

# Analysis of Patients with Persisting Concussion Symptoms Caused by Motor Vehicle Collisions with Respect to Vehicle Safety Systems 2000-2020

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## Background

- Motor vehicle collisions (MVC) are among the leading causes of persisting concussion symptoms (PSC) in adults in Canada, although the exact incidence is unknown.<sup>1</sup>
- The type of crash, and the performance of vehicle safety systems such as seatbelts, head rests, and airbags in the event of MVC affect the vehicle occupants' risk for concussion and other injuries.
- Injury statistics have shown that female vehicle occupants are subject to a greater risk of sustaining concussions in frontal car collisions, and perhaps other crash configurations.<sup>2</sup>

## Objectives

- To correlate the demographic and safety issues involved in MVC based on the type of collision causing concussion with PCS to enhance the safety of passengers in MVC.
- To provide information that may be used to improve vehicle safety systems and public policies to ensure that vehicle occupants of all ages and sexes are adequately protected from concussion in MVC.

## Methods

### Study Design

- This study began with a retrospective clinical chart review of 147 MVC patients with concussion and PCS seen in consultation by one of the investigators, Dr. Charles Tator, of the Canadian Concussion Centre at Toronto Western Hospital between the years of 1999-2020.
  - Information on demographic characteristics, radiographic findings, type of MVC, initial and persisting symptoms, and recovery was collected.
- Additional demographic and crash data (including speed, air bag deployment, head rest positioning, seat positioning, seat belt use, steering wheel, etc.) was collected by questionnaire to increase our knowledge of recovery and vehicle safety systems (39 respondents to date).

## Methods

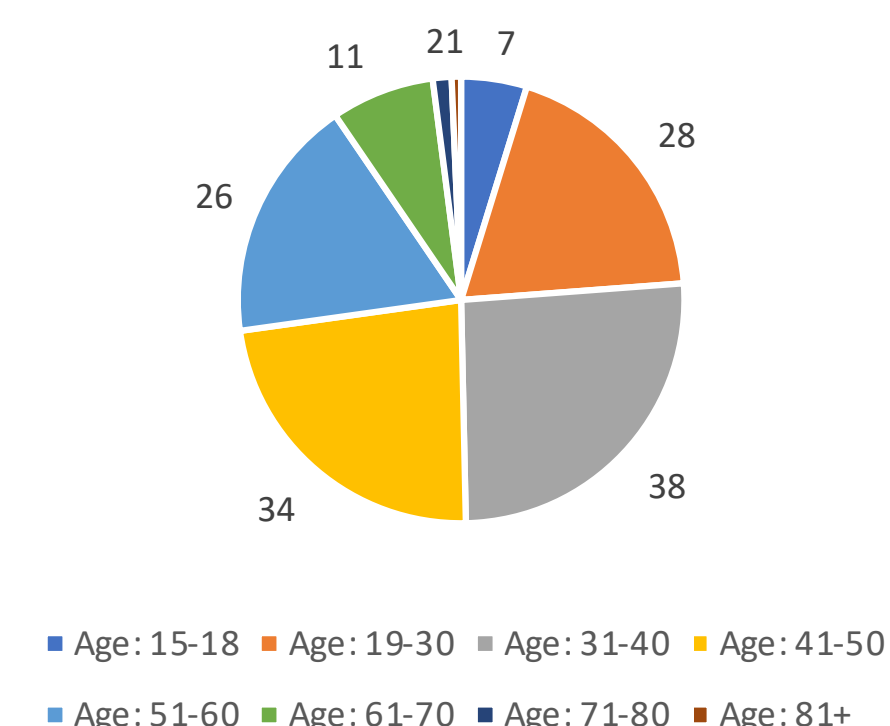
### Inclusion Criteria

- Vehicle occupants of MVC between the ages of 15-81 with at least one concussion symptom lasting for one month or more.
- Only vehicle occupants were included in the study; cyclists and pedestrians involved in MVC were excluded.

### Demographic Features

- Of the 147 patients included in the retrospective clinical chart review, 102 (69.4%) were female, and 45 (30.6%) were males.
- Of the 39 questionnaire respondents (to date), 33 (84.6%) were female and 6 (15.4%) were male.

