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REPORT **R-826**

Work-Related Road Collisions in Québec, from 2000 to 2008

Characteristics and Classification

Sonia Pignatelli
François Bellavance
Patrice Duguay

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PEER REVIEW

In compliance with IRSST policy, the research results published in this document have been peer-reviewed.

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SUMMARY

Approximately 2% of all workers who receive compensation from the Commission de la santé et de la sécurité du travail du Québec (CSST) were involved in a work-related road collision (WRC). Yet, road collisions account for 25% to 30% of all work-related accidental deaths. They are the leading cause of work-related accidental deaths.

Given this, the IRSST sponsored a study of WRC in Québec. The study had two parts, and a separate report has been published for each part. The first part of the study was a review of the literature on WRC risk factors (IRSST report R-791 available in French only). The second part was an innovative statistical data analysis, the subject of this report. Through the combined efforts of the CSST and the Société de l'assurance automobile du Québec (SAAQ), a unique database was created, covering over 8000 workers compensated by the CSST following a work-related road collision that took place between 2000 and 2008.

Most workers involved in a WRC were driving a vehicle (83%), but some were passengers (11%) or pedestrians (6%). Almost 25% of WRC involved truck drivers or delivery drivers, 10% involved police officers or detectives, 6% were labourers or material handlers, 5% were bus drivers and just under 3% were specialized and support staff in nursing and therapeutic occupations. Together, these occupations accounted for close to half of the workers involved in WRC.

The sectors of activity where the most WRC occurred were public administration (22%), transportation and warehousing (20%), trade (14%), other commercial/personal services (12%) and health and social services (10%). Almost four out of every five victims of WRC were from these sectors.

Using multiple correspondence and cluster analyses, seven segments (types) of WRC were identified. The largest segment (in terms of number of workers compensated) included mainly collisions between two or more vehicles where the speed limit was 60 km/h or less: one quarter of all WRC were in this segment. The second largest segment (23%) also included victims of collisions between two or more vehicles, but the accidents occurred where the speed limit was higher. The percentage of serious or fatal accidents in this segment was double the average, at 31%. A third segment (18%) included workers injured primarily in accidents involving only one vehicle—a single-vehicle road departure, for example, or a collision with a stationary object. The fourth segment (16%) included mainly workers who had no apparent injuries at the time of the accident, according to the police report. A fifth segment (10%) principally covered accidents involving emergency vehicles such as police cars, ambulances or fire trucks. The sixth segment (6%) comprised accidents involving pedestrians, one out of four of whom were seriously or fatally injured. A last segment (2%) was chiefly formed of workers injured in a forest environment; though few in number, these accidents had the highest percentage of serious or fatal injuries (one in three accidents).

Characteristics that differentiate these seven segments include type of vehicle, speed limit, environment, nature and severity of the injury, probable cause of the accident, type of accident,

road configuration, time of the accident and worker's gender. There were also significant differences among the segments with respect to number of days of compensation and total benefits paid.

The prevention of work-related road collisions is a challenge for the workplace and the CSST. The results of this study contribute to a better understanding of the problem and provide information that can help in developing prevention programs specifically adapted to each of the work-related road collision segments identified.

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1. INTRODUCTION

In the industrialized countries, the ratio of accidental work-related deaths occurring on the road is very high [1, 2]. In Québec, although only 2% of victims compensated by the Commission de la santé et de la sécurité du travail du Québec (CSST) are workers involved in a work-related road collision (WRC), deaths linked to road accidents constitute between 25% and 30% of all accidental deaths in the workplace [3, 4] and are the leading cause of work-related accidental deaths.

Despite this, relatively few studies have examined the characteristics of and the risk factors associated with this type of event. For the most part, this is due to a lack of integrated databases containing information about both compensated workers and the circumstances of the accidents, such as causes, road configuration, time and day of the accident, type of vehicle involved, and weather conditions. [5].

In response to the situation and drawing upon methods suggested in the literature to improve understanding of this type of industrial accident [6], the CSST and the SAAQ combined their efforts to create a database unique in Québec. The matching of data provides a broader perspective of over 8000 work-related road collisions that occurred between 2000 and 2008.

The objective of this study is to carry out an in-depth descriptive analysis of this database using univariate and multivariate methods, including multiple correspondence analysis and cluster analysis. The results pinpoint the main characteristics of WRC and help to draw up a portrait of the most common scenarios of work-related road collisions.

This report is divided into three sections. The first explains the approach used in the study, the data available and the statistical tools and methods used. The second part shows the results of the descriptive analysis of work-related road collisions and highlights their significant differences with respect to road collisions with injured victims in Québec as a whole over the same period. It also includes the results of the multiple correspondence analyses and cluster analyses that identified seven WRC segments and provides a description of them. The final section discusses the results obtained.

2. METHODOLOGY

The goal of this section is to present the approach used in the study and to explain some of the choices made. The data available for the study, the stages of data preparation and the statistical tools and methods used will be described.

2.1 Data-matching Process

The CSST and the SAAQ provided the research team with a file containing information on the work-related road collisions that occurred in Québec between 2000 and 2008. The file contains information on victims compensated by the CSST, the vehicles involved and the circumstances surrounding the events. It was compiled using a data-matching approach that consisted of enriching the information of CSST data files with that of various SAAQ files. While the information from the CSST was useful for understanding the extent of the phenomenon, it did not provide information about the circumstances of a given accident, other than its type.

The CSST and the research team carried out the first step of the matching process, drawing up a list of information relevant to this study. The list included personal data, such as last and first name, date of birth, social insurance number, health insurance number, gender and the date of the event. That information enabled the SAAQ data to be matched to it. The CSST extracted information dated between 2000 and 2008 from the 114,094 compensation claim files for which the cause of injury was a road collision, a transportation accident or unknown (see Table 1). The definition of WRC used in this study for the data extraction applies to any event in which compensation was paid by the CSST to at least one worker, involving a road vehicle in movement or caused by a road vehicle in movement. Off-road accidents and accidents involving pedestrians or non-passengers in a non-road or unspecified area, for which the causal agent of the injury was a plant or industrial powered vehicle, were excluded. It is the same definition as that used in a previous study by the IRSST [4]. The CSST then sent the data file containing the information directly to the SAAQ, which matched it with their data from police reports. It therefore excludes WRC occurring outside of Québec to workers covered by the CSST.

For files with an accident-type code clearly associated with a road collision (13,131 cases), a match rate of 57.9% (7598 files) was obtained by the SAAQ. For files in which the accident-type code was unknown or missing (100,963 files), the match rate was 1.9% (1000 subjects). There could not be a very high rate of matches for this type of file, because it covers all industrial accidents with a missing value for type of accident, and not solely work-related road collisions. Table 1 shows the match rate for each type of accident suitable for extraction from the CSST's compensation claim files. A total of 8598 files from the CSST were matched with SAAQ data.

Once matching and verification of the internal consistency of the data was done, a depersonalized file (i.e., with no personal information) was provided by the SAAQ to the research team for data processing and analysis.

Table 1 Matching rate between the CSST and SAAQ data

Accident-type code (CSST)	Description	Number of CSST files	Number of files matched with SAAQ data	Matching rate (%)
40000	Transportation accident, unspecified	227	139	61.2
41000 to 41900	Highway accident	10 994	6 708	61.0
42000 to 42200	Non-highway accident, except rail, air, water (excluding cases in which the cause was a plant or industrial powered vehicle, codes 85000 to 85900)	615	191	31.1
43000	Pedestrian struck by a vehicle or unspecified mobile equipment, (for this type of accident, cases in which the causal agent was a plant or industrial powered vehicle must be excluded, codes 85000 to 85900)	226	96	42.5
43100	Pedestrian struck by a vehicle or mobile equipment in a roadway	378	210	55.6
43200	Pedestrian struck by a vehicle or mobile equipment, on the side of a road	99	51	51.5
43300	Pedestrian struck by a vehicle or mobile equipment, in a parking lot or non-roadway area (excluding cases in which the causal agent was a plant or industrial powered vehicle, code 85000 to 85900)	452	148	32.7
44200	Collision between a railway vehicle and another vehicle	57	23	40.4
49000	Transportation accident, NEC	83	32	38.6
Sub-total	**Coded files**	**13 131**	**7 598**	**57.9**
99990	“Unknown” or “Uncoded” files	12 425	107	0.9
	Files with a missing value	88 538	893	1.0
Total	**Total number of files**	**114 094**	**8 598**	**7.5**

2.2 Data Available to the Research Team

The information in the matched file from the CSST concerns the worker receiving compensation (age, gender, profession, annual income, etc.), the characteristics of the enterprise where he or she is employed (sector of economic activity, insurable payroll, etc.), the injury (date of event, causal agent, nature and site of the injury, etc.), and its consequences (number of days of compensation, total benefits, income replacement indemnity, permanent physical or mental

impairment, medical assistance expenses, occupational rehabilitation, social rehabilitation, rehabilitation expenses, death benefit, total expenses, total amount of indemnities, etc.).

The SAAQ provided data from police reports completed at the scene of the accident. The data concerned the people involved (victim's age and gender, type of road user, seatbelt use, numbers of years of driving experience, severity of injuries, etc.), the type of vehicle (automobile, heavy vehicle, emergency vehicle, etc.) and the circumstances surrounding the accident (road configuration, nature and condition, road category, cause of the accident, signage, vehicle movement, visibility, lighting, weather or meteorological conditions, time of the accident, environment, etc.).

Information about the causes of accidents came from a supplementary police report that is generally completed for accidents with injuries. Several causes for the same event can be provided in the report. If several causes appeared, only the top two causes of the accident, according to the police officer, were selected for this study. It is also important to note that the accidents reported were not necessarily caused by the workers who were compensated. This was a limitation of the available database.

In general, the SAAQ data did not reveal whether the people involved in the accident were working at the time of the accident, except in certain cases (drivers of heavy vehicles or emergency vehicles); this could only be determined through the CSST data. Appendices 1a and 1b provide the list of all the variables available in the matched database provided to the researchers. Only a subset of these variables was used in this study to characterize the work-related road collisions. The modalities of the variables used are presented in the tables of the results in section 3 of this report.

In addition to the matched CSST-SAAQ file, the SAAQ provided information on all road accidents with injuries from 2002 to 2008, which enabled a comparison to be made between WRC and road accidents with injuries in general.

2.3 Preparation of Data by the Research Team

Before the various statistical analyses were carried out, preliminary data preparation steps were taken. Among the most important was the grouping of certain modalities. This was a necessary step in the use of multiple correspondence analysis [7], enabling information to be summarized and facilitating the interpretation of results. The groups were formed based on the study of the frequency tables. They concerned nominal variables with numerous modalities, of which several were infrequent.

Another preparation step involved creating new variables. Since a police officer could record more than one cause in the accident report, and we selected the two main causes for the analyses, and binary variables associated with various possible causes of accidents were created (Appendix 2). Each of these variables, which were 14 in number, was defined as follows: if the cause was found among the two main factors that contributed to the accident, the binary variable was equal to 1; if not, the value was equal to 0. This step was performed to make it possible to use the probable causes of accidents in the analyses.

The data and the various analyses were processed using SAS software, version 9.2 for Windows.

2.4 Statistical Analyses

The study of the variable frequency tables enabled the characteristics and principal causes of WRC to be pinpointed and a comparison to be made with those that were not associated with work as a whole.

An in-depth descriptive analysis of WRC was then performed. Multiple correspondence analysis (MCA) was performed on a selection of variables from the matched database, a particularly appropriate method in a case such as this, in which most of the variables were categorical. MCA was used in order to condense the information contained in the variables into a smaller number of factors (or dimensions) that were subsequently used in a cluster analysis of the WRC. For the MCA, the variables were divided into two groups, active and illustrative. The former were used in the process of calculating factors used in the cluster analysis to identify WRC segments, while the latter, although they had no impact in the calculation of factors, played just as important a role in the interpretation of segments.

Since the objective of this study was to describe WRC according to the characteristics and circumstances of accidents, the active variables for the MCA were selected from the SAAQ variables. The CSST variables were used only as illustrative variables to document the segments and provide additional information on the workers involved.

The selection of active variables for the MCA was based on several criteria, some of which were indispensable to the use of the method. It is preferable to choose active variables with little correlation. Each active variable must provide additional information in the scope of the analysis. That is why, for example, the variable “Type of vehicle” (automobile, heavy vehicle, etc.) was selected, while others, such as the number of cylinders or vehicle weight, were not. For the same reasons, only one of the “Severity of injuries” and “Severity of accident” variables was chosen. The “Driving experience” variable, which represents the numbers of years of driving experience, was not retained as an active variable, because it was strongly correlated with “Age.” In addition, the selected variables could not have many missing values. This is why the “Seatbelt use” variable, which has a missing value rate of 29%, was not kept as an active variable. In order to obtain results that could be interpreted with respect to the MCA and the cluster analysis, the modalities of variables had to be aggregated into a small number of similar-sized groups. Finally, the active variables chosen were those more closely related to the circumstances surrounding the accidents and how they occurred.

Tables 2 and 3 present the list of active variables selected for the MCA and the illustrative variables, respectively. The variables were categorized according to whether they defined a characteristic of the worker, the vehicle or the accident (event).

Table 2 List of active variables used in the MCA

ACTIVE VARIABLES		
Worker	**Vehicle**	**Event characteristics**
Gender, age, severity of the injuries, user type	*Vehicle type and age*	*Time, day, month, road configuration, accident reconstruction diagram, environment, type of accident, nature of roadway, signage, weather, visibility, speed limit, vehicular movement*

Table 3 List of illustrative variables

ILLUSTRATIVE VARIABLES		
Worker	**Vehicle**	**Event characteristics**
Occupation, economic activity sector, injury site, number of days of compensation, total amount of benefits, seatbelt use		*Severity of the accident, Road condition, road surface condition, probable causes, lighting, number of vehicles*

An analysis of WRC segments using the first dimensions of the MCA was then carried out. Its goal was to identify the segments of work-related road collisions with similarities in terms of characteristics and risk factors.

3. RESULTS

This section presents the results of various analyses carried out in the scope of the study. First, the results of the descriptive analysis on work-related road collisions and the comparison between these accidents and road accidents with injured people "in general" are presented. Next, the results of the multiple correspondence analyses and cluster analyses, which identified seven WRC segments are shown. In the final part, the results of the descriptive analysis of the seven segments are revealed.

3.1 Descriptive Analysis of WRC

This section provides a portrait of all the characteristics of work-related road collisions. It is the result of a descriptive analysis of the information on the 8598 WRC victims contained in the matched CSST and SAAQ database. The information is presented in three parts: a description of the victims, a description of the vehicles involved and information to better understand the circumstances surrounding WRC.

3.1.1 Characteristics of WRC Victims

Table 4 presents the characteristics of workers involved in WRC for the variables originating from the SAAQ database: user type, age, gender, severity of injuries, numbers of years of driving experience and seatbelt use. The table also takes into account the comparison between WRC victims and victims of road accidents with injuries in general (non-WRC). Since the majority of workers compensated by the CSST following a work-related road collision are drivers aged between 18 and 65, for this comparison we selected only drivers aged 18 to 65 for both WRC and non-WRC (last two columns in Table 4). Furthermore, despite the fact that WRC are, by definition, accidents in which the workers involved were compensated by the CSST for a minor, serious or fatal injury, in one out of four cases the police report stated that there was no apparent injury (Table 14). Therefore, to make as fair a comparison as possible between the two groups, we also excluded the comparison of drivers without apparent injury according to the police report, both for the WRC and for the non-WRC. The result is a comparison between the various accident characteristics pertaining to the 5080 drivers aged between 18 and 65 injured in a WRC, and the 196,322 drivers aged from 18 to 65 injured in a road accident in Québec during the period under study.

Table 4 Characteristics of WRC victims—SAAQ variables, 2000 to 2008

	All WRC		WRC (Drivers)		Non-WRC (Drivers)	
	%	n	%	n	%	n
Number of victims		8 598		5 080		196 322
User type						
Driver	83%	7 148	100.0%	5 080	100.0%	196 322
Passenger	11%	904				
Pedestrian	6%	520				
Unspecified	0%	26				
Gender						
Female	26%	2 250	23.5%	1 196	47.3%	92 940
Male	74%	6 348	76.5%	3 884	52.7%	103 373
Missing values					0.0%	9
Age						
Mean (standard deviation; min; max)	39 (12; 11; 78)		39 (11; 18; 64)		36 (13; 18; 64)	
0-15	0%	5				
16-24	11%	972	10.3%	525	26.1%	51 313
25-34	28%	2 396	27.8%	1 411	24.2%	47 452
35-44	27%	2 344	27.8%	1 412	21.7%	42 656
45-54	23%	1 947	23.8%	1 207	17.9%	35 099
55-64	10%	842	10.3%	525	10.1%	19 802
65+	1%	92				
Severity of injuries						
No apparent injury	25%	2 128				
Minor injury	65%	5 626	87.7%	4 457	92.0%	180 684
Serious injury	8%	656	9.3%	474	6.7%	13 068
Deceased	2%	188	2.9%	149	1.3%	2 570
Driving experience (class 5)						
< 1 year	1%	94	0.9%	48	4.8%	9 408
[1–2 [	1%	97	1.1%	58	5.4%	10 626
[2–6 [	8%	681	8.4%	427	17.3%	33 902
[6–11 [	14%	1 165	14.4%	729	15.0%	29 490
11 years or more	69%	5 919	73.9%	3 753	55.9%	109 742
Outside Québec/unspecified	8%	642	1.3%	65	1.6%	3 154
Seatbelt use						
Used	59%	5 053	73.7%	3 743	85.0%	166 800
Not used or used incorrectly	12%	1 033	14.2%	721	11.4%	22 426
Missing values	29%	2 512	12.1%	616	3.6%	7 096

The average age of WRC victims is 39 (standard deviation of 12 years) and almost three quarters of them are men (74%). The largest group is the "25–34 year" age group (28%), closely followed by the "35–44 year" age group (27%).

