Injury situation of novice drivers in road traffic
-A medical and technical analysis-

C. Haasper, D. Otte*, J. Nehmzow*, C. Probst, C. Müller, M. Panzica, T. Hüfner, and C. Krettek

*Trauma Department with *Accident Research Unit, Hannover Medical School (MHH), Hannover, Germany*

ABSTRACT

Background Novice drivers are at high risk for crash involvement. We performed an analysis of causations, injury patterns and distributions of novice drivers in cars and on motorcycles in road traffic as a basis for proper measurements.
Method Data of accident and hospital records of novice drivers (licence < 2 years) were analysed focusing the following parameters: injury type, localisation and mechanism, Abbreviated Injury Scale (AIS), maximum AIS (MAIS), delta-v, collision speed and other technical parameters and have been compared to those of experienced drivers.
Results In 18352 accidents in the area of Hannover (years1985–2004), 2602 novice drivers and 18214 experienced drivers were recorded having an accident. Novice car drivers were more often and severe injured than experienced and on motorcycles the experienced riders were at higher risk. Novice drivers of both groups sustained more often extremity injuries. 4.5 % novice car drivers were not restraint compared to 3.7 % of the experienced drivers and 6.1 % novice motorcycle drivers did not wear a proper helmet (versus 6.5 %). Severe injuries sustained at a rate of 20 % at collision speeds below 30 km/h and in 80% at collision speeds above 50 km/h. Novice car drivers drove significant older cars. The risk profile of novice drivers is similar to those of drivers older than 65 years.
Conclusions Structural protection and special lectures like skidding courses could be proper remedial action next to harder punishment of violations.

Key words
Car accident, injury mechanism, motorcycle, prevention

INTRODUCTION

According to annual accident reports novice drivers are at a higher risk in road traffic [1]. This thesis is proven every year in Germany and a discussion in different reporting media could be observed. Plenty of initiatives were run to reduce risk. When looking at the literature the definition is very heterogeneous.
In recent years, not only the severity of road accidents has been reduced, but also the frequency and sustained injuries [2, 3]. This trend reflects progress in crash safety protection design of automobiles [4]. Compared to 1973 with 18424 fatal accidents in Germany in 2006 only 5091 could be observed indicating a new historic base line [3]. Nevertheless, in 2006 1011 young people between 18 and 24 years were killed in road traffic accidents (– 6,0% compared to the preceding year) and 83292 injured (– 3,7%) [3]. When calculating those numbers compared to the portion of population of 8.2%, risk of accident in road traffic is doubled. The safety of car occupants was enhanced by mandatory belt use, the interior design – especially the restrain systems and airbags –, and on the other hand structural changes focusing the exterior design and enhancing stiffness of car frames tremendously [5].
Although there are previous studies that outline distinct characteristics and risk profiles with a special view on psychological markers and background, there is a lack of in-depth technical evaluation of the potential influence of external factors and real-world prevalence. Most previous studies utilized medical, police and/or insurance records to obtain both accident and medical data [6]. In consideration of the results of previous studies with alternative aims, we strongly believe that a specific technical in-depth crash investigation in combination with a medical data analysis is the most inclusive basis for the improvement of safety of novice drivers. A special focus was given upon the usage of safety devices like belts and helmets and, if those provide as sufficient protective measurement. Furthermore we wanted to identify special characteristics in novice driver's accidents. The purpose of this study was therefore to estimate the prevalence of knee injuries in real world car crashes in Germany and to identify any change in prevalence with time.

METHOD

Based on a non-standardized definition of the term „novice driver“ we defined this subpopulation in analogy to the pending driver's licence as those holding one less than 2 years. The local traffic accident research unit collected prospective data in regard to all reported traffic crashes within the area. 18352 traffic accidents were documented between 1985 and 2004. Specially trained documentation personnel are notified by police dispatchers and arrive on scene, often simultaneously with the rescue personnel. Thus, investigation of the crash (including stereotactic photographs for measurement of distance), and clinical injury documentation is performed on site. The report is then completed at the medical institution providing care for the victims, with documentation of x-ray films, injury type and severity. The monitoring includes demographic data, type of road user (car/truck occupant, motorcyclist, cyclist, pedestrian), delta-v (km/h; change of velocity at the collision time as a basic force indicator) of motorized vehicle user; vehicle collision speed (km/h) of motorbikes, Abbreviated Injury Scale (AIS), Maximum AIS (MAIS), Injury Severity Score (ISS) and incidence of serious and/or severe multiple injuries (polytrauma, ISS ≥ 16) [2, 7, 8, 9]. 1000 accidents are recorded annually.
The Abbreviated Injury Scale (AIS), developed by the Association for the Advancement of Automotive Medicine is the most widely used anatomic injury severity scale in the world [10]. A six-point severity scale is used to rank threat to life. For injuries of the limbs most regions are described by the first three steps as those are rarely life-threatening. This information was used along with the impact vector and the resulting relative motion of the car and differentiated according to frontal and side impact.
Traffic crash reports from 1985 to 2004 produced by the process described above, were carefully analyzed for the involvement of novice drivers. A liability curve was generated using the ratio guilty/not guilty related to the delinquents age and supported by a polynomic trend line.
For statistical analysis t-, Pearson- or Linear-Trend-tests were used. A p>0,001 was considered to be significant.

