho-bar squared					0.528

Note: * t-test with respect to 1 (tests the equality of the scale parameters)