Of note is that 83% of WRC victims were driving when the accident occurred and 90% of them sustained minor injuries that did not require hospitalization or had no apparent injury, according to the police report. There are also many missing values for the "Seatbelt use" variable attributable to victims "Without apparent injury" (according to the police report) for which that information was not gathered.

Among the differences between WRC and non-WRC is that women are more highly represented in non-WRC (47.3%) than in WRC (23.5%). Age distribution is also different. By comparison, the percentage of victims under 24 years old is 26.1% for the non-WRC and 10.3% for WRC. The rate of serious or fatal injuries is slightly higher for WRC (12.2% versus 8.0%). The rate of seat belt use is also lower for drivers who were victims of WRC (73.7% versus 85.0%).

Table 5 presents additional information about WRC victims that comes from certain variables compiled by the CSST, such as occupation, the employer's sector of activity and injury site. The most highly represented sectors are those of "Public administration" (22%), "Transportation and warehousing" (20%) and "Trade" (14%). Also, among occupations with the highest number of WRC victims are found "Truck drivers" (18%), who, along with delivery drivers [1] (6%), constituted almost a quarter of the victims. They are followed by "Police officers/detectives" (10%), "Handlers" (6%) and "Bus drivers" (5%). Thus, ten occupations represented more than half of WRC. In 39% of the cases, the injuries affected the "Cervical, lumbar or thoracic" regions and in 32% of the cases, they were "Multiple."

Table 6 shows the results of cross-referencing of CSST and SAAQ data. The data were of the average indemnities paid and the average number of days of absence from work for the four levels of injury severity, according to the police report. A positive relationship can be seen between the level of severity of injuries and the average amount of indemnities paid. By using the information in this table, it is estimated that approximately 57% of total indemnities from the CSST were paid to workers who were slightly injured or had no apparent injury, which constitutes 90% of the victims. In turn, 10% of victims who sustained serious injuries (8%) or who died (2%), received 43% of indemnities paid by the CSST for WRC. This estimate is based on the average amount of indemnities paid and the number of victims for each level of severity of injury.

[1] The occupations of truck drivers and delivery drivers are two closely related occupations that can be grouped together.

Table 5 Characteristics of WRC victims—CSST variables, 2000 to 2008

	All WRC	
	%	n
Number of victims	100%	8 598
Workers' occupations		
Truck drivers	18%	1 508
Police officers and detectives	10%	865
Delivery drivers	6%	552
Labourers, material handlers and comparable workers	6%	527
Bus drivers	5%	439
Nursing and therapeutic specialized and support staff	3%	223
Security guards and officers	2%	164
Travelling salespeople	1%	101
Registered nurses, with the exception of supervisors	1%	100
Letter carriers	1%	86
Other		
Non-manual (white collar)	11%	937
Mixed (manual and non-manual)	10%	878
Manual (blue collar)	9%	750
Missing values	17%	1 468
Employers' primary economic activity sectors		
Public administration	22%	1 877
Transportation and warehousing	20%	1 697
Trade	14%	1 203
Other business/personal services	12%	996
Medical and social services	10%	884
Communication and energy	5%	472
Public works and buildings	5%	447
Missing values	12%	1 022
Injury sites		
Cervical, lumbar, thoracic spine, neck, vertebrae	39%	3 393
Multiple sites	32%	2 788
Upper limbs and face	10%	901
Lower limbs	8%	655
Internal organs and nervous system	6%	475
Brain, skull	2%	161
Other/cannot be classified	3%	225

Table 6 Number of days of compensation and indemnities paid by the CSST according to severity of injuries, 2000 to 2008

	Type of injury				
	Total	**WAI**[2]	**Minor**	**Serious**	**Death**
Number of victims	8 598	2 128	5 626	656	188
%	100%	25%	65%	8%	2%
Days					
n[3]	7 228	1 632	4 931	630	35
Mean	141	99	120	410	217
Median	21	14	20	166	19
5th percentile	2	2	2	5	3
25th percentile	8	6	8	39	14
75th percentile	94	58	80	641	220
95th percentile	906	524	714	1 562	1 373
Indemnities ($)					
n	8 530	2 100	5 590	655	185
Mean	15 382	7 236	10 645	61 553	87 496
Median	1 704	956	1 636	19 953	68 686
5th percentile	160	109	177	395	1 826
25th percentile	557	384	578	4 146	12 989
75th percentile	8 787	3 925	7 278	83 302	145 478
95th percentile	93 026	33 215	54 207	233 374	228 461
Estimated costs (in thousands of $)	132 254	15 398	59 889	40 379	16 449
%	100%	12%	45%	31%	12%

[2] WAI: Without apparent injury.

[3] The number of days of compensation is available for 7228 of the 8598 WRC victims in our sample. The number of days of compensation is missing for victims who died at the scene of the accident or in the following hours.

3.1.2 Characteristics of Vehicles Involved in WRC

Table 7 provides information on vehicles involved in WRC. The "Light trucks" category includes all trucks weighing less than 3000 kg and the "Heavy vehicles" category includes road tractors, tool vehicles (bulldozers, snowblowers, excavators, etc.), equipment vehicles such as tow trucks, vehicles used to transport hazardous goods, and any other vehicle weighing more than 3000 kg. More light trucks and heavy vehicles (41%) than automobiles (33%) are involved in WRC. Ten percent of these are emergency vehicles (police, fire, ambulance, etc.), 6% are buses, and 1% are in the "Other types" category, which includes smaller vehicles such as scooters, bicycles and ATVs. In addition, 6% of victims included in the sample are pedestrians. They are workers involved in a WRC other than as a driver or passenger, which explains the missing value for type of vehicle. That diversity of vehicles is not found in the non-WRC, in which the majority of vehicles involved are automobiles (80.3%). In addition, the proportion of more recent-model vehicles is much higher for WRC then for non-WRC.

Table 7 Characteristics of vehicles involved in WRC, 2000 to 2008

	All WRC		WRC (Drivers)		Non WRC (Drivers)	
	%	n	%	n	%	n
Number of victims		8 598		5 080		196 322
Type of vehicle						
Automobiles	33%	2 855	34.2%	1 737	80.3%	157 670
Light trucks < 3000 kg	18%	1 546	18.3%	932	11.1%	21 810
Heavy vehicles ≥ 3000 kg	23%	1 988	28.0%	1 423	0.0%	5
Unspecified trucks	1%	107	1.4%	70	0.0%	0
Emergency vehicles	10%	834	8.9%	450	0.0%	21
Bus/minibus	6%	542	6.3%	322	0.0%	17
Other types	1%	94	1.6%	83	7.7%	15 021
Missing values	7%	632	1.2%	63	0.9%	1 778
Age of vehicle						
2 years and less	35%	3 022	37.2%	1 892	20.6%	40 363
Between 3 and 5 years	25%	2 122	25.8%	1 311	21.0%	41 154
6 years and more	32%	2 728	34.4%	1 749	58.5%	114 786
Missing values	8%	726	2.5%	128	0.0%	19

3.1.3 Characteristics of the Circumstances Surrounding WRC

The description of the circumstances surrounding WRC covers five aspects: the moment (time, day, season, weather conditions), the scene (road category, environment, signage, speed limit), the type of accident (severity, type of collision), the features of the road (configuration and condition, lighting) and the causes of the accident.

Table 8 presents the characteristics associated with the moment of the accident. Most WRC took place between 8:00 a.m. and 8:00 p.m. (78%), and, in 90% of the cases, on a weekday (Monday to Friday). Winter (December to February) is the season in which WRC are the most frequent

(30%), followed by fall (September to November) (26%). For more than half of WRC (53%), the weather at the time of the accident was clear and thus did not affect vision. The number of missing values for the "Visibility" variable is high, because that information was not gathered for most of the victims "Without apparent injury."

Among the differences between WRC and non-WRC, the distribution is different with respect to time (more accidents during daylight hours for WRC), day (more accidents from Monday to Thursday and fewer on weekends for WRC), season (more accidents in the winter and fewer in the summer for WRC), and weather (more accidents when there is precipitation and wind for WRC).

With respect to road categories, WRC occur most frequently on numbered routes (43%) (Table 9). In addition, they occur most frequently in "Business or retail" (31%) and "Rural" (30%) environments. There are fewer WRC than non-WRC in environments where there are schools or residences (16.7% compared to 22.0%), and in business and retail areas (32.8% compared to 38.0%); environments that have speed limits of 60 km/h or less (38.0% compared to 47.5%). In contrast, the percentage of WRC compared to non-WRC is higher in rural environments (37.8% compared to 32.2%), where the speed limits are generally 80 or 90 km/h (27.3% compared to 22.8%).

Table 8 Characteristics associated with the moment of the accident, 2000 to 2008

	All WRC		WRC (Drivers)		Non WRC (Drivers)	
	%	n	%	n	%	n
Number of victims		8 598		5 080		196 322
Time of accident						
Midnight to 3:59 a.m.	5%	419	4.4%	221	7.0%	13 832
4:00 a.m. to 7:59 a.m.	11%	942	11.5%	585	10.2%	20 074
8:00 a.m. to 11:59 a.m.	32%	2 712	31.2%	1 584	17.7%	34 834
12:00 p.m. to 3:59 p.m.	29%	2 490	29.5%	1 500	24.6%	48 322
4:00 p.m. to 7:59 p.m.	17%	1 420	16.4%	832	26.8%	52 589
8:00 p.m. to 11:59 p.m.	7%	615	6.3%	320	12.8%	25 061
Missing values			0.7%	38	0.8%	1 610
Day of accident						
Monday	18%	1 510	18.1%	918	13.2%	25 914
Tuesday	19%	1 659	19.4%	986	13.8%	27 099
Wednesday	20%	1 700	19.1%	970	13.9%	27 311
Thursday	18%	1 534	17.8%	906	15.6%	30 589
Friday	15%	1 296	15.4%	783	17.6%	34 478
Saturday	6%	523	5.9%	298	13.9%	27 367
Sunday	4%	376	4.3%	219	12.0%	23 564
Season						
Winter	30%	2 578	29.3%	1 488	25.8%	50 596
Spring	21%	1 805	21.1%	1 074	21.5%	42 124
Summer	23%	1 937	23.2%	1 177	27.1%	53 225
Fall	26%	2 278	26.4%	1 341	25.7%	50 377
Weather						
Clear	53%	4 519	53.1%	2 695	56.2%	110 354
Precipitation and wind	25%	2 121	24.6%	1 248	20.9%	40 946
Cloudy and overcast	23%	1 958	22.4%	1 137	22.9%	45 022
Visibility						
Good	65%	5 557	81.9%	4 162	84.3%	165 463
Obstructed	9%	784	10.9%	554	8.7%	16 998
Unspecified	26%	2 257	7.2%	364	7.1%	13 861

Table 9 Characteristics associated with the scene of the accident, 2000 to 2008

	All WRC		WRC (Drivers)		Non WRC (Drivers)	
	%	n	%	n	%	n
Number of victims		8 598		5 080		196 322
Road category						
Numbered route	43%	3 700	53.1%	2 695	46.8%	91 931
Street	31%	2 664	32.9%	1 670	39.0%	76 601
Road	6%	526	7.3%	373	9.1%	17 805
Parking lot	2%	166	0.8%	40	1.0%	1 998
Logging road	2%	159	2.1%	109	0.3%	584
Missing values	16%	1 383	3.8%	193	3.8%	7 403
Environment						
School and residential	16%	1 336	16.7%	848	22.0%	43 252
Business and retail	31%	2 676	32.8%	1 668	38.0%	74 544
Industrial and manufacturing	6%	511	6.6%	333	4.2%	8 177
Rural	30%	2 582	37.8%	1 919	32.2%	63 164
Forestry	3%	250	3.5%	178	0.8%	1 621
Recreational/park and camping	1%	69	0.8%	43	0.4%	867
Unspecified	14%	1 174	1.8%	91	2.4%	4 697
Signage						
Absent	52%	4 440	66.1%	3 356	65.4%	128 435
Present	22%	1 933	26.9%	1 364	28.3%	55 556
Missing values	26%	2 225	7.1%	360	6.3%	12 331
Posted speed limit						
60 km/h and less	36%	3 132	38.0%	1 928	47.5%	93 176
70 km/h	11%	966	14.1%	718	12.6%	24 768
80 km/h and 90 km/h	22%	1 880	27.3%	1 385	22.8%	44 696
100 km/h or more	9%	745	10.4%	527	8.0%	15 611
Unspecified	22%	1 875	10.3%	522	9.2%	18 071

Among the highlights of Table 10, which presents the characteristics associated with type of accident, the most frequent WRC result from rear-end collisions (21%), loss of control involving a single vehicle (18%), collisions at an intersection (17%) and front-end collisions (8%). The latter type of accident is less frequent than the others, but usually causes serious or fatal injuries to the vehicle's occupants. In fact, in cases of drivers injured in a WRC, the percentage of front-end collisions is considerably higher (9.2%) than for those injured during non-WRC (5.9%). There are also almost 75% more serious or fatal WRC (18.2%) than non-WRC (10.5%).

Table 10 Characteristics associated with type of accident, 2000 to 2008

	All WRC		WRC (Drivers)		Non WRC (Drivers)	
	%	n	%	n	%	n
Number of victims		8 598		5 080		196 322
Severity of the accident						
Serious or fatal	15%	1 331	18.2%	926	10.5%	20 680
Minor or material	85%	7 267	81.8%	4 154	89.5%	175 642
Type of accident						
With collision (unsecured object)	74%	6 367	71.5%	3 633	70.4%	138 206
Collision with stationary object	5%	471	5.4%	274	7.9%	15 436
Without collision	20%	1 760	23.1%	1 173	21.7%	42 680
Number of vehicles involved						
1 vehicle	30%	2 606	27.5%	1 396	29.1%	57 157
2 vehicles	56%	4 808	57.7%	2 929	56.9%	111 657
3 vehicles or more	14%	1 184	14.9%	755	14.0%	27 508
Accident diagram						
Rear-end collision	21%	1 847	21.1%	1 072	23.3%	45 672
Collision at an intersection	17%	1 473	18.2%	924	16.8%	33 070
Front-end collision	8%	656	9.2%	467	5.9%	11 660
1 vehicle running off the road to the right or the left	18%	1 561	19.5%	993	20.1%	39 494
1 vehicle - other	11%	945	7.0%	356	7.9%	15 496
2 vehicles - other	7%	644	7.1%	363	6.1%	11 887
Unspecified	17%	1 472	17.8%	905	19.9%	39 043
Vehicular movement						
Straight ahead	62%	5 368	67.2%	3 415	68.2%	133 906
Other movement	21%	1 777	21.7%	1 104	21.6%	42 397
No movement	8%	649	7.5%	382	7.2%	14 218
Missing values	9%	804	3.5%	179	3.0%	5 801

Table 11 presents the characteristics associated with road features. Seventy-six percent of WRC occur in full daylight and, in 58% of cases, the roadway is flat and straight. With respect to the differences between WRC and non-WRC, the percentage of WRC is lower when the surface is dry (56.1%) than non-WRC (60.4%), which is consistent with the fact that WRC are more frequent when there is precipitation or wind (Table 9). Furthermore, there are more WRC on road surfaces other than asphalt (8.1%) than non-WRC (5.4%).

