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Motor Vehicle Collisions and Their Demographics: A 5-Year Retrospective Study of the Hamilton-Wentworth Niagara Region*

ABSTRACT: This retrospective study examined population demographics associated with motor vehicle collision (MVC) fatalities over a 5-year period in the Hamilton-Wentworth Niagara region. Variables were drawn from the five factors proposed by Fierro (1) for investigating deaths caused by transportation: human, chemical, environmental, vehicular, and highway. Factors analyzed included age, gender, position to the vehicle, site(s) of injury, toxicology, environmental contributors, and vehicular findings. From 1999 to 2004, there were 321 MVC fatalities that primarily involved males 20 to 29 years of age and commonly drivers or pedestrians. Cars and trucks were the most frequent vehicles. Fatalities occurred most often on local and regional roads on Fridays and Sundays between 6 pm and 6 am. Mechanical failure and weather conditions were not significant contributors. Toxicological analyses (275/321) were performed on the majority of the study population. Ethanol was present in isolation and with other substances, especially cannabis, mostly in male drivers 20–59 years of age.

KEYWORDS: forensic science, transportation pathology, motor vehicle collision, toxicology

Motor vehicle collisions with resultant fatalities can involve numerous contributing factors. These fatalities have been reported in the literature often in the context of particular areas of interest such as gender, age (2–13), site of injury (14–26), and toxicology (8,27–36). Results are limited to certain populations and various study criteria limiting generalization. In Canada and the Province of Ontario, annual information pertaining to motor vehicle collisions and traffic safety are published in the Canadian Motor Vehicle Traffic Collision Statistics (37) and Ontario Road Safety Annual Report (38). The Ontario Road Safety Annual Report (38) attempts to describe data using the same five factors suggested by Fierro (1). However, details pertaining to geographic differences of motor vehicle collision fatalities within the province are not detailed. Furthermore, the use of restraint devices such as seatbelts has been mandatory in the Province of Ontario since January 1976. Information gleaned from the Ontario Road Safety Annual Report reveals that seatbelt usage remains high even in fatal accidents at approximately 90% of occupants but there has been some variability as identified through the annual report (38).

This study examined motor vehicle collision fatalities experienced by the Regional Forensic Pathology Unit in Hamilton, Ontario, Canada. The Regional Forensic Pathology Unit serves the Hamilton-Wentworth Niagara region that includes the Haldimand, Halton, Hamilton-Wentworth, Niagara, Norfolk, and Simcoe counties. According to 2001 Census data (Statistics Canada, 2005), the population accounts for approximately 1.4 million persons over a combined geographical area of 5754.18 km^2. The region includes farming, heavy industry, urban, recreational, and seasonal communities connected with country, city, and regional roads that are paved and unpaved, and 400-series highways.

The aim of this study was to provide an illustration of fatalities due to motor vehicle collisions specific for the Hamilton-Wentworth Niagara region to facilitate possible future directive prevention strategies.

Methods

A retrospective analysis was completed on fatalities resulting from motor vehicle collisions (MVCs) between the years of 1999 and 2004 at the Regional Forensic Pathology Unit at Hamilton General Hospital in Hamilton, Ontario, Canada. All 329 decedents were examined by one of five forensic pathologists, with the majority of deaths investigated by three of these five forensic pathologists.

Case extraction was manually completed from log books that indicated whether or not a MVC resulted in death. Unfinished case reports, those with no cause of death recorded, and those which were external examinations only, were also retrieved for possible inclusion. Autopsy, police, and toxicology reports were read thoroughly for detailed information pertaining to this study. Cases in which a MVC was a determinate contributing factor resulting in death and those cases that included other various forms of vehicular transport (but not necessarily involved in a collision) were included initially for further data extraction.

