

Restraint Use Among Children in Motor Vehicle Crashes in Ohio

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I. INTRODUCTION

Motor vehicle crashes (MVCs) remain a leading cause of death and injury to children in the United States [1-2] and worldwide [3]. Investigation of state or regionally maintained crash databases provides opportunities to examine larger paediatric populations and gain insights on child restraint use across diverse transportation contexts. These data can capture region-specific patterns and populations that may be under-represented in US national datasets. Recent investigations have demonstrated the value of Ohio's statewide crash reporting system as a research resource because it represents crashes across varied roadway environments and includes detailed information on crash circumstances, vehicles, and individuals involved [4]. The objective of this work was to provide a preliminary assessment on current rates of child restraint system (CRS) and seat-belt use for children involved in MVCs in Ohio from 2017 to 2023.

II. METHODS

Traffic crash report data (2017–2023) were obtained from the Ohio Department of Public Safety (ODPS). This dataset includes all MVCs reported to law enforcement across the state of Ohio, including data at the crash, unit, and person levels for crash severities ranging from property damage only to fatal. Vehicle data were verified using the National Highway Traffic Safety Administration's VIN decoder [5]. Data were filtered to include all passenger vehicle occupants aged 0–13 years old (yo).

Restraint Use and Injury Severity Definitions

Restraint use was determined from the *Safety Equipment* variable as: "rear-facing (RF) CRS", "forward-facing (FF) CRS", "booster seat", "shoulder and lap belt", "lap or shoulder belt only", "none", or "other/unknown". Use of an appropriate restraint type was determined using the child's age (Table I). Child height and weight information were not collected in the dataset. Therefore, age-based transition thresholds were determined using US best practice recommendations for CRS use, anticipated height and weight based on age from CDC growth chart data, and US CRS manufacturer allowable height, weight, and/or age ranges for different CRS types and modes of use [6-8]. Injury severity was determined for each paediatric occupant from the *Injury* variable as: "no apparent injury", "possible injury", "suspected minor injury", "suspected serious injury", or "fatal".

TABLE I
AGE THRESHOLD DEFINITIONS FOR APPROPRIATE RESTRAINT

Safety Equipment	Inappropriate	Early Transition	Appropriate	Removed*
Rear-facing (RF) CRS	NA	NA	≤ 6 yo	> 7 yo
Forward-facing (FF) CRS	< 2 yo	NA	≥ 2 yo & ≤ 10 yo	> 11 yo
Booster Seat	< 4 yo	4 yo	≥ 5 yo & ≤ 12 yo	> 12 yo
Shoulder & Lap Belt	< 8 yo	≥ 8 yo & ≤ 10 yo	≥ 11y	NA
Lap or Shoulder Belt Only	None	None	None	NA
None	None	None	None	NA

*Potential CRS coding error, removed from analysis.

III. INITIAL FINDINGS

During 2017–2023, 3,632,151 individuals were involved in MVCs reported to law enforcement in Ohio. Of these individuals, 263,067 (7.24%) were paediatric passenger vehicle occupants aged 0–13 yo. Restraint use was other/unknown for 2.62% of occupants, and they were excluded from further analyses. Considering all ages with known restraint use, 2.14% of children used no restraint. An additional 17.79% of children utilised an inappropriate restraint type, and 23.94% were identified as early transition to booster seats or the lap-and-shoulder belt. The remaining 56.00% of children used appropriate restraint types.

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Of crashes involving occupants aged 0–13 yo with known restraint, 85.89% children sustained no apparent injury (n=220,010), 8.77% possible injury (n=22,469), 4.87% suspected minor injury (n=12,481), 0.42% suspected serious injury (n=1,085), and 0.04% were fatal (n=108). Possible and minor injury severities, as well as suspected serious injury and fatalities, were grouped for analysis to increase sample sizes.

Of the children who sustained a serious injury or fatality, a higher proportion were using no restraint (27.54%) compared to children sustaining no injury (1.77%) or possible/minor injuries (6.87%) (Table II). Proportions of early transition restraint and inappropriate restraint were relatively similar across injury severities but represented a meaningful proportion of cases.

TABLE II
RESTRAINT USE BY INJURY SEVERITY (0–13 YO)

Injury Severity	Total N	None	Inappropriate	Early Transition	Appropriate
None	242,479	1.77%	17.83%	23.72%	56.68%
Possible/minor injury	12,480	6.87%	17.56%	28.95%	46.62%
Suspected Serious Injury/Fatal	1,193	27.54%	17.21%	22.67%	32.58%

IV. DISCUSSION

Overall, restraint use rates for children aged 0–13 yo involved in MVCs in Ohio were relatively high, with only 2.14% of children using no CRS or seat-belt restraint. Recent observational data in the US estimate non-restraint use of children 0–13 yo at 11.8% [9]. However, inappropriate restraint use and early transitions to the booster and belt were also common (17.79% and 23.94%, respectively), indicating more work can be done to improve CRS use following best practice recommendations. Higher proportions of no restraint were observed for possible/minor injury (6.87%) and suspected serious injury/fatal (27.54%) compared to no injury crashes (1.77%), emphasising the importance of restraint use to protect children in MVCs. This trend follows national US data, where 43% of child MVC fatalities in 2023 were unrestrained [10]. Future work will investigate relationships between type of restraint use, appropriate restraint use and associated injury outcomes with age and other demographic, vehicle, and crash factors, with the goal of identifying targeted education and outreach opportunities or other state or local interventions to improve appropriate restraint use for children in Ohio.

Epidemiological investigations of paediatric MVC occupants can be challenging due to the limited number of paediatric cases represented in some databases. For example, this Ohio crash dataset included 1,085 suspected serious injuries and 108 fatalities sustained by 0–13 yo occupants over a seven-year period. For comparison, the unweighted number of cases involving 0–13 yo children in the US national Crash Investigation Sampling System (CISS) included 88 seriously injured (MAIS3+) occupants and 33 fatalities over the same timeframe. Investigation of Ohio crash data and similar state or regional databases can provide larger sample sizes to enable identification of trends in appropriate use of CRS and injury outcomes in MVCs. However, other challenges exist with the Ohio crash database, such as the relatively limited CRS information captured. Other datasets, like CISS, include specific CRS manufacturer and model information, more detailed CRS-type documentation, and identification of CRS installation methods and potential misuse. Future work will explore opportunities to gather more detailed CRS information in the Ohio crash dataset, assess rates of incorrect CRS identification, and implement strategies to improve data collection and validity.

Ultimately, analysis of state and regional crash databases can help to identify specific locations that may require targeted interventions at the city, county, or state level and can identify trends associated with varying laws or recommendations implemented at those levels. For example, Ohio child passenger safety laws require that children use a CRS when under 4 yo or less than 18.1 kg, that children 4–8 yo and weighing more than 18.1 kg and shorter than 145 cm use a booster seat or other approved CRS, and that children 8–15 yo utilise seat-belts regardless of vehicle seating position [11]. Preliminary outcomes from this analysis indicate that 6.54% of children <4 yo and 20.36% of children <8 yo involved in MVCs in Ohio may not be travelling according to the Ohio state law based on age alone.

Overall, implementation of regional analyses may be helpful for other locations and provide the opportunity to identify local trends by leveraging modern data that are representative of the target population. These

frameworks can help to identify targeted education, outreach, and/or legislative interventions. Additionally, each individual regional analysis contributes to overall understanding of facilitators and barriers to appropriate restraint use and associated injury outcomes for children involved in MVCs and can contribute to broader understanding of child passenger safety trends to continue to reduce the burden of MVCs at a larger scale.

V. REFERENCES

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