Table 11 Characteristics associated with road features, 2000 to 2008

	All WRC		WRC (Drivers)		Non WRC (Drivers)	
	%	n	%	n	%	n
Number of victims		8 598		5 080		196 322
Road configuration						
Flat and straight	58%	4 960	65.0%	3 302	68.7%	134 882
With curve and/or slope	26%	2 245	32.9%	1 671	28.4%	55 672
Unspecified	16%	1 393	2.1%	107	2.9%	5 768
Road surface type						
Asphalt	78%	6 740	91.9%	4 670	94.6%	185 623
Other than asphalt	22%	1 858	8.1%	410	5.4%	10 699
Road condition						
In good condition	80%	6 918	94.4%	4 796	94.7%	185 917
Unspecified	20%	1 680	5.6%	284	5.3%	10 405
Surface condition						
Dry	55%	4 764	56.1%	2 850	60.4%	118 634
Not dry	43%	3 737	42.9%	2 181	38.5%	75 597
Unspecified	1%	97	1.0%	49	1.1%	2 091
Lighting						
Daylight and clear	76%	6 548	78.1%	3 965	66.3%	130 080
Other	24%	2 050	21.9%	1 115	33.7%	66 242

With respect to drivers, “Distraction/inattention” (40.3%) and “Speeding/reckless driving” (28.9%) are among the most frequent causes of WRC (Table 12). However, “Distraction/inattention” is a slightly less significant factor than for non-WRC (43.9%), while “Speeding/reckless driving” is a slightly more significant factor than for non-WRC (26.4%). Other differences include weather conditions and vehicle problems, which are more frequent causes of WRC then of non-WRC, i.e., 16.2% and 4.0% compared to 13.3% and 2.2%, respectively, and driving while impaired by alcohol or drugs is much less frequent in WRC (1.7% versus 6.3%). Table 12 presents only the causes of accidents that were cited most often in accident reports. In addition, as stated in sections 2.2 and 2.3, it is possible that, for a single accident, more than one cause could be reported by the police officer. In those cases, only the top two causes according to the police officer were selected.

Table 12 Causes of WRC, 2000 to 2008

	All WRC		WRC (Drivers)		Non WRC (Drivers)	
	%	n	%	n	%	n
Number of victims		8 598		5 080		196 322
- Victims with information available about the causes		7 433		4 647		175 897
Accident causes						
Distraction/inattention	40%	2 997	40.3%	1 873	43.9%	77 166
Speeding/reckless driving	28%	2 104	28.9%	1 343	26.4%	46 522
Weather conditions	16%	1 211	16.2%	753	13.3%	23 404
Running a stop sign/traffic light	10%	773	11.0%	509	9.5%	16 706
Temporary obstacle/animals/ infrastructure problem	7%	502	6.6%	308	6.8%	11 923
Fatigue	5%	343	5.1%	238	5.1%	8 977
Problem with the vehicle	4%	281	4.0%	184	2.2%	3 897
Impaired driving	2%	140	1.7%	81	6.3%	11 057

3.2 Multiple Correspondence Analyses

This section discusses the results of a series of multiple correspondence analyses (MCA) that were carried out on the active and illustrative variables for the 8598 WRC available in our database. Initially, these analyses identified three WRC segments representing 24.2% of the total WRC sample. The information for the remaining WRC was condensed into a smaller number of dimensions that were used afterward in a cluster analysis.

The first MCA was performed on all the active and illustrative variables selected. The first two dimensions were selected to express the information contained in these variables, and their contribution in terms of total adjusted inertia (Benzecri adjustment) is 78.1%. Figure 1, which illustrates the position of the modalities of variables according to the first two dimensions, enabled the first segment of work-related road collisions to be determined. It consisted of a group of 520 workers identified by the “Pedestrians” modality of the “User type” variable.

The subjects corresponding to this segment were isolated and taken from the sample for a second MCA. This enabled a second segment of WRC to be identified. It is made up of 1376 workers who, according to the police reports, did not suffer an injury at the scene of the accident. They are represented in Figure 2 by the “WAI” (without apparent injury) modality of the “Severity of injuries” variable and the “Missing values” modality of several variables, such as environment

type, road surface type and speed limit. As those workers did not present with apparent injuries, some information about the circumstances of the accident was not gathered by the police officers.

The subjects that correspond to this segment were removed from the sample and a third MCA was carried out on the 6702 remaining subjects. Another group also presenting with specific characteristics was identified. It consisted of 183 workers injured in a forest environment. That group is represented in Figure 3 by the “Logging road” modality of the “Road category” variable and by the “Forestry” modality of the “Environment” variable.

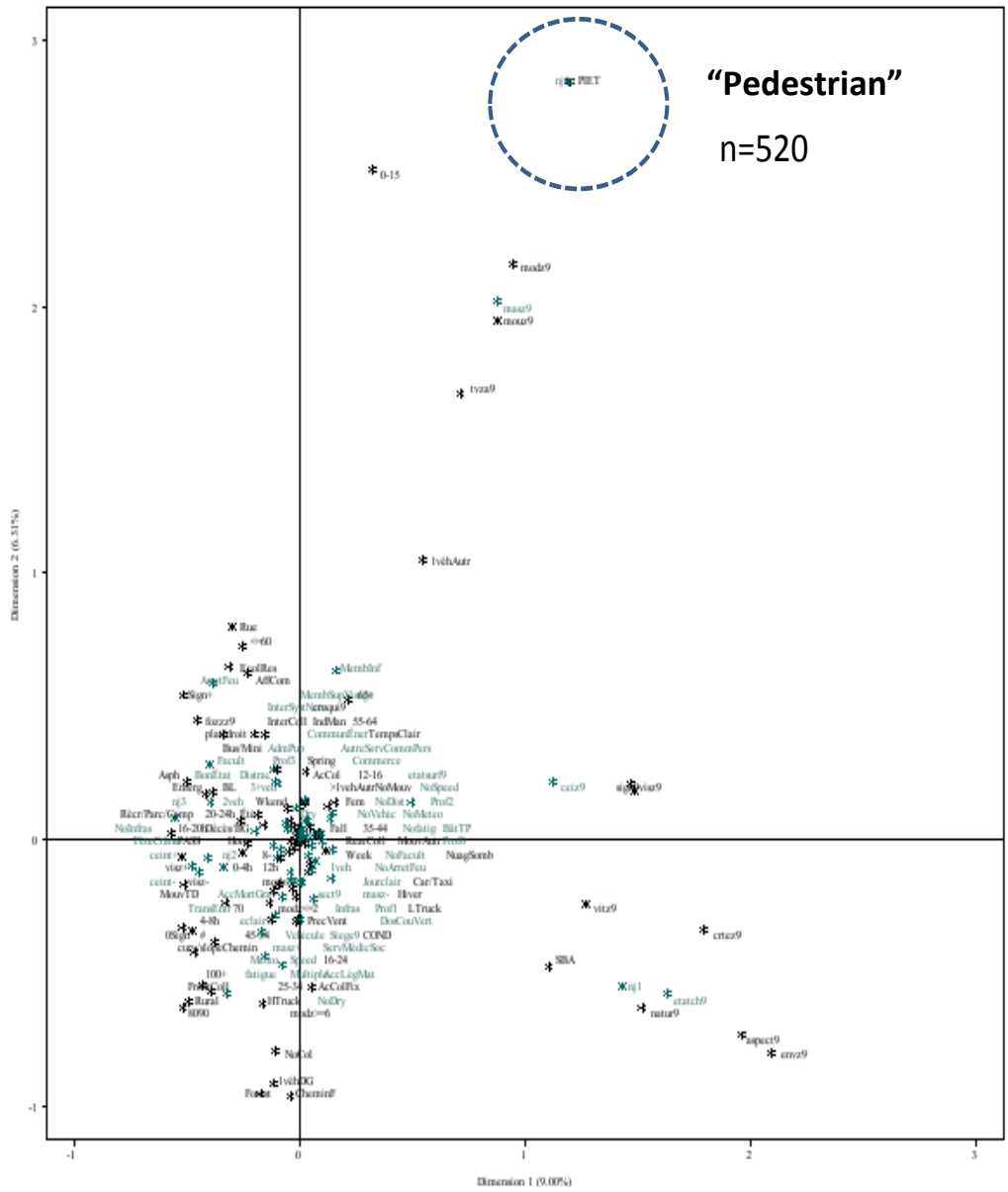

Figure 1 Position of “Pedestrian” segment according to the first two dimensions of the first MCA, Québec, 2000 to 2008

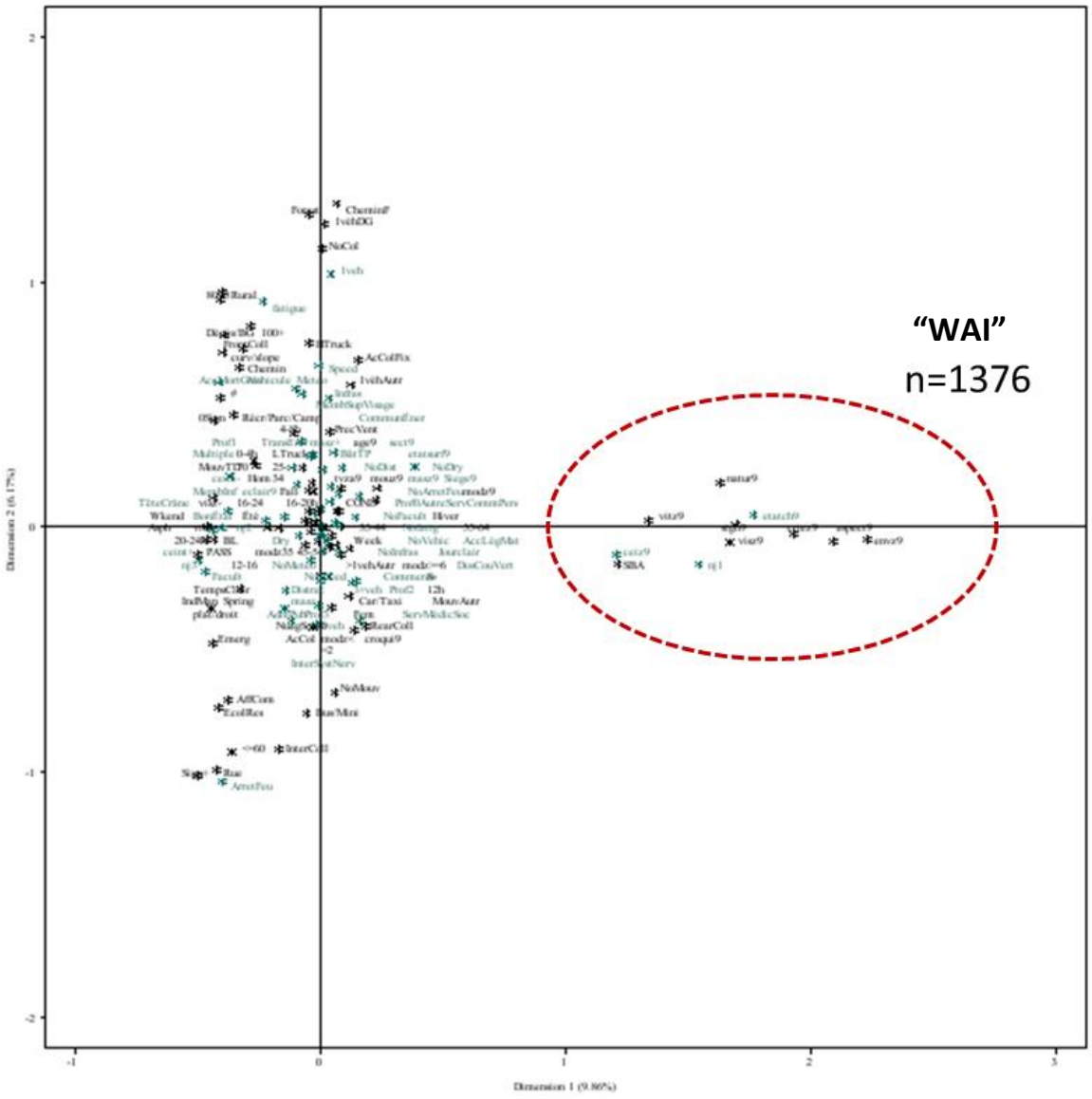

Figure 2 Position of the "Without apparent injury" segment according to the first two dimensions of the second MCA, Québec, 2000 to 2008

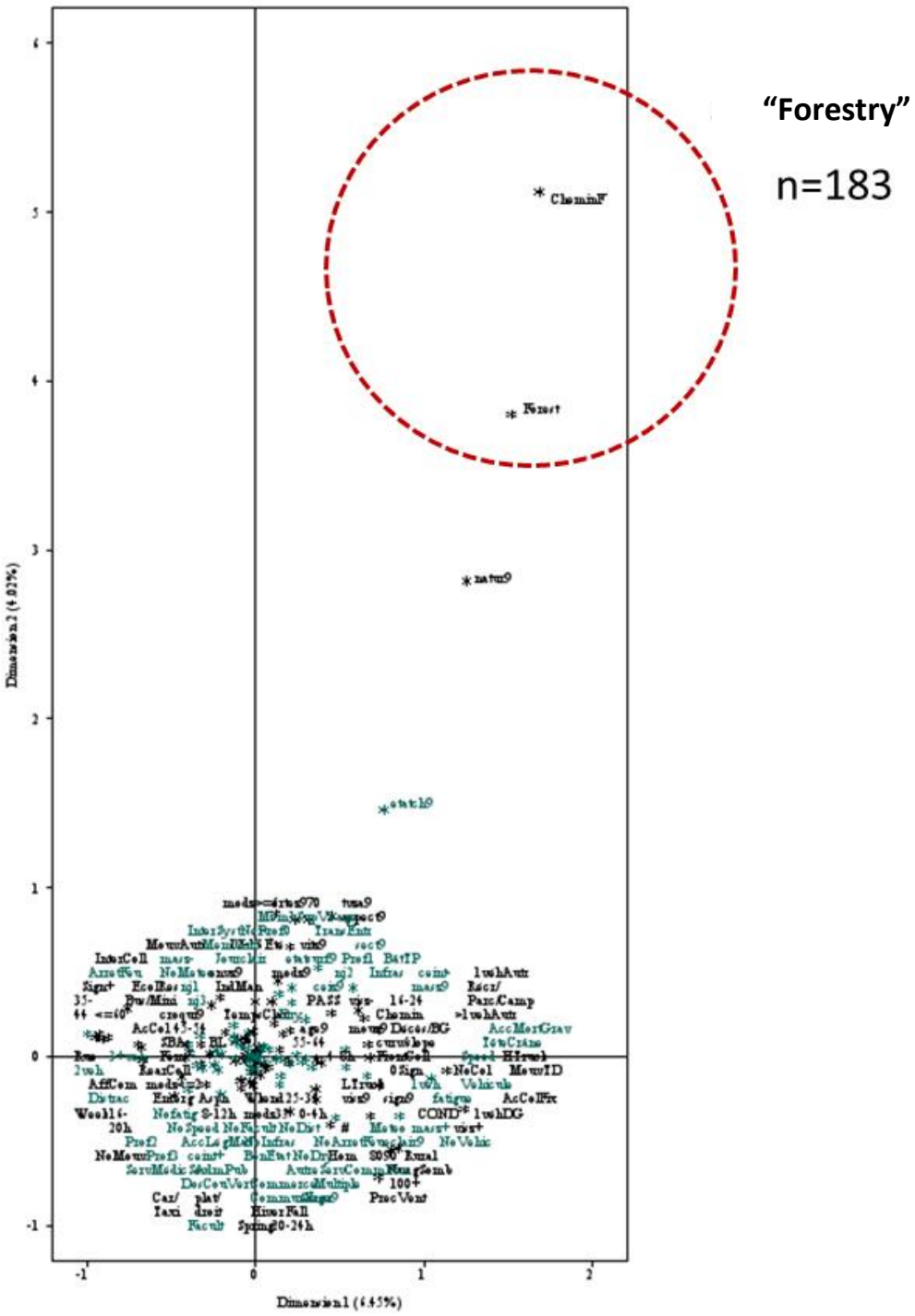

Figure 3 Position of the "Forestry" segment according to the first two dimensions of the third MCA, Québec, 2000 to 2008

A final MCA was carried out on the 6519 subjects that had not been assigned to one of the first three segments. The first two dimensions explain 83.1% of the total adjusted inertia (Benzecri adjustment). They were selected to summarize the information regarding the active variables of the MCA. The position of each of the modalities of the variables according to these two

dimensions is illustrated in Figure 4. The groups were recoded for certain variables between each MCA. This was to ensure that, for each of the variables, the sizes of the groups were more or less the same.

The study of Figure 4 combined with the figure of the SAS output in Appendix 3 suggests how the two dimensions could be interpreted. First, the abscissa factor is strongly linked to the posted speed limit and provides a good indicator of the severity of injuries. In fact, the "Under 60 km/h" (speed limit) and "Without apparent injury" (severity of injuries) modalities are situated on the left in Figure 4, while the "100 km/h and over" and "Death/serious injuries" modalities are on the right side. More specifically, the "Less than 60 km/h" and "100 km/h or more" modalities for the "Speed limit" variable have coordinates of -0.8654 and 0.8405, respectively, for the first dimension (Appendix 3). The "Death/serious injury" and "Without apparent injury" modalities (severity of injuries) have coordinates of 0.7092 and -0.2642, respectively.

The ordinate factor is an indicator of the moment of the accident. Thus, the "Midnight to 3:59 a.m." and "8:00 p.m. to 11:59 p.m." modalities of the "Time of the accident" variable are found in the upper part of Figure 4, while the "8:00 a.m. to 11:59 a.m." and "Noon to 3:59 p.m." modalities are found in the lower part.