A standard data extraction table was produced for analyzing each case. Human factors included age, gender, size, location of the decedent with respect to the motor vehicle, site(s) of injury, and co-morbidity. Decedent characteristics were segregated and classified as *in utero*, baby (<2 years), child (>2–17 years), or adult (>18 years). Position with respect to the vehicle included driver, passenger (and passenger placement if known), pedestrian, bicyclist, horseback rider, skateboarder, rollerblader, *in utero* (of which there were four cases), and unknown if information was not available. Site(s) of injury was classified as head, spine, torso, and/or limbs

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based on the observations, findings, and conclusions of the forensic pathologist. A fifth site of injury, *in utero*, was used to describe injuries suffered to one fetus in early stages of development (previable at <20 weeks). Co-morbidity as a contributing factor was recorded if listed as significant by the forensic pathologist.

Chemical factors included all toxicological results of testing of blood and urine as provided by the Centre for Forensic Sciences (CFS), Toronto, Ontario, Canada. Toxicological agents were identified based on the presence or absence and levels of ethanol, cannabinoids, drugs of therapeutic significance, and drugs of abuse. Testing of several decedents did not occur if these individuals were passengers in the vehicle or if death occurred remotely from the MVC. Prolonged survival time after injury resulted in a lack of blood and urine being available for testing. In cases where peripheral blood was insufficient, urine ethanol concentrations or heart blood concentrations were recorded. In the majority of cases, the ethanol concentration was measured in milligrams per 100 mL of whole blood. However, in those cases where concentrations were measured in mmol/L, a standard conversion chart was used to convert to mg/100 mL (39). For the purposes of this report, values will be converted to % w/v by a factor of 0.001.

Environmental factors for this study included conditions both external and internal to the vehicle. External conditions comprised the time of the day, the day of the week, and the season during which the MVC occurred. The time of occurrence was recorded in 6 h increments either as early am (12 am–6 am), late am (6 am–12 pm), early pm (12 pm–6 pm), or late pm (6 pm–12 am). The day of the week on which the MVC occurred was provided by police reports and hospital admission charts. The season was divided into 3-month intervals as follows: spring (March, April, May), summer (June, July, August), fall (September, October, November), winter (December, January, February). Weather conditions were recorded independently by police and for the study reported as snow, poor visibility, darkness, fog, rain, and wind and ice. Internal vehicular observations included whether the victim was restrained or unrestrained and completely or partially expelled. The presence of distracters (for example cellular telephones) or fatigue while operating the motor vehicle was noted in a few reports.

Types of vehicles were categorized as car, truck, sport utility vehicle (SUV), van, motorcycle, train, bicycle, plane, boat, pedestrian, or other. "Other" included all-terrain vehicles (ATVs), horses, industrial vehicles, rollerblades, skateboards, and sky-diving equipment. Vehicles were divided into primary and secondary vehicles and recorded separately. The primary vehicle was defined as that used by or containing the victim. In those instances in which the victim was a pedestrian, there was no primary vehicle assigned and the vehicle striking the pedestrian was considered secondary. The type of collision was classified as head-on, side-swipe, rear impact, side impact (t-bone), stationary object, roll-over, run-over, or "none" for cases that did not involve a collision between two vehicles or a vehicle and an object. Secondary and tertiary collisions were considered for analysis (for example a motor vehicle struck another vehicle head-on (1°), rolled over (2°), and then struck a stationary object (3°)); however, the variance in accidents and collisions was so large that further analyses were not possible. Mechanical failure was recorded as either present, absent, or unknown. The mechanism(s) of mechanical failure of the vehicle was not recorded and therefore not examined.

Other factors including road type, speed, place of death, and length of hospital stay were examined. The type of road on which the MVC occurred was recorded as residential (community streets branching from local roads), local (city and rural roads with a speed limit of 60 km/h or 37 mph), highway 80 km/h (rural highways with 80 km/h or 50 mph speed limits), or major highway (100 km/h speed limits, 62 mph, or more). High/excessive speed if documented was recorded. When the place of death was in hospital, the hospital stay was classified as either emergency, admission (0 < 12 h), day (more than 12 hours but less than 24 hours), week (more than 1 day but less than 7 days), month (more than 7 days but less than 30 days), or remote (>30 days).