RESULTS

Epidemiology

Between 1985 and 2004 (20 years) 18352 traffic accidents including injured persons were collected. 20816 of those were motorbike or car drivers (tab. 1). Of all drivers 2602 (12.5 %) obtained less than two years prior the accident and were considered as novice drivers. Those were divided to 1614 car- and 233 motorbike novice driver and compared to 11750 car- and 729 motorbike-drivers that had a driver licence longer than 2 years at the time of the accident. The average age of all accident victims was 37.2 (15–97) years. The average age of novice driver at the time of the accident was 23.7 years versus 39.1 within the subpopulation of experienced drivers. The significant younger novice driver sustained significant more often in the earlier years (1993.8 versus 1995.4). In total young (<25 years) and old drivers (>65) were identified for being at higher risk in a liability curve (fig. 1). For novice car drivers (tab.1) a mean age of 23.7 +/- 9.0 was calculated. 69.0% were male. The experienced car drivers were in mean 39.5 +/- 15.1 years old. 67.7 % were male. Gender difference was between novice and experienced drivers not significant for all car drivers. Significant more male drivers had accidents in experienced motorbike riders. For novice motorbike riders a mean age of 23.7 +/- 8.3 was calculated and 79.1% were male. The experienced motorbike drivers were in mean 31.7 +/- 9.8 years old and 90.1% were male.

Car-drivers

Accident circumstances

Novice drivers had significant more often accidents on rural roads than inside cities compared to experienced car drivers besides that more than 2/3 of all accidents occurred out of town (tab. 1). Only every twentieth accident happened on highways. Non significant less often novice drivers were guilty (5.7 vs. 6.7 %). About 2/3 of all accidents were during daylight time, but nonetheless even here novice car driver were significant over represented during dusk or dawn. Novice drivers had accidents during all week days when experienced ones had significant more often accidents during working days. Cars of

novice drivers were significant older than those of experienced car drivers (mean values: tab.1). When examining the accidents causations significant more often skidding, excessive speed or overtaking were identified in novice drivers. In all novice drivers liability was significant more often identified, especially in solo accidents without participation of any other road user (471 Novice driver (16.9 %) vs. 1616 experienced drivers (7.4 %); tab.1, fig.1)). Safety devices like belts were significant less often used (4.5 % vs. 3.7 %) and alcohol affected the accident events more often than in experienced drivers (7.0 % vs. 4.9 %).

Injury severity
59 % (n=1263) of all novice car drivers were unhurt compared to the group of experienced drivers of 64.8 % (n=10572) (tab.2). Slightly injured (MAIS 1) were 33.9 % compared to 29.0 % experienced car drivers. Severely injured (MAIS 2–4) were 6.1 % versus 5.3 % of experienced drivers and worst injured (MAIS 5 und 6) were 0.6 % versus 0.4 %. Novice driver were overall significant more often and severe injured than the experienced ones. Of all car drivers head injuries were observed in 574 (19.3 %) novice drivers versus 3071 (14.0 %) and neck injuries 389 (15.7 %) versus 2790 (15.8 %) experienced drivers (fig. 2). Thorax injuries were seen in 381 (12.8 %) versus 2674 (12.4 %) and abdomen 110 (3.4 %) versus 707 (3.0 %) experienced drivers. Pelvic injuries were recorded in 115 (3.5 %) versus 558 (2.2 %) experienced drivers. Extremity injuries were for the upper counted with 380 (13.7 %) injured novice drivers versus 1948 (9.0 %) and lower 359 (12.3 %) versus 2073 (9.3 %) experienced drivers. For head, pelvis, upper and lower extremity significant differences were demonstrated.

Motorbike-riders
Accident circumstances
Novice drivers crashed more often on rural roads than inside cities compared to experienced car drivers but not significant and near 80 % of all accidents happened on residential or urban streets (tab. 1). More accidents were recorded during daylight, but the difference was not significant. During the week accidents were recorded on an equal level, while a non-significant peak was observed for experienced drivers on weekends (Fr-Su).
After analyzing accidents causations there were no significant differences. In novice driver a significant higher liability was demonstrated (tab 1). A helmet protection was not worn by every 20th victim. Alcohol influenced less often the crash incidence than in car drivers without significant differences in both subgroups.

Injury severity
59 % (n=1263) of all novice motorbike riders were not injured compared to 64.8 % of the experienced (n=10572) (tab. 2). Lightly injured (MAIS 1) were 62.9 % versus 63.2 % of all experienced motorbike drivers. Severe injured (MAIS 2–4) were 23.4 % of novice drivers compared to 28.7 % of the experienced. Worst injured (MAIS 5 and 6) were 1.1 % of all riders in both groups. In this group experienced riders were significant more often and severe injured than novice riders. When analyzing body regions 68 (15.1 %) versus 222 (15.2 %) of all experienced riders had head and neck injuries in 24 (5.5 %) compared to 100 (9.1 %) (fig. 3). Thorax injuries were observed in 77 (20.8 %) novice drivers versus 334 (28.7 %) and abdominal injuries were in 22 victims (47.7 %) compared to 106 (8.0 %). Pelvic injuries were demonstrated in 53 (17.2 %) of novice drivers versus 176 (17.2 %). Extremity injuries were more often seen in novice drivers: upper 138 (47.7 %) versus 470 (44.9 %) experienced motorbike riders and lower 218 (73.7 %) compared to 712 (68.7 %). A significant difference could not be demonstrated for any body region in the subgroups.

