

Injury Frequencies and Injury Risks in Frontal Car Crashes for AIS2+ and AIS1 Injuries that may lead to Long-Term Impairment – a GIDAS investigation

Martin Östling, Hanna Jeppsson, Jolyon Carroll, Ron Schindler,
Anders Kullgren, Carolyn Roberts, Jason Forman

I. INTRODUCTION

Field data analyses of real-world crashes are essential to improve car crash injury prevention efforts. As an example, focused car crash epidemiology studies increase our knowledge about who is most frequently injured and who is at higher injury risk [1]. The number of people injured in car crashes is several times higher than the number of fatalities. Therefore, non-fatal crashes should also be considered when deciding what injury prevention measures should be taken to further improve the protection performance in cars [2-3]. In fact, most of the injuries leading to long-term impairment are of AIS1 'minor' level [3-5], where injuries to the cervical spine and upper and lower extremities show the highest risk of leading to long-term impairment [5]. Previous efforts in field data analysis have had a focus on moderate (AIS2+) and/or more severe injuries (AIS3+) when identifying potential areas of safety improvement. Therefore, the current study is designed to provide insights into how injury frequency, injury risk, and injury pattern observations vary when AIS1 injuries with a high risk of sustaining long-term impairment are compared with a conventional picture, where only AIS2+ or AIS3+ injuries are included.

II. METHODS

The same method as presented in [6] was used to create a dataset from the German In-Depth Accident Study (GIDAS) database, released January 2024. Included vehicles were registered as passenger cars 2002 or later, involved in a single event crash with another passenger car in either a frontal impact or a side impact in front of the A-Pillar. Excluded vehicles were involved in events with fire, rollover, or had an unknown Energy Equivalent Speed (EES). EES was used in favor of delta velocity [1]. Included occupants were front-row occupants coded as belted with an age of 13 years or older. Excluded occupants were coded as ejected from the vehicle, were of unknown sex, or with unknown injury level according to the Maximum Abbreviated Injury Scale (MAIS), 2015 codebook. The dataset consisted of 3,882 cars in frontal crashes, with 4,679 belted front-row occupants, whereof 2,714 were males and 1,965 females. We refer to these occupants as exposed occupants. Of the 4,679 occupants, 2,125 sustained an AIS1+ injury. AIS1 injuries earlier identified having a high risk of long-term impairment are cervical spine injuries and joint injuries to the upper and lower extremities [5]; we refer to these as AIS1' injuries and identify these by AIS codes. By limiting the included AIS1 injuries to AIS1' injuries the number of injured occupants was reduced to 1,058 people, of which 279 had AIS2+ injury(s). Similar to [6], the dataset was divided into four crash severity categories based on the crash severity metric EES: 0–15 km/h, 16–25 km/h, 26–40 km/h and >40 km/h. In crashes with airbag activation, injury frequencies and injury risks were calculated for occupants sustaining AIS1', AIS2+ and AIS3+ injuries, Table I. Injury risks were calculated by dividing all injured occupants with all exposed occupants in each crash severity category. The injury distributions and injury risks per body region are shown in Fig. 1. Only the highest AIS injury per body region was counted, and the injury risks were calculated per body region.

III. INITIAL FINDINGS

Most AIS1' and AIS2+ injuries occur in the crash severity categories 16–25 km/h and 26–40 km/h, being 77% and 67% of all AIS1' and AIS2+ injuries, respectively. The injury risk for all injury severities increased with crash severity, but it can be noted that for AIS1' injuries the injury risk was close to 20% already in the lowest crash severity category. Cervical spine injuries were the most common AIS1' injuries for drivers and front-seat passengers, with the injury risk being similar across all crash categories. The most common cervical spine AIS code was 640278.1 (whiplash injury).

M. Östling (e-mail: martin.ostling@autoliv.com; tel: +46(0)733614959) is a Senior Global System Integration Architect, H. Jeppsson is a Senior Traffic Safety Research Engineer, J. Carroll is a Senior Research Specialist in Biomechanics and R. Schindler is a Senior Research Engineer, all at Autoliv. A. Kullgren is Head of Research at Folksam and Adjunct Professor at Chalmers University of Technology, Sweden. C. Roberts is a Biomechanist at MEA Forensic, USA. J. Forman is Associate Professor at Center for Applied Biomechanics at University of Virginia, USA.

TABLE I

INJURY FREQUENCY AND INJURY RISK FOR AIS1', AIS2+ AND AIS3+ INJURIES IN CRASHES WITH ACTIVATED AIRBAG

Crash severity	AIS1' frequency	AIS1' risk	AIS2+ frequency	AIS2+ risk	AIS3+ frequency	AIS3+ risk
0–15 km/h	11.9%	19.6%	7.6%	5.6%	3.0%	0.3%
Low (16–25 km/h)	40.9%	25.9%	29.0%	8.3%	9.1%	0.4%
Mid (26–40 km/h)	36.3%	27.7%	38.4%	13.2%	33.3%	1.7%
High (≥ 40 km/h)	10.9%	32.3%	25.0%	33.5%	54.5%	10.8%
	100%	-	100%	-	100%	-