Statistical Testing

Statistical analysis was performed using Statistica 6 ® software (40). The chi-square test and Fisher exact test were used to evaluate relationships between variables. Both tests are non-parametric methods that do not depend on the distribution of the decedent population. The chi-square test examined relationships between two dichotomous variables and the Fisher exact test determined the exact probability under the null hypothesis (that there are no differences between selected groups) of obtaining the distribution of frequencies across cells. Significance was determined as $p < 0.05$.

Chi-square tests were restricted to known information. When unknowns occurred within a selected variable, a second chi-square was performed to compare known to unknown values to ensure statistical integrity.

Ethics

This study was approved by the Research Ethics Board of McMaster University under the Tri-Council Policy of Canada for research with human participants and by the Chief Coroner for the Province of Ontario. Identifying information pertaining to decedents in the study population, including medicolegal case numbers and collision details, was not extracted in any data.

Results

All 321 fatalities identified as having resulted from MVC between January 1999 and December 2004 by the Regional Forensic Pathology Unit were examined in detail.

Human Factors

The study population ranged in age from fetal to 94 years with an average age of 38 years. The age of decedents demonstrated a normal distribution with a peak incidence in the age group 20 to <30 and a smaller peak in the age group 70 to <80. Eliminating the fetal group did not skew the age distribution of decedents.

Males represented 71.7% of the study population (230/321). Females were over-represented in the age group 70 to <80 years ($p = 0.0013$).

Most decedents were adults (279/321) with the remaining population represented by children (33/321), and infants and fetuses (9/321).

Position of the decedent with respect to the vehicle illustrated that driver fatalities were most common (45.2%, 147/321). Pedestrian fatalities were second to that of drivers comprising 21.8% (70/321). Passengers represented 53/321 (16.5%) and bicyclists 16/321 (5.0%). Though passenger location was not known in 35.8% of total passengers (19/53), there were 18/53 definitive observations of front seat passenger fatalities (33.9%).

There were more males than females as drivers (3.1:1), pedestrians (2.2:1), and bicyclists (7:1). Drivers were primarily between the age of 20 to <30 years (27.9%, 41/147). Males and females were almost equivalent with respect to passenger incidence (30/53 and

23/53, respectively). Exact passenger position in the vehicle was known amongst female decedents (21/34) more often than males (13/34) ($p = 0.0075$).

Passengers ranged from 10 to <90 years with the majority being 20 to <30 years (17/53). Front seat passengers were predominantly female (2:1) and had peak incidences aged 10 to <20 years and 70 to <80 years. All motorcyclist fatalities (4.7%, 15/321) were males ($p = 0.0059$) and a majority were between the age of 20 to <30 years (33.3%, 5/15). Pedestrians' ages were almost evenly distributed over the various age groupings with a slight skew toward the younger age group. Bicyclist fatalities were evenly distributed across all age groups except in those aged 50 to <60 years in which there were no cases.

Anatomic site of injury was variable within the population; however, head injuries occurred in 67.8% of the total population (229/321). Isolated fatal head injuries were the most prevalent occurring in 18.4% (59/321). The remainder of head injuries occurred in combination with other injury sites. Combined injuries of the head/torso/limb occurred in 14.6% of the population (47/321), and injuries in the combination of head/torso occurred in 14.3% (46/321). Isolated torso injuries occurred in 14.3% of the population (46/321). Head/torso/limb combination injuries were common in motorcyclists, pedestrians, and drivers. Head/torso injuries occurred most in drivers and were common in bicyclists. Isolated torso injuries occurred in drivers, front seat passengers, and other passengers for which passenger location was not known.

Cars were the most common primary vehicle. Specific sites of injury varied with respect to primary versus secondary vehicles, with head/torso (27/321) and isolated torso (19/321) injuries being most prevalent in the victim in the primary vehicle.

