Road Traffic Crashes Involving Children in France: Trends and Challenges

Sophie Cuny, Albine Chanove, Jacques Saadé, Philippe Lesire, Stéphane Buffat

Abstract This study provides an overview of the road traffic crashes involving children in France from 2010 to 2023 based on the analysis of the national database. It describes the evolution and issues related to children up to 13 years old, by type of road user. Results show that while the number of injurious crashes involving children decreased by 28% between 2010 and 2023, the number of fatally injured children declined more significantly, by 56%. This trend is consistent for children as car passengers, cyclists, and pedestrians. However, a sharp rise in the number of injured children using electric micromobility devices has been observed. Male and female children are equally involved in passenger car crashes, whereas males are overrepresented in cyclist and pedestrian crashes. Children aged 10 to 13 years account for the largest share of injuries among cyclists and micromobility users. Younger children are more frequently fatally injured as passenger car occupants. The analysis highlights important improvements in child road safety in France. However, the results also suggest areas for improvement. Helmet use remains low, despite being mandatory for cyclists under age 12. Although children under 14 are prohibited from using electric micromobility devices, the number of casualties is increasing.

Keywords Car occupant, child, electric micromobility users, national database, vulnerable road user (VRU).

I. INTRODUCTION

Road safety for children remains a significant concern across Europe, with recent data highlighting both progress and persistent challenges. According to the 2022 European Road Safety Observatory report [1], 386 children aged 0–14 years lost their lives in road crashes in Europe in 2020, marking a 47% decrease compared to 2011. Despite this improvement, disparities exist between countries, and certain risk factors continue to contribute to child fatalities.

European statistics indicate that children are most frequently involved in road crashes as vehicle passengers (46%), pedestrians (32%), and cyclists (13%) [1]. Notably, 90% of fatal child crashes occur during the day, predominantly between noon and 8.00pm, and under clear weather conditions. Geographic variations are also evident, with child fatalities occurring primarily in urban areas in Romania (74%), while in Latvia, 80% of cases take place outside urban centres [2].

In France, road safety indicators align closely with European averages. Between 2018 and 2020 the mortality rate for children in road crashes stood at 6.2 deaths per million children, with fatalities decreasing by 34% compared to the 2011–2013 period. In 2023, 49 children aged 0–13 years died in road crashes, reflecting a 55% reduction from 2010 [3]. Most child fatalities in rural areas involve vehicle passengers (73%), whereas urban fatalities primarily affect pedestrians (64%) and cyclists (23%). Research also highlights that in 25–30% of cases, children are either improperly restrained or entirely unrestrained, contributing significantly to injury severity [4].

Given these findings, improving road safety for children will require a multi-faceted approach. The Observing Child Safety on the Roads (OURSE) project was set up with this in mind. It is dedicated to improving the safety of children on the roads, while investigating traffic crashes and the conditions of transport for children on the roads in France, as well as suggesting areas for improvement. This project, funded by the Renault Foundation, lasts 18 months and involves the collaboration of three organisations working in the field of road safety: the LAB (Laboratory of Accidentology, Biomechanics and the Study of Human Behaviour), which is leading the project; the CEESAR (European Centre for Safety Studies and Risk Analysis); and the Association Prévention Routière (traffic

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prevention association). The project has three components: the analysis of the national database of traffic crashes; the study of police accident reports involving at least one child who died in a car; and a final part in the form of surveys on children's safety in real-world situations in passengers cars, buses and as electric micromobility users. This study, which is the first step of the OURSE project, aimed to analyse the current state of child road safety in France through the national accident census, to describe trends and critical situations, and to identify areas for improvement.

Regarding regulation in France, from 1 January 1992, children under the age of 10 years must use an age-appropriate child restraint system in passenger cars [5]. On 22 March 2017, wearing a bicycle helmet became compulsory for children (drivers or passengers) under 12 years of age [6]. Children under the age of eight on a bike are allowed to use the sidewalks. Since 1 September 2023, the legal age to use an electric micromobility device has been raised from 12 years to 14 years old. The wearing of a helmet is recommended but not mandatory on electric micromobility devices [7].

II. METHODS

Data

This study is based on the analysis of the national database of traffic crashes occurring in France. It is called Bulletins d'Analyse d'Accident Corporel de la Circulation database (BAAC) and is administered by the National Interministerial Road Safety Observatory (ONISR). The police forces are required to record information related to each traffic crash that occurred on the public area and resulted in injuries to at least one person involved [8]. Each crash is described by about 80 variables related to four topics [9]: general information about the crash (time, light, location, weather conditions, intersection); infrastructure (road categories, maximum authorised speed, road conditions); vehicles (vehicle categories, age, point of impact, maneuver before the crash); and involved persons (type of user, gender, age, place, safety equipment, severity of injuries). In the database, electric micromobility devices include e-scooter, segways, electric unicycle, electric hoverboard, all recorded in the same category.

For the present study, crashes that occurred in metropolitan France between 1 January 2010 and 31 December 2023, and involving at least one child aged between 0 and 13 years were extracted from the database. Crashes resulting in the death of a child were identified as fatal crashes and compared to all child-involved crashes.

Analysis

Trends in the numbers of all crashes involving children and the numbers of killed and injured children between 2010 and 2023 in France are displayed and tendencies analyzed in the first part of the study.