### Age of the 147 Patients in MVC



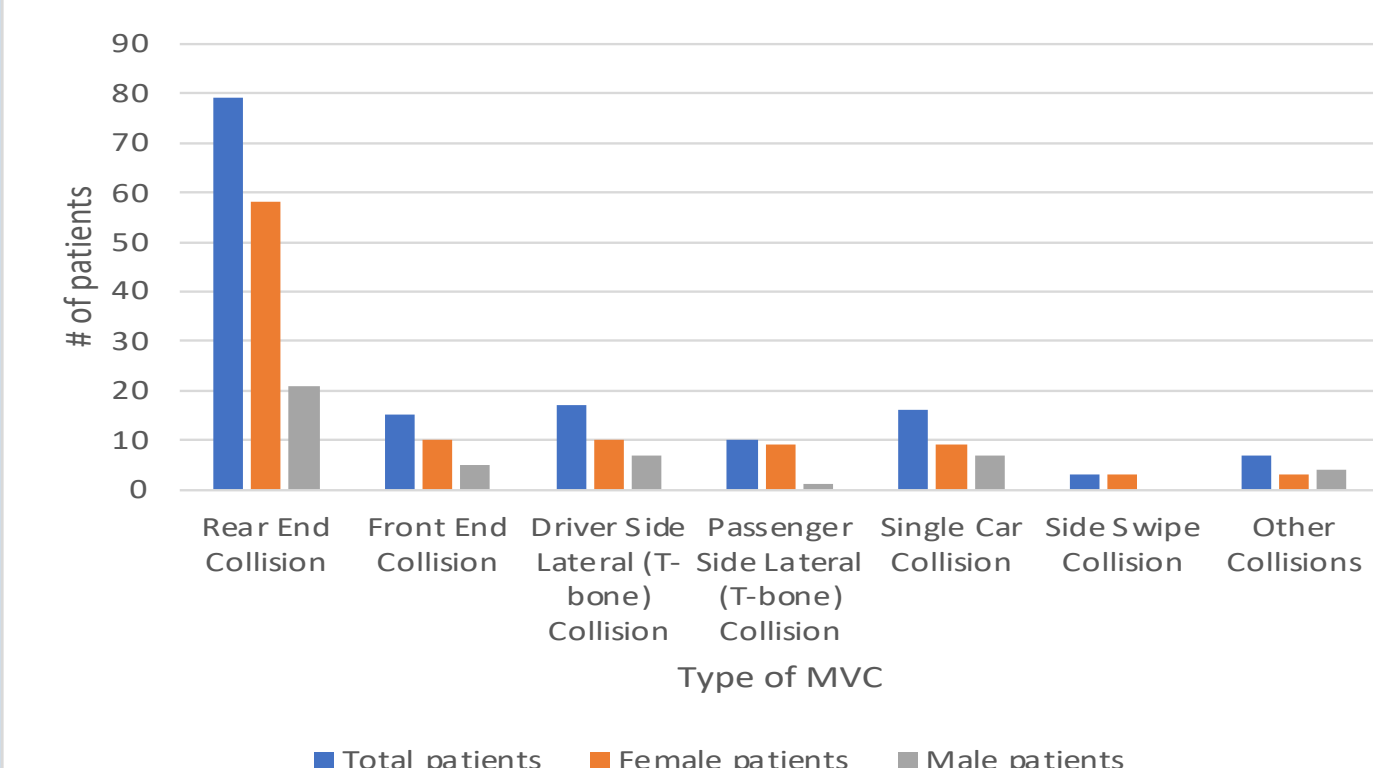
## Results

- The mean age and standard deviation at the time of concussion for the 147 vehicle occupants was 41.6 years  $\pm$  13.7 (for female occupants: 42.1 years  $\pm$  12.5, for male occupants: 40.4 years  $\pm$  16.2).
  - Vehicle occupants of driver side lateral (T-bone) collisions were the oldest at the time of concussion, with an average age of 49.8 years  $\pm$  13.7, while vehicle occupants of front-end collisions were the youngest at the time of concussion, with an average age of 35.9  $\pm$  12.9.
- On average, female vehicle occupants suffered a greater number of initial (mean=6.3) and persisting (mean=13.0) concussion symptoms post-MVC than males (mean=5.5, mean=10.8), respectively.