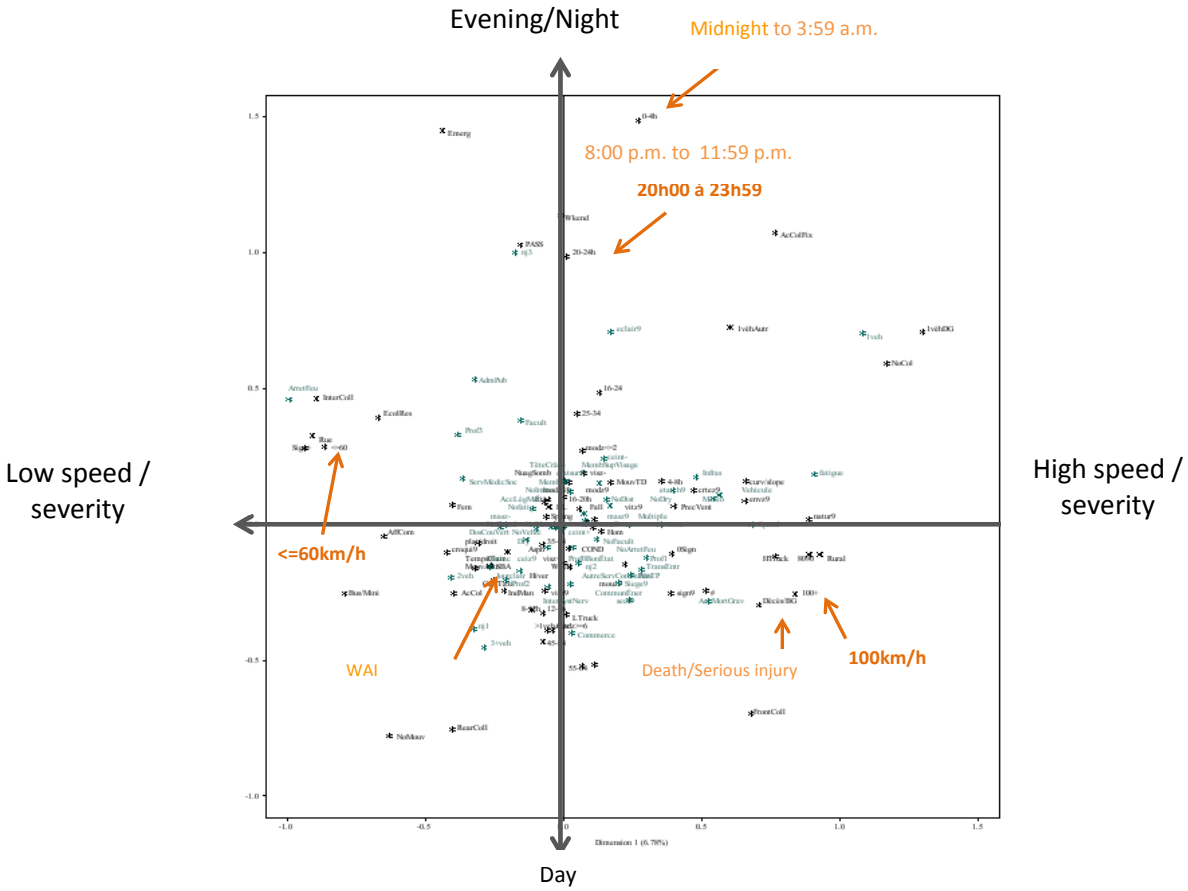

Figure 4 Position of the modalities of the variables according to the first two dimensions and interpretation of the dimensions of the final MCA, Québec, 2000 to 2008

3.3 Cluster Analysis

An initial hierarchical cluster analysis using the first two dimensions of the final MCA enabled a determination of the number of segments to retain in order to classify the remaining 6519 WRC. The complete linkage method was preferred over other methods tested (Ward, average linkage and single linkage) because the results more clearly identified the number of segments to retain. Among the criteria generally used to choose the number of segments, the level of R-squared, which is a measurement of overall homogeneity, drops significantly when going from four to three groups (R-squared applied to four groups = 0.704; R-squared applied to 3 groups = 0.427). Figure 5 depicts the level of overall homogeneity according to the number of segments in the hierarchal cluster analysis.

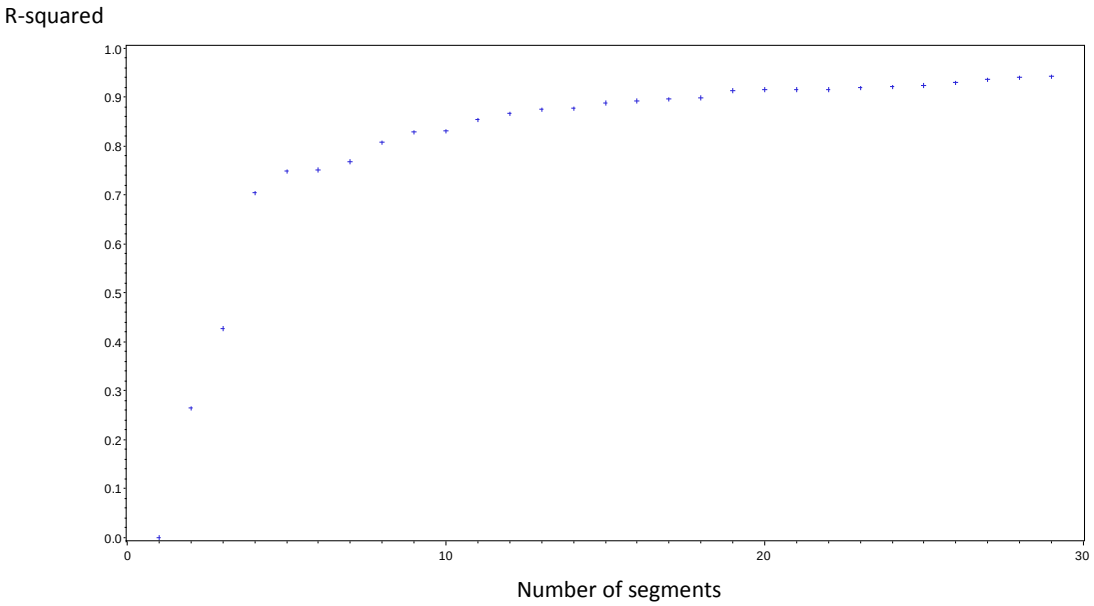

Figure 5 Level of overall homogeneity (R-squared) according to number of segments

The semi-partial R-squared, which expresses the loss of homogeneity that results from forming a new group, is highest when going from three to four groups (semi-partial R-squared = 0.277). Finally, the visual analysis of the dendrogram presented in Figure 6 also suggests four groups.

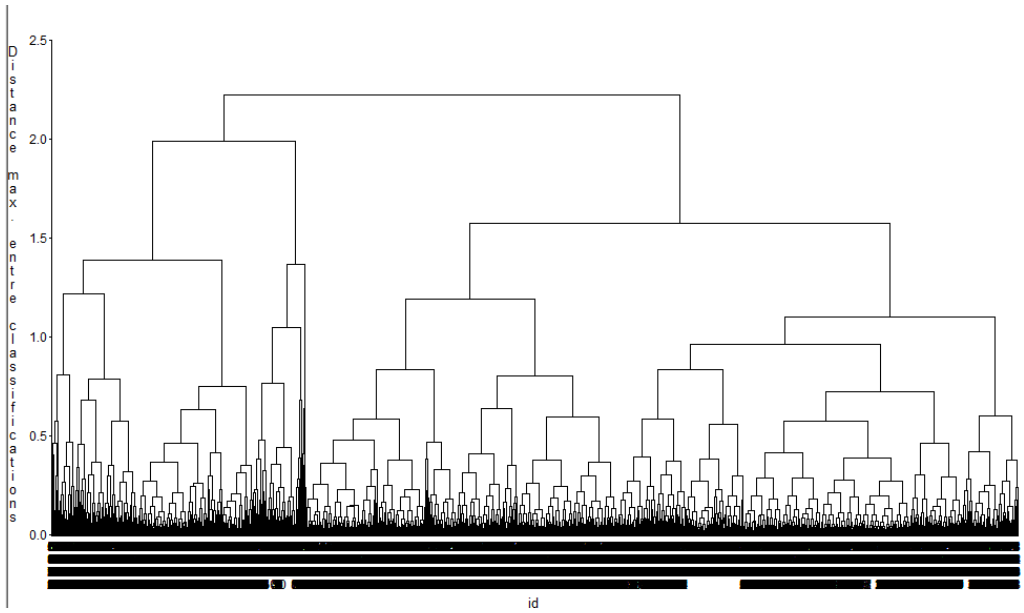

Figure 6 Dendrogram associated with the hierarchical cluster analysis of 6519 WRC

The four-segment solution was therefore selected and then refined using a non-hierarchal cluster analysis. More specifically, the centroids of the solution obtained with the hierarchal method were used as cluster centres for a K-means analysis to obtain the final clustering of the 6519 WRC into four segments.

3.4 The Seven Work-related Road Collision Segments

The first three multiple correspondence analyses and the cluster analysis identified a total of seven segments. Three among them were clearly defined from a modality of an active variable in the MCA: “Pedestrians,” “Without apparent injury” and “Forestry.” The descriptive analysis of the WRC segments, the detailed results of which are revealed in the next section, enabled the specific characteristics of each of the segments to be more closely examined and names for the four other segments to be suggested. Table 13 presents the names and the distribution of the 8598 WRC in the seven segments identified.

The segment with the most workers (25.1%) is predominantly composed of collisions between two vehicles or more in low speed limit zones. The second most important segment in terms of numbers of workers mainly consists of victims of collisions between two vehicles or more (22.6%) as well, but these occurred in high speed limit zones. The third segment is primarily made up of workers injured in accidents caused by speeding or fatigue and in which a single vehicle was involved (18.2%). The fourth segment comprises victims without apparent injuries according to the police report (16.0%). The fifth segment is composed, for the most part, of accidents involving emergency vehicles (police cars, ambulances, fire trucks, etc.) (9.9%). The sixth segment deals only with workers who were on foot (6.0%). The seventh and final segment is of workers compensated following a road accident in a forest environment (2.1%).

Table 13 The seven work-related road collision segments, 2000 to 2008

No	Segment	n	%
1	Collision in a low speed limit zone involving two or more vehicles	2158	25.1%
2	Collision in a higher speed limit zone involving two or more vehicles	1947	22.6%
3	Single vehicle, caused by speeding or fatigue	1565	18.2%
4	Without apparent injury	1376	16.0%
5	Involving an emergency vehicle	849	9.9%
6	Pedestrian	520	6.0%
7	Forest environment	183	2.1%
	Total	8598	100.0%

3.5 Descriptive Analysis of the Seven WRC Segments

This section presents the characteristics of the seven WRC segments identified by the multiple correspondence analyses and the cluster analysis. The format and the list of variables found in section 3.1 are repeated here to present the information in the tables. Each segment is then described separately according to the principle characteristics that differentiate it from the other segments and all the other work-related road collisions.

To identify the modalities of the variables that most characterize or differentiate each of the segments, an indicator (a test value) measuring the difference between the proportion of the modality of a variable in the segment and the general proportion of the modality for all the WRC was calculated. The higher the absolute value of the indicator (test value), the closer the associated modality is characteristic of the segment. Appendix 4 contains the tables with the indicator values that were used to identify the most significant variables in the description of the segments. An indicator value of greater than two in terms of absolute value signifies a statistically significant difference from the 5% threshold. Since our sample size is quite large, we obtained a very high number of modalities in the segments for which the proportion is significantly different than the WRC as a whole. Therefore, in tables 14 to 22, which present the results, the modalities with an absolute value of the indicator (test value) that is greater than or equal to ten for each of the segments are in bold, in order to rapidly identify the greatest statistically significant differences with the WRC as a whole. However, in the description of the results, the differences will mainly be highlighted with one value of the positive statistic that appears to be the most significant from the standpoint of road safety among those values that are statistically significant and by taking into account the segment size.

First, Table 14 shows the distribution of the characteristics of WRC victims from the SAAQ database for each of the seven segments. Tables 15 and 16 provide information on some variables provided by the CSST, such as profession, activity sector, injury site, number of days of

compensation and the indemnities paid. The distribution of vehicle characteristics in Table 17 plays an important role in the identification and interpretation of segments, including the one made up primarily of emergency vehicles (segment 5).

Table 14 Characteristics of WRC victims by segment—Variables from the SAAQ, 2000 to 2008

		Segment						
	All	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	8 598	2 158	1 947	1 565	1 376	849	520	183
User type								
Driver	83%	**92%**	**95%**	84%	**99%**	**60%**	0%	75%
Passenger	11%	8%	5%	16%	**1%**	**39%**	0%	25%
Pedestrian	6%	0%	0%	0%	0%	0%	**100%**	0%
Unspecified	0%	0%	0%	0%	0%	1%	0%	0%
Gender								
Female	26%	**36%**	18%	17%	33%	32%	24%	8%
Male	74%	**64%**	82%	83%	67%	68%	76%	92%
Age								
Mean ± standard deviation	39 ± 12	40 ± 11	41 ± 12	36 ± 12	40 ± 11	33 ± 9	40 ± 13	37 ± 12
16-24	11%	8%	9%	15%	11%	17%	14%	19%
25-34	28%	23%	23%	36%	25%	**46%**	21%	26%
35-44	27%	30%	27%	24%	30%	24%	26%	22%
45-54	23%	28%	27%	17%	22%	10%	22%	25%
55-64	10%	11%	13%	8%	11%	2%	13%	7%
65+	1%	1%	1%	1%	1%	0%	4%	1%
Severity of injuries								
No apparent injury	25%	**16%**	**12%**	**9%**	**91%**	13%	**3%**	9%
Minor injury	65%	**80%**	71%	**77%**	**8%**	**84%**	75%	64%
Serious injury	8%	3%	12%	11%	**1%**	3%	18%	21%
Deceased	2%	0%	5%	4%	0%	0%	5%	5%
Seatbelt use								
Used	59%	**76%**	**74%**	**75%**	**8%**	69%		48%
Not used or used incorrectly	12%	11%	12%	19%	**1%**	20%		**38%**
Missing values	29%	**13%**	**13%**	**6%**	**91%**	**11%**		14%

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table 15 Characteristics of WRC victim by segment—CSST variables, 2000 to 2008

		Segment						
	All	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	8 598	2 158	1 947	1 565	1 376	849	520	183
Workers' occupations								
Truck drivers	18%	**7%**	24%	**35%**	16%	**4%**	7%	20%
Police officers and detectives	10%	8%	5%	9%	4%	**42%**	5%	3%
Delivery drivers	6%	7%	9%	6%	7%	2%	2%	1%
Labourers, material handlers and comparable workers	6%	6%	7%	5%	5%	5%	11%	9%
Bus drivers	5%	**12%**	3%	1%	5%	5%	1%	1%
Nursing and therapeutic specialized and support staff	3%	2%	1%	3%	2%	**11%**	0%	2%
Security guards and officers	2%	2%	0%	2%	1%	4%	7%	2%
Travelling salespeople	1%	2%	2%	1%	1%	0%	0%	0%
Registered nurses, with the exception of supervisors	1%	2%	1%	0%	2%	1%	0%	1%
Letter carriers	1%	2%	1%	0%	1%	0%	2%	0%
Other								
Non-manual (white collar)	11%	14%	12%	6%	15%	4%	11%	6%
Mixed (manual and non-manual)	10%	11%	10%	8%	11%	7%	14%	15%
Manual (blue collar)	9%	9%	10%	6%	7%	3%	19%	20%
Missing values	17%	16%	17%	17%	21%	12%	20%	21%
Employers' primary economic activity sectors								
Public administration	22%	22%	16%	17%	17%	**54%**	25%	8%
Transportation and warehousing	20%	19%	22%	**29%**	18%	9%	12%	21%
Trade	14%	15%	19%	10%	15%	4%	19%	5%
Missing values	12%	10%	14%	13%	14%	4%	9%	34%
Other business/personal services	12%	11%	11%	13%	11%	10%	16%	8%
Medical and social services	10%	13%	7%	7%	14%	16%	4%	4%
Communication and energy	5%	7%	6%	5%	6%	2%	5%	2%
Public works and buildings	5%	4%	6%	6%	5%	1%	12%	18%
Injury site								
Cervical, lumbar, thoracic spine, neck, vertebrae	39%	**48%**	35%	30%	**53%**	45%	**8%**	21%
Multiple sites	32%	26%	36%	43%	24%	28%	38%	45%
Upper limbs and face	10%	10%	10%	11%	10%	10%	16%	11%
Lower limbs	8%	5%	7%	6%	4%	8%	**32%**	9%
Internal organs and nervous system	6%	7%	6%	5%	4%	5%	2%	8%
Other/cannot be classified	3%	2%	3%	3%	3%	1%	2%	3%
Brain, skull	2%	2%	2%	2%	1%	3%	2%	3%

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table 16 Number of days of compensation and indemnities paid by the CSST according to severity of injuries, 2000 to 2008