Technical parameters
In the group of car drivers a remarkable portion of severe injuries (MAIS 2-4) were observed only above a delta-v of 30 km/h (fig. 4). Up to a delta-v of 50 km/h car accidents could be experienced without any injury. Above a delta-v of 70 km/h worst injuries could be expected. In motorbike riders severe injuries could be seen even below a low collision speed less than 30 km/h in 20% of all accidents (fig. 5). An

increase of 30 km/h in relative speed showed no significant severer injuries. The risk to be severely injured was higher in older cars. In new cars (<3 years) 66.9 % of drivers were not injured, 27.5 % light injured (MAIS 1) and 4.8 % severe injured (MAIS 2-4). In old cars (> 9 years) 63.0 % of all drivers were not injured, 30.3 % light injuries (MAIS 1) and 5.8 % severe injuries (MAIS 2-4). The injury severity increased in relation to the age of the car continuously.

DISCUSSION

Already in the 1970s a higher risk for novice drivers in road traffic was identified [10]. Young adults involvement in car accidents are above the average in Germany [3]. In the literature a high risk acceptance especially in young male in addition to overestimating their own driving abilities and low driving experience is discussed [11]. A lot of protective measurements were initiated to lower accident rates. Attended driving or the driver's licences on trial are actual examples. The age to obtain a car licence was reduced to 17 after promising results of a trial [12].
In this study it was possible to generate a liability curve (fig. 1), in which young and old drivers were identified to be at higher risk. For novice drivers being inexperienced and overestimation were factors, while the older showed longer reaction times and lower perception indicating a higher risk in fatality analyses [13]. Despite not investigating psychological factors in this study, those are important factors in accidents [14]. For older drivers a not significant elevated risk could be demonstrated in the literature above a designated annual driving distance (more than 14000 km) [15]. Furthermore it is known that this subpopulation has the lowest accident rate per licence, but otherwise show the lowest rate of use as well. Overtaking, skidding and high speed could be identified in this study to be significant parameters in novice car drivers' accidents. That is the reason why a good education of traffic participants is mandatory for prevention [16]. Higher punishment for novice drivers or general speed limits until a sufficient experience could be preventive measurements. When analyzing day and week times a focus could be identified for novice drivers during night time and weekends. Because of an unknown exposition profile the cause of the higher risk could only be estimated [1]. But during that time so called „disco drivers" are on the road. Novice drivers are driving significant often older cars. Those cars are in general types of the compact class and are often not equipped with modern safety devices like ABS, ESP or other electronic stability programs. An additional measurement could be not exposing novice drivers to technical low equipped cars. The modification of the interior and exterior design was already identified to be effective protection in cars [2, 17, 18]. The injury severity in cars is basically determined by the collision circumstances like impact angle and delta-v which is the change of velocity at the collision time as a basic force indicator. Car occupants are moving in relative vectors inside the cars. In case of a collision the car is slowing down and the people inside are restrained by belts for car parts, which could induce injuries. In frontal collisions and additional use of belts higher delta-vs are necessary for injuries than for side collisions. Next to injury foci like the head, extremity injuries are pointed out in novice drivers. In contrast motorbike riders showed fewer injuries but a relative higher extremity injury rate. A lack of discipline using elementary safety devices like protection suites or helmets is present, too. In contrast the effectiveness was demonstrated often and needs not to be discussed [19, 20, 21]. The safety belt advantage is accepted to be best of all passive safety devices. Due to this knowledge a mandatory usage is required by law since 1983 for all car drivers.
Measurements like attended driving and higher punishments for driving under alcohol or drug influence and special education courses could be successful. The high risk profile above a designated age must be outlined. Next to speed, skidding and overtaking could be identified being risky situations. A psychological training against overestimation and special skidding courses (ADAC) could be preventive measurements. Such an education could be useful to become more experienced in border line situations. But those should only be conducted to learn special rescue manoeuvres. Some behaviour seems to be only influenced on a low level despite a broader education nowadays. Integrative concepts could be useful to lower accident rates in road traffic.
Novice drivers are still at a high risk. Safety devices are often unused despite the technological advantages of the modern systems. The car's age seems to be important in reference to the victim's injuries. This

study has highlighted some new and old facts about road traffic-related accidents of novice drivers. Advanced strategies must be developed to provide effective injury prevention. Despite the fact that we have shown a reduction in injury prevalence, the medical and socio-economic consequences of novice driver's accidents is high. It is therefore of paramount importance to continue to push for advances in car safety design.

ACKNOWLEDGEMENT

The authors would like to thank B. Wiese, Institute for Biometry (MHH), for her assistance with statistical analysis.