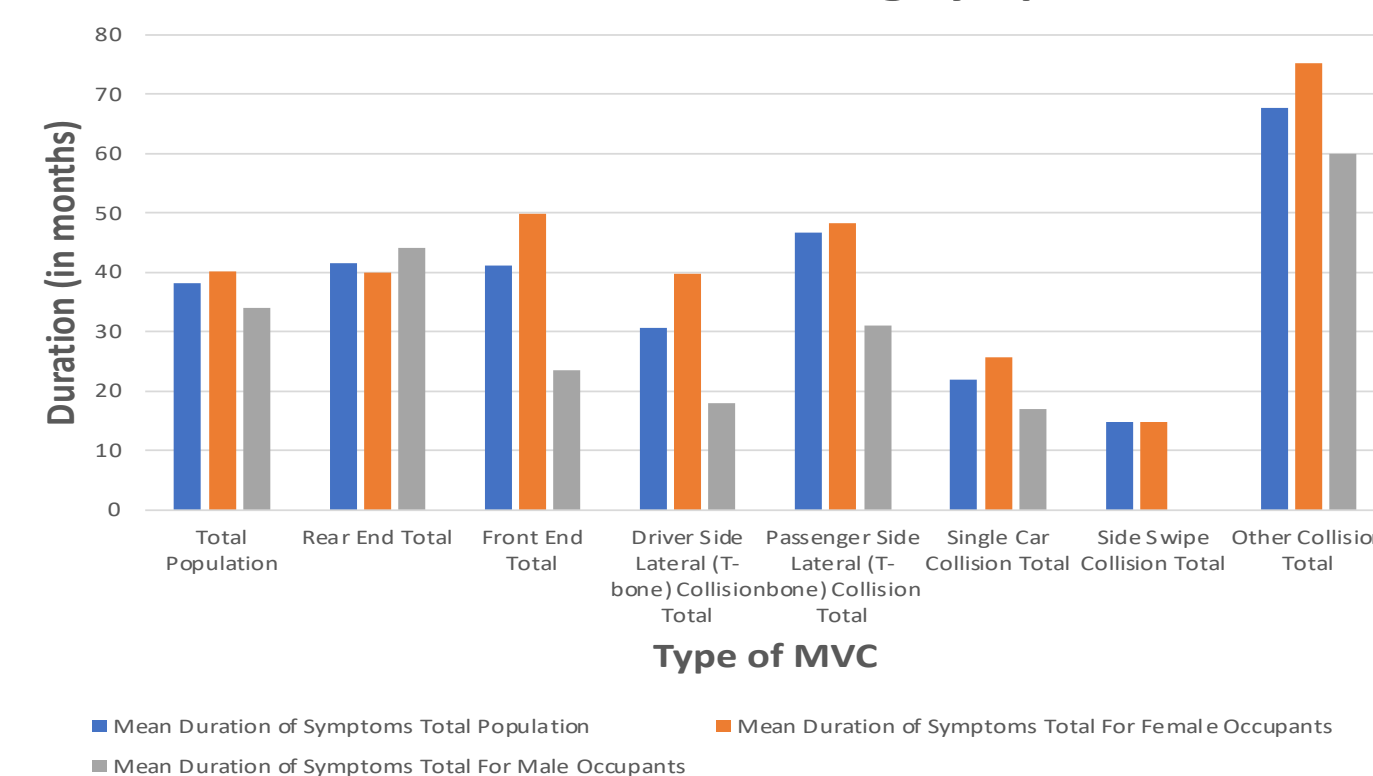
## Results

| Concussion Features                                | Rear-End Collision | Front-End Collision | Driver Side Lateral (T-bone) Collision | Passenger Side Lateral (T-bone) Collision | Single Car Collision | Side Swipe Collision | Other Collisions |
|--|--------------------|---------------------|--|---|----------------------|----------------------|------------------|
| Proportion of Individuals                          | 79 (53.7%)         | 15 (10.2%)          | 17 (11.6%)                             | 10 (6.8%)                                 | 16 (10.9%)           | 3 (2.0%)             | 7 (4.8%)         |
| Proportion of Recovered Individuals                | 2                  | 0                   | 1                                      | 1   | 3                    | 0                    | 0                |
| Female:  | 58:21              | 10:5                | 10:7                                   | 9:1                                       | 9:7                  | 3:0                  | 3:4              |
| Male:  | 41.9 $\pm$ 12.3    | 35.9 $\pm$ 12.9     | 49.8 $\pm$ 13.7                        | 38.9 $\pm$ 15.9                           | 37.6 $\pm$ 17.3      | 38.3 $\pm$ 4.0       | 44.9 $\pm$ 14.9  |