The second step of the analysis focuses on the most represented modes of transport in child-involved crashes, i.e. car passenger, pedestrian, cyclist and electric micromobility user, which account for 95% of traffic crashes involving children and 92% of child fatalities. Thus, evolutions of the numbers of children injured and killed as car passengers, pedestrians, cyclists and electric micromobility users are presented. Cyclists include those riding an electric bicycle. Characteristics of the crashes, the vehicles and the children, as the location and the time of the crashes, the presence of an intersection, the age of the passenger cars transporting children, the gender and age of the drivers transporting children, the type of impact on the vehicles, the type of opponent in the collision, as well as the age and gender of the children and the use of restraint systems and helmets for cyclists and electric micromobility users are analyzed according to the modes of transport and the severity of the accident (all accidents and accidents with at least one child fatality). Percentages are calculated over all the years 2010 to 2023, unless evolutions of the proportions over time require the presentation of annual percentages. The percentages relating to children killed as electric micromobility users are presented although they are calculated on a very small number of cases.

Children as bus occupants will also be discussed at the end of the study to complete the overview of children's crashes in France.

III. RESULTS

Overall trends

The annual number of traffic crashes involving children in France from 2010 to 2023, along with the total number of recorded crashes regardless of age, are presented in Fig. 1. Between 2010 and 2023, the number of crashes

involving children aged 0–13 years decreased by 28%. This is slightly better than the 23% reduction observed for all crashes in France. When referring to 1993 (the first year following the implementation of mandatory child restraint systems in passenger cars), the number of crashes involving children was divided by four in 2023, decreasing from 16,441 crashes to 4,168 crashes, while the whole number of road traffic crashes in France was divided by 2.5 during the same period (from 137,400 crashes to 51,600).

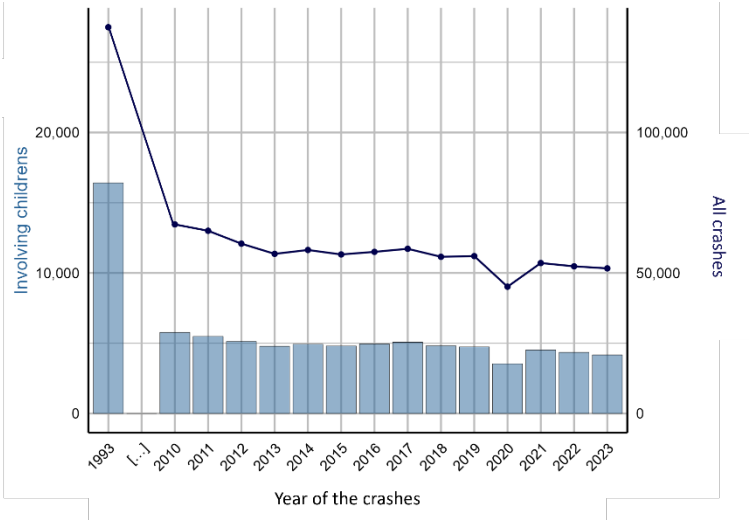

Fig. 1. Evolution of the number of traffic crashes in France as reported in the BAAC. It shows all crashes (dots) and all crashes involving children (bars).

Crashes involving a child under the age of 14 years accounted for 8% of all crashes reported each year. This percentage is stable over the period, apart from 2020, during which travelling was limited due to COVID-related restrictions. The number of children who died on the roads decreased by 56% between 2010 and 2023, from 111 fatally injured children to about 50 in the most recent years, as shown in Fig. 2. The graph also displays the evolution in the number of injured and uninjured children involved in a traffic crash. The number of injured decreased by 31% between 2010 and 2023, and by 300% between 1993 and 2023.

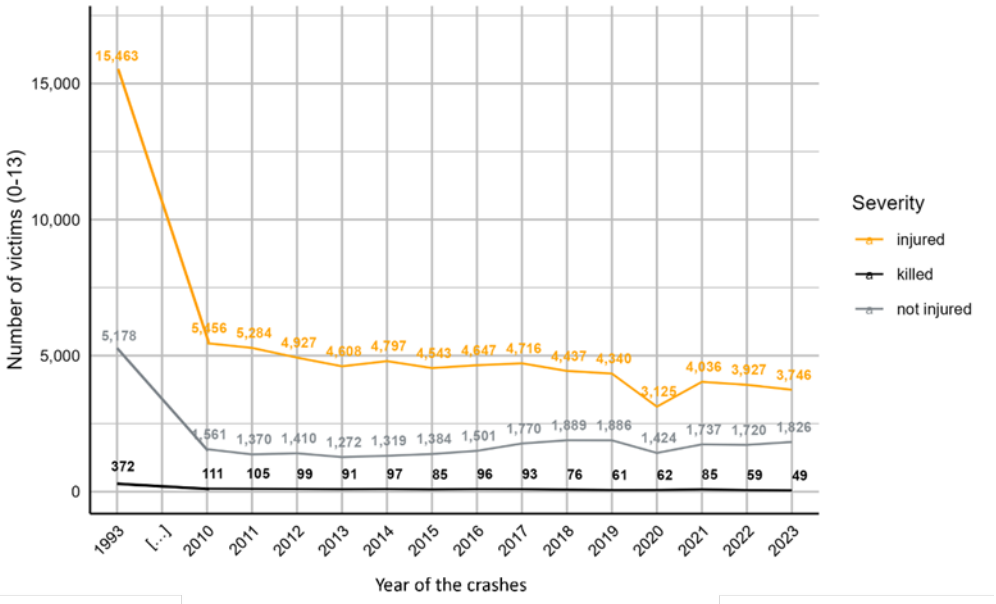

Fig. 2. Evolution of the numbers of children involved in road traffic crashes by injury severity (uninjured, injured, and fatally injured).

