In-depth Study of severe pedestrian accidents in China

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I. INTRODUCTION

Every year more than 270,000 pedestrians die in road traffic accidents globally [1]. In China, about 25% of all fatalities in road traffic accidents are pedestrians [2]. ChinaNCAP is considering the introduction of pedestrian protection testing in the near future. This study aims to understand real-life pedestrian accidents in China by studying important parameters, such as accident environment, injury mechanism and head impact position.

II. METHODS

Database and inclusion criteria

The China In-Depth Accident Study (CIDAS) database [3] was used to extract field data for this study. In CIDAS, pedestrian cases collected from 2011 June to 2014 July, with both pedestrian and vehicle information available, were analyzed. Three kinds of impact vehicle were included: sedan, MPV and SUV. Pedestrians hit by more than one vehicle were excluded, as were pedestrians who were lying on the ground and cases where the vehicle was reversing prior to impact.

Reconstruction

Currently, reconstruction results, especially pre-crash parameters (heading angle, coordinate of collision point, etc.), are not available on the CIDAS database. Those accidents with sufficient information on brake marks, accident process description and on-site road measurements were selected for reconstruction in PC-Crash (86 cases of the total 160 sampled pedestrian cases). Each case was studied closely to understand the detailed head impact location, following the method of Fredriksson *et al*. [4].

III. INITIAL FINDINGS

Crash Characteristics

Of the total 160 pedestrians sampled, 91% were adults and 72% were walking before the crash occurred. In CIDAS, most (83%) of the pedestrians crossed from the side of the vehicle. The majority of the crashes happened during daytime (54%) and in fine weather (88%). Before the crash occurred, 17% of the pedestrians were obscured. Most of the vehicles were travelling straight ahead (89%), while 11% were turning.

Injury severity

In order to understand severe injury on pedestrians, AIS3+ injury level was nominated for this study. Given that two cases had unknown injury level, this resulted in 77 persons selected on this criteria. Of these, 75% sustained an AIS3+ head injury, 32% an AIS3+ thorax injury and 17% sustained injuries to lower extremities.

TABLE I

PROPORTION OF AIS3+ INJURED PEDESTRIANS WITH AIS3+ INJURY FOR GIVEN BODY REGION (TOP 3 BODY REGIONS)

Body region	Head	Thorax	Low Extr.
AIS3+ risk	75%	32%	17%

Head impact position

Wrap around distance (WAD) was studied for MAIS3+ cases, with photo documentation available and detectable head impact points (n=47 cases). About 75% were below 2,100 mm (Fig. 1, *Left*), while a WAD of 2,300 mm included nearly 100% of the head impact points.

The head impact points mentioned above were checked manually from photo and defined in different areas (pure glass, A-pillar area, instrument panel (IP) area and hood/bonnet), following the method from a previous pedestrian study [4]. Most common sources of head injury were the windshield area, especially A-pillar and IP area (Fig. 1, *Right*). In addition, leg contact position in front of car was studied. It showed that more impacts were located to left and right quarters of the car front (69%), as compared with the two centre quarters (31%).

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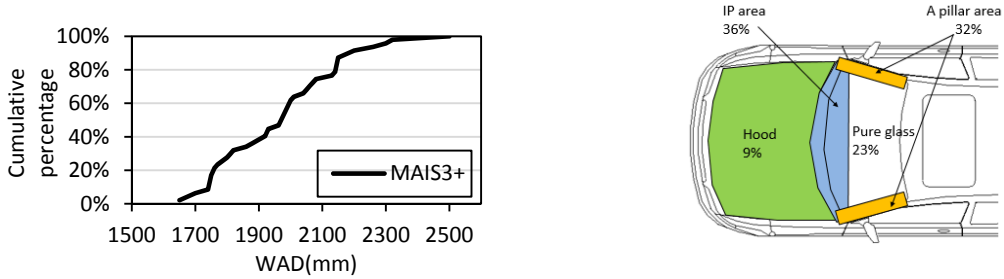

Fig. 1. Head impacts with MAIS3+ injury (n=47). *Left*: WAD cumulative curve; *Right*: head impact position.

Injury severity vs head impact/crash speed

Fig. 2 (*Left*) shows that A-pillar head impacts resulted in the highest risk of fatal injury. Fig. 2 (*Right*) shows that 60% of the AIS3+ crashes occurred below 60 kph.

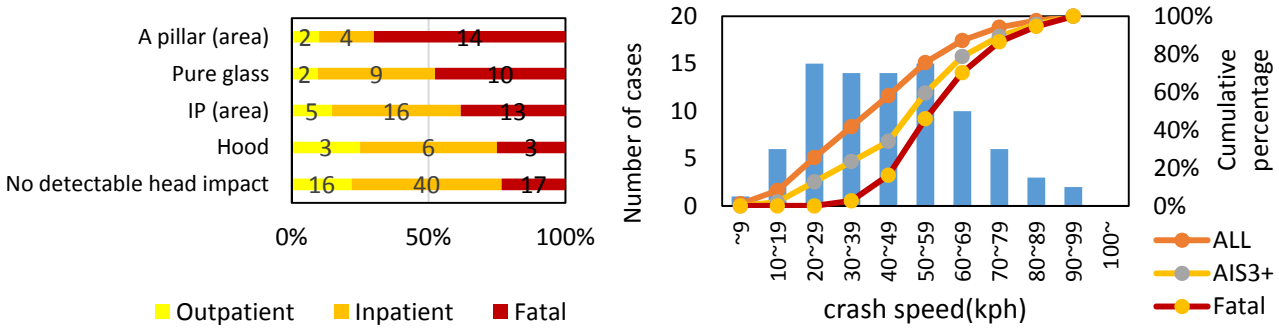

Fig. 2. *Left*: injury severity vs impact point; *Right*: crash speed distribution (bars representing all case numbers).

IV. DISCUSSION

This study set out to conclude the most important accident parameters for vehicle-pedestrian crashes, based on real-life accidents in the CIDAS database. It is important that the accident data used is representative for China. The inclusion criteria of this database could have some influence on the statistical results. The CIDAS database is more focused on severe injury accident, which could result in bias on those results that include all injury levels. The injury severity is more severe than the national average. This study is a preliminary analysis and patterns observed may change as more data becomes available.

For the injured body region, a similar study [4] based on GIDAS data (Germany In-Depth Accident Study) shows much higher risk on the leg than in this study. This study also shows that the leg contact position most frequently happened close to the left and right corners of the car, which is related to a higher risk of pedestrian's head impacting the A-pillar. This suggests a recommendation to include the whole bumper width for leg protection tests and in sensor tests for pedestrian hood/bonnet and airbag in regulation and NCAP tests. This study also showed a low frequency of hood/bonnet as an injury source for severe head injuries, while a majority of those injuries were caused by the windshield structure, which is in line with earlier studies conducted in Europe and in the USA [4-5]. A-pillar was the most dangerous part for head impact, just as the GIDAS study showed. (The GIDAS study used AIS 1998 version, while the CIDAS database uses AIS 2005, which could be one of the reasons for differences observed in leg injury frequency.)

This study found that the head is the most common body region to sustain severe injury in vehicle-pedestrian accidents. Injury risk is high when the head impacts the A-pillar, with the fatal percentage at 70%. In 61% of MAIS3+ cases there was obvious head impact on the vehicle, and about 75% head impact points were below WAD2100. Head injury from the windshield area, and especially its frame/A-pillars, is therefore an important area for pedestrian protection in Chinese cars.

V. REFERENCES

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