

Evolution of powered two-wheeler user injury severity and patterns in France from 2010 to 2021

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I. INTRODUCTION

Efforts in reducing fatal and serious injuries in Powered Two-Wheeler (PTW) crashes have been primarily concentrated on head trauma and helmet effectiveness [1]. Over time, the implementation of safety countermeasures has contributed to an evolution in injury patterns and reducing serious thoracic injuries has emerged as a priority for PTW user protection [2]. However, detailed analyses remain necessary to quantify these trends and assess their relevance in the French context. The aim of this study is to analyze the change of PTW user injuries over the last decade in France to identify the body regions and injury types that should be targeted for personal protective equipment development and implementation.

II. METHODS

Data from the Rhône road trauma registry [3], collected on PTW users involved in Road Traffic Crashes (RTCs) in the Rhône County (France) between January 2010 and December 2021 was used. The Rhône registry covers all casualties, including injured individuals treated at healthcare facilities, whether hospitalized or not, as well as all fatalities, and is expected to be quasi-exhaustive. Each injury has been coded using the Abbreviated Injury Scale (AIS) version 1990 from 2010 to 2014, and the AIS 2005 update 2008 version since 2015. For this work, AIS 1990 and 2005 injury codes were converted to AIS 1998 for consistency throughout the study period. The overall severity of a casualty was assessed using the Maximum AIS (MAIS) over all injuries. MAIS1+ is used to describe all casualties whatever their injury severity level and MAIS3+ (MAIS of 3 or more) is used for characterizing seriously injured casualties. Chi-square or Fisher's exact test was performed, as appropriate, to compare injury trends across three different time periods (2010-2014, 2015-2017 and 2018-2021). The year 2020 was excluded from the analysis due to the impact of COVID-19 on travel patterns and crash rates.

III. INITIAL FINDINGS

A total of 21,279 PTW casualties resulting in 48,573 injuries were included in this study. Nearly half (47%) of casualties sustained injuries in a single body region, 35% in two regions, and 18% in three or more regions; 11% (n=2,422) sustained serious injuries. On average over all years, MAIS1+ casualties most frequently sustained injuries to the lower limbs (64%), upper limbs (46%), and spine (14%) (Figure 1a). MAIS3+ casualties most frequently sustained injuries to the lower limbs including pelvic ring (46%), thorax (40%), upper limbs (19%), and head (17%) (Figure 1b). Among MAIS1+ casualties, the most common injury types were skin injuries (67%)—primarily affecting the lower limbs (41%) and upper limbs (22%)— and spinal strain (11%). The most common serious injury types among MAIS3+ casualties were lung contusions (23%), femoral fractures (21%), hemo/pneumothorax (19%), tibial fractures (19%), rib fractures (>3 ribs/flail chest) (18%), radial fractures (12%), and cerebral hemorrhages/hematoma (10%). The proportion of MAIS1+ casualties with head, face, chest, spine, and limb injuries increased significantly ($p<0.05$) between the periods 2010–2014 and 2018–2021, while external and neck injuries decreased. Among MAIS3+ casualties, two body regions showed significant variations ($p<0.05$ and a variation of 5% or more) between 2010-2014 and 2018-2021 periods: thoracic injuries (from 33% to 43%), and upper limb injuries (from 27% to 12%).