Between 2010 and 2023, 1,169 children aged from 0 to 13 years lost their lives in traffic crashes in France. Children travelling as car passengers accounted for 60% of the fatalities, while vulnerable road users (VRUs) represented one-third of the deaths, with 23% as pedestrians and 9% as cyclists. These proportions remain quite unchanged throughout the period. Crashes involving electric micromobility users began to be recorded in the national statistics starting from 2019. Children fatalities as electric micromobility users accounted for 2% of the fatalities observed between 2019 and 2023, reaching 4% in 2023. Children involved as users of powered two-wheelers, passengers of light and heavy trucks, or occupants of light motor quadricycles together account for 5% of crashes involving children in France.

Trends for car occupants, pedestrians, cyclists and electric micromobility users

Between 2010 and 2023, the number of crashes involving a child as car passenger decreased by 12% (from 2,401 to 2,107). Crashes involving child pedestrians and cyclists declined more significantly, by 45% (2,450 to 1,335 crashes) and 50% (482 to 248 crashes), respectively. In contrast, the number of crashes involving a child as a user of an electric micromobility device increased from 32 in 2019 to 140 in 2023. The number of injured children in traffic crashes follows the same downward trend as the number of crashes: injuries among child car passengers decreased by 19%, by 44% for pedestrians, and by 50% for cyclists (Fig. 3). However, the number of children injured while using an electric micromobility device has quadrupled since 2019, reaching 134 injured children in 2023. In total, 88% of the children were injured after a crash as electric micromobility users. Figure 3 shows that the number of child passengers killed in cars decreased by 58%. Although the number of pedestrian and cyclist fatalities fluctuates yearly, overall pedestrian fatalities decreased by 54%, and cyclist fatalities declined by 63%. Since 2019, five children have been fatally injured while using an electric micromobility device.

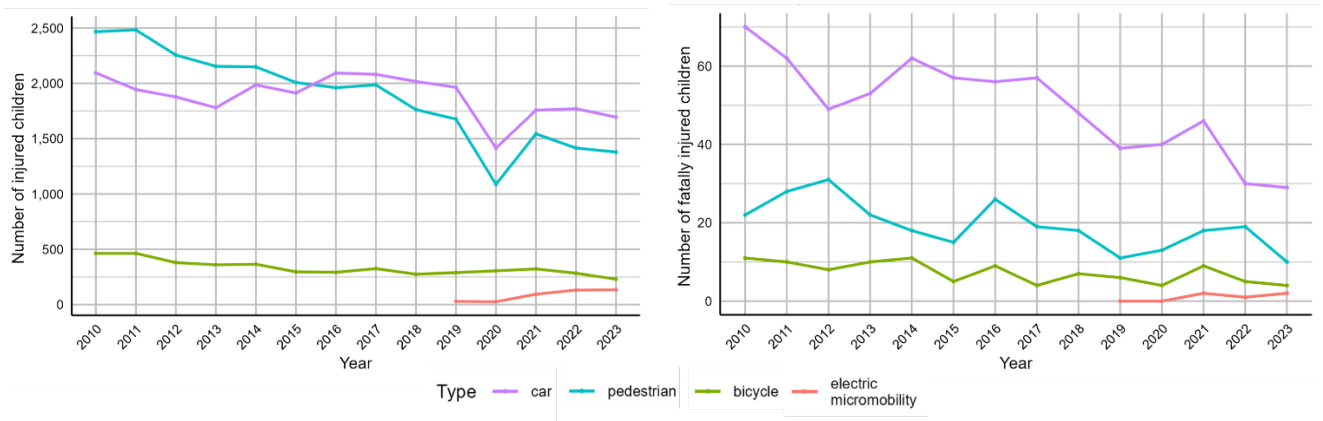

Fig. 3. Number of injuries (left) and fatalities (right) in crashes involving children

General crash characteristics

Crashes involving children most frequently occur between 4.00pm and 6.00pm (Fig. 4), regardless of the mode of transport. This time category represents 31% of crashes involving at least one child in passenger cars and 43% of crashes with at least one child as micromobility user. The most frequent hours are the same for fatal cases, although the share of night crashes (7.00pm to 6.00am) is higher compared to all crashes for car passenger. The five fatal cases of child electric micromobility users are presented, although it might be difficult to derive relevant trends from this small number.

The share of crashes at intersections varies significantly depending on the mode of transport: 23% for pedestrians, 27% for car passengers, 42% for cyclists, and 56% for electric micromobility users. Urban areas account for up to 90% of crashes involving pedestrians, cyclists and electric micromobility users, whereas only 43% of crashes involving cars occur in these areas. Additionally, 58% of crashes with fatally injured children as car passengers took place on secondary roads in rural areas, while 18% occurred on highways.

