Descriptive Statistics on Crashes of E-Scooters with Passenger Cars in Sweden

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I. INTRODUCTION

Electric-scooter (e-scooter) crashes involving passenger cars are a concern in many urban areas where e-scooters have become a popular mode of transportation. In Germany 2022, 10 e-scooter riders died and another 7417 were injured in road crashes [1]. In France 2022, 35 died [2]. Police-reported crashes often involve another motor vehicle and occur when they share the road [3]. According to Spanish data, in crashes involving a motor vehicle and a micro mobility user (primarily bicycles and e-scooters), side impacts were most frequent, followed by lateral collisions at intersections [4]. E-scooter riders involved in crashes with passenger cars are at higher risk of sustaining severe injuries compared to single crashes. Head injuries are of particular concern [5-6].

In Sweden, the focus has primarily been on single-e-scooter crashes as they are most common [7]. However, the interaction of e-scooters with other road users remains uncertain. The future road transport system will likely include e-scooters and their integration must be data driven [8]. Our aim was to describe e-scooter crashes with passenger cars to enable development of interventions targeting the most prevalent crash and injury types.

II. METHODS

The Swedish Traffic Accident Data Acquisition database (STRADA) [9], the national system for road traffic injury data collection, was used to study crashes related to e-scooter use in Sweden between 2020 and 2022. The police and hospital records available in STRADA typically include parameters describing the crash (brief description of the crash, crash type, location, etc.), personal information about the injured road user (age, gender, use of protective equipment, etc.) and full diagnoses classified according to the Abbreviated Injury Scale (AIS) 2005 [10]. The brief description of the crashes was reviewed and analyzed to classify the crash characteristics.

III. INITIAL FINDINGS

Between 2020 and 2022, there were a total of 613 e-scooter crashes involving a passenger car in Sweden, as reported by the police. Out of these crashes 363 took place at intersections, 236 on road sections and 13 at parking lots or on sidewalks. Most crashes (61%) occurred when the paths of the passenger car and the e-scooter crossed. Additionally, 19% of the crashes occurred while the driver of the passenger car was making a left (31%) or right (46%) turn (remaining to 100%: unknown). Most crashes occurred during daylight hours (69%), on dry surfaces (66%), and in fair weather conditions (75%). Among the crash locations, zebra crossings were most common with a total of 232 crashes occurring on zebra crossings at intersections and 133 on zebra crossings at a road section. E-scooter riders were more often hit by a passenger car (70%) than riding into a passenger car (17%). The proportion of being hit by a passenger car was slightly higher when the crash occurred on road sections in comparison to those at intersections (75% and 66%, respectively). Males represented more than half of the e-scooter riders (63%) with a mean age of 25 years. In total 71% of the e-scooter riders were slightly injured, 12% moderately and 2% severely injured. One crash resulted in a fatality.

For 186 riders, hospital data could be retrieved. Of these, 36% sustained Maximum (M)AIS2+ injuries. Injuries to the lower and upper extremities dominated the injured body regions (253/435 injury diagnoses) followed by injuries to the head and face, Table I.

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TABLE I
INJURY DISTRIBUTION FOR 186 E-SCOOTER RIDERS WITH 435 INJURY DIAGNOSES IN COLLISIONS WITH PASSENGER CARS

Body region	AIS 1	AIS 2	AIS 3	AIS 4	Unknown	Total
Head	37	9	3	2	1	52
Face	61	10				71
Cervical spine	8					8
Upper Extremity	77	27				104
Thorax	13	9	1			23
Thoracic spine		3				3
Abdomen	9					9
Lumbar spine	6	10				16
Lower Extremity	115	28	4		2	149
Total	326	96	8	2	3	435

IV. DISCUSSION

Hospital reports were sparse; there were only 186 hospital-reported injured riders in 613 police-reported e-scooter crashes. During the Covid-19 pandemic, only a limited number of hospitals in Sweden gave priority to reporting to STRADA. Consequently, hospital reports are missing. These numbers may seem low. However, while Germany has more e-scooter crashes recorded in national data than Sweden, in-depth information on crash configurations and injuries sustained is rarely collected. The German In-Depth Accident Study (GIDAS), released July 2023, recorded only 11 crashes of e-scooters with cars. Most of these crashes occurred on bicycle crossings and with a car turning. The only AIS3 injury noted was to the head.

Many injury crashes occurred at intersections and zebra crossings. Naturalistic studies have identified a 'hybrid' phenomenon, wherein e-scooter riders switch patterns of behaviour swiftly and repeatedly; they may transition from behaving like a pedestrian to a cyclist and then revert to pedestrian behaviour [11]. This may explain the high proportion of crashes occurring on zebra crossings. Infrastructure measures such as elevated zebra crossings may help to reduce the burden of e-scooter and passenger car collisions.

Crash characteristics appear favourable to develop vehicle safety systems like Automated Emergency Braking (AEB) to mitigate crashes with e-scooters. Adverse weather conditions, hindering detection, are uncommon. Straight crossing path scenarios were common and AEB systems are more mature in addressing these compared to turning. Still, AEB systems might face difficulties in detecting e-scooters [12]. The data suggests prioritising scenarios where a car goes straight and hits a e-scooter with its front at intersections and on zebra crossings.

In line with previous research, head injuries remain most prevalent at the highest injury severity and are therefore a priority for prevention. Helmets are effective in preventing injuries in bicycle crashes [13] and likely also mitigate injuries in e-scooter crashes. However, impacts to the face, which is typically not protected, are a concern requiring further protection [7][14]. Extremity injuries are prevalent at moderate injury severities, like for bicyclists [15]. Inflatable vest with shoulder protection might offer some protection for upper extremities [16].

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