| Mean Age of Vehicle Occupant at Time of Concussion | 5.9                | 5.7                 | 7.0                                    | 8.1                                       | 6.4                  | 7.3                  | 2.0              |
| Mean Number of Initial Symptoms                    | 13.4               | 12.3                | 13.8                                   | 10.4                                      | 9.8                  | 13.3                 | 4.4              |
| Mean Number of Persisting Symptoms                 | 41.1 $\pm$ 39.9    | 41.1 $\pm$ 35.3     | 30.7 $\pm$ 26.3                        | 46.6 $\pm$ 31.1                           | 21.9 $\pm$ 18.5      | 14.7 $\pm$ 1.5       | 67.7 $\pm$ 33.8  |

### Type of MVC



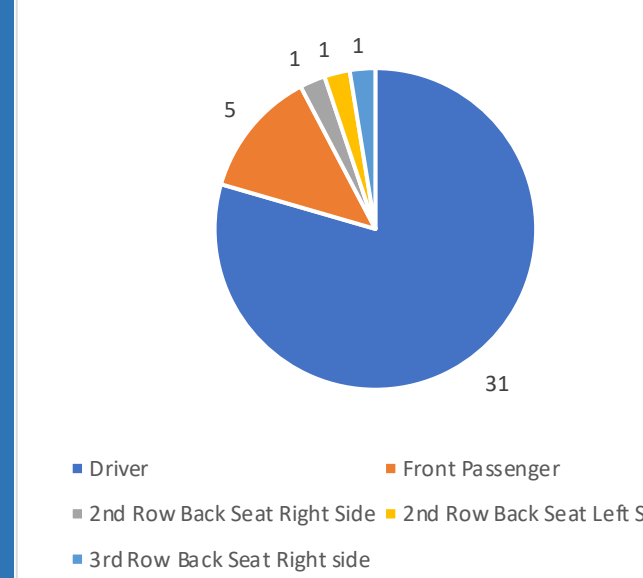
### Mean Duration of Persisting Symptoms



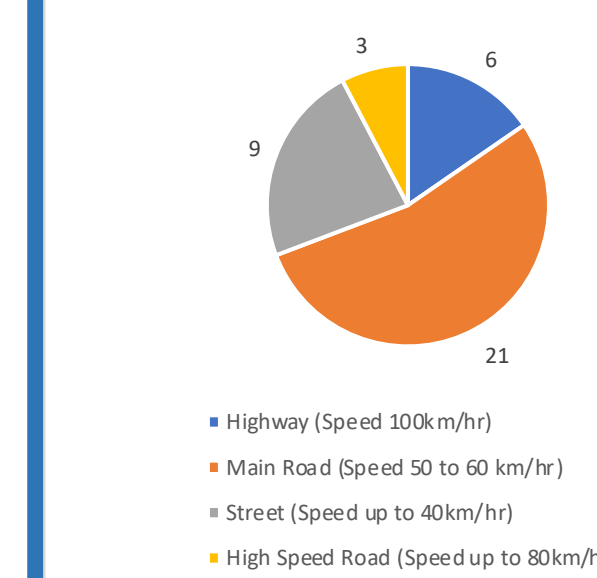
- Of the 39 questionnaire respondents, only 8 instances of airbag deployment were reported. Respondents reported airbag deployment in four out of five passenger side lateral (T-bone) collisions, the highest incidence rate among all MVC mechanisms.
- In contrast, airbag deployment only occurred in one out of twenty rear end collisions.