Single primary vehicle collisions represented 42.1% (135/321) of the study population. When secondary vehicles were present, trucks (17.8%, 57/321) and cars (17.1%, 55/321) were common. Sites of injury most commonly observed from involvement of trucks were in the combinations of head/torso (13/57), head/torso/limb (11/57), and head/spine/torso/limb (11/57). Cars as secondary vehicles produced isolated head (15/55) and head/torso/limb (9/55) injuries.

Chemical Factors

Toxicological analyses were performed following death in 85.1% of the study population (275/321). Peripheral blood was analyzed from 272 decedents. Ethanol was the most common toxicological substance identified in toxicological analyses occurring in 29.9% (96/321). Of the 29.9%, ethanol was found independently in 23.1% and in combination with other substances in 6.8%. The blood ethanol concentrations were reported to be from 0.009 to 0.441% w/v (9–441 mg/100 mL) of whole blood in 92 cases with the remaining four either in "trace" amounts (2/96) or having unknown concentrations (2/96). "Trace" amounts were defined by the Centre for Forensic Sciences in Toronto as between 0.005 and 0.009% w/v and so for the purposes of calculation and reporting in this paper will be referred to as negative. Ethanol was present in more males ($p < 0.001$) than females with a ratio of 3.8:1. When ethanol levels were detected to be >0.3% w/v (300 mg/100 mL), all of the decedents were males between the ages of 30 and <60 years. In cases where the ethanol concentration was <0.3% w/v, age was normally distributed around 20 to <30 years.

The distribution of ethanol concentrations was also analyzed with respect to 0.08% w/v (80 mg/100 mL), which is the legal limit for operating a motor vehicle in Canada (41). Of the 94 measured ethanol concentrations, 76.6% (72/94) were at or above the legal limit. Significantly more males were above the legal limit than females ($p < 0.001$) with a male to female ratio of 8:1.

Other toxicological substances identified included drugs of therapeutic significance and drugs of abuse with a combined incidence in 13.7% of the study population (44/321). Drugs of therapeutic significance were found in equal ratios between males and females (1:1) and were frequently represented in decedents aged 50 to <80 years. Typical drugs of abuse that were found included cannibinoids, stimulants (3,4-methylenedioxymethamphetamine), cocaine, heroin, and other opioids. Drugs of abuse, and particularly cannabinoids, were detected more in males compared with females (2.4:1) though not significantly ($p = 0.1891$) and were found primarily in those aged 10 to <40 years.

Environmental Factors

The majority of motor vehicle collisions occurred during the fall (31.2%). Summer and spring motor vehicle collisions accounted for 26.7% and 23.1%, respectively. The least represented season was winter (18.7%, 60/321). Weather conditions were felt by investigators (police) to have played a contributory role in 15 cases. These weather conditions included snow (6/15), poor visibility (3/15), darkness (2/15), rain (2/15), fog (1/15), and wind and ice (1/15), and occurred most often in spring (7/15) and winter (5/15).

Fatal collisions occurred most often on a Friday and on a Sunday. Collisions occurring on these 2 days were distributed around a peak age of 20 to <30 years. The male to female ratios were significant ($p = 0.0383$) and were 2.3:1 on Friday and 2.8:1 on Sunday. Decedents involved in collisions on a Friday were also frequently aged 30 to <50 and 70 to <80, whereas decedents involved in collisions on a Sunday were commonly 10 to <20 years and 30 to <40 years. Other days of the week and the number of fatal collisions were evenly distributed. There were differences in age with peak distributions in those 10 to <20 years on Wednesday, 20 to <30 years on Tuesday, Thursday, and Saturday, and 30 to <40 years on Monday. The male to female ratio by day of the week was a maximum of 4.8:1 on Saturday.