While 82% of pedestrians, 81% of cyclists and 79% of electric micromobility users involved in crashes were located on the carriageway, a smaller proportion of crashes occur on other road locations. For example, 4% of child cyclists, 6% of pedestrians and 7% of electric micromobility users are involved in crashes on the sidewalk. Only 6% of bicycle and 7% of electric micromobility users are involved in crashes on a cycle path. And 44% of pedestrians are involved in crashes outside a pedestrian crossing, with this percentage rising to 53% in fatal cases.

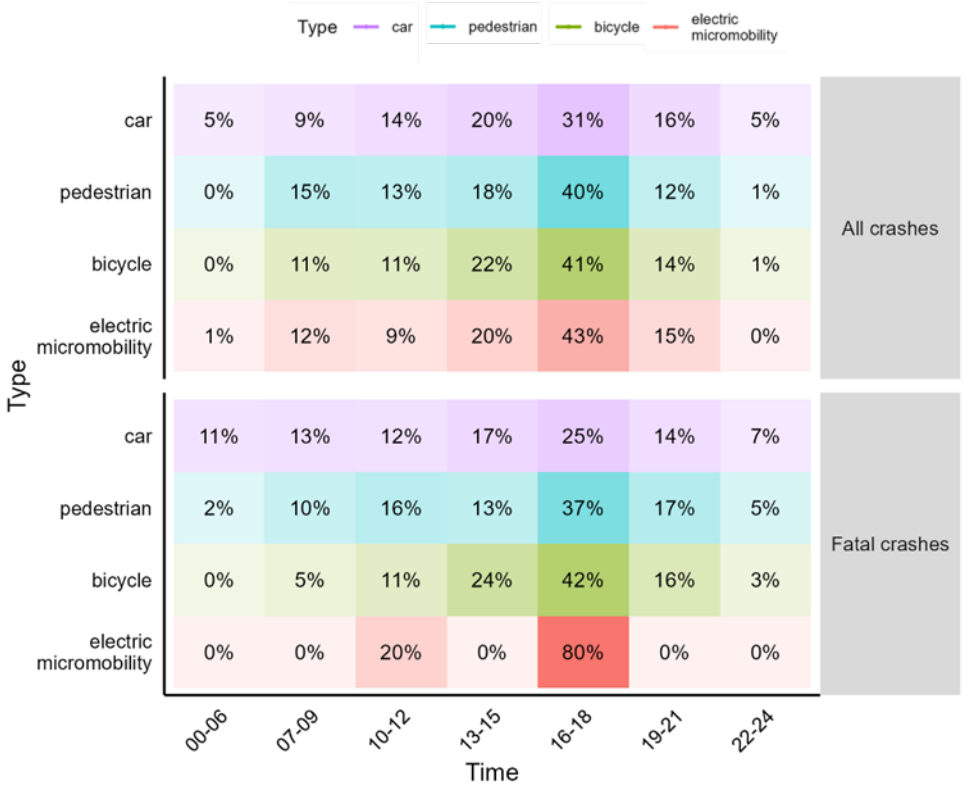

Fig. 4. Time of crashes according to transport mode for all and fatal crashes.

Collision characteristics

Collisions with a passenger car as opponent are the most common type of collisions involving children, regardless of the mode of transport. Such collisions account for 47% of children as car passengers, 75% as pedestrians, 71% as cyclists, and 68% as electric micromobility users. Collisions with a VRU account for 9% of children in cars, 12% of pedestrians, 9% of cyclists and 10% of electric micromobility users. Falls without the involvement of another party account for 6% of children as cyclists and 8% of children using an electric micromobility device. These distributions differ for fatal crashes (Fig. 5): single vehicle crashes are the leading crash configuration of children fatalities in a passenger car (38%), and crashes against heavy goods vehicles (HGVs) account for a larger share when compared to all crashes (12% in fatal crashes vs. 4% for all severity).

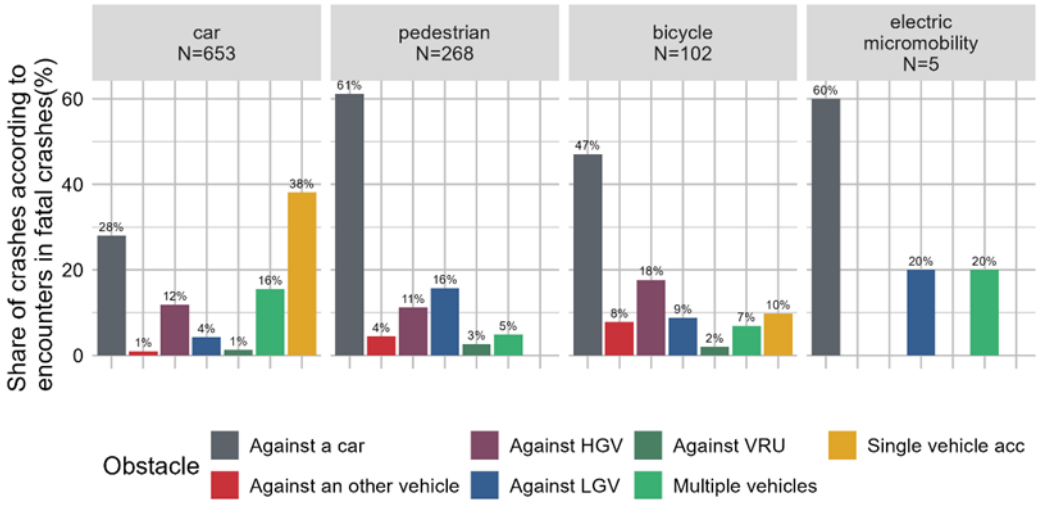

Fig. 5. Shares of children's fatal accidents' opponents by transport mode.