		Segment						
	All	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	8 598	2 158	1 947	1 565	1 376	849	520	183
Days								
n	7 228	1 870	1 641	1 356	1 006	740	465	150
Mean	141	104	180	166	105	61	248	263
Median	21	17	33	29	15	14	60	49
5th percentile	2	2	3	3	2	2	3	5
25th percentile	8	7	10	10	6	5	14	14
75th percentile	94	70	146	128	61	36	251	222
95th percentile	906	545	1 073	1 085	619	231	1 382	1 392
Indemnities ($)								
n	8 530	2 139	1 932	1 555	1 356	845	520	183
Mean	15 382	9 789	21 259	19 636	7 611	5 888	34 146	30 642
Median	1 704	1 395	2 782	2 549	921	941	5 168	3 879
5th percentile	160	149	183	223	108	144	229	279
25th percentile	557	501	731	767	375	412	872	1 039
75th percentile	8 787	6 137	14 412	12 752	4 053	3 522	29 662	26 283
95th percentile	93 026	43 642	125 014	114 827	36 342	22 959	173 209	180 074
Estimated costs (in thousands of $)	132 082	21 124	41 392	30 731	10 472	4 999	17 756	5 607
%	100%	16%	31%	23%	8%	4%	13%	4%

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table 17 Characteristics of vehicles involved in WRC by segment, 2000 to 2008

		Segment						
	All	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	8 598	2 158	1 947	1 565	1 376	849	520	183
Type de vehicle								
Automobiles	33%	**49%**	34%	**22%**	44%	20%	0%	5%
Light trucks < 3000 kg	18%	20%	22%	15%	22%	8%	0%	**50%**
Heavy vehicles ≥ 3000 kg	23%	**9%**	**33%**	**47%**	21%	**8%**	0%	28%
Unspecified trucks	1%	0%	2%	2%	2%	0%	0%	3%
Emergency vehicles	10%	**4%**	**3%**	10%	4%	**55%**	0%	2%
Bus/minibus	6%	**14%**	4%	1%	6%	6%	0%	5%
Other types	1%	2%	1%	1%	0%	1%	0%	5%
Missing values	7%	**1%**	**1%**	**1%**	3%	1%	**100%**	2%
Age of vehicle								
2 years or less	35%	31%	34%	45%	35%	**51%**	0%	41%
Between 3 and 5 years	25%	27%	24%	26%	27%	33%	0%	15%
6 years and more	32%	40%	39%	27%	35%	**14%**	0%	39%
Missing values	8%	**2%**	**3%**	**2%**	3%	2%	**100%**	5%

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Tables 18 to 22 include the characteristics of circumstances surrounding WRC for each of the segments and cover the following five aspects, respectively: the moment (time, day, season, weather conditions), the scene (road category, environment, signage, speed limit), type of accident (severity, types of collision), road features (road configuration and condition, lighting) and the causes of the accident. Significant differences can be noted among the segments and with respect to the characteristics of the scene of the accident (Table 19), particularly with respect to the road category and speed limit, which enabled the two first segments to be differentiated and identified.

Table 18 Characteristics associated with the moment of the accident by segment, 2000 to 2008

		Segment						
	All	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	8 598	2 158	1 947	1 565	1 376	849	520	183
Time of accident								
Midnight to 3:59 a.m.	5%	**1%**	1%	**10%**	3%	**17%**	4%	2%
4:00 a.m. to 7:59 a.m.	11%	8%	11%	18%	9%	9%	9%	17%
8:00 a.m. to 11:59 a.m.	32%	38%	35%	24%	36%	**15%**	33%	22%
12:00 p.m. to 3:59 p.m.	29%	34%	34%	21%	30%	18%	31%	32%
4:00 p.m. to 7:59 p.m.	17%	16%	16%	16%	16%	19%	17%	21%
8:00 p.m. to 11:59 p.m.	7%	4%	3%	11%	5%	**22%**	7%	5%
Day of accident								
Monday	18%	19%	18%	18%	19%	12%	14%	23%
Tuesday	19%	21%	19%	20%	20%	13%	18%	22%
Wednesday	20%	20%	20%	18%	23%	15%	19%	22%
Thursday	18%	19%	20%	15%	18%	13%	20%	19%
Friday	15%	16%	17%	13%	13%	14%	19%	5%
Saturday	6%	3%	3%	9%	4%	**19%**	6%	7%
Sunday	4%	2%	2%	6%	3%	**14%**	4%	3%
Season								
Winter	30%	29%	34%	26%	35%	27%	23%	20%
Spring	21%	23%	20%	21%	19%	23%	22%	13%
Summer	23%	23%	20%	23%	20%	26%	23%	46%
Fall	26%	25%	26%	30%	26%	24%	31%	21%
Weather								
Clear	53%	**63%**	48%	**40%**	52%	53%	59%	61%
Precipitation and wind	25%	**16%**	29%	**36%**	27%	18%	18%	17%
Cloudy and overcast	23%	20%	23%	24%	22%	29%	22%	22%
Visibility								
Good	65%	**86%**	**81%**	**85%**	**0%**	79%	0%	67%
Obstructed	9%	8%	12%	12%	**0%**	16%	0%	26%
Unspecified	26%	**6%**	**7%**	**3%**	**99%**	**5%**	**100%**	7%

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table 19 Characteristics associated with the scene of the accident by segment, 2000 to 2008

		Segment						
	All	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	8 598	2 158	1 947	1 565	1 376	849	520	183
Road category								
Numbered route	43%	**25%**	**83%**	**76%**	**8%**	**18%**	**17%**	**3%**
Street	31%	**68%**	**6%**	**6%**	**7%**	**77%**	**45%**	**0%**
Road	6%	3%	8%	**14%**	1%	2%	4%	9%
Logging road	2%	0%	0%	0%	0%	0%	0%	84%
Parking lot	2%	1%	1%	1%	0%	1%	**20%**	0%
Missing values	16%	**2%**	**2%**	**4%**	**84%**	**2%**	13%	4%
Environment								
School and residential	16%	**29%**	**7%**	**7%**	**3%**	**38%**	23%	0%
Business and retail	31%	**59%**	23%	**9%**	**7%**	**52%**	**52%**	1%
Industrial and manufacturing	6%	9%	8%	4%	1%	4%	10%	3%
Rural	30%	**3%**	**59%**	**76%**	**6%**	**4%**	**12%**	4%
Forestry	3%	0%	2%	2%	1%	0%	0%	**91%**
Recreational/park and camping	1%	1%	1%	2%	0%	1%	1%	1%
Unspecified	14%	**1%**	**0%**	**1%**	**82%**	**1%**	2%	0%
Signage								
Absent	52%	**42%**	**84%**	**90%**	**1%**	**35%**	0%	**93%**
Present	22%	**54%**	**8%**	**4%**	**0%**	**62%**	0%	3%
Missing values	26%	**3%**	**7%**	**7%**	**99%**	**3%**	**100%**	3%
Speed limit								
60 km/h or less	36%	**78%**	**8%**	**7%**	**13%**	**85%**	52%	10%
70 km/h	11%	9%	**20%**	11%	4%	4%	4%	**61%**
80 km/h and 90 km/h	22%	**3%**	**44%**	**52%**	**6%**	**4%**	6%	3%
100 km/h or more	9%	**0%**	**19%**	**19%**	4%	1%	2%	0%
Unspecified	22%	**10%**	**9%**	**12%**	**74%**	**7%**	37%	26%

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table 20 Characteristics associated with type of accident by segment, 2000 to 2008

		Segment						
	All	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	8 598	2 158	1 947	1 565	1 376	849	520	183
Severity of the accident								
Serious or fatal	15%	**8%**	**31%**	19%	**1%**	9%	23%	34%
Minor or material	85%	**92%**	**69%**	81%	**99%**	91%	77%	66%
Type of accident								
With collision (unsecured object)	74%	**99%**	**93%**	**10%**	72%	81%	**97%**	52%
Collision with stationary object	5%	**0%**	**1%**	**16%**	7%	10%	0%	2%
Without collision	20%	**1%**	**6%**	**74%**	21%	9%	**3%**	45%
Number of vehicles involved								
1 vehicle	30%	**2%**	**5%**	**89%**	28%	16%	**83%**	49%
2 vehicles	56%	**81%**	**71%**	**9%**	58%	69%	**13%**	49%
3 vehicles or more	14%	16%	**24%**	**2%**	14%	15%	3%	2%
Accident diagram								
Rear-end collision	21%	**32%**	**33%**	**1%**	30%	**8%**	**2%**	11%
Collision at an intersection	17%	**31%**	**9%**	**0%**	14%	**50%**	2%	2%
Front-end collision	8%	**2%**	**23%**	5%	3%	2%	1%	20%
1 vehicle running off the road to the right or the left	18%	**0%**	**2%**	**71%**	19%	6%	6%	32%
1 vehicle - other	11%	**2%**	**3%**	18%	8%	9%	**71%**	13%
2 vehicles - other	7%	7%	12%	2%	8%	5%	11%	8%
Unspecified	17%	**26%**	20%	**3%**	18%	20%	8%	14%
Vehicular movement								
Straight ahead	62%	**53%**	65%	**84%**	64%	73%	0%	83%
Other movement	21%	**29%**	22%	12%	23%	21%	0%	15%
No movement	8%	**15%**	9%	**1%**	8%	4%	0%	0%
Missing values	9%	**3%**	5%	3%	5%	2%	**100%**	2%

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table 21 Characteristics associated with road features by segment, 2000 to 2008

		Segment						
	All	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	898	2 158	1 947	1 565	1 376	849	520	183
Road configuration								
Flat and straight	58%	**87%**	65%	**39%**	**1%**	**79%**	**87%**	32%
With curve and/or slope	26%	**12%**	34%	**60%**	**1%**	21%	11%	**66%**
Unspecified	16%	**0%**	**1%**	**0%**	**98%**	0%	2%	2%
Road surface type								
Asphalt	78%	**99%**	**95%**	**93%**	**1%**	**100%**	86%	**1%**
Other than asphalt	22%	**1%**	**5%**	**7%**	**99%**	**0%**	14%	**99%**
Road condition								
In good condition	80%	**98%**	**97%**	**95%**	**1%**	**98%**	87%	62%
Unspecified	20%	**2%**	**3%**	**5%**	**99%**	**2%**	13%	38%
Surface condition								
Dry	55%	62%	54%	48%	50%	59%	63%	57%
Not dry	43%	38%	45%	51%	48%	40%	35%	40%
Unspecified	1%	1%	1%	1%	2%	1%	2%	2%
Lighting								
Daylight and clear	76%	**87%**	83%	**64%**	79%	**51%**	74%	79%
Other	24%	**13%**	17%	**36%**	21%	**49%**	26%	21%

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table 22 Causes of WRC by segment, 2000 to 2008

	Segment							
	All	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Total number of victims	8 598	2 158	1 947	1 565	1 376	849	520	183
- Victims with information available about the causes	7 433	1 882	1 818	1 490	885	743	445	170
Accident causes								
Distraction/inattention	40%	**56%**	39%	**24%**	37%	40%	50%	21%
Speeding/reckless driving	28%	**10%**	33%	**50%**	37%	**12%**	16%	44%
Weather conditions	16%	9%	19%	**27%**	19%	10%	7%	6%
Running a stop sign/traffic light	10%	**21%**	**3%**	**1%**	5%	**32%**	4%	3%
Temporary obstacle/animals/ infrastructure problem	7%	3%	6%	10%	8%	4%	5%	**29%**
Fatigue	5%	1%	5%	**12%**	4%	2%	2%	5%
Problem with the vehicle	4%	2%	3%	7%	4%	2%	3%	2%
Impaired driving	2%	2%	2%	1%	0%	5%	2%	0%

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Segment 1: Collisions in low speed limit zones involving two or more vehicles

This segment includes 25.1% of the sample of 8598 WRC victims (Table 13). It is mainly composed of workers injured slightly (80%) (Table 14) in rear-end collisions (32%) or at an intersection (31%), involving two vehicles (81%) or more (16%) (Table 20), which took place on a street (68%), with signage present (54%), in zones where the speed limit is 60 km/h or less (78%) (Table 19). Almost half the vehicles involved were automobiles (49%); buses/minibuses were also highly represented compared to the other segments (14%) (Table 17). Furthermore, the occupation most often found is that of bus driver (12%) (Table 15). It is one of the segments with the fewest heavy vehicles (Table 17) and the most women (36%) (Table 14).

Distraction or inattention remain the most often reported accident causes (56%), followed by running a stop sign or a red light (21%) (Table 22). Furthermore, this segment has the lowest level of WRC related to speeding (10%). For almost half the workers compensated (48%), the injuries were to the cervical, lumbar or thoracic regions (Table 15).

Segment 2: Collisions in high speed limit zones involving two or more vehicles

This group is the second largest in terms of numbers of workers concerned (22.6%) (Table 13). They are more often seriously injured (12%) or die (5%) as the result of an accident, compared to WRC victims in general (8% and 2%, respectively) (Table 14). Most of the collisions involve two

or more vehicles (95%) (Table 20). They are often rear-end (33%) or front-end collisions (23%) that are fatal or serious for the worker or the other victims (31%), in zones with posted speed limits of 70 km/h or more (83%), on a numbered route (83%), in a rural area (59%), where there is no signage (84%) (tables 19 and 20). Note that 67% of all WRC victims involved in a front-end collision are included in this segment, as are 37% of those who are seriously injured and 47% of those who die. It is therefore not surprising to note that the median amount of indemnities paid to these victims is double that paid to victims in the first segment (Table 16).

The most highly represented occupation is that of truck driver (24%), followed by delivery driver (9%) working in the transportation and warehousing sector (22%) or trade (19%) (Table 15). In Table 17, the vehicles involved are most often heavy trucks (33%) and light trucks (22%). Distraction/inattention are the most common causes (39%), but are situated within the mean (40%) (Table 22). Speeding/reckless driving (33%) and weather conditions (19%) follow. As a comparison, the accident rate linked to speeding is three times higher than in the first segment (10%). These WRC are slightly more frequent in the winter (34%) (Table 18).

Segment 3: Single vehicle, speeding/reckless driving or fatigue

This segment represents 18.2% of workers involved in WRC (Table 13). Almost 90% of them were injured in collisions involving a single vehicle, mainly due to running off the road (71%), very often in a curve or down a slope (60%) (tables 20 and 21). The most significant cause of accidents in this group is speeding/reckless driving. In fact, in 50% of cases, speeding/reckless driving are one of the most important contributing factors to the accident, according to the police officer, which is 1.8 times higher than the mean (Table 22). This factor differs from the other segments because of the high rate of accidents caused by bad weather conditions (27%), fatigue (12%), or a problem with the vehicle (7%). In fact, by themselves, distraction/inattention (24%) and running a stop sign/traffic light (1%) make up far fewer causes of accidents than for WRC in general. This segment includes the highest number of accidents caused by fatigue. More than 50% of all the accidents related to this cause are found in this group. It is interesting to note that collisions in the fatigue segment occur more frequently than on average in the evening and at night (11% between 8:00 p.m. and 11:59 p.m., 10% between midnight and 3:59 a.m. and 18% between 4:00 a.m. and 7:59 a.m.; Table 18). Thus, although 61% of accidents in that segment occur during the day, between 8:00 a.m. and 7:59 p.m., it is below the mean (78%). In fact, almost 40% of all WRC occurring at night are in that segment.

In 47% of cases, the accidents involve heavy vehicles (Table 17). The proportion of truck drivers (35%) and workers in the transportation and warehousing sector (29%) is therefore higher (Table 15). In this segment, 83% are men and, with the exception of the fifth segment, the average age (36 years) is the lowest. In fact, half the workers involved are between 16 and 34 years old (51%), which is a slightly higher percentage than for WRC as a whole (39%) (Table 14).

Much like in the second segment, the percentage of workers who are seriously injured (11%) or who die (4%) is significant, and many of them sustain multiple injuries (43%) (tables 14 and 15). These accidents mainly occur on numbered routes (76%), in a rural environment (76%), where the posted speed limit is 80, 90 or 100 km/h (71%) (Table 19). The median amount of indemnities paid to victims in this segment is also similar to that paid to victims in the second segment (Table 16).

Segment 4: Without apparent injury

This segment comprises 16.0% of all WRC victims (Table 13). They are mainly workers compensated by the CSST who, according to the police report, sustained no apparent injury (91%) (Table 14). In slightly over half the cases (53%), the injury site is the cervical, lumbar or thoracic regions—injuries that may not have been apparent when the accident occurred (Table 15). The median amount of compensation is the lowest of the seven segments (Table 16). No single occupation or employers' sector of economic activity predominates in this segment, compared with WRC as a whole (Table 15). As these are accidents involving material damage, some information about the victim, road features, scene and cause of the accident were not reported; that information is therefore missing from the SAAQ database.

The vehicles in which the workers were riding in this segment are, compared to WRC as a whole, slightly more likely to be automobiles (44% compared to 33%) or light trucks (22% compared to 18%) (Table 17). However, 21% are heavy vehicles, which is marginally less than for WRC in general (23%). Ninety-nine percent of the victims were drivers and one third of them were women, more than for WRC in general (83% drivers and 26% women) (Table 14). With the first and fifth segments, it has the highest female/male ratio among the seven segments. Rear-end collisions are more frequent in this segment than on average (30% compared to 21%) (Table 20).