The majority of fatal collisions occurred between 6 pm and 6 am with 6 pm to midnight (late pm) representing 33.0% (106/321) and midnight to 6 am (early am) representing 29.0% (93/321). These collisions were most frequent on a Friday (22/106, 15/93), Saturday (14/106, 13/93), or Sunday (24/106, 19/93). Daytime collisions (late am and early pm) represented 29.6% (95/321). In the remaining 8.4%, the time of collision was not known (27/321). The differences between genders across all age groups did not attain significance with regard to the late pm and early am analyses ($p = 0.0695$). However, when those aged 20 to 29 years were compared to all other age groups during this time period findings did reach statistical significance ($p = 0.0173$).

Detailed analyses of the internal environment of the vehicles were abandoned as information was often missing and if provided, vague and inconsistent. Some information was provided regarding the use of restraints, expulsion of the decedent from the vehicle, and fatigue as a contributing factor of the collision causing death. Presence of patterned injuries (seatbelt injuries) or a lack thereof was not used as conclusive evidence of position within the vehicle.

Of the study population, 17.8% (57/321) were noted to have been expelled from the vehicle. Partial expulsion occurred in 1.6% (5/321). It is not known with certainty whether the remainder of the population (80.6%, 259/321) remained in the vehicle following the collision. Of those 57 decedents completely expelled from the vehicle, three were known to have been restrained and 15 were known not to have been restrained. Of the five decedents partially

expelled from the vehicle, 1 was known to have been restrained and 1 was known not to have been restrained.

Fatigue as a potential contributing factor was noted in 4/321 (1.2%) cases.

Vehicle Factors

Head-on collisions occurred in 112/321 fatalities (34.9%) in the study population and was the primary collision that occurred. The next most frequent collision was collision with a stationary object (19.3%, 62/321). Other collisions included side swipes (11.5%, 37/321), rear-end (8.7%, 28/321), roll-overs (7.5%, 24/321), side impacts/t-bones (6.2%, 20/321), and run-over (4.7%, 15/321).

The majority of collisions involved a single vehicle (primary or secondary in pedestrian collisions) (63.2%, 203/321). The primary vehicle was a car in 40.2% of decedents (129/321). Pedestrian fatalities accounted for 70/321 observations (21.8%).

Secondary vehicles were present in 57.9% of fatalities (186/321 observations). Trucks and cars were almost equally represented as secondary vehicles with 17.8% and 17.1%, respectively (57 and 55/321). There were 25 cases in which the primary and secondary vehicles were both unknown.

Mechanical failure was not a significant ($p = 0.7115$) problem as mechanical fitness was determined to be adequate in 96.9% of collisions (311/321 observations). Of the remaining 10 cases, there was one incident of mechanical failure (0.3%) and 9 (2.8%) in which mechanical fitness was unknown.

Location Factors

Most fatalities (45.2%, 145/321) occurred on local roads with 60 km/h speed limits. Roadways with a speed limit of 80 km/h, mostly regional roads, accounted for 26.8% (86/321) of the fatalities. Fatalities occurring in collisions on the 400-series highways (equivalent to divided Interstate US highways) with 100 km/h speed limits accounted for 11.2% (36/321) of decedents.

The most common collisions occurring on local roads (60 km/h) were head-on (53.6%, 60/112), followed by stationary object collisions (40.3%, 25/62), side swipe collisions (59.4%, 22/37), and rear collisions (46.4%, 13/28). Head-on collisions were most prominent on road ways with 80 km/h speed limits (23.2%, 26/112) and 100 km/h 400-series highways (12.5%, 14/112). On roadways with 80 km/h speed limits, stationary object (30.6%, 19/62) and side swipe collisions (35.1%, 13/37) were frequent. On 100 km/h, 400-series highways stationary object (17.7%, 11/62), roll-over (20.8%, 5/24), and rear collisions (10.7%, 3/28) were also common. Age groupings of the decedents with regard to road-type followed normal distribution patterns for local roads, 80 km/h roadways, and 400-series highways with a peak in 20 to <30 years reflecting age distributions. Fatalities on residential roads were common in 10 to <30 age groups with smaller peaks in decedents aged 40 to <50 and 60 to <70 years. Off-road deaths occurred most frequently in those aged 10 to <20 and 30 to <40 years.