Similarly, the share of collisions with HGVs is higher in fatal crashes involving child VRUs, accounting for 11% of pedestrian fatal cases and 18% of cyclist fatalities. Frontal impact on vehicles is the most common type of collision for both fatal and non-fatal crashes (Fig. 6). It accounts for 59% of children as car passengers, 51% of children as cyclists, and 53% of children as electric micromobility users. Among child pedestrians, 80% were hit by the front-end of a vehicle. Additionally, side impacts are more frequent in fatal car crashes (21%) and their share is specifically important in bicycle crashes, where they represent 34% of the cases. Rear-end collisions for pedestrians account for 10% of fatal collisions, primarily affecting the youngest children (under 6 years old in 90% of cases). The distribution of impact types (in all crashes) is quite similar between bicycle and electric micromobility user crashes.

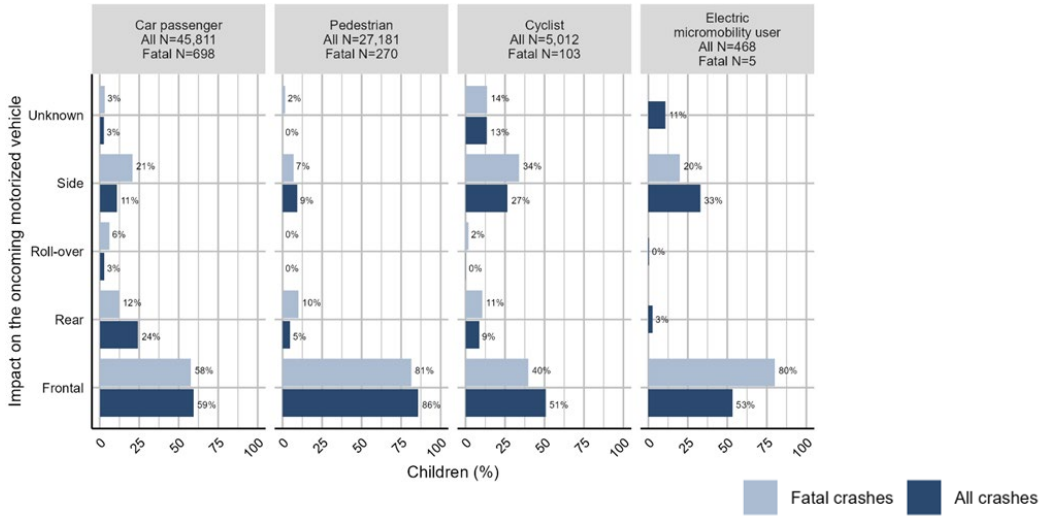

Fig. 6. Impact type according to transport mode of children for fatal and all crashes.

Vehicle and driver characteristics

The average age of passenger cars (defined from the date of first registration of the vehicle) transporting children and involved in injurious crashes is consistent with the average age of passenger cars involved in all crashes in France [3], and has increased from eight to 10.5 years between 2010 and 2023 (Fig. 7). The average age of cars in which a child was fatally injured is always higher than the average for all injury crashes (except for 2022), averaging 11 years of age over the period and reaching 15 years of mean age in 2023.

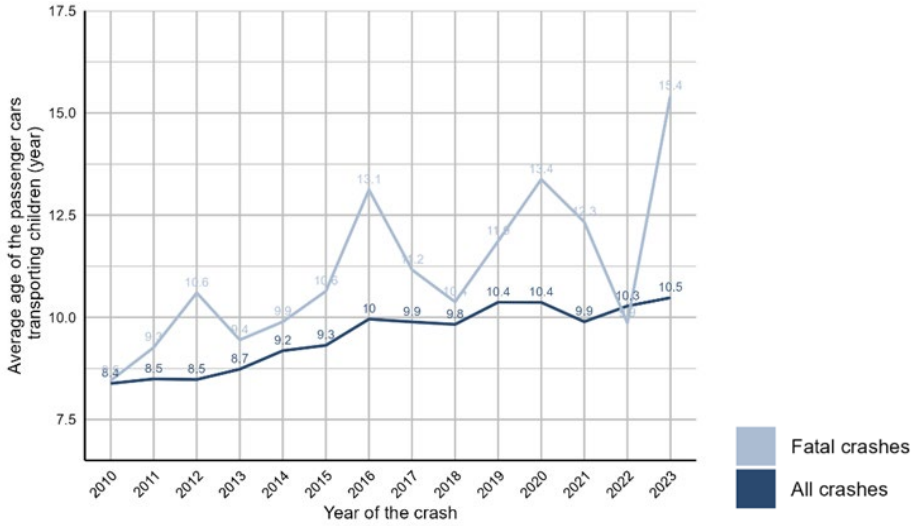

Fig. 7. Average age of passenger cars transporting children involved in injurious crashes (2010-2023).