Segment 5: Emergency vehicles

This segment includes 9.9% of the WRC in the sample (Table 13). Its main characteristic is that it is primarily made up of workers injured in accidents involving an emergency vehicle (55%)[4] (Table 17). Proportionally, these workers are therefore more likely to be working in the public administration (54%) or medical and social (16%) sectors (Table 15). They include police officers (42%) and specialized and support staff working in nursing and therapeutic care (11%). Compared to WRC overall, collisions in this segment occur most often at an intersection (50% compared to 17%), in an urban environment where the posted speed limit is 60 km/h or less (85% compared to 36%), between 8:00 p.m. and midnight (22% compared to 7%) or between midnight and 4:00 a.m. (17% compared to 5%), on Saturday (19% compared to 6%) or Sunday (14% compared to 4%) (tables 18 to 20). This segment also differs from the others because of the high numbers of collisions caused by running a stop sign or traffic light (32% compared to 10%) (Table 22). It is three times higher than for WRC in general.

The injuries suffered are mainly minor (84%) and affect the cervical, lumbar or thoracic regions (45%), which explain why the median amount of compensation is lower than that of the other segments (tables 14 to 16). Of the seven segments, the average age of victims is lowest (33 years) in this segment, due to the preponderance of 25 to 34 year-olds (46%) and 16 to 24 year-olds (17%) (Table 14). There are slightly more women (32%) than for WRC as a whole, which is also the case in segments 1 and 4. It is also the group with the highest number of victims who were passengers (39%). The percentage of people not wearing a seatbelt is also quite high (20%).

[4] Note that in 20% of cases, the vehicle involved is an automobile. It may have been an emergency vehicle that was not identified as such in the police report. For example, in Table A5.4 of Appendix A5, 33% of police vehicles are identified as an "Automobile."

In order to complete the study of WRC in which an emergency vehicle is present, a more detailed analysis of collisions involving police officers, ambulance technicians and firefighters was carried out. A total of 1199 compensated workers were identified (252 ambulance technicians, 65 firefighters and 882 police officers) within the seven WRC segments. The results of that analysis are presented in Appendix 5.

Segment 6: Pedestrians

This segment includes 6% of all WRC (Table 13). It is made up of workers involved in a road accident as pedestrians, and, after the seventh segment (Table 14), it has the highest rate of serious injuries (18%) and deaths (5%). In fact, 14% of all workers seriously injured or killed in a WRC are in this group. The median amount of compensation paid by the CSST to these victims is the highest of the seven segments (Table 16).

These WRC occur mainly during the day (81% between 8:00 a.m. and 8:00 p.m.), from Monday to Friday (90%) (Table 18), where the posted speed limits are 60 km/h or less (52%) (Table 19), and on routes with few curves or slopes (11%) (Table 21). The most frequent cause of accidents in this group is distraction/inattention (50%) (Table 22) and one accident in five occurs in a parking lot (Table 19).

The average age in the group is 40 and the percentage of workers 55 years old or more (17%) is higher than the average of WRC (11%) (Table 14). Male/female distribution is similar to that of WRC as a whole.

These workers come from the public administration (25%) trade (19%), transportation and warehousing (12%), and buildings and public works (12%) sectors (Table 15). The most highly represented occupations are those of handlers (11%), truck drivers (7%), and security guards and officers (7%) (Table 15).

Segment 7: Forestry

This is the smallest segment and concerns 2.1% of the WRC sample (Table 13). Its primary characteristic is that it consists of workers injured in a forest environment (91%) (Table 19). It is the segment with the highest proportion of serious injuries (21%), deaths (5%) (Table 14), and multiple injuries (45%) (Table 15). The proportions of WRC taking place in the early morning (4:00 a.m. to 7:59 a.m.) (17%) and the early evening (4:00 p.m. to 7:59 p.m.) (21%) are slightly higher than the mean (Table 18). The median amount of compensation paid by the CSST to these victims is the second highest of the seven segments (Table 16).

Most of the victims in this segment were injured in an accident involving a truck (81%) (Table 17). It is the segment with the highest proportion of men (92%) (Table 14). The average age in this group is 37 and people under 24 years old are particularly overrepresented (19% compared to 11% for all WRC) (Table 14). It is also the segment with the lowest rate of seatbelt use[5] (48%) (Table 14).

[5] The lower rate of seatbelt use of 8% in segment 4, "Without apparent injury," can be explained by the high percentage of missing values (91%) in that segment. In all probability, it may be closer to seatbelt use for all drivers, i.e., over 90%.

Speeding and reckless driving are the main causes of these accidents (44%), followed by problems related to infrastructure, a temporary obstacle or animals (29%) (Table 22). Moreover, the roadway is less often described as being in good condition (62%) compared to the mean (80%) (Table 21). Among the types of accidents that occur more frequently than for WRC as a whole are collisions involving a single vehicle (49% compared to 30%) and front-end collisions (20% compared to 8%) (Table 20).

Almost half the WRC occurred during the summer (46%), which is two times higher than the mean (Table 18), and 61% occurred in zones with posted speed limits of 70 km/h, which is almost six times higher than for WRC in general (Table 19). Almost 70% of these accidents took place in curves and/or on a slope, which is 2.5 times higher than the mean (26%) (Table 21). It is the segment with the highest number of accidents in the building and public works sector (18%), or 3.5 times higher than for WRC in general (5%), but in over one third of cases, the economic activity was undetermined (Table 15).

4. DISCUSSION

This study attempts to palliate the lack of information on the characteristics and risk factors of work-related road collisions and is based on the data-matching method proposed in other studies [5, 6]. By combining the efforts of the CSST and the SAAQ, a database unique in Québec was created. It integrates information gathered about 8598 workers compensated by the CSST after work-related road collisions from 2000 to 2008, and the circumstances surrounding these accidents. The descriptive statistical analyses revealed some differences between the characteristics of work-related road collisions and road accidents in general. Multivariate statistical analyses also enabled the identification of seven WRC segments.

The results show that men are involved in WRC (74%) more often than women, which reflects the higher concentration of men in jobs that include being on the road. Similar results have been found in other studies [5, 8, 9]. However, women represent one third of workers injured in WRC involving two vehicles in zones with lower posted speed limits (segment 1), in accidents without apparent injuries (segment 4), and in accidents included in the segment with numerous emergency vehicles (segment 5).

The study also indicates that there are two-and-a-half fewer drivers under 24 involved in work-related road collisions than in road accidents with injuries in general. In fact, it is the least represented age group (10.3%). This suggests that young people have perhaps fewer opportunities to work at a job that requires driving on a regular basis and are therefore less exposed to that type of work-related accident. Workers who are 25 to 34 years old are the most highly represented in WRC (28%), followed by the 35 to 44 age group (27%) and the 45 to 54 age group (23%). Other studies [5, 8] arrive at similar results. It should be noted that this age group includes almost half the injured workers included in segment 5, concerning mainly accidents involving emergency vehicles; it is therefore overrepresented compared to WRC in general.

Among the causes, speeding/reckless driving were reported in 28.9% of collisions (Table 12). This cause is more present in accident segments involving a high percentage of heavy vehicles, such as those involving a single vehicle (segment 3), those with two vehicles in a zone with a higher posted speed limit (segment 2), and in those that occur in a forest environment (segment 7). Previous research has also determined that speeding is responsible for most work-related road collisions involving heavy vehicles [17, 18].

The results also show that fatigue is most often reported as the cause in the accident segments involving the highest number of heavy vehicles, i.e., accidents involving a single vehicle (segment 3). In those cases, fatigue is blamed in 12% of cases, which is more than double that for WRC (5%). These percentages may appear relatively low, but there are no tools to measure fatigue, and it is assessed by the police officers filing the accident reports, according to their observations. Moreover, the review of the literature indicates that insufficient sleep, long hours awake or long working hours, and the road environment are among the main causes of fatigue [10, 11, 12, 13].

In 2% of WRC, the event caused the death of a worker. This percentage coincides with that established in the Boufous and Williamson study [5]. If only drivers are considered, the percentage of them killed in a WRC in Québec out of all drivers compensated by the CSST is

2.9%, or more than twice as high as the percentage of drivers killed (1.3%) among all drivers injured or killed in a road accident in Québec.

We also note more serious injuries and deaths in the segments with a high proportion of heavy vehicles (segments 3, 2 and 7). This suggests a relationship between the severity of the accidents and the size of the vehicles. Other studies have also found that heavy vehicle drivers are more likely to be seriously injured and that they have a higher rate of fatalities than drivers of lighter vehicles who are injured while working [8, 14, 15, 16].

The relatively high rate of non-use of a seatbelt in the emergency vehicle group (segment 5) combined with a high rate of workers who were victims as passengers in a vehicle (39%) suggests that the latter are less likely to wear a seatbelt. Our review of the literature [19] also shows shortcomings with respect to the protection and safety of passengers being transported in the rear compartment of ambulances. Deaths and injuries, per kilometre travelled, are more numerous than for other types of emergency vehicles. In addition to not being very resistant to collisions, the rear compartment is not solidly attached to the front part of the vehicle. Tests have been done on ambulances in which modifications were made to obtain three different prototypes that better protect passengers [20]. In the authors' opinion, given current knowledge of systems of protection, it is unacceptable that ambulances continue to transport passengers in an unsafe compartment.

Extent of and limits to this study

In some European countries, such as France, road accidents that occur when workers are travelling to and from their workplaces and homes (commuting accidents) are included in official statistics on industrial accidents, unless otherwise indicated. This is not the case in North America. It is therefore necessary to be careful when comparing results from different countries.

In this study, a WRC is defined as being an accident involving workers who are covered by the CSST. However, the SAAQ data includes traffic accidents involving people who were working at the time of the collision, but were not covered by the CSST. They include people who were working for companies situated outside of Québec, but who were in an accident while at work and while driving on roads in Québec, in addition to some categories of workers who are excluded from CSST insurance coverage, or who are not covered unless they make the request and pay the necessary contributions. Since all these people are not covered by the CSST and there are no data in the SAAQ files to show whether they were at work at the time of the accident, it is not possible to differentiate them from the entire group of those injured in road accidents. These cases are therefore not included in the WRC. A single exception remains, that of drivers of heavy vehicles or emergency vehicles, who, it would be reasonable to assume, were working at the time of the accident. However, they were not included in this study.

The administrative data have the advantage of being inexpensive to obtain and to process. However, they mainly provide information about the immediate circumstances surrounding the accidents, without being exhaustive. According to the Stukey *et al.* model [21], used in our review of the literature [19] to classify the characteristics and risk factors, they could be divided into five hierarchal levels (Table 23).

Table 23: The five hierarchical levels of the risk factors of a traffic accident, according to the Stuckey *et al.* model (2007)

Hierarchical level	Category
1	Driver and passengers
2	Immediate environment, vehicle
3	External environment, road
4	Organizational environment, work arrangements
5	Policy environment (local, national, international), legislation and standards

Upon examination of Table 23, it appears that the CSST and SAAQ administrative data enable only the factors related to the first three hierarchal levels to be documented. Accordingly, factors concerning working conditions (numbers of consecutive working hours, tight deadlines, etc.), the organization of accident prevention and safety activities at businesses that have workers on the road, and laws and regulations are not analyzed in this study. Nonetheless, they are factors that are considered to be related to the occurrence of work-related road collisions [1, 2, 19]. In particular, they can influence risk factors situated at lower hierarchal levels, i.e., those that are more directly related to the occurrence of the accident. For example, the existence and monitoring of a vehicle maintenance program that falls within the sphere of the company's organizational environment affects the condition of vehicles driven by its workers.

In contrast, the matching of the CSST's administrative data and data from police accident reports constitute a strength of the study and greatly increase the scope and usefulness of the results. Thus, while the CSST data provide little information on the circumstances of the accident (time of the accident, type of vehicle, condition of the vehicles, the drivers, the environment, the road, probable causes, etc.), the police accident reports do contain this information. In addition, although the SAAQ data do not enable accidents involving workers to be identified, those of the CSST not only enable identification of workers covered by the *Act respecting industrial accidents and occupational injuries*, but also contain other relevant information: the occupation of the worker involved, the employers' sector of activity, characteristics of the injury, etc.

The data analyzed thus reveal the characteristics and risk factors related to the immediate circumstances of the accident and the probable causes, according to the police report. Moreover, the statistical analysis methods utilized point to seven "Types of accident" (segments) with their own characteristics, which are associated with certain occupations, industries or working circumstances toward which it is possible to direct prevention or research activities.

Our study stands out through the choice of analysis methods used, such as multiple correspondence analysis and cluster analysis. Similarities between the results presented here and those obtained by Boufous and Williamson [1, 5] and other studies validate the usefulness of this approach to better understand the problem of work-related road collisions.

5. CONCLUSION

This study contributes to a better understanding of the problems arising from work-related road collisions and provides useful information to direct and develop prevention programs adapted to the specificities of the various segments identified and the groups of workers more likely to be involved in a road accident in the scope of their jobs.

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APPENDICES

Appendix 1a - List of Variables Extracted from the CSST Database

Age (date of birth)
Worker's gender
Worker's occupation
Last regional office to have processed the file
Worker's gross annual income
Employers' principal sector of economic activity
Jurisdiction governing the employer
Employers' coverage status
Québec economic activity sector (CAEQ) pertaining to the experience file
North American Industry Classification System (NAICS) pertaining to the experience file
CSST classification unit pertaining to the experience file
French name of the classification unit
Insurable payroll pertaining to the experience file
CAEQ of the establishment
NAICS of the establishment
Postal code of the establishment
Date of original event
Category code of the file attached to the event file
Compensated relapses indicator
Final decision concerning the eligibility of the original event
Cause of death of worker
Date that cause of death was accepted
Injury site
Injury type
Type of accident or exposure
Causal agent of the injury
Secondary causal agent of the injury
Indicator of vertebral ailment
Indicator for an injury with a name ending in "itis"
Code of mental injury
Total benefits
Income replacement indemnity
Number of days of compensation
Explanation code for the end of the income replacement indemnity payment period
Personalized rehabilitation plan indicator
Permanent physical or mental impairment
Anatomicophysiological deficit
Start date of an eligible claimed compensation period
End date of the claimed compensation period
Explanation code for an IRI payment
Medical assistance expenses
Occupational rehabilitation
Social rehabilitation
Rehabilitation expenses
Death benefit

Indemnity for physical injury
Permanent disability indemnity
Social and economic stabilization
IRI—first 14 days paid by the employer
IRI—during the consolidation and rehabilitation period
IRI—after the consolidation and rehabilitation period
Total expenses
Total indemnities

Appendix 1b - List of Variables Extracted from the SAAQ Database

Year of the accident
Road configuration
Road category
Probable cause of the accident—primary factor that most contributed to the accident, according to the police officer
Probable cause of the accident—secondary factor that most contributed to the accident, according to the police officer
Probable cause of the accident—other factors (maximum 10) that most contributed to the accident, according to the police officer
Impact code (accident reconstruction diagram)
Municipal code
Date of the accident
Hit-and-run
Lighting
Environment
Road condition
Road surface condition
Type of accident
Severity of the accident
Time of the accident
Day of the accident
Location
Month of the accident
Road surface type
Number of vehicles involved
Number of victims slightly injured in the accident
Number of victims seriously injured in the accident
Number of victims killed in the accident
Total number of victims in the accident
Route number
Weather (meteorological conditions)
Speed limit
Driver's age
Age of vehicle
Year of vehicle
Motorcycle capacity
Driver's experience (class 5)
Vehicle's weight category
Location of use (without restriction, urban, off-road, etc.)
Make of vehicle
Vehicle's weight
Movement of vehicles
Number of cylinders of the vehicle
Number of axles on the vehicle
Provincial or state licence plate
Province or state where drivers licence was issued
Direction of vehicle before impact

Driver’s gender
Signage
Driving licence status
Type of property
Type of vehicle
Type of user
Type of use
Visibility
Victim’s age
Victim’s date of birth
Severity of victim’s injuries or victim’s condition
Victim’s position (driver, passenger, pedestrian, etc.)
Movement of pedestrian victims
Seatbelt use
Victim’s gender
Road user type

Appendix 2 - List of New Binary Variables Associated with Causes of Accidents

Impaired driving (alcohol, pharmaceuticals, other drugs)
Fatigue
Distraction/inattention
Lack of visibility
Speeding/reckless driving
Running a stop sign/traffic light
Tailgating
Driving on the wrong side of the road
Failure to yield
Negligence of pedestrian/cyclist
Problem with the vehicle
Weather conditions
Temporary obstacle/animals/infrastructure problem
Other