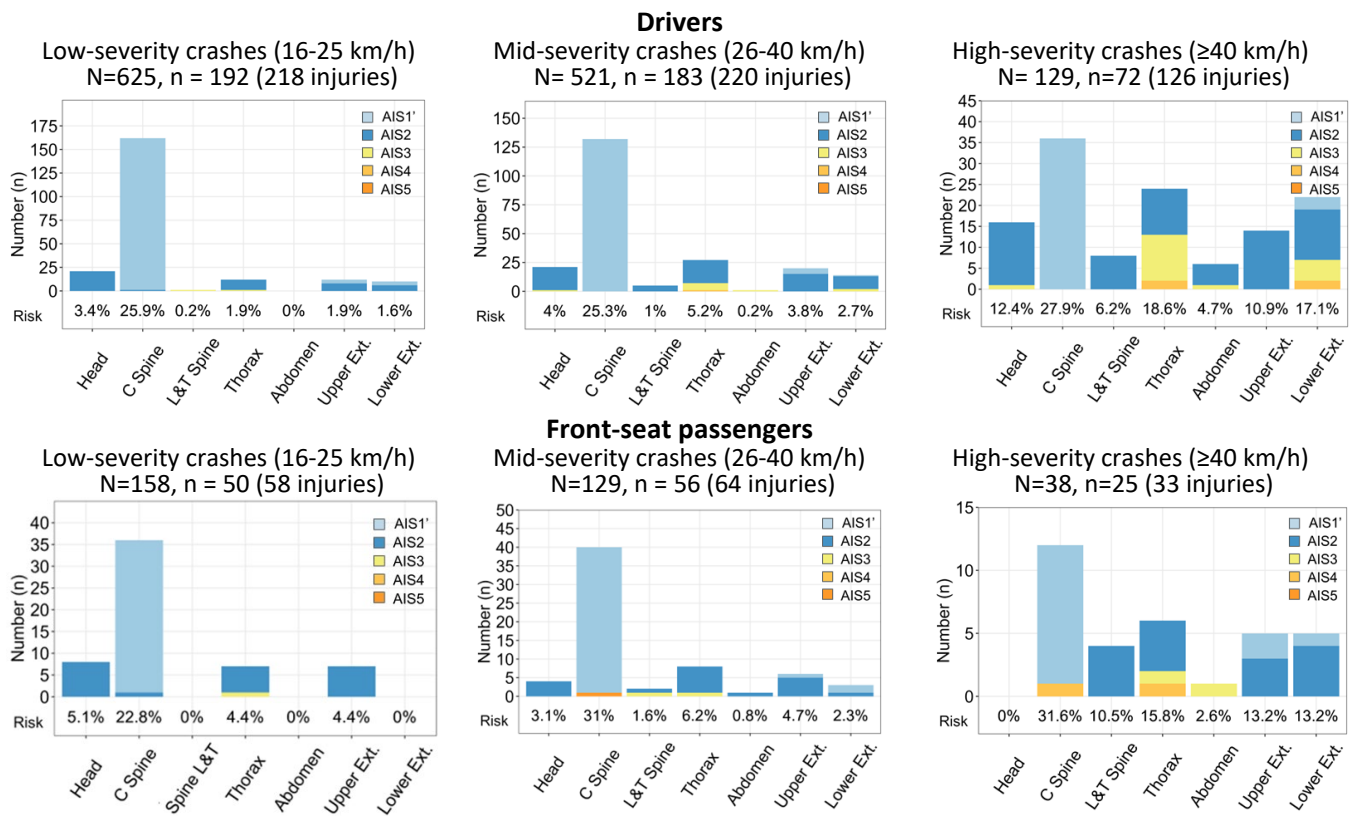


Fig. 1. Injury distribution and injury risk per body region for drivers and front-seat passengers in low, mid, and high severity crashes. (Note: spine abbreviations: C = cervical, T = Thoracic, and L - Lumbar.)

IV. DISCUSSION

Different safety priorities can be identified depending on what injury severity category is investigated. Therefore, a multi-harm approach is needed when addressing real-world crash conditions [2]. By including both injury frequency and injury risk over the whole range of crash and injury severities when calculating the overall injury probability [7], a real-world assessment matrix can be established. This matrix can then be the base for further injury prevention opportunities and priorities; noting that technological innovations should be developed based on identified needs. The current work highlights the importance (frequency and risk) of AIS1 injuries identified with a high risk of sustaining long-term impairment. AIS 1' injuries to the cervical spine should be of specific focus, given their high frequency in low, medium, and high severity frontal collisions. Most prior neck injury countermeasure design has centered on rear impacts, however, these data demonstrate the need to extend neck injury prevention to frontal collisions. The risk of AIS1 neck injuries in frontal impacts is not increasing with crash severity as other injury types do, see Fig. 1., which also has been shown in previous studies based on crash recorder data [8]. Perhaps most importantly, continuing studies will have to include both life-threatening injuries and those much more numerous minor injuries that can lead to long-term impairments when identifying protective functions and strategies. It is hoped that this analysis supports such considerations into the future.

V. REFERENCES

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