Pedestrian Injury Trends Evaluated by Comparison of the PCDS and GIDAS Databases

Guibing Li, Dietmar Otte, Jikuang Yang, Ciaran Simms

I. INTRODUCTION

Vehicle design for pedestrian protection has become a greater focus in recent decades. In many jurisdictions vehicle front-end design is now governed by legislation and also assessed using voluntary NCAP testing through subsystem impactors. Although accident data in many countries show that the number of pedestrians seriously injured and killed is reducing [1], it is unclear how pedestrian risk has changed over the years as a function of vehicle design. This short paper assesses the pedestrian injury trends by comparing the Pedestrian Crash Data Study (PCDS) database from US cities in the mid-1990s [2] with more recent data from the German In-Depth Accident Study (GIDAS) database.

II. METHODS

Accident data

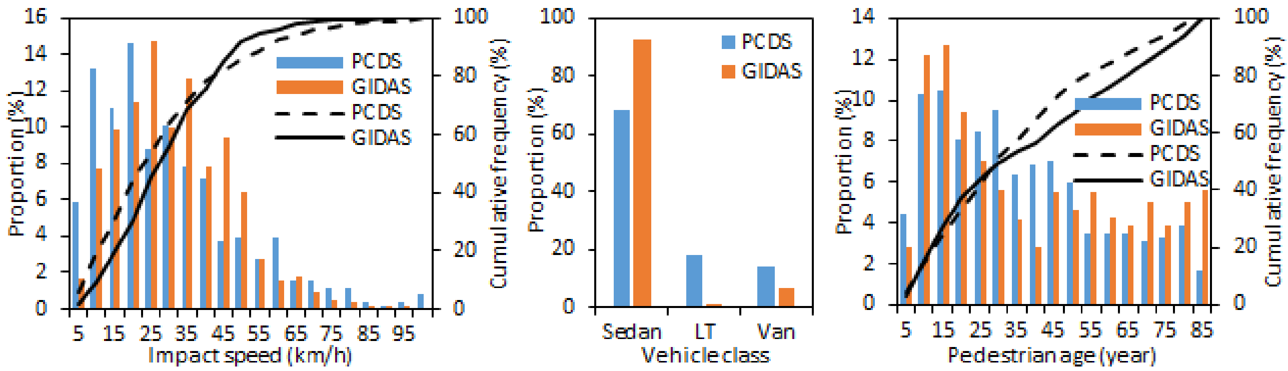
The PCDS sample of 552 vehicle-pedestrian crashes collected over the period 1994–1998 [2] and 1,258 vehicle-pedestrian accidents from GIDAS after the year 2000 were used in the current study. Inclusion criteria were: 1. the vehicle was moving forward at impact; 2. the vehicle was a passenger car, light truck (LT, i.e. pick-up or SUV) or van; and 3. the pedestrian was upright (not lying/sitting on the road) and impacted by the vehicle front (forward of the top of the A-pillar). All injuries were recorded using the Abbreviated Injury Scale (AIS). The distributions of injuries by impact speed, vehicle class and pedestrian age were analysed.

AIS2+ Injury rate

The AIS2+ injury rate is defined as the number of AIS2+ injuries divided by the number of accident cases for a given condition (i.e. if 100 AIS2+ leg injuries occurred in 200 passenger car cases, the AIS2+ leg injury rate is 0.5). Therefore, the injury rate reflects the aggressivity of the vehicle front-end to pedestrians in accidents at the generalised level (though speed and other factors need to be controlled for). Using this approach, the AIS2+ injury rates for the complete databases and for subcategories involving different vehicle classes and body regions were compared between the PCDS and GIDAS databases.

III. INITIAL FINDINGS

Fig. 1 shows the distributions of impact speed, vehicle class and pedestrian age for the PCDS and GIDAS. The vehicle class LT includes SUVs and pick-ups, while vehicle class van includes MPVs, minivans and vans.



(a) (b) (c)

Fig. 1. Distribution of impact speed (a), vehicle class (b) and pedestrian age (c) in PCDS and GIDAS.

