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Seasonal and Weather Effects on Older Adults' Driving Trip Distances

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Abstract

The purpose of this study was to determine if season or weather affected the objectively measured trip distances of older drivers (≥ 70 years n=279) at seven Canadian sites. During winter, for all trips taken, trip distance was 7% shorter when controlling for *site* and whether the trip occurred during the day. In addition, for trips taken within city limits, trip distance was 1% shorter during winter and 5% longer during rain when compared to no precipitation when controlling for *weather* (or *season* respectively), *time of day,* and *site*. At night, trip distance was about 30% longer when controlling for *season* and *site* (and *weather*), contrary to expectations. Together these results suggest that older Canadian drivers alter their trip distances based on season, weather conditions and time of day, although not always in the expected direction.

Key words: Driving, Older Adults, GPS, Naturalistic Driving, Winter

Introduction

Canadian statistics from 2009 indicate that 3.25 million or 74.9% of people aged 65 years and over had a driver's licence, and 200,000 or 40.7% were age 85 years and over (Turcotte, 2012). It is predicted that approximately 85% of older adults over the age of 65 will have a driver's licence in the year 2028 in Ontario, but it stands to reason that a similar trend will be seen across Canada as well (Hopkins, Kilik, Day, Row & Tseng, 2004). It is also predicted that the discrepancy in licencing rates between male and female older drivers will narrow to 1:1 by as early as 2023 (Dobbs, 2008). Further to this, Rosenbloom (2001) noticed an increasing dependency of seniors on the personal automobile to meet their transportation needs, and Turcotte (2012) found older adults are living longer in highly car dependent neighbourhoods.

In addition to the aging driving population, there is the U-shaped curve that indicates per 100 million kilometers (km) driven, older adults have an increased casualty crash rate involving injuries (Langford, Koppel, Charlton, Fildes, & Newstead, 2006). Additionally, older adults aged 80+ have the second highest crash rate per km driven, just short of the rate for 15-19 year olds (Langford et al., 2006; Langford, Koppel, McCarthy, & Srinivasan, 2008). There have been two main theories that attempt to explain this increase; the first is the low-mileage bias, which suggests that, regardless of age, drivers who drive relatively low annual mileages are at an increased risk for crashes, due to most of their trips occurring in congested urban areas and intersections where the risk of crashes are increased (Hakamies-Blomqvist, Raitanen, & O'Neill, 2002; Janke, 1991; Langford et al., 2006; Langford et al., 2008). The second theory is the frailty bias, which suggests that crashes involving injuries are more likely to be reported to the police. In such instances, older drivers are also more likely to be injured in a crash because of age-related fragility (Li, Braver, & Chen, 2003) resulting in more older drivers being included in crash databases due to police reports.

In Canada, crash risk for all road users increased with rainfall and snowfall, compared to dry conditions (Andrey, Hambly, Mills &Afrin , 2013), as did risk of injury (rainfall 74%; snowfall 89%; Andrey, 2010). If older adults are at greater risk for crashes and related injury then these weather-related statistics provide reason for concern. Thus, it is important to examine the extent to which older adults are driving during these conditions.

As argued by Lindstrom-Forneri, Tuokko, Garrett, & Molnar (2010) it is important to consider both individual and environmental factors as well as interactions between these factors when examining the driving behaviour of older adults. Most frameworks on driving behaviour, including the one by Lindstrom-Forneri et al. (2010), refer to Michon's model (Michon, 1985) which categorizes different levels of compensatory behaviours: 1) strategic, which refers to planning decisions (e.g., using familiar or unfamiliar roads, postponing trips, or shortening trips), 2) tactical, which involves maneuvering such as adjusting one's speed due to environmental conditions, and 3) operational, which pertains to control of the vehicle (e.g., using turning signal lights).