REFERENCES

1. Laapotti, S., Keskinen, E., Hatakka, M., Hernetkoski, K., Katila, A., Peraaho, M., Salo, I.: Driving circumstances and accidents among novice drivers. Traffic.Inj.Prev. 7, 232-237 (2006)
2. Haasper, C., Otte, D., Knobloch, K., Zeichen, J., Krettek, C., Richter, M.: Kniegelenksverletzungen des ungeschützten Verkehrsteilnehmers im Straßenverkehr. Unfallchirurg 109, 1025-1031 (2006)
3. Statistisches Bundesamt: Verkehr (Verkehrsunfälle). Fachserie 8, 7- (2007)
4. Duncan GJ und Meals R: One hundred years of automobile-induced orthopedic injuries. Orthopedics 18, 165-170 (1995)
5. McGovern, M. K., Murphy, R. X., Jr., Okunski, W. J., Wasser, T. E.: The influence of air bags and restraining devices on extremity injuries in motor vehicle collisions. Ann Plast.Surg 44, 481-485 (2000)
6. Shope, J. T.: Graduated driver licensing: review of evaluation results since 2002. J.Safety Res. 38, 165-175 (2007)
7. American Association for Automotive Medicine: Abbreviated Injury Scale - Revision 90. Am.Ass.F.Autom.Med., Morton Grove, Illinois, USA (1995)
8. Baker, S. T., O'Neill, B., Heddon, W., Long, E. B.: The Injury Severity Score: A method for describing patients with multiple injuries and evaluating emergency care. J.Trauma. 14, 187-195 (1974)
9. Foltin, E. und Stockinger, A.: [Effects of injury pattern on the predictability of 4 multiple trauma scores. Presentation of a method for identifying artifacts]. Unfallchirurg 102, 98-109 (1999)
10. Garthe, E., States, J. D., Mango, N. K.: Abbreviated injury scale unification: the case for a unified injury system for global use. J Trauma 47, 309-323 (1999)
11. Nyberg, A. und Gregersen, N. P.: Practicing for and performance on drivers license tests in relation to gender differences in crash involvement among novice drivers. J.Safety Res. 38, 71-80 (2007)
12. Bund: Drittes Gesetz zur Änderung des Straßenverkehrsgesetzes und anderer straßenverkehrsrechtlicher Vorschriften - Begleitetes Fahren mit 17 . Bundesgesetzblatt Teil 1 2005, 2412-2416 (2005)
13. Evans, L.: Risks older drivers face themselves and threats they pose to other road users. Int.J.Epidemiol. 29, 315-322 (2000)
14. Vassallo, S., Smart, D., Sanson, A., Harrison, W., Harris, A., Cockfield, S., McIntyre, A.: Risky driving among young Australian drivers: trends, precursors and correlates. Accid.Anal.Prev. 39, 444-458 (2007)
15. Hakamies-Blomqvist L, Raitanen T, O´Neill D: Driver ageing does not cause higher accident rates per km. Transport Res F 5, 271-274 (2002)
16. Hirsch, P., Maag, U., Laberge-Nadeau, C.: The role of driver education in the licensing process in Quebec. Traffic.Inj.Prev. 7, 130-142 (2006)
17. Otte, D., Pohlemann, T., Wiese, B., Krettek, C.: Änderung des Verletzungsmusters Polytraumatisierter in den zurückliegenden 30 Jahren. Unfallchirurg 106, 448-455 (2003)
18. Haasper, C., Otte, D., Knobloch, K., Probst, C., Board, T. N., Krettek, C., Richter, M.: Knee injuries in restrained car drivers in german road traffic accidents. J.Trauma 65, 136-141 (2008)
19. Goodwin, A. H., Wells, J. K., Foss, R. D., Williams, A. F.: Encouraging compliance with graduated driver licensing restrictions. J.Safety Res. 37, 343-351 (2006)

20. Richter, M., Pape, H. C., Otte, D., Krettek, C.: The current status of road user injuries among the elderly in Germany: a medical and technical accident analysis. J.Trauma 58, 591-595 (2005)

21. McGovern, M. K., Murphy, R. X., Jr., Okunski, W. J., Wasser, T. E.: The influence of air bags and restraining devices on extremity injuries in motor vehicle collisions. Ann Plast.Surg 44, 481-485 (2000)