Table I shows the AIS2+ injury rate (number of AIS2+ injuries divided by number of accident cases) for the

Guibing Li is PhD student in Bioemechanics at Trinity College Dublin in Ireland. Dietmar Otte is Prof. of accident analysis in the Accident Research Unit, Medical University of Hannover in Germany. Jikuang Yang is Prof. of Bioemechanics in the Department of Applied Mechanics at Chalmers University of Technology in Sweden. Ciaran Simms is Prof. of Bioemechanics in the Department of Mechanical and Manufacturing Engineering at Trinity College Dublin in Ireland (Tel: +353 1 896 3768, E-mail: csimms@tcd.ie).

whole sample, vehicle class and body region between PCDS and GIDAS. Mid-body includes the neck, thorax, abdomen, spine and upper limbs, while lower limbs includes the pelvis and legs. The ratio data show the injury rate in PCDS divided by the corresponding injury rate for GIDAS. For all conditions the AIS2+ injury rate in PCDS is significantly higher than that for GIDAS. Table II shows distributions of AIS2+ injuries by different body regions.

TABLE I
COMPARISON OF AIS2+ INJURY RATE BETWEEN PCDS AND GIDAS

	Body region	PCDS				GIDAS				Ratio (PCDS/GIDAS)			
		All	Car	LT	Van	All	Car	LT	Van	All	Car	LT	Van
AIS2+ injury rate	All	2.70	2.53	3.68	2.21	1.18	1.18	0.9	1.26	2.3	2.1	4.1	1.8
	Head/Face	0.97	0.92	1.10	1.07	0.31	0.30	0.20	0.50	3.1	3.1	5.5	2.1
	Mid-body	0.83	0.65	1.67	0.56	0.40	0.41	0.20	0.32	2.1	1.6	8.4	1.8
	Lower limbs	0.90	0.96	0.91	0.58	0.47	0.47	0.50	0.44	1.9	2.0	1.8	1.3

TABLE II
DISTRIBUTION OF AIS2+ INJURIES BY BODY REGION

	Head	Arm	Thorax	Abdomen	Pelvis	Leg
PCDS	31%	8%	10%	8%	6%	33%
GIDAS	24%	12%	13%	4%	7%	34%

IV. DISCUSSION

Table I shows that light trucks (SUVs & pick-ups) have significantly higher AIS2+ injury rate than cars and vans in PCDS, especially for the mid-body region, similar to previously reported [3]. However, this trend is not observed in the GIDAS data (which actually shows lower injury rates for SUVs compared to cars), possibly due to the small sample for SUVs in GIDAS (see Fig. 1). Vans have generally lower AIS2+ injury rates for the mid-body and lower limbs but higher AIS2+ injury rates for the head/face than cars in both PCDS and GIDAS. However, a previous study indicated that vans have higher aggressivity to pedestrian thorax than cars in accidents [4]. This difference may largely be due to the influences from arm injuries, which account for 32% and 35% of all AIS2+ mid-body injuries in PCDS and GIDAS, respectively. The results in Table I also indicate that, generally, SUVs and cars have higher AIS2+ lower limb injury rate than vans in accidents.

Fig. 1 shows that the impact speed is generally lower in PCDS than in GIDAS, that LTVs (LT and van) take significantly higher proportion in PCDS than GIDAS, and that generally PCDS has lower proportion of children (<15 years) and older people (>60 years). However, a significantly higher AIS2+ injury rate was observed for a given vehicle class in PCDS than GIDAS, based on these impact speed and pedestrian age distributions (see Table I). For cars, the AIS2+ injury rate in PCDS is 2.1 times that in GIDAS, and higher again for the head (3.1 times). For light trucks, the AIS2+ injury rate in PCDS is 4.1 times that in GIDAS, and for the head and mid-body the ratios are 5.5 and 8.4, respectively. Similarly, 1.8 times higher overall AIS2+ injury rates were observed in PCDS than GIDAS for vans, and 2.1 and 1.8 times higher for the head/face and mid-body in van cases, respectively. Table II shows that PCDS has a higher head injury proportion (31% vs 24%) but lower thorax injury proportion (10% vs 13%) than GIDAS, which is surprising since an obvious higher proportion of light trucks was observed in PCDS (18%) than in GIDAS (1%) (see Fig. 1). It is not immediately clear why these large differences in injury rate between PCDS and GIDAS are observed, but it is possible to make some speculative comments. The shapes of the vehicles in the PCDS database reflect designs of late 1980s/early 1990s in the USA, which have significantly sharper vehicle fronts than the late 1990s/early 2000s vehicles that dominate (80%) the GIDAS database. It is likely that the stiffness reductions in the European car fleet associated with the EU Directive on pedestrians and the inclusion of pedestrian testing in EuroNCAP are not a strong factor, since most of the GIDAS vehicles predate these changes. Nonetheless, it is possible that the European fleet is less stiff, though this remains to be assessed.

V. REFERENCES

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