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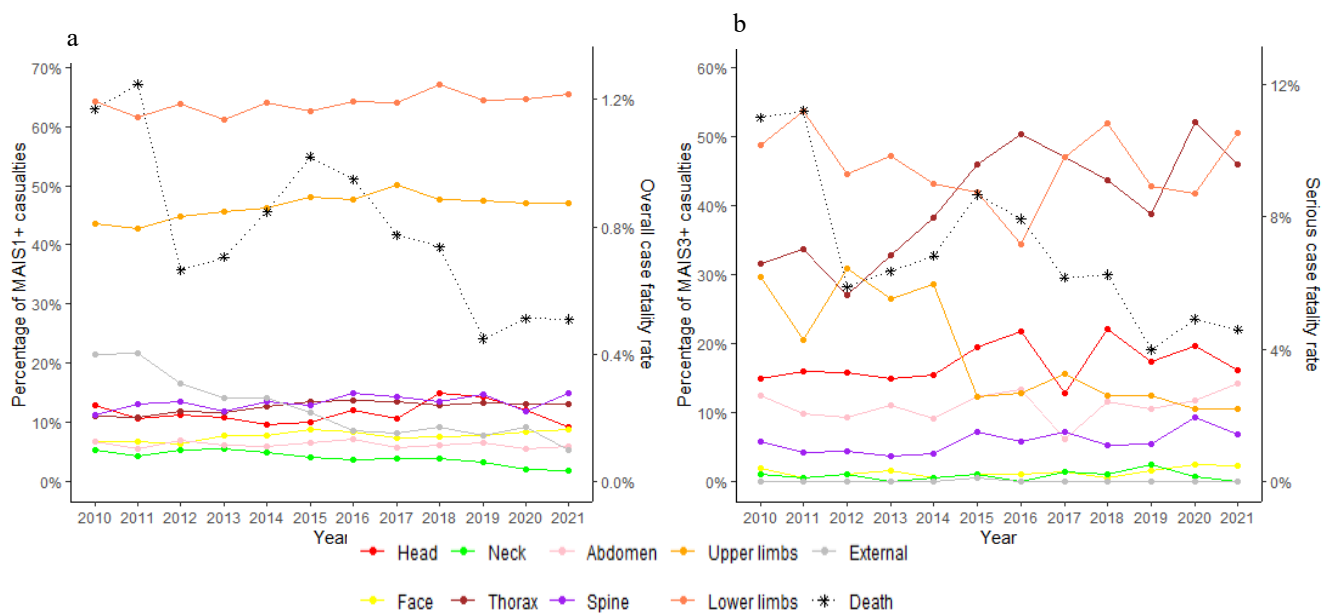


Fig. 1. Evolution of the frequency of injured powered two-wheeler road crash casualties by body region (left side Y-axis) along with the proportion of fatalities (right side Y-axis), considering a) all injured (MAIS1+); and b) seriously injured (MAIS3+) with at least one serious injury (AIS3+) in the region (The Rhône road trauma registry 2010 – 2021).

IV. DISCUSSION

Twelve years of RTC data from the Rhône registry in France were analyzed to examine temporal injury trends and patterns among PTW crash casualties. Lower and upper limbs were the most frequently injured body regions. Our findings align with studies identifying these body regions as the most commonly injured among PTW casualties [4-5], reflecting the high vulnerability of extremity injuries due to direct impacts and sliding mechanisms during crashes [6]. Seriously injured casualties (MAIS3+) most commonly sustained injuries to the lower limbs and to the thorax. The prevalence of injuries increased over the 2010-2021 time period for most body regions among MAIS1+ casualties; and significant temporal shifts were observed in the proportions of thoracic and upper limb serious injuries among MAIS3+ casualties. The decrease in serious upper limb injuries prevalence is likely explained by AIS 2005's reclassification of long bone fractures severity in AIS 1998, which downplays the importance of criteria such as bone displacement. Conversely, serious thoracic injuries, unaffected by this reclassification, have exhibited a statistically significant increase over time, consistent with a recent German study reporting a surge in serious thoracic injuries [7]. This increment may reflect enhanced injury detection due to the extended use of advanced diagnostic imaging procedures, such as whole-body CT scans, which may have also contributed to the concurrent decrease in fatality rate [7-8]. Thoracic injuries (lung contusions, hemo/pneumothorax, and rib cage fractures) and head injuries (cerebral hemorrhage/hematoma) identified in serious casualties are clinically relevant and potentially fatal [9], unlike most femoral and tibial fractures, which are generally more surgically manageable, or superficial skin injuries, which are common but pose no vital consequences. For head injuries, helmets have been proven effective [1] and are mandatory in France since 1973. However, thoracic protection is also crucial to mitigate the prevalence of serious casualties. Wearable airbags designed to protect the torso (thorax, abdomen, and spine) have shown promising results in numerical simulations and experimental tests [10-11], indicating significant safety benefits. Their adoption among PTW users is steadily increasing [12], and studies assessing their real-world effectiveness are needed.

V. REFERENCES

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