Of those collisions in which excessive speed was noted (54 cases), 22 occurred on regional roads (80 km/h), 19 occurred on local roadways (60 km/h), and 8 occurred on the 400 series (100 km/h) roadways. Of the subgroup of decedents in whom speed was considered to be a factor, males were involved in 38/54 and females 16/54. The age group represented most commonly was 20 to <30 years (35.2%, 19/54) followed by decedents aged 30 to <40 years (22.2%, 12/54), and 10 to <20 years (16.7%, 9/54).

Death occurred at the scene in 54.5% (175/321) and was significantly greater for males ($p = 0.0095$) compared with females. The remainder (45.5%, 146/321) died in hospital, either in emergency (30.1%, 44/146), during admission between 0 and 12 h (26.7%, 39/146), within 1 day between 12 and 24 h (15.1%, 22/146), within the first week (16.4%, 24/146), during the first month post-collision (6.8%, 10/146), or a remote time following the motor vehicle collision (4.1%, 6/146).

Discussion

Age and Gender

It has been reported in the literature that more males than females are injured and/or die in motor vehicle collisions (4,6,9,10,13,16,42). Fatalities resulting from motor vehicle collisions reflected these findings as males compromised 71.7% of the decedent population. Males exceeded females in the majority of age categories, with the exception of the 70–79 year age group. The average age of the study population was 38.0 years. Males were on average younger than females as the average age of males in the study was 36.1 years and that of females was 42.8 years. Though this study included four fetal deaths, three females and one male, removing those fetal deaths did not change average age results or distributions.

Site(s) of Injury and Location with Respect to the Vehicle

Sites of injury and location of the decedent to the vehicle in our study reflected the common locations and injuries frequently documented in the literature (43). This study demonstrated that common injury sites included head or torso, and combinations of head and torso, head, torso, and limb, and head, spine, torso, and limb. Fatalities were primarily drivers and frequently pedestrians and front seat passengers. As supported in the literature (1,14,15,17–23,26), the injury patterns commonly afflict drivers, pedestrians, and front seat passengers. Drivers were also commonly 20–29 and 30–49 years. Though the literature demonstrates that teenagers are at a higher risk for involvement in motor vehicle collisions most often as drivers (3,5,44), teenagers were also primary participants in pedestrians and passenger groups.

Toxicology

Since the intent of this paper was not to review the performance of toxicology testing and the reporting of results, it was accepted that the quantitation of drugs was scientifically sound. All testing was done in a forensic laboratory, which is regulated to the standards for forensic work as accepted by regulatory bodies. Forensic pathologists are dependent on robust testing as performed and the reports were used to formulate conclusions with regard to the contribution of these substances in the collision events. For interpretation of tetrahydrocannabinol (THC), only if the active ingredient was identified was it considered as a potential contributor to the collision. If any of the nonactive metabolites of this product were identified, it was defined as "cannabinoids;" furthermore it was not possible to state whether or not there was active THC present at the time of the collision especially when there was even a short survival time.

The study group exemplified established findings in the literature regarding toxicological findings and motor vehicle collision involvement, responsibility, and fatality. Toxicology screens were positive in approximately one-third of the study population and

included all but 50 decedents in whom toxicology was unknown or not performed (including fetal deaths, children, and passengers). Isolated ethanol and ethanol in combination with cannabis were most frequent (27,28,35,36,43,45–52). Isolated ethanol and ethanol in combination with cannabis is known to impair driving skills (53–56) whereas isolated cannabis and impact on the driver is not entirely evident (57,58). Decedents were primarily males aged 20–29 years and over half of those with positive toxicology findings were drivers, also evident in other studies (59). Ethanol consumption and drug use did not differ between seasons but was increased on the weekend (3,27,60).