Regarding the vehicle drivers, 51% of the drivers of passenger cars transporting children and involved in crashes are male, while 49% are female. The share of female drivers is considerably lower in the general crash statistics (about a third are female drivers). The percentage is nearly similar in crashes leading to a child fatal injury (52% male, 48% female). The drivers involved in crashes while transporting children are 38 years old on average (36 years old when the child is fatally injured). Younger children are driven by younger drivers: the average age of drivers is 32 years old for children under 2 years old, 37 years old for children 4-5 years old and 41 years old for children over 10 years old.

Since 2018, the type of bicycle propulsion (human-powered or electric) has been coded in the database. Between 2019 and 2023, 1% of children involved in crashes were using an electric bike. Among them, 56% were passengers. They were younger than non-electric bike users: 35% are under 6 years old on an electric bike compared to 9% for all children cyclists.

Children characteristics

There are systematically more boys than girls among children involved in crashes, regardless of the mode of transport (Fig. 8). This trend is particularly evident among active modes, such as pedestrians, electric micromobility users and cyclists, where 80% of the children involved are male, compared to 53% of male children as car passengers. The male-to-female ratio remains similar in both fatal and non-fatal crashes across transport modes.

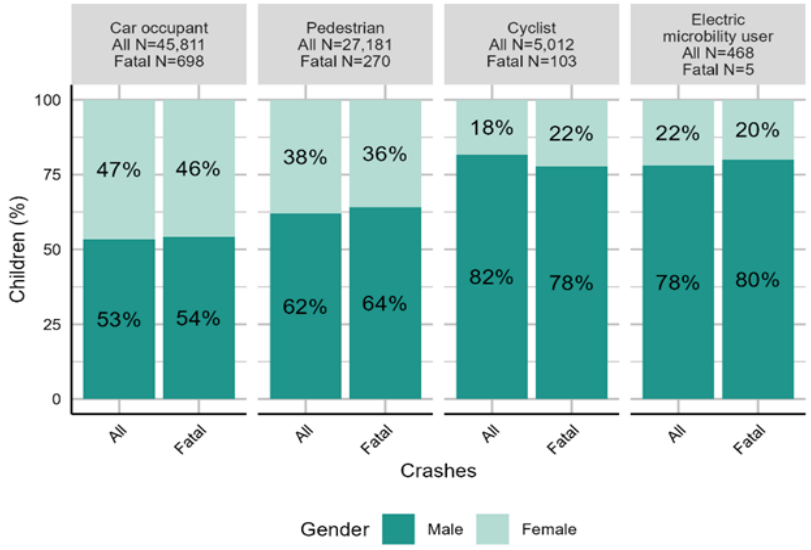

Fig. 8. Gender of children involved in fatal and all crashes according to transport mode.

While the ages of children involved in crashes as car passengers are evenly distributed (around 15% per age group, Fig. 9), there is an over-representation of children under 2 years old among fatalities. This age group accounts for 20% of child passenger fatalities. For pedestrian crashes, young children up to 3 years old represent 34% of fatalities despite making up only 15% of all child pedestrians involved in crashes. The trend is reversed for older children (12–13 years old), who account for 22% of pedestrian crashes but only 15% of pedestrian fatalities. Regarding cyclists, the number of child cyclists increases with the age of the child, , with 68% of the children involved aged 10 years and older. For electric micromobility users, only 55% of the children involved in crashes were of legal age for using this device at the time of the crash (i.e. 12 years or older).