Table 1: Epidemiology and accident circumstances in cars and motorbikes

n (%)		Novice car driver	Others car	Significance (p>0,001)	Novice motorbike rider	Others motorbike	Significance (p>0,001)
Accidents, injured drivers		2312	17193		290	1021	
Sex	male	1614 (69.0 %)	11750 (67.7 %)	n.s.	233 (79.1 %)	925 (90.1 %)	s.
Age		23,7 +/- 9,0	39,5 +/- 15,1	s.	23,7 +/- 8,3	31,7 +/- 9,8	s.
Accident site	Urban	1419 (69.2 %)	11344 (73.8 %)	s.	208 (79.7 %)	729 (78.8 %)	n.s.
	Rural	740 (25.2 %)	4369 (19.5 %)	s.	78 (18.8 %)	234 (17.1 %)	n.s.
	Autobahn	153 (5.7 %)	1480 (6.7 %)	n.s.	4 (1.5 %)	58 (4.2 %)	n.s.
Time	Day	1417 (63.7 %)	12084 (72.2 %)	s.	210 (73.4 %)	789 (79.5 %)	n.s.
	Night	728 (29.2 %)	3901 (21.2 %)	s.	59 (20.2 %)	163 (14.0 %)	n.s.
	Dusk/Dawn	166 (7.1 %)	1195 (6.5 %)	s.	18 (6.0 %)	67 (6.1 %)	n.s.
Day	Mo-Thu	1260 (55.5 %)	10493 (61.3 %)	s.	172 (61.1 %)	557 (55.5 %)	n.s.
	Fr-Su	1052 (44.5 %)	6700 (38.7 %)	s.	118 (38.9 %)	464 (44.5 %)	n.s.
Vehicle age	0-3	268 (11.4 %)	3574 (21.0 %)	s.	80 (26.9 %)	243 (23.8 %)	n.s.
	4-6	286 (12.4 %)	3323 (19.3 %)	s.	61 (20.7 %)	175 (18.1 %)	n.s.
	7-9	457 (20.4 %)	3024 (17.5 %)	s.	35 (12.2 %)	105 (10.6 %)	n.s.
	9+	958 (41.0 %)	4528 (26.5 %)	s.	37 (13.0 %)	175 (18.2 %)	n.s.
Accidentcausation (yes/no)	Skidding	510 (19.2 %)	1801 (8.5 %)	s.	63 (20.3 %)	190 (17.7 %)	s.
	Speed	767 (30.0 %)	3853 (19.9 %)	s.	102 (29.8 %)	347 (30.0 %)	n.s.
	Distance	100 (5.2 %)	728 (4.8 %)	n.s.	17 (7.7 %)	58 (5.8 %)	n.s.
	Overtaking	110 (3.6 %)	544 (2.8 %)	s.	30 (10.5 %)	101 (9.2%)	n.s.
Liability	Yes, alone	471 (16.9 %)	1616 (7.4 %)	s.	52 (16.6 %)	186 (15.2 %)	n.s.
	Yes	889 (41.4 %)	6482 (39.9 %)	s.	63 (22.4 %)	157 (15.1 %)	n.s.
	No	948 (41.5 %)	9056 (52.4 %)	s.	174 (60.9 %)	675 (69.5 %)	n.s.
	Unknown	4 (0.2 %)	39 (0.3 %)	n.s.	1 (0.1 %)	3 (0.2 %)	n.s.
Usage of restraint devices	no belt/helmet	115 (4.5 %)	674 (3.7 %)	s.	17 (6.1 %)	62 (6.5 %)	n.s.
Influence alcohol/drugs		196 (7.0 %)	976 (4.9 %)	s.	15 (3.8 %)	57 (4.2 %)	n.s.

Table 2: Injury severity of car drivers and motorbike riders

n (%)	Novice car driver	Others car	Significance (p>0,001)	Novice motorbike rider	Others motorbike	Significance (p>0,001)
not injured	1263 (59.0 %)	10572 (64.8 %)	s.	27 (11. 8%)	65 (6.4 %)	s.
MAIS 1	742 (33.9 %)	4756 (29.0 %)	s.	146 (62.9 %)	517 (63.2 %)	n.s.
MAIS 2	192 (4.8 %)	1146 (4.2 %)	n.s.	69 (18.0 %)	271 (21.6 %)	n.s.
MAIS 3	53 (1.0 %)	305 (0.8 %)	n.s.	28 (4.5 %)	111 (6.0 %)	n.s.
MAIS 4	14 (0.3 %)	105 (0.3 %)	n.s.	6 (0.9 %)	22 (1.1 %)	n.s.
MAIS 5	17 (0.3 %)	90 (0.2 %)	n.s.	7 (0.9 %)	14 (0.6 %)	n.s.
MAIS 6	20 (0.3 %)	96 (0.2 %)	n.s.	4 (0.5 %)	11 (0.4 %)	n.s.
unknown	11 (0.5 %)	121 (0.5 %)	n.s.	3 (0.6 %)	10 (0.7 %)	n.s.
Head injury	574 (19.3 %)	3071 (14.0 %)	s.	68 (15.1 %)	222 (15.2 %)	n.s.
Neck injury	389 (15.7 %)	2790 (15.8 %)	n.s.	24 (5.5 %)	100 (9.1 %)	n.s.
Thorax injury	381 (12.8 %)	2674 (12.4 %)	n.s.	77 (20.8 %)	334 (28.7 %)	n.s.
Upper extremity injury	380 (13.7 %)	1948 (9.0 %)	s.	138 (47.7 %)	470 (44.9 %)	n.s.
Abdomen injury	110 (3.4 %)	707 (3.0 %)	n.s.	22 (47.7 %)	106 (8.0 %)	n.s.
Pelvic injury	115 (3.5 %)	558 (2.2 %)	s.	53 (17.2 %)	176 (17.2 %)	n.s.
Lower extremity injury	359 (12.3 %)	2073 (9.3 %)	s.	218 (73.7 %)	712 (68.7 %)	n.s.