Vehicular Factors

Vehicles involved in collisions were most commonly cars, trucks, and bicycles (3,61,62). Other vehicles including motorcycles, SUVs, and off-road and industrial vehicles were included in this study and are not commonly studied in the literature. Studies including those cited often observe vehicle and site of injury correlations; however, in this study gender differences in the decedent population and vehicles involved in those fatal collisions illustrated differences. Males were commonly pedestrians and bicyclists and in collisions with trains and cars. When occupying a vehicle, males typically were in cars and either were participant in single-vehicle collisions or in collisions with trucks. Females were primarily pedestrians or occupants of cars. As pedestrians, they were struck by cars, trucks, trains, and vans. As occupants of cars, they were in collisions similar to that of males. The literature examines causal factors of fatal collisions including risk-taking behaviours and environmental contributors (12,13,63). In this study, various contributors were analyzed. Mechanical failure was recorded and observed not to be a significant factor contributing to fatal motor vehicle collisions fatalities illustrating operator responsibility and error.

Motor vehicle collisions reflected common collisions occurring in the literature (3,6,64). Head-on, stationary object, and side swipe collisions were frequent and these collisions occurred in the younger and older populations. These collisions were also supported by the road type on which collisions frequently occurred on including local and regional roads (3). Local and regional environments typically have higher volumes of motor vehicles. Their speed limits were also often abused as determined in this study from police reporting, though it is possible that under-reporting of speed contributing to a fatal collision has occurred.

Environmental and Other Location Factors

Fatalities produced seasonal differences when differences were not reflected in some literature (25). Fatalities occurred most often in the fall perhaps reflecting seasonal trends of student populations attending university or college within Hamilton. Summer fatalities may have been increased because of the pursuit of recreational activities within our community. Fatal collisions occurred most in the early am and late pm and in particular on Fridays and Sundays. Combining these results with seasonal and toxicological findings, it may be inferred that collisions occurred as a result of beginning or returning from travel and primarily returning from night-time activities like "bar-hopping" on Saturdays. More males than females represented the population on these days and during these times and in particular were commonly 10–29 years of age further confirming the literature (27). Weather conditions, as reported in police reports, were not found to play a significant role in these collisions or in fatal collisions in general.

Of interest were fatal collisions occurring on Wednesdays in the winter season. These collisions occurred most during the early morning and late evening like other seasons. Upon review it was found that Christmas Eve and Christmas Day and New Year's Eve and New Year's Day occurred on a Tuesday–Wednesday and Wednesday–Thursday for the years 2002 and 2003.

Regarding place of death, findings were similar to a study conducted by Toro (25) who found that death at the scene occurred in 48.3% of the population and for those who were treated in hospital, death occurred within hours of admission or shortly thereafter. Remote survival was infrequent. In this study, decedents were found to die at the scene and in hospital at almost equal frequencies. For those who were treated in hospital, death followed often within emergency or following admission. Rarely decedents did survive beyond 1 week postcollision.

Conclusion

This study of motor vehicle collision fatalities occurring in the Hamilton-Wentworth Niagara region confirmed numerous findings in the literature. Demographic analyses demonstrated that young male drivers were and continue to be most at risk for involvement in fatal motor vehicle collisions, that males in general are involved in fatal motor vehicle collisions more often than females, and that ethanol and/or cannabis are frequently identified. Despite efforts by law enforcement, civilian organizations such as Mothers Against Drunk Driving (MADD), and government agencies at municipal, regional, provincial, and national levels to reduce deaths related to motor vehicle trauma particularly in conjunction with the abuse of ethanol and other drugs, the trend continues. The findings of this study that the majority of deaths occurred around the time periods of Thursday evening to Sunday evening correlates well with social behavior patterns involving ethanol. Harm reduction strategies need to be further enhanced in order to achieve a successful decrease in this trend since it is very apparent that human and chemical factors continue to have the most significant impact on the outcomes as identified.

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