## Results

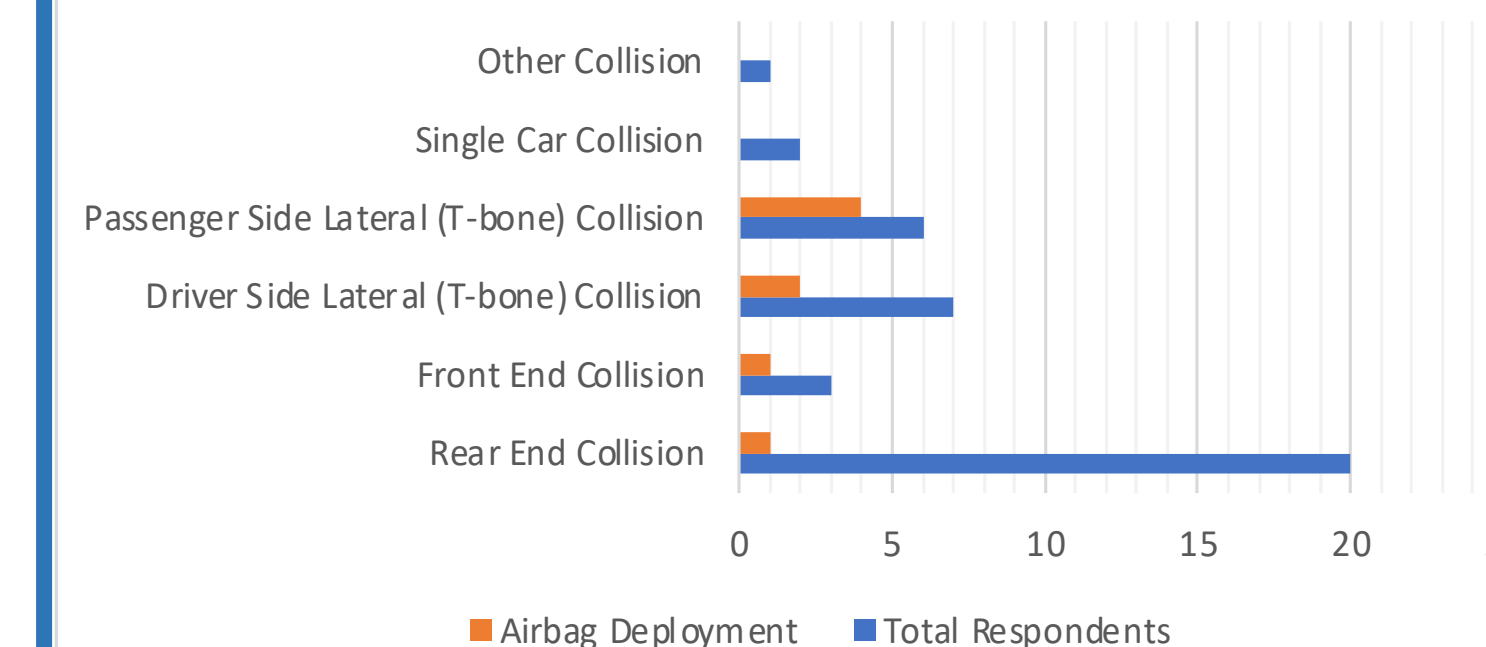
### Seating Position in the Vehicle



### Type of Road Involved in MVC



### Airbag Deployment Among Total Questionnaire Respondents



## Conclusions

- Despite male vehicle occupants being more likely than female vehicle occupants to sustain MVC in Ontario,<sup>3</sup> these findings demonstrate a greater preponderance of females with PCS than males in all types of MVC, suggesting that female vehicle occupants are at a greater risk for developing PCS following MVC.
- Very few vehicle occupants reported recovery from PCS following MVC over years of clinical follow up.
- Given the results of this study, automobile manufacturers should consider improvements to vehicle safety systems, especially for females.

## References

- Jagnoor et al., 2014, "Mild traumatic brain injury and motor vehicle crashes: Limitations to our understanding", *Injury, International Journal of the Care of the Injured*, 46: 1871-1874
- Antona-Makoshi et al., 2018, "Accident analysis to support the development of strategies for the prevention of brain injuries in car crashes", *Accident Analysis and Prevention*, 117: 98-105
- Ontario Road Safety Annual Report 2017.