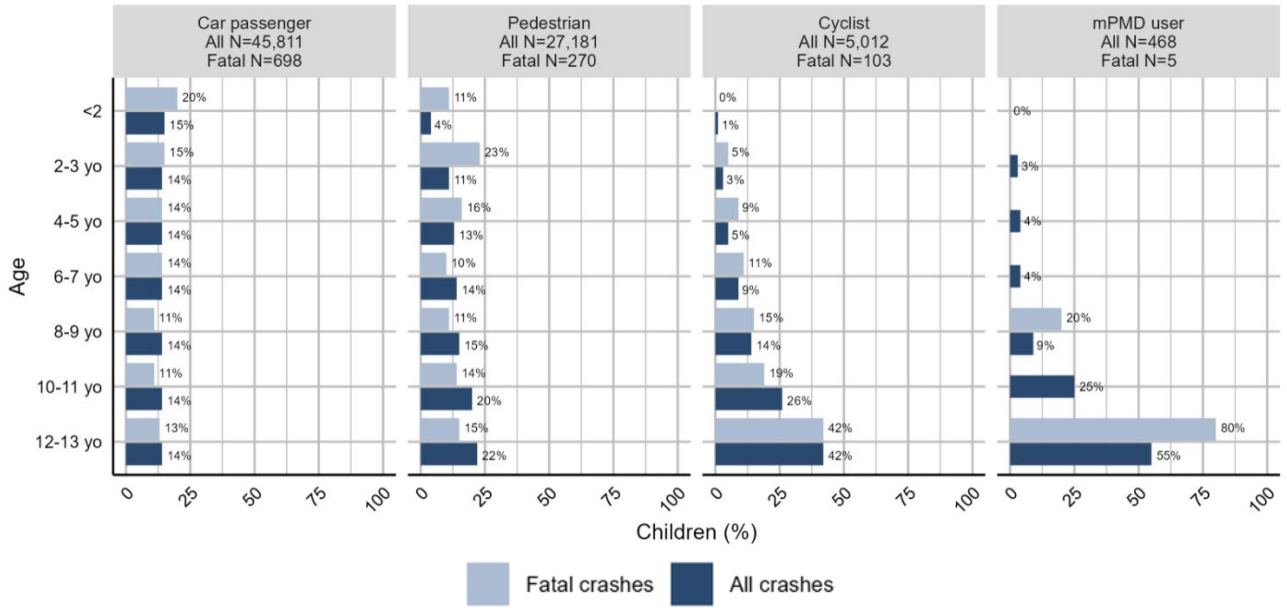

Fig. 9. Age of the children involved in fatal and all crashes according to the mode of transport.

Police forces reported that 10% of the children in a passenger car involved in a crash were totally unrestrained, and this figure rose to 25% for the fatally injured children. The proportion of children wearing a helmet has increased over the period: in 2010, 11% of children cyclists in crashes wore a helmet, 31% in 2018 (first complete year after helmet-wearing became mandatory) and 38% in 2023. The use of helmets decreases with age (Fig. 10): 41% of children aged 2 to 3 years old wore a helmet, compared to only 17% of children aged 12–13 years. Regarding children on electric micromobility devices, 11% were wearing a helmet during the crash.

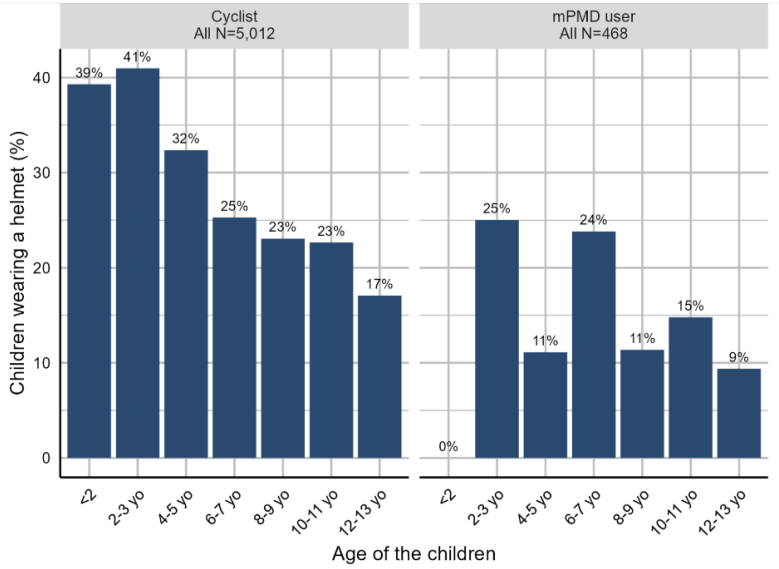

Fig. 10. Proportions of children involved in accident as cyclists and electric micromobility users with helmet, according to age.

The database shows that the child is not always alone on the bike or on the electric micromobility device during the crash. The presence of a passenger was noted in 31% of child crashes as users of electric micromobility devices (13% with two other children on the same device, and 18% with an adult). The share of children as passengers of bicycles doubled, from 8% in 2010 to 17% of crashes in 2023. Regarding children involved as pedestrians, half of them were alone at the time of the crash, the other half were accompanied. Accompanied children were on average younger than others (average of 6 years old compared to an average of 9 years old for unaccompanied children).

Crashes during leisure trips are the most frequently occurring, regardless of the mode of transport. Nevertheless, it was noted that the share of home–school trips doubled for bicycle crashes during the studied period (10% of crashes in 2010 and 19% in 2023). For pedestrian crashes, 28% crashes took place during home–school trips, and this figure remained stable over the period of the study.

Children in bus or coaches

Since 2010, the number of crashes involving children in buses and coaches has been stable, at around 40 cases per year. The death toll was eight children killed over the period of the study, most of them (six deaths) occurring in 2017. There have been no deaths for children under the age of 14 years in buses or coaches since 2017. Children aged 10–13 years account for 62% of the children involved as bus or coach passengers: 52% of children involved are boys, 48% are girls. The use of a seat belt (mandatory in coaches for all passengers since 2015) is linked to the age of the child: the wearing rate of a seat belt is the highest among children aged 4–5 years (81% used a seatbelt), and then decreases in the older age group (51% for 12–13 age category). The use of the seat belt was also linked to the type of transport. During school transport, the use of the seat belt was higher than during other trips: 66% of children were restrained in school buses. This figure was only 46% if the journey was made for other purposes. The vehicle sustained a frontal impact in 68% of the cases and mostly collided with a passenger car (in 47% of the crashes), with only 26% of the crashes involving the bus or coach itself. The mean age of the children on board was 7 years.