Appendix 3 - SAS Output: Coordinates of the Modalities on the MCA Axes

Coordinates on the axes (dimensions)		
Modality	**Dimension 1**	**Dimension 2**
0-4 h	0.2710	1.4863
40 893	-0.0733	-0.3258
16-20 h	0.0020	0.1004
20-24 h	0.0123	0.9863
4-8 h	0.3551	0.1603
8-12 h	-0.1146	-0.3140
COND	0.0240	-0.1577
PASS	-0.1561	1.0264
BL	-0.0502	0.0647
Décès/BG	0.7092	-0.2954
SBA	-0.2642	-0.1521
16-24	0.1300	0.4858
25-34	0.0490	0.4073
35-44	-0.0746	-0.0739
45-54	-0.0738	-0.4306
55-64	0.0671	-0.5198
age9	0.2013	-0.4890
aspect9	0.2216	-0.6185
curv/slope	0.6618	0.1582
plat/droit	-0.3078	-0.0701
Fall	0.0850	0.0075
Hiver	0.0184	-0.0893
Spring	-0.0607	0.0276
Été	-0.0661	0.0829
Week	0.0012	-0.1437
Wkend	-0.0092	1.1345
AcCol	-0.3958	-0.2522
AcColFix	0.7665	1.0713
NoCol	1.1723	0.5923
NuagSomb	0.0194	0.1533
PrecVent	0.4016	0.0674
TempsClair	-0.2013	-0.1005
1véhAutr	0.6036	0.7252
1véhDG	1.3013	0.7088
>1vehAutr	-0.0570	-0.3888
FrontColl	0.6789	-0.6964
InterColl	-0.8951	0.4630

Coordinates on the axes		
Modality	**Dimension 1**	**Dimension 2**
RearColl	-0.4023	-0.7547
croqui9	-0.4216	-0.1016
Bus/Mini	-0.7925	-0.2555
Car/Taxi	-0.2510	-0.2033
Emerg	-0.4384	1.4486
HTruck	0.7683	-0.1157
LTruck	0.0115	-0.3294
tvza9	0.1079	-0.0105
modz35	-0.0555	0.0934
modz9	0.0578	0.0559
modz<=2	0.0702	0.2727
modz>=6	-0.0397	-0.3885
Fem	-0.4015	0.0732
Hom	0.1367	-0.0249
MouvAutr	-0.3188	-0.1609
MouvTD	0.1716	0.1558
NoMouv	-0.6315	-0.7759
mouz9	0.2221	-0.1470
visz+	-0.0057	-0.0093
visz-	0.0745	0.1875
visz9	-0.0672	-0.2440
#	0.5168	-0.2432
Rue	-0.9102	0.3266
crtez9	0.4714	0.1250
AffCom	-0.6501	-0.0429
EcolRes	-0.6717	0.3914
IndMan	-0.2149	-0.2426
Rural	0.9312	-0.1102
envz9	0.6594	0.0859
100+	0.8405	-0.2557
70	0.1131	-0.5168
8 090	0.8924	-0.1104
<=60	-0.8654	0.2863
vitz9	0.1136	0.0186
Asph	-0.0332	-0.0007
natur9	0.8913	0.0180
0Sign	0.3925	-0.1071
Sign+	-0.9356	0.2811
sign9	0.3905	-0.2548

Appendix 4 - Test Values (Definition and Results)

Definition of the test value

The test value of the *j* modality in the *k* segment is defined as follows [7]:

$$\text{v-test} = \frac{n_{jk} - n_k \cdot \frac{n_j}{n}}{\sqrt{n_k \cdot \frac{n - n_k}{n - 1} \cdot \frac{n_j}{n} \cdot \left(1 - \frac{n_j}{n}\right)}}$$

where
n represents the total number of observations in the sample
n_j represents the number of observations in the j modality
n_k represents the total number of observations in the k segment
n_{jk} represents the number of observations with the j modality in the k segment

Tables of results

The following tables (A4.14 to A4.22) present the test values for each of the WRC segments. The format and the list of variables presented in section 3.5 are repeated in the tables. A value between parentheses in the tables indicates a negative test value.

Table A4.14: Results of test values associated with Table 14 (Characteristics of WRC victims by segment—SAAQ variables, 2000 to 2008)

	Segment						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	2 158	1 947	1 565	1 376	849	520	183
User type							
Driver	12.4	15.4	1.1	16.9	(18.7)		(2.8)
Passenger	(4.7)	(8.8)	7.3	(12.2)	28.1		6.3
Pedestrian						92.7	
Unspecified	0.7	(0.4)	(0.4)		4.2		
Gender							
Female	11.5	(9.3)	(9.0)	6.4	3.9	(1.2)	(5.8)
Male	(11.5)	9.3	9.0	(6.4)	(3.9)	1.2	5.8
Age							
16-24	(5.2)	(4.1)	4.6	(1.0)	5.3	2.0	3.4
25-34	(6.0)	(5.5)	7.5	(2.3)	12.5	(3.4)	(0.7)
35-44	2.9	(0.5)	(3.1)	2.9	(1.9)	(0.7)	(1.5)
45-54	6.7	5.7	(6.0)	(0.6)	(9.3)	(0,4)	0.8
55-64	1.3	4.8	(2.9)	1.4	(7.7)	2.3	(1.5)
65+	(1.7)	1.8	(0.7)	(1.1)	(2.5)	5.9	0.0
Severity of injuries							
No apparent injury	(10.3)	(14.5)	(16.3)	62.5	(8.6)	(11.9)	(4.9)
Minor injury	16.2	5.7	10.3	(49.2)	12.0	4.6	(0.3)
Serious injury	(8.5)	9.0	5.7	(10.4)	(5.4)	8.9	7.0
Deceased	(6.8)	8.0	4.0	(5.6)	(3.8)	3.9	2.6
Seatbelt use							
Used	19.1	16.0	14.5	(41.9)	6.4		(3.1)
Not used or used incorrectly	(1.4)	0.4	8.8	(13.2)	7.4	(8.0)	11.0
Missing values	(19.7)	(17.6)	(22.0)	54.8	(12.2)	36.1	(4.5)

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table A4.15: Results of test values associated with Table 15 (Characteristics of WRC victims by segment—CSST variables, 2000 to 2008)

	Segment						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	2 158	1 947	1 565	1 376	849	520	183
Workers' occupations							
Truck drivers	(14.5)	8.9	19.8	(1.2)	(11.0)	(6.3)	1.0
Police officers and detectives	(4.4)	(7.7)	(1.2)	(7.8)	33.0	(4.0)	(3.3)
Delivery drivers	2.0	4.3	(1.1)	1.8	(4.9)	(3.9)	(3.3)
Labourers, material handlers and comparable workers	(0.0)	0.9	(1.4)	(1.5)	(2.0)	4.6	1.5
Bus drivers	16.4	(5.0)	(8.6)	(0.2)	(0.7)	(4.2)	(2.8)
Nursing and therapeutic specialized and support staff	(2.8)	(5.3)	1.7	(2.5)	15.5	(3.6)	(0.4)
Security guards and officers	(0.9)	(5.7)	(0.2)	(1.6)	4.4	9.0	(0.3)
Travelling salespeople	2.2	2.2	(1.4)	0.8	(3.0)	(2.1)	
Registered nurses, with the exception of supervisors	4.6	(1.8)	(3.7)	3.3	(1.6)	(1.7)	(0.8)
Letter carriers	4.1	(0.1)	(3.3)	(0.5)	(2.0)	2.2	
Other							
Non-manual (white collar)	5.3	1.5	(6.8)	5.3	(6.3)	(0.2)	(2.1)
Mixed (manual and non-manual)	2.3	(1.0)	(2.6)	0.9	(3.1)	2.8	2.3
Manual (blue collar)	1.1	1.6	(3.7)	(2.1)	(6.0)	8.6	5.6
Missing values	(1.3)	(0.7)	(0.3)	4.4	(4.4)	1.9	1.5
Employers' primary economic activity sectors							
Public administration	0.1	(7.5)	(5.0)	(47)	236	16	(4.7)
Transportation and warehousing	(1.2)	2.4	9.9	(1.8)	(8.6)	(4.8)	0.5
Trade	1.5	7.2	(5.2)	1.7	(8.5)	3.2	(3.6)
Missing values	(3.0)	3.7	1.2	2.2	(7.9)	(2.2)	9.3
Other business/personal services	(0.5)	(0.8)	2.5	(1.3)	(1.6)	3.1	(1.4)
Medical and social services	4.4	(5.9)	(4.4)	5.6	6.0	(5.0)	(2.9)
Communication and energy	2.5	1.1	(1.0)	1.5	(4.2)	(0.7)	(2.0)
Public works and buildings	(4.1)	1.0	1.2	(1.1)	(5.2)	7.1	7.9
Injury site							
Cervical, lumbar, thoracic spine, neck, vertebrae	9.7	(4.4)	(8.3)	11.3	3.5	(15.2)	(5.1)
Multiple sites	(7.2)	4.2	9.5	(7.2)	(3.0)	3.0	3.6
Upper limbs and face	(1.6)	(1.2)	1.2	(0.3)	(0.6)	4.2	0.2
Lower limbs	(4.8)	(1.0)	(3.0)	(4.9)	0.9	21.2	0.9
Internal organs and nervous system	2.8	1.5	(0.5)	(1.9)	(0.8)	(3.7)	1.3
Other/cannot be classified	(1.0)	2.3	0.7	0.2	(2.8)	(0.5)	0.6
Brain, skull	(0.6)	0.9	0.1	(2.6)	2.2	0.1	0.9

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table A4.17: Results of test values associated with Table 17 (Characteristics of vehicles involved in WRC by segment, 2000 to 2008)

	Segment						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	2 158	1 947	1 565	1 376	849	520	183
Type of vehicle							
Automobiles	18.1	1.0	(10.1)	9.0	(8.4)		(8.2)
Light trucks < 3000 kg	2.3	5.6	(3.3)	3.7	(8.2)		11.3
Heavy vehicles ≥ 3000 kg	(17.4)	11.7	24.9	(2.4)	(10.7)		1.5
Unspecified trucks	(3.8)	3.7	2.4	1.3	(3.1)		1.8
Emergency vehicles	(10.0)	(11.7)	1.1	(8.1)	47.3		(3.5)
Bus/minibus	17.7	(5.1)	(8.9)	(0.7)	(1.0)		(0.8)
Other types	3.7	(2.3)	(0.0)	(2.8)	0.6		5.7
Missing values	(12.8)	(11.6)	(10.9)	(7.5)	(7.3)	83.5	(2.7)
Age of vehicle							
2 years and less	(4.6)	(1.2)	9.0	(0.3)	10.2		1.7
Between 3 and 5 years	2.7	(1.0)	1.3	1.8	6.0		(3.1)
6 years and more	9.3	8.3	(4.5)	3.1	(11.4)		2.2
Missing values	(11.8)	(10.3)	(9.8)	(7.4)	(7.6)	77.5	(1.7)

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table A4.18: Results of test values associated with Table 18 (Characteristics associated with the moment of the accident by segment, 2000 to 2008)

	Segment						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	2 158	1 947	1 565	1 376	849	520	183
Time of accident							
Midnight to 3:59 a.m.	(9.8)	(8.6)	10.9	(3.4)	17.7	(0.5)	(1.7)
4:00 a.m. to 7:59 a.m.	(5.1)	(0.4)	9.6	(2.5)	(1.5)	(1.6)	2.9
8:00 a.m. to 11:59 a.m.	7.6	3.2	(7.2)	4.3	(10.6)	0.6	(2.7)
12:00 p.m. to 3:59 p.m.	5.5	5.4	(7.5)	0.6	(7.7)	0.8	0.8
4:00 p.m. to 7:59 p.m.	(1.0)	(0.2)	(0.7)	(0.2)	1.8	0.1	1.8
8:00 p.m. to 11:59 p.m.	(7.5)	(7.4)	6.4	(2.7)	17.2	(0.4)	(1.2)
Day of accident							
Weekday							
Monday	1.4	1.2	0.2	1.2	(4.7)	(1.9)	1.9
Tuesday	2.2	(0.2)	1.2	0.6	(4.9)	(1.1)	1.1
Wednesday	0.7	0.4	(1.6)	3.5	(3.7)	(0.7)	0.7
Thursday	1.8	3.2	(3.7)	0.3	(3.9)	1.2	0.3
Friday	1.9	2.3	(1.9)	(2.3)	(0.9)	2.9	(3.9)
Weekend							
Saturday	(7.4)	(6.1)	5.7	(3.7)	16.5	(0.3)	0.3
Sunday	(6.1)	(5.4)	4.0	(2.6)	15.0	0.1	(1.1)
Season							
Winter	(0.7)	4.1	(3.4)	4.6	(1.9)	(3.4)	(2.9)
Spring	2.9	(1.2)	(0.3)	(2.1)	1.3	0.8	(2.8)
Summer	0.0	(2.7)	0.4	(2.5)	2.3	0.3	7.6
Fall	(2.0)	(0.6)	3.5	(0.6)	(1.4)	2.6	(1.6)
Weather							
Clear	11.4	(4.1)	(10.8)	(0.7)	0.2	3.2	2.4
Precipitation and wind	(10.4)	4.8	11.4	2.0	(4.9)	(3.4)	(2.5)
Cloudy and overcast	(2.9)	(0.0)	1.1	(1.2)	4.8	(0.4)	(0.3)
Visibility							
Good	23.9	16.8	18.9	(54.5)	9.2		0.7
Obstructed	(1.3)	5.3	3.7	(12.5)	7.0		8.1
Unspecified	(25.2)	(21.7)	(22.9)	67.4	(14.6)	39.4	(6.1)

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table A4.19: Results of test values associated with Table 19 (Characteristics associated with the scene of the accident by segment, 2000 to 2008)

	Segment						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	2 158	1 947	1 565	1 376	849	520	183
Road category							
Numbered route	(19.4)	40.4	29.0	(28.6)	(15.7)	(12.3)	(11.0)
Street	43.5	(27.2)	(23.7)	(21.3)	30.6	7.1	
Road	(6.1)	4.4	14.6	(8.4)	(5.0)	(2.0)	1.5
Logging road	(7.2)	(6.7)		(4.9)		(2.9)	83.0
Parking lot	(3.2)	(4.4)	(4.1)	(4.8)	(1.9)	31.2	
Missing values	(20.7)	(19.0)	(15.0)	74.4	(11.9)	(1.7)	(4.4)
Environment							
School and residential	19.6	(12.3)	(10.9)	(13.6)	18.9	4.5	
Business and retail	31.8	(8.5)	(21.0)	(20.7)	14.0	10.8	(9.0)
Industrial and manufacturing	6.3	4.6	(4.1)	(8.7)	(1.9)	3.8	(1.5)
Rural	(32.0)	31.9	43.8	(21.4)	(17.6)	(9.2)	(7.7)
Forestry	(9.0)	(3.3)	(1.1)	(5.8)		(3.8)	71.5
Recreational/park and camping	(1.2)	(0.8)	4.8	(3.3)	(0.3)	0.9	0.4
Unspecified	(20.5)	(19.4)	(16.7)	80.5	(11.4)	(8.0)	
Signage							
Absent	(10.0)	32.9	33.3	(41.2)	(10.3)		11.4
Present	41.0	(17.0)	(19.6)	(21.7)	29.4		(6.3)
Missing values	(27.7)	(21.4)	(19.3)	67.7	(16.2)	39.8	(7.1)
Posted speed limit							
60 km/h or less	46.8	(30.0)	(27.0)	(19.6)	30.9	7.4	(7.6)
70 km/h	(4.5)	14.5	(0.6)	(9.8)	(7.0)	(5.4)	21.4
80 km/h and 90 km/h	(24.5)	26.8	31.8	(15.8)	(13.5)	(9.1)	(6.1)
100 km/h or plus	(15.6)	18.3	16.0	(6.7)	(8.8)	(5.8)	
Unspecified	(15.9)	(15.4)	(10.8)	50.7	(11.1)	8.5	1.5

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table A4.20: Results of test values associated with Table 20 (Characteristics associated with type of accident by segment, 2000 to 2008)

	Segment						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	2 158	1 947	1 565	1 376	849	520	183
Severity of the accident							
Serious or fatal	(11.8)	21.6	3.8	(15.9)	(5.5)	4.7	7.0
Minor or material	11.8	(21.6)	(3.8)	15.9	5.5	(4.7)	(7.0)
Type of accident							
With collision (unsecured object)	30.0	21.3	(63.9)	(2.2)	5.1	12.5	(6.7)
Collision with stationary object	(12.4)	(9.7)	20.9	3.4	5.8		(2.0)
Without collision	(25.6)	(17.7)	57.6	0.5	(8.8)	(10.4)	8.4
Number of vehicles involved							
1 vehicle	(32.5)	(27.2)	56.2	(1.9)	(9.2)	27.0	5.5
2 vehicles	27.3	15.1	(41.7)	1.9	7.8	(20.1)	(1.9)
3 vehicles or more	4.1	14.6	(14.9)	(0.3)	1.1	(7.0)	(4.6)
Accident diagram							
Rear-end collision	13.8	13.6	(21.9)	8.1	(10.2)	(11.1)	(3.5)
Collision at an intersection	20.0	(11.4)	(19.4)	(3.7)	27.1	(9.7)	(5.4)
Front-end collision	(11.3)	28.2	(4.3)	(7.2)	(7.1)	(5.9)	6.2
1 vehicle running off the road to the right or the left	(24.8)	(21.2)	59.6	1.3	(9.4)	(7.2)	4.8
1 vehicle - other	(16.1)	(13.3)	9.4	(3.4)	(2.1)	44.8	0.9
2 vehicles - other	(0.6)	8.1	(8.7)	0.9	(2.8)	2.9	0.4
Unspecified	12.1	3.8	(16.3)	0.9	2.3	(5.9)	(1.1)
Vehicular movement							
Straight ahead	(10.3)	2.4	19.3	1.0	6.9		5.7
Other movement	11.2	1.7	(9.0)	2.7	0.1		(1.8)
No movement	15.6	2.0	(11.7)	1.1	(4.5)		
Missing values	(12.6)	(8.1)	(9.1)	(6.4)	(7.5)	73.2	(3.4)