There is substantial evidence that older drivers, particularly women, appear to modify their driving practices as they age. For example, older drivers tend to: drive less often, closer to home, in the daytime, on weekdays, and in familiar areas (e.g., Collia, Sharp, & Giesbrecht, 2003; D'Ambrosio, Donorfio, Coughlin, Mohyde, & Meyer, 2008; Keall & Frith, 2004). They also tend to avoid: driving at night, driving in bad weather, driving in rush hour, driving on highways, and making complex manoeuvres such as left hand turns (e.g., Baldock, Mathias, McLean & Berndt, 2006; Charlton et al., 2006; D'Ambrosio et al., 2008; Hakamies-Blomqvist & Wahlström, 1998; Lyman, McGwin Jr, & Sims, 2001; Oxley, Charlton, Scully, & Koppel, 2010). To date most of the research has used questionnaires or interviews to examine self-reported driving practices (frequency, distance and types of situations most often avoided).

Evidence is accumulating that self-reported driving practices may not be accurate. Several studies have found that older drivers misestimate driving distance when compared to objectively measured mileage using in-vehicle recording devices (Blanchard, Myers & Porter, 2010; Crizzle & Myers, 2013; Huebner, Porter & Marshall, 2006; Molnar et al., 2013; Porter et al., 2014; Staplin, Gish & Joyce, 2008). With regards to weather, Blanchard et al. (2010) found that in a sample of 61 drivers aged 67-92 years, 43% of those who reported avoiding driving in bad weather actually drove during "bad weather".

Related to the present study of seasonal effects on older adults driving there is a study by Sabback & Mann (2005) who specifically addressed the influence of climatic and road conditions on the driving practices of older adults in New York and Florida, albeit using only self-report (telephone surveys) for driving frequency, miles driven, climatic, seasonal and road conditions. They found older adults (n=20) in Western New York reported altering their driving patterns due to seasonal variations in weather conditions.

Further to this Myers, Trang & Crizzle (2011) is the only study to date that has looked at the naturalistic driving patterns of older adults specifically during the winter season over a two week period. Overall, the sample was more likely to drive (69%) than not drive (31%) on days with inclement weather and 67% drove on days when weather advisories had been issued for the region. This differs from the Kilpelainen & Summala (2007) suggestion that older drivers would not drive during adverse weather conditions as their trips are generally more discretionary.

The primary purposes of the present study were to determine if there were seasonal (winter versus non-winter) and weather related (inclement versus non-inclement) changes in the driving patterns (specifically trip distances) of Canadian older adults over a full year. Additionally, we examined trip distances at night compared to daylight hours as length of daylight varies by season in northern countries. Our primary hypotheses were that there would be a decrease in trip distance during winter and a decrease in trip distance during inclement weather conditions, regardless of season. We further hypothesized that trip distance would decrease during night-time driving regardless of season or weather conditions, and that increased age, decreased mobility, and poorer health status would result in an even greater decrease in trip distance during both winter and inclement weather conditions.

Methods

This study utilized data from the Canadian Driving Research Initiative for Vehicular Safety in the Elderly (Candrive II) project. Candrive is a longitudinal cohort study assessing the everyday driving patterns of older drivers, as well as the development of a clinical decision rule to stratify the risk of crashes (Marshall et al., 2013).

Participants

The participants for Candrive were recruited from Ottawa, Toronto, Montreal, Hamilton, Thunder Bay, Winnipeg and Victoria. At the time of enrollment, participants (n=928) had to be 70 years of age or older, possess a valid driver's licence, report driving at least 4 times per week on average, and live in their respective city at least 10 months of the year (see Marshall et al., 2013), and agree to having an In Car Recording Device (ICRD) installed in their vehicle for the study duration (see Porter et al., 2014). Institutional approval for each site was granted by the appropriate ethics board, and all participants provided written informed consent.

Additionally, for the present study, participants must have indicated at the baseline assessment that they were not considering restricting or quitting driving in the next 6 months. As well, participants must have only driven the vehicle that was equipped with the electronic device over the first year of the study (as we could not capture data from other vehicles they drove which would lead to an underestimation of driving exposure). The latter criteria resulted in 433 people being excluded from the analyses (see Figure 1). Participants (n=152) with missing, incomplete and not useable driving data files were also excluded from analysis.