IV. DISCUSSION

The situation for children on the roads in France has improved between 2010 and 2023, with the number of crashes decreasing by 28%, a slightly greater reduction than the 23% decline observed for all crashes. Child fatal injuries (under 14 years old) have dropped by 56%, while overall road mortality in France has decreased by 20% over the same period. This trend is comparable to European data, which show a 47% reduction in child fatalities between 2011 and 2020 [1]. However, this reduction shows disparities depending on the mode of transport. Crashes involving children in cars decreased by 12%, but pedestrian and cyclist crashes decreased by 45% and 50%, respectively. This reduction cannot be completely attributed to a real gain in safety for cyclists since at the same time the total number of bicycle fatalities increased in France by 50% between 2010 and 2023 (from 147 to 221). This reduction could be linked partly to a change in children's behaviour. One study [10] examined the reduction of children's activities in public spaces, such as walking or cycling, which reduces their exposure to road risks but does not contribute to improving their health and physical fitness.

Children under 2 years old represent 20% of the overall children's fatal injuries in passenger cars, despite representing only 15% of those involved in crashes. Increased rate of fatal injuries is also observed for younger car passengers by [11] and [12]. Several hypothesis could explain this observation: there may be an increased fragility of the youngest children, implying special medical needs. [13] shows that appropriate medical care, in pediatric units rather than in adult centers, is essential to reduce the mortality of the youngest children involved in accidents. Besides that, the types of crashes may differ, depending on the age of the driver and the child. The data analysed shows that younger children are driven by drivers younger than average (32 versus 38 years old). A lower quality of use of restraint systems for children under 2 years old could also explain this finding. In Sweden, 69% of fatally injured children under the age of 10 years were not restrained [14]. An observational survey conducted in France showed that only 10% of children under the age of 2 years are properly restrained (compared to 34% for children of all ages) [15]. On this question, the OURSE project will provide some insights into the future, since one of the next steps will be to conduct an in-depth study of police reports of crashes involving fatally injured children in cars. This should enable a more detailed comparison between younger and older children concerning various factors contributing to fatal injuries, particularly the proper use of child restraint systems.

Side impacts continue to account for a significant proportion of car occupant fatalities: 23% in a 2011 fatal crash study [4], and 20% in recent years. In 2015, Europe introduced Regulation R129 for child restraint system homologation, incorporating a dynamic side-impact test that was absent in the previous R44 standard. The effectiveness of this new regulation in enhancing side-impact safety should be assessed in the coming years.

The Gender Similarities Hypothesis [16] proposes that women and men, as well as girls and boys, are more alike than different, with age and context influencing observed differences. More broadly, children tend to mimic what they see. In France in 2023, males account for 86% of fatalities among bicycle users, and 64% among pedestrians [3]. A similar pattern emerges in the present study, with boys aged 0–13 years being

disproportionately involved in crashes during active modes of transport as pedestrians, cyclists, and electric micromobility users.

Examining extended data series reveals changes in helmet-wearing behaviour for child cyclists: although usage rates have increased, they remain insufficient, despite helmets reducing the risk of AIS2+ head injury by 68% [17]. In 2023, 62% of child cyclists involved in crashes were still not wearing a helmet. Usage surveys in France show a wearing rate of 37.6% in large urban areas [3] (although this study was not specific to children).

Given the vehicle age in which children are fatally injured (15 years on average), rate of use of Advanced Driver Assistance Systems (ADAS), which is not available in the national database, is expected to be very low. Thus, the renewal of the car fleet could improve children safety in particular situations. For example, the crash scenario where the passenger car is alone and goes off the road accounts for 38% of children killed in cars, and therefore potentially could be addressed by electronic stability control and lane-keeping assistance. Another example: 53% of child pedestrians, 50% of cyclists, and 49% of electric micromobility users are involved in crashes during the day, on roads in built-up areas with speed limits up to 50 km/h, and these scenarios could potentially be detectable by an automated emergency braking system. However, situations where the bicycle and the electric micromobility device have a passenger (17% of bicycle crashes and 32% of crashes with electric micromobility device) could be a recognition issue for such systems.

Although every crash must be recorded in the national database, there is an under-reporting of almost two-thirds [18] of non-fatal crashes in France. It mainly concerns crashes resulting in the lightest injuries and crashes involving one VRU without any other vehicle involved, whereas fatal crashes are exhaustively reported. Therefore, it is expected that the proportion of falls without third parties involved, i.e. 6% of bicycle crashes and 8% of electric micromobility crashes, are largely underestimated in the present data. Nevertheless, crashes involving electric micromobility devices have been rising sharply since 2019. The legal age of use (12 years old until 2023) was respected by only 55% of those involved. The requirement of use is to drive on the road, with the recommendations of use being to wear a helmet and to be alone on the vehicle, but only 5% of children involved in crashes on an electric micromobility device were driving in conditions that complied with the obligations and recommendations. As 88% of these crashes result in injuries, this emphasises the need to reinforce the application of existing laws.

V. CONCLUSION

While the overall safety level has improved since 2010, as seen in the decrease of crashes numbers and fatalities, there are still points that need improvement: the fatalities of children under 2 years in cars, which will be addressed in more detail in the next step of the OURSE project; the discrepancy between the number of male and female children involved in traffic crashes as pedestrians, cyclists, and electric micromobility users; the use of electric micromobility devices, despite being forbidden now for children under 14 years, is increasing along with the number of casualties. Injured children could suffer from physical and psychological long-term consequences, which can be a real burden at social, physical and economic levels. Finally, although crashes for children as pedestrians and cyclists have decreased, this may simply indicate a decrease in these activities among children.

VI. ACKNOWLEDGEMENTS

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