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table A4.21: Results of test values associated with Table 21 (Characteristics associated with road features by segment, 2000 to 2008)

	Segment						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Number of victims	2 158	1 947	1 565	1 376	849	520	183
Road configuration							
Flat and straight	32.2	7.6	(16.1)	(46.5)	13.1	13.7	(7.0)
With curve and/or slope	(16.7)	9.2	34.1	(23.5)	(3.4)	(8.0)	12.5
Unspecified	(23.2)	(21.1)	(19.0)	90.4		(8.9)	(5.4)
Road surface type							
Asphalt	27.5	19.6	15.4	(76.4)	15.8	4.1	(25.9)
Other than asphalt	(27.5)	(19.6)	(15.4)	76.4	(15.8)	(4.1)	25.9
Road condition							
In good condition	24.0	21.1	16.5	(81.2)	13.9	3.8	(6.3)
Unspecified	(24.0)	(21.1)	(16.5)	81.2	(13.9)	(3.8)	6.3
Surface condition							
Dry	6.9	(0.9)	(6.9)	(4.2)	2.2	3.6	0.5
Not dry	(6.4)	1.2	7.0	3.5	(2.0)	(4.2)	(0.8)
Unspecified	(2.4)	(1.5)	(0.4)	3.5	(0.9)	2.6	1.4
Lighting							
Daylight and clear	13.5	8.6	(12.3)	2.4	(18.3)	(1.0)	1.0
Other	(13.5)	(8.6)	12.3	(2.4)	18.3	1.0	(1.0)

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table A4.22: Results of test values associated with Table 22 (Causes of WRC by segment, 2000 to 2008)

	Segment						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Total number of victims	2 158	1 947	1 565	1 376	849	520	183
- Victims with information available about the causes	1 882	1 818	1 490	885	743	445	170
Accident causes							
Distraction/inattention	15.7	(1.5)	(14.4)	(9.3)	(0.1)	4.4	(5.1)
Speeding/reckless driving	(20.3)	5.2	20.9	6.1	(10.2)	(5.7)	4.6
Weather conditions	(9.3)	3.3	13.0	2.6	(5.1)	(5.5)	(3.7)
Running a stop sign/traffic light	18.0	(11.6)	(13.9)	(5.9)	20.7	(4.5)	(3.2)
Temporary obstacle/animals/ infrastructure problem	(7.0)	(1.1)	5.8	(2.0)	(2.9)	(1.3)	11.6
Fatigue	(8.2)	0.1	14.4	(1.3)	(3.7)	(2.9)	0.4
Problem with the vehicle	(4.9)	(0.8)	8.2	0.9	(2.5)	(0.7)	(1.0)
Impaired driving	(0.3)	(0.1)	(1.9)	(3.6)	7.4	0.6	

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Appendix 5 - Descriptive Analysis of Collisions Involving Police Officers, Ambulance Technicians and Firefighters

A descriptive analysis of collisions specifically involving police officers, ambulance technicians and firefighters was carried out to complete the study of WRC involving an emergency vehicle. Ambulance technicians were identified by using the modality "Emergency vehicle" (ambulance) of the "Type of vehicle" variable available in the SAAQ database. Because equivalent information was not available for firefighters and police officers, they were identified with the profession codes from the CSST database. These were firefighting occupations (code 6111) for firefighters, while "police officers" included government police officers and detectives (code 6112), and private police agents and investigators (code 6113). Table A5.1 presents the distribution of the 1199 workers who were compensated (252 ambulance technicians, 65 firefighters and 882 police officers) within the seven WRC segments. Police officers make up 74%, ambulance technicians, 21%, and firefighters, 5%. Table A5.1 also shows that most of these workers are found in segment 5. The others are mainly represented in the first three segments (18%, 11% and 19%, respectively, for all of the three occupations). Tables A5.2 to A5.9 depict the characteristics of these workers and the accidents in which they were involved.

WRC involving police officers, ambulance technicians and firefighters have high levels of victims who were passengers, oscillating between 25% for police officers and 47% for ambulance technicians (Table A5.2). We can also see in Table A5.2 that men are represented in higher numbers than women in each of these three occupations, and even more so with respect to firefighters (94%). These accidents concern workers who are younger than those compensated as a whole by the CSST for WRC. The age group that is the most highly represented is that of 25 to 34 year-olds for the three occupations, and over 65% of police officers receiving benefits are younger than 35 (Table A5.2).

The level of serious injuries and deaths are lower than for WRC as a whole (Table A5.2) and levels of cervical, lumbar and thoracic injuries are high for police officers (51%) and ambulance technicians (49%) (Table A5.3). With respect to seatbelt use, the level of non-utilization in each of the three occupations is higher than for work-related road collisions as a whole (Table A5.2).

The analysis also indicates that a higher proportion of accidents involving police officers, ambulance technicians and firefighters occurs in the evening and at night (8:00 p.m. to 4:00 a.m.), as well as on the weekend, compared to WRC in general (Table A5.5). This is also a trend that was noted during the analysis of segment 5. In addition, almost one quarter of accidents involving ambulance technicians and firefighters occur between 4:00 p.m. and 8:00 p.m., which is much higher than for WRC as a whole (17%).

Bad weather conditions constitute the most significant factor in accidents involving ambulance technicians. In fact, 42% of accidents involving workers took place in the winter, and 64% of accidents in which they were involved took place under cloudy conditions or when there was precipitation or wind (Table A5.5). In almost one quarter of accidents involving ambulance technicians, poor weather conditions were reported as contributing factors (Table A5.9).

Running a stop sign or traffic light was also the most frequent cause reported in accidents involving these workers (Table A5.9). The rate of accidents occurring in an intersection is higher than for WRC on average, at 17% (Table A5.7). These are also the most frequent causes of accidents in speed limit zones of 60 km/h or less (Table A5.6). The accidents were not necessarily caused by the victim in cases in which more than one vehicle was involved. This was a limit associated with the available database.

Table A5.1: Distribution of ambulance technicians, police officers and firefighters among the segments, 2000 to 2008

	SEGMENT							
Frequency **% in the row** **% in the column**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
Ambulance technician	29 12% 14%	14 6% 11%	63 25% 28%	20 8% 23%	123 49% 24%	0 0% 0%	3 1% 30%	252 100% 21%
Police officer	165 19% 78%	109 12% 83%	151 17% 67%	61 7% 71%	363 41% 72%	27 3% 90%	6 1% 60%	882 100% 74%
Firefighter	18 28% 8%	9 14% 7%	11 17% 5%	5 8% 6%	18 28% 4%	3 5% 10%	1 2% 10%	65 100% 5%
Total	212 18%	132 11%	225 19%	86 7%	504 42%	30 3%	10 1%	1199 100%

Segment: 1 = two vehicles, low speed limit zone; 2 = two vehicles, high speed limit zone; 3 = single vehicle, speeding or fatigue; 4 = without apparent injury; 5 = emergency vehicle; 6 = pedestrian; 7 = forest environment.

Table A5.2: Characteristics of ambulance technicians, police officers and firefighters—SAAQ data, 2000 to 2008

	All	Segment 5	Police officers	Ambulance technicians	Firefighters
Number of victims	8 598	849	882	252	65
User type					
Driver	83%	60%	71%	52%	68%
Passenger	11%	39%	25%	47%	28%
Pedestrian	6%	0%	3%	0%	5%
Unspecified	0%	1%	0%	0%	0%
Gender					
Female	26%	32%	31%	21%	6%
Male	74%	68%	69%	79%	94%
Age					
Mean (standard deviation)	(39;12)	(33;9)	(33;8)	(37;10)	(37;10)
0-15	0%	0%	0%	0%	0%
16-24	11%	17%	15%	10%	15%
25-34	28%	46%	50%	34%	35%
35-44	27%	24%	24%	31%	22%
45-54	23%	10%	9%	22%	25%
55-64	10%	2%	1%	4%	3%
65+	1%	0%	0%	0%	0%
Severity of injuries					
No apparent injury	25%	13%	14%	23%	20%
Minor injury	65%	84%	82%	69%	78%
Serious injury	8%	3%	4%	8%	2%
Deceased	2%	0%	0%	0%	0%
Seatbelt use					
Used	59%	69%	68%	62%	57%
Not used or used incorrectly	12%	20%	17%	22%	26%
Missing values	29%	11%	15%	16%	17%

Table A5.3: Characteristics of ambulance technicians, police officers and firefighters— CSST variables, 2000 to 2008

	All	Segment 5	Police officers	Ambulance technicians	Firefighters
Number of victims	8 598	849	882	252	65
Employers' economic activity sector					
Public administration	38%	54%	99%	2%	97%
Transportation and warehousing	21%	9%	1%	0%	0%
Trade	14%	4%	0%	0%	0%
Missing values	12%	4%	0%	1%	2%
Other business/personal services	13%	10%	0%	1%	2%
Medical and social services	15%	16%	0%	97%	0%
Communication and energy	6%	2%	0%	0%	0%
Public works and buildings	5%	1%	0%	0%	0%
Injury site					
Cervical, lumbar, thoracic spine, neck	51%	45%	51%	49%	29%
Multiple sites	39%	28%	27%	29%	34%
Upper limbs and face	13%	10%	8%	12%	11%
Lower limbs	10%	8%	9%	4%	15%
Internal organs and nervous system	6%	5%	2%	2%	8%
Other/Cannot be classified	3%	1%	1%	1%	2%
Brain, skull	2%	3%	1%	3%	2%

Table A5.4: Characteristics of vehicles involved in WRC affecting ambulance technicians, police officers and firefighters, 2000 to 2008

	All WRC	Segment 5	Police officers	Ambulance technicians	Firefighters
Number of victims	8 598	849	882	252	65
Type of vehicle					
Automobiles	33%	20%	33%	2%	28%
Light trucks < 3000 kg	18%	8%	3%	0%	15%
Heavy vehicles ≥ 3000 kg	23%	8%	0%	10%	8%
Unspecified trucks	1%	0%	0%	0%	0%
Emergency vehicles	10%	55%	57%	85%	45%
Bus/minibus	6%	6%	0%	0%	0%
Other types	1%	1%	2%	1%	0%
Missing values	7%	1%	4%	3%	5%
Age of vehicle					
2 years and less	35%	51%	63%	47%	25%
Between 3 and 5 years	25%	33%	26%	46%	17%
6 years and more	32%	14%	6%	7%	54%
Missing values	8%	2%	4%	0%	5%

Table A5.5: Characteristics associated with the moment of the accident (ambulance technicians, police officers and firefighters), 2000 to 2008

	All	Segment 5	Police officers	Ambulance technicians	Firefighters
Number of victims	8 598	849	882	252	65
Time of accident					
Midnight to 3:59 a.m.	5%	17%	15%	9%	2%
4:00 a.m. to 7:59 a.m.	11%	9%	9%	14%	11%
8:00 a.m. to 11:59 a.m.	32%	15%	21%	23%	23%
12:00 p.m. to 3:59 p.m.	29%	18%	20%	17%	25%
4:00 p.m. to 7:59 p.m.	17%	19%	19%	23%	25%
8:00 p.m. to 11:59 p.m.	7%	22%	16%	14%	15%
Day of accident					
Monday	18%	12%	12%	14%	22%
Tuesday	19%	13%	15%	12%	22%
Wednesday	20%	15%	16%	18%	14%
Thursday	18%	13%	14%	14%	12%
Friday	15%	14%	14%	17%	14%
Saturday	6%	19%	16%	15%	8%
Sunday	4%	14%	12%	10%	9%
Season					
Winter	30%	27%	29%	42%	26%
Spring	21%	23%	22%	21%	28%
Summer	23%	26%	23%	19%	28%
Fall	26%	24%	27%	19%	18%
Weather					
Clear	53%	53%	53%	36%	63%
Precipitation and wind	25%	18%	25%	31%	15%
Cloudy and overcast	23%	29%	22%	33%	22%
Visibility					
Good	65%	79%	73%	75%	78%
Obstructed	9%	16%	12%	12%	9%
Unspecified	26%	5%	15%	13%	12%

Table A5.6: Characteristics associated with the scene of the accident (ambulance technicians, police officers and firefighters), 2000 to 2008

	All	Segment 5	Police officers	Ambulance technicians	Firefighters
Number of victims	8 598	849	882	252	65
Road category					
Numbered route	43%	18%	38%	51%	31%
Street	31%	77%	46%	36%	52%
Road	6%	2%	7%	4%	9%
Logging road	2%	0%	0%	1%	2%
Parking lot	2%	1%	1%	0%	0%
Missing values	16%	2%	7%	8%	6%
Environment					
School and residential	16%	38%	23%	21%	29%
Business and retail	31%	52%	40%	38%	34%
Industrial and manufacturing	6%	4%	5%	2%	3%
Rural	30%	4%	25%	31%	23%
Forestry	3%	0%	1%	0%	2%
Recreational/park and camping	1%	1%	1%	0%	3%
Unspecified	14%	1%	4%	8%	6%
Signage					
Absent	52%	35%	51%	48%	45%
Present	22%	62%	35%	38%	42%
Missing values	26%	3%	14%	14%	14%
Posted speed limit					
60 km/h or less	36%	85%	55%	48%	51%
70 km/h	11%	4%	9%	10%	17%
80 km/h and 90 km/h	22%	4%	16%	23%	12%
100 km/h or more	9%	1%	7%	11%	3%
Unspecified	22%	7%	12%	9%	17%

Table A5.7: Characteristics associated with type of accident (ambulance technicians, police officers and firefighters), 2000 to 2008

	All	Segment 5	Police officers	Ambulance technicians	Firefighters
Number of victims	8 598	849	882	252	65
Severity of the accident					
Serious or fatal	15%	9%	8%	19%	9%
Minor or material	85%	91%	92%	81%	91%
Type of accident					
With collision (unsecured object)	74%	81%	76%	73%	72%
Collision with stationary object	5%	10%	16%	21%	20%
Without collision	20%	9%	9%	6%	8%
Number of vehicles involved					
1 vehicle	30%	16%	25%	27%	29%
2 vehicles	56%	69%	60%	60%	60%
3 vehicles or more	14%	15%	16%	13%	11%
Accident diagram					
Rear-end collision	21%	8%	19%	18%	12%
Collision at an intersection	17%	50%	22%	32%	28%
Front-end collision	8%	2%	4%	5%	5%
1 vehicle running off the road to the right or the left	18%	6%	14%	23%	18%
1 vehicle - other	11%	9%	9%	2%	11%
2 vehicles - other	7%	5%	12%	1%	8%
Unspecified	17%	20%	19%	18%	18%
Vehicular movement					
Straight ahead	62%	73%	57%	75%	57%
Other movement	21%	21%	24%	19%	26%
No movement	8%	4%	11%	4%	11%
Missing values	9%	2%	8%	2%	6%

Table A5.8: Characteristics associated with road features (ambulance technicians, police officers and firefighters), 2000 to 2008

	All	Segment 5	Police officers	Ambulance technicians	Firefighters
Number of victims	8 598	849	882	252	65
Road configuration					
Flat and straight	58%	79%	70%	71%	71%
With curve and/or slope	26%	21%	23%	21%	22%
Unspecified	16%	0%	7%	8%	8%
Road surface type					
Asphalt	78%	100%	89%	90%	91%
Other than asphalt	22%	0%	11%	10%	9%
Road condition					
In good condition	80%	98%	90%	91%	86%
Unspecified	20%	2%	10%	9%	14%
Surface condition					
Dry	55%	59%	56%	43%	62%
Not dry	43%	40%	43%	55%	37%
Unspecified	1%	1%	1%	2%	2%
Lighting					
Daylight and clear	76%	51%	57%	62%	62%
Other	24%	49%	43%	38%	38%

Table A5.9: Causes of accidents involving ambulance technicians, police officers and firefighters, 2000 to 2008

	All	Segment 5	Police officers	Ambulance technicians	Firefighters
Number of victims	8 598	849	882	252	65
Accident causes					
Distraction/inattention	40%	40%	35%	35%	39%
Speeding/reckless driving	28%	11%	22%	26%	26%
Weather conditions	16%	8%	16%	23%	13%
Running a stop sign/traffic light	10%	28%	12%	26%	24%
Temporary obstacle/animals/ infrastructure problem	7%	4%	7%	6%	6%
Fatigue	5%	2%	2%	2%	2%
Problem with the vehicle	4%	2%	2%	1%	3%
Impaired driving	2%	5%	5%	4%	3%