Figure 1: Liability curve in relation to the age of traffic participants with polymeric trend line

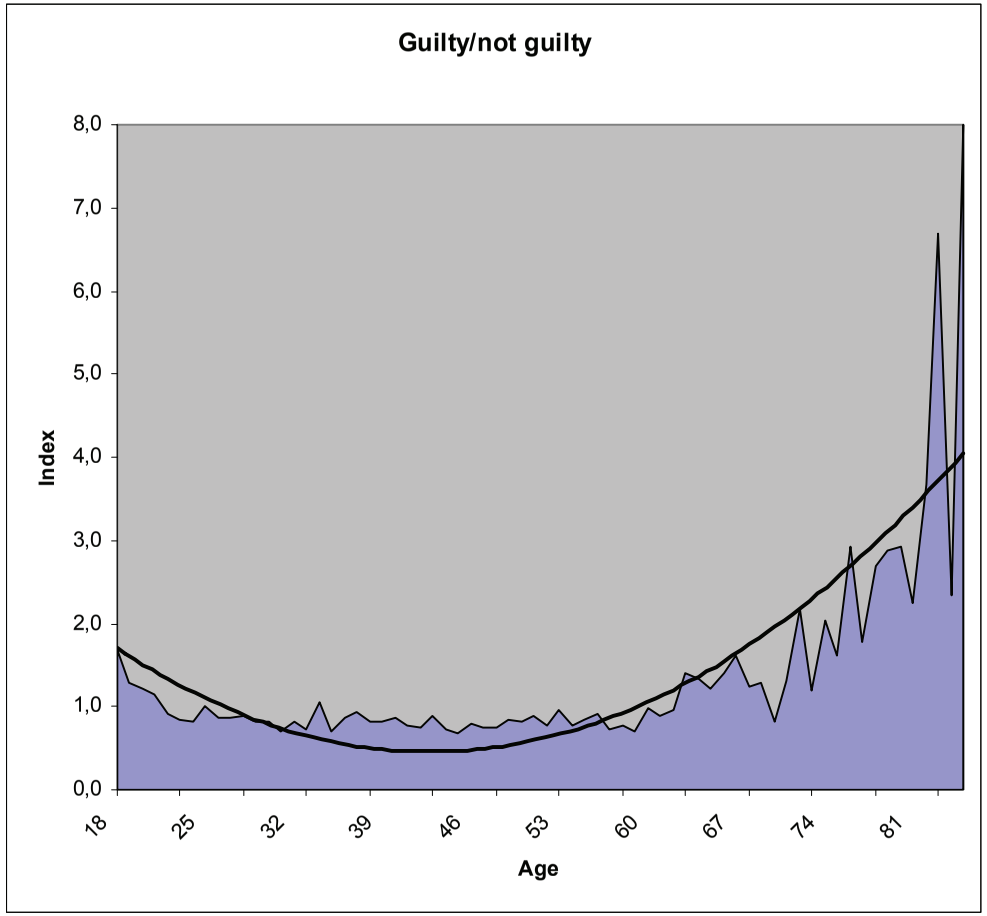


Figure 2:

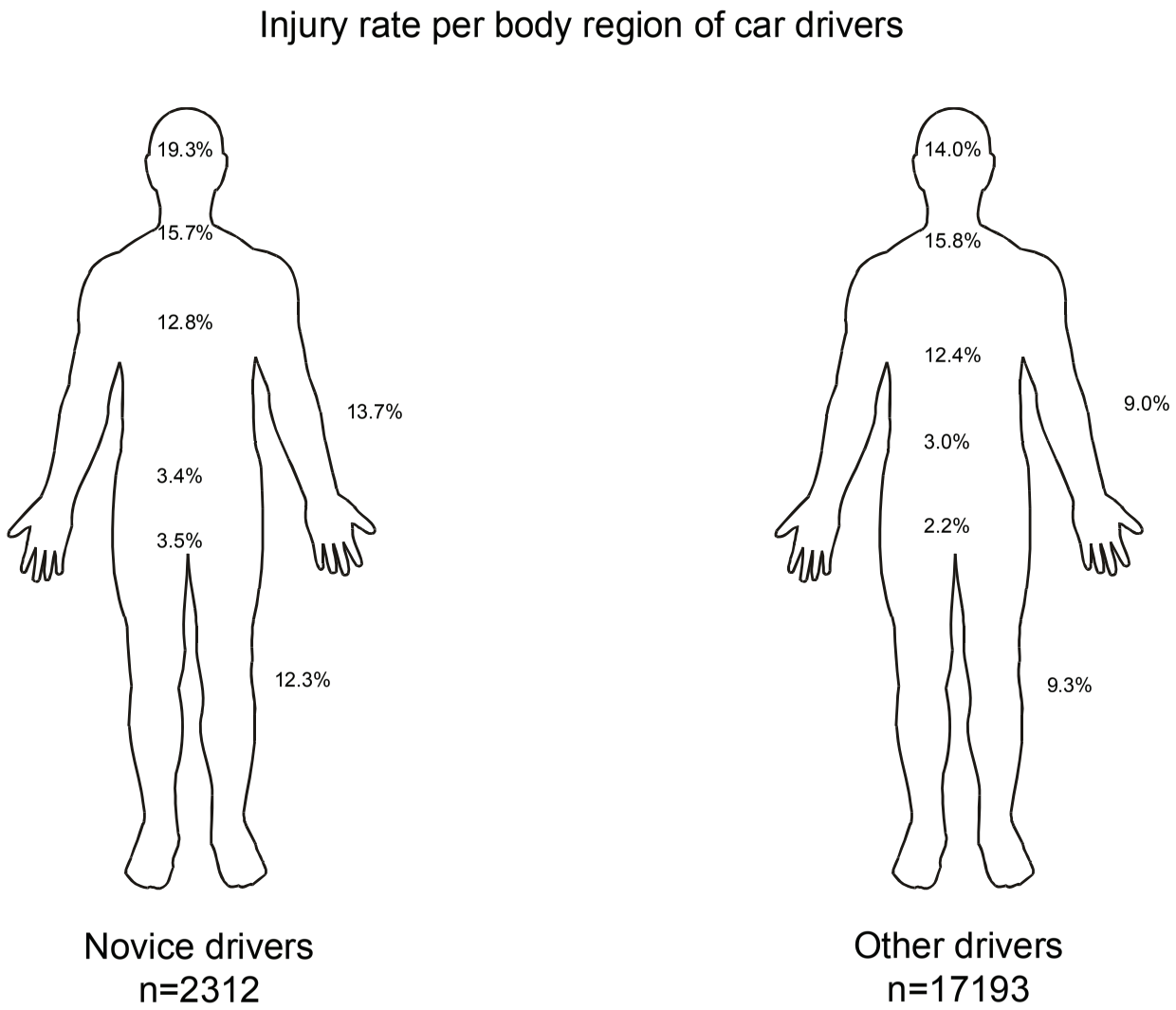
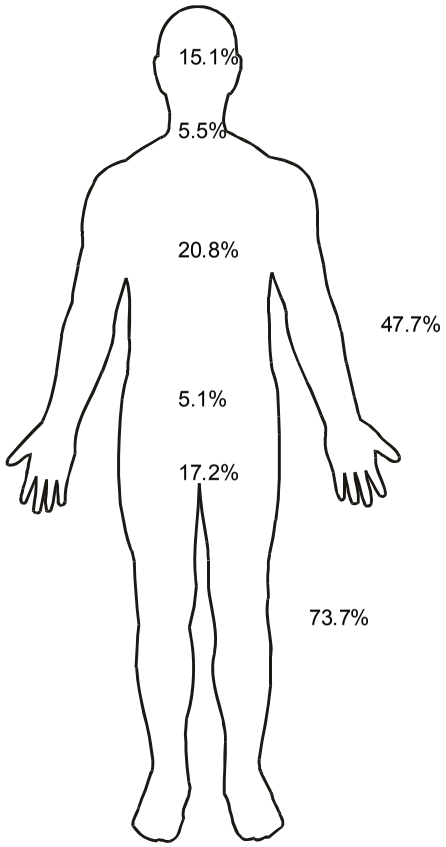
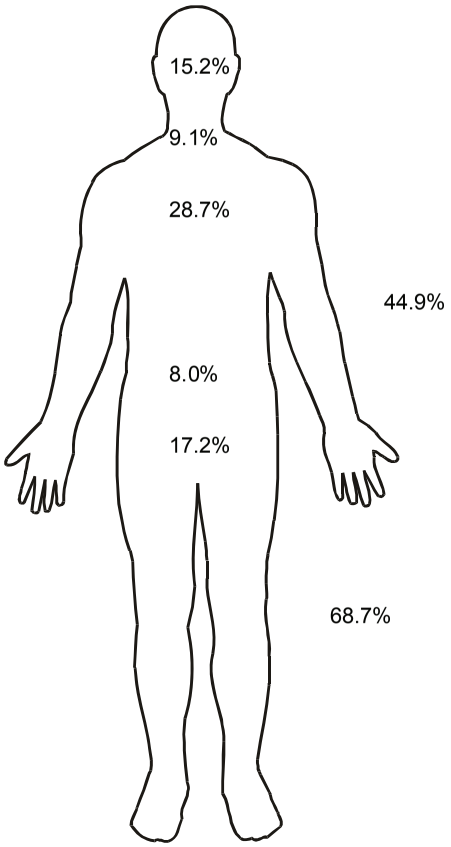


Figure 3:

Injury rate per body region of car drivers



Novice riders
n=290



Others
n=1021

Figure 4:

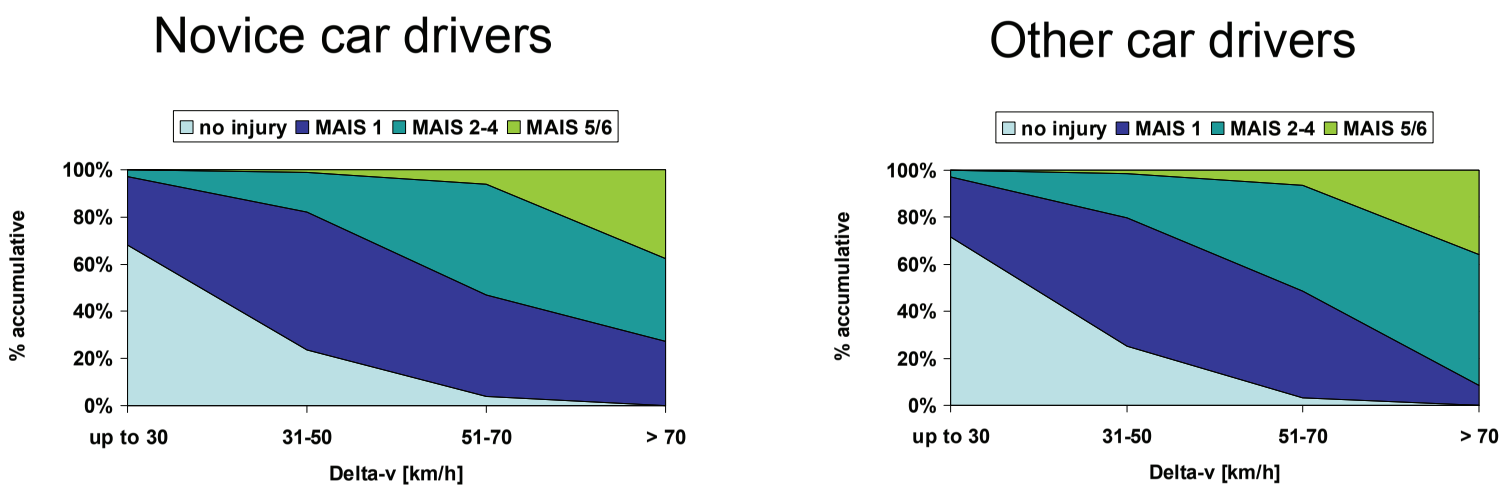
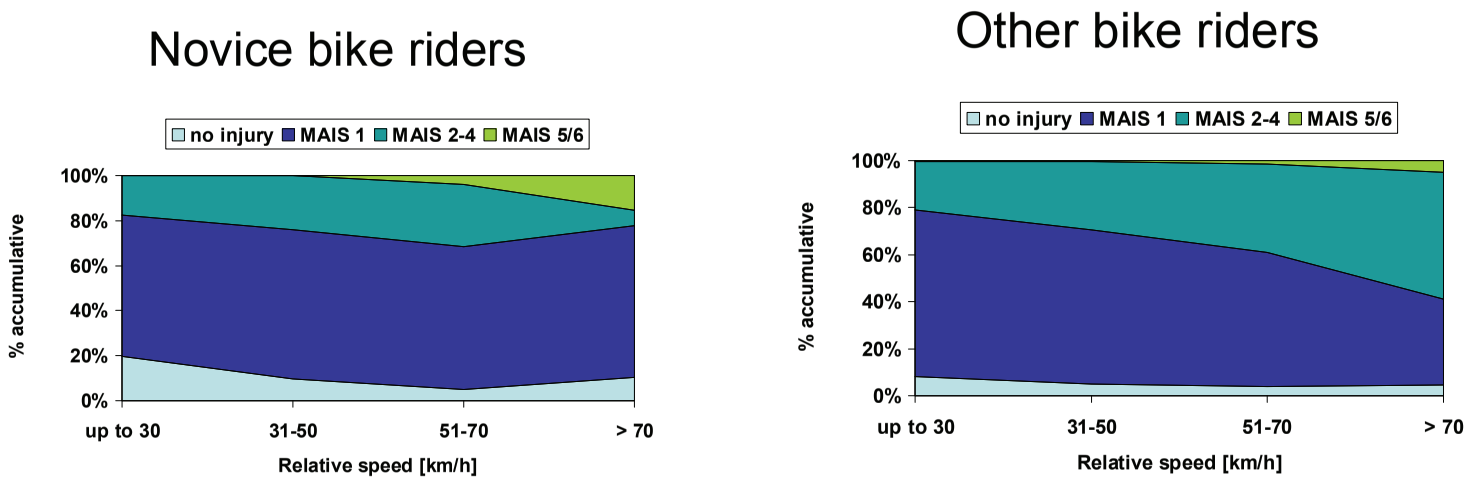

Novice car drivers
no injury
MAIS 1
MAIS 2-4
MAIS 5/6
% accumulative
100%
80%
60%
40%
20%
0%
up to 30
31-50
51-70
> 70
Delta-v [km/h]
Other car drivers
no injury
MAIS 1
MAIS 2-4
MAIS 5/6
% accumulative
100%
80%
60%
40%
20%
0%
up to 30
31-50
51-70
> 70
Delta-v [km/h]

Figure 5:


Novice bike riders
no injury
MAIS 1
MAIS 2-4
MAIS 5/6
100%
80%
60%
40%
20%
0%
% accumulative
up to 30
31-50
51-70
> 70
Relative speed [km/h]
Other bike riders
no injury
MAIS 1
MAIS 2-4
MAIS 5/6
100%
80%
60%
40%
20%
0%
% accumulative
up to 30
31-50
51-70
> 70
Relative speed [km/h]