Apart from changing vehicles, some data was lost due to inadvertent disconnections of the devices (e.g., during vehicle servicing). To allow for short interruptions, participants had to have a minimum of 335 days of driving data (one month short of a year), with at least 90% of usable GPS information collected over the year, to be included in the analyses. Missing GPS data were often due to trips being very short (unable to establish a satellite connection), however there could also have been problems with the GPS receiver and/or connection with the ICRD; the latter could have resulted in a systematic loss in trips for analysis. As illustrated in Figure 1, 279 participants met the above criteria for inclusion in the "All trips" dataset.

As weather data was obtained from stations within or adjacent to each of the seven research centers, we also created a separate database for "City trips" comprising of 248 of the 279 subjects. This dataset allowed us to examine the specific effects of weather (not just season) on trip distance. This also means that the All trips dataset had no weather data associated with it and we could only examine the effects of season. Participants whose first 3 digits of their postal code indicated that they lived outside of the census 2011 population centre of their respective Candrive site were excluded (n = 31) from the weather analysis as shown in Figure 1. Additionally, any trips by these 248 participants that started and ended outside of population centre limits were also removed from this dataset.

[Figure 1]

Data Collection

Participants in the Candrive study completed a comprehensive assessment at baseline and annually, as described in Marshall et al. (2013). For this study, we examined age, gender, marital status, living arrangements, education, volunteer status, availability of friends and family to drive, self-reported health status, medications, scores on the Expanded Cumulative Illness Rating Scale (CIRS) and time to complete the Rapid Pace Walk and Timed Up and Go tests. The CIRS (Hudon, Fortin, &

Soubhi, 2007), as modified by Candrive, provided information on 44 medical conditions that participants ranked from no problem (0) to an extremely severe problem (4).

Installed in each participants vehicle was the ICRD. The ICRD was the OttoView-CD data acquisition system (Persen Technologies Inc., Winnipeg, MB) which was installed into the vehicles of all participants at the time of enrolment. The GPS antenna receives positional, speed, and Greenwich Mean Time (GMT) time and date information, and the OttoView-CD device collected and stored information on driving time, vehicle speed, distance, and other vehicle engine data; this information was collected once per second (Porter et al., 2014).

Data Analyses

Winter

Winter in Canada is challenging to define. The meteorological definition of winter is the three months consisting of: December, January and February (MetOffice, 2013), whereas, for the astronomical definition, winter starts at the winter solstice and ends at the spring equinox (MetOffice, 2013). Both of these definitions encompass only 3 months of the year. In Canada, many people think of the winter season as being longer, beginning with snowfall and/or cold temperatures and ending when the snow melts and the temperature warms up, which varies considerably in different parts of the country (e.g., Winnipeg versus Victoria). For the purposes of this study, six definitions of winter were developed for examination (as shown in Table 1).

[Table 1]

The driving trips examined in this study were collected between June 29, 2009 and November 18, 2011. Using each of the definitions shown in Table 1 to classify trips, the proportion of winter days captured for each location ranged from 26% to 58% for Ottawa, 20% to 58% for Toronto, 21% to 62% for Montreal, 25% to 64% for Hamilton, 28% to 57% for Thunder Bay, 30 to 55% for Winnipeg, and 0% to 69% for Victoria.

Night

Trips from both datasets were further categorized according to whether they took place during daylight hours or not (*time of day*). For brevity purposes, trips that occurred outside of daylight hours are being referred to as night. Night driving was defined as any trip where at least a portion of the trip occurred after sunset or before sunrise (Myers et al., 2011). Sunrise and sunset were calculated using the date and the GPS coordinates from the beginning and end of the trip using the method described by Teets (2003).

City

City trips were defined as those which started and ended within the census 2011 population centre for the respective city or within 10km of the airport. Trips in proximity to the airport were included for two reasons: 1) weather data were collected from the weather stations at each city's respective airport, and 2) because the airport in every city except Winnipeg is located outside of the population centre.

Weather

Weather data came from Environment Canada's hourly historical weather records for each of the seven city's airport weather stations. Airport weather stations were used because they consistently collect information on weather conditions (e.g., mainly clear, drizzle). In addition to weather conditions, the hourly weather data provides information on: temperature, humidex and windchill values. Usually this information was collected once an hour on the hour mark. In addition, an average of thirty years (1971-2000) of weather data were used to determine what could be considered normal or extreme temperatures for each city. Extreme temperatures were defined as temperatures greater than or equal to