

SAFETY FINDINGS

Exploring Pedestrian Crashes in Five Cities in Québec, Canada – Association with Road Types and Land Use

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Findings

Pedestrian injury rates are a major concern, particularly in North America. This study examined pedestrian crashes in five cities in Quebec, Canada (2017, 2019, 2020, 2021), related to road types and land use. Using police-reported data mapped via ArcGIS Pro, results show that major roads and residential areas are hotspots for pedestrian-vehicle crashes across all cities. Notably, a significant correlation exists in all studied cities between road types and land use where crashes happen. This underscores the need for road safety measures and targeted interventions to mitigate pedestrian risks in these areas, such as on major roads in residential and mixed land use areas.

1. QUESTIONS

Pedestrians are particularly vulnerable on roads, facing higher risks when interacting with heavy or fast motorized traffic. In 2019, the proportion of road traffic injuries involving pedestrians stood at 18% in Canada (Government of Canada 2020). While extensive research exists on pedestrian accident severity globally, specific locations of pedestrian-vehicle crashes in relation to road type and land use is not always put forward (Abou-Senna, Radwan, and Mohamed 2022; Dumbaugh, Li, and Joh 2013). This research aims to fill this gap by examining how road type and land use are associated to pedestrian-vehicle crashes. The hypotheses posits that crash rates vary significantly based on two factors. First, arterial roads with high traffic volume and speed are expected to experience more crashes. Secondly, areas with mixed land use or higher population density are anticipated to observe more pedestrian-vehicle crashes.

To achieve this goal, the study mapped pedestrian-vehicle crashes across five major cities in Quebec (Canada). These cities include Montreal with a population of 1.76 million, Laval with 422,000 inhabitants, Gatineau with 291,000 inhabitants, Longueuil with 255,000 inhabitants, and Saguenay with 145,000 inhabitants. Together, these cities represent 34% of the province's population and have a significant proportion of pedestrian-vehicle crashes. The study will analyze the environmental characteristics surrounding these crashes, focusing on road types and land use patterns to gain insights into the correlations between these factors and pedestrian accidents.

2. METHODS

The crash data were collected from aggregated police reports spanning four years (2017, 2019, 2020, 2021) and sourced from the Données Québec online platform (Government of Quebec 2023). To pinpoint the precise locations of these crashes within the four studied cities, we used the ArcGIS Pro geocoding module (Esri Inc. 2023), resulting in a dataset of 4875 crashes. To contextualize each crash, we used the Government of Quebec's road network dataset, accessible from their website (Government of Quebec 2023). This dataset allowed us to classify roads into three groups: 1) major (transit collector, municipal collector, arterial), 2) local, and 3) national or regional roads. Land use classifications varied based on cities but were consolidated into five categories: 1) residential, 2) mixed, 3) commercial, 4) industrial, and 5) others. After integrating these various layers within a spatial database, we conducted statistical analyses to explore potential significant differences between road types and pedestrian-vehicle crashes, as well as land use type and pedestrian-vehicle crashes. The Kruskal-Wallis test was applied to examine these differences. Additionally, Chi-Square tests were performed to ascertain any associations between road types and land use where crashes occurred.

3. FINDINGS

Among 4875 crashes, the majority occurred on major roads, followed by local roads. In most cities, pedestrian-vehicle crashes were predominantly on major roads, except Gatineau, where slightly more crashes were reported on local roads. Regarding national and regional roads, the crash percentage was notably lower across the four cities, except Saguenay, where a quarter of crashes took place on these roads. Based on the Kruskal-Wallis test, no significant differences were found between road types in all and across cities ([Table 1](#)).

Table 1. Proportion of pedestrian-vehicle crashes for type of road and cities

	All pedestrian crashes	Laval	Montreal	Longueuil	Gatineau	Saguenay
Local road	30.65 %	32.10%	40.29%	35.22%	45.92%	29.79 %
Major road	63.34 %	66.60%	54.54%	49.06%	44.56%	44.68%
National and regional road	6.01 %	1.30%	5.17%	15.72%	9.52%	25.53%
Total	100%	100%	100%	100%	100%	100%

The analysis by land use revealed that most pedestrian-vehicle crashes occurred in residential areas, followed by mixed land use areas. This trend was consistent across cities; however, in Longueuil and Gatineau, the number of crashes in mixed land use areas was notably higher and nearly as prevalent as in residential areas. We conducted tests to identify any significant differences based on land use concerning crashes, yet no distinctions were observed in all or across cities ([Table 2](#)).

Table 2. Proportion of pedestrian-vehicle crashes for land use and cities

	All pedestrian crashes	Laval	Montréal	Longueuil	Gatineau	Saguenay
Residential	69.40 %	77.60%	72.10%	45%	52.04%	33.57%
Mixed land use	23.50%	15.40%	23.00%	45%	40.48%	0.00%
Commercial	1.90%	3.20%	0.00 %	6.25%	0.68%	47.86%
Industrial	3.00%	3.20%	3.00%	2.5%	3.06%	0.71%
others	2.00 %	0.60%	1.90%	0.00 %	3.74%	17.86%
Total	100%	100%	100%	100%	100%	100%

After cross-referencing data on the road network and land use for all cities, we found that most crashes occurred on major roads spanning different land use areas. Notably, the combination of major road and mixed land-use areas was over-represented, accounting for most recorded pedestrian-vehicle crashes. A similar trend was observed between the industrial sector and major road, as well as between the residential sector and major roads. Furthermore, we conducted a chi-square test to examine the association between these two groups, revealing significant correlations between road types and land uses where pedestrian-vehicle crashes occur ([Table 3](#)). We also did the test separately for each city and the results indicated significant associations between these two groups across cities.

Table 3. Proportion of pedestrian-vehicle crashes, between road type and land use (all cities) and resulting Chi-square test

	Residential	Mixed land use	Commercial	Industrial	others	Total
Local road	28,17 %	8.82 %	0.47 %	1.15 %	0.84 %	39.45
Major road	31.06 %	19.73 %	0.45 %	1.58 %	1.72 %	54.54
National and regional road	2.60 %	2.46 %	0.53 %	0.08 %	0.33 %	6.01
Total	61.84%	31 %	1.46 %	2.81 %	2.89 %	100%
X ² (p)	202.68 (0.001)					

This study is limited by the lack of control variables due to the unavailability of pedestrian and traffic volume data. Also, it doesn't account for the share of the different types of roads and land use in the cities studied, since we used crashes (points) as our observations. Nonetheless, the study's findings hold implications for urban planning and policymaking. The notable concentration of pedestrian-vehicle crashes on major roads, particularly within residential areas confirms our hypotheses. Similarly, it corroborates the findings of previous studies on the occurrence of pedestrian-vehicle crashes on major roads in Toronto, Canada (Rothman et al. 2010) but differs from the case of Vancouver where pedestrian-vehicle crashes were concentrated in commercial area (Osama and Sayed 2017). This underscores the need for targeted safety measures. Integrating pedestrian-friendly infrastructure, such as enhanced crossings and traffic calming interventions, becomes imperative

in these high-risk zones. Policymakers can leverage this data to advocate for policy changes focused on improving safety standards, including stricter speed regulations and enhanced pedestrian crossings. Further research stemming from these findings could inform targeted interventions and may significantly contribute to reducing crash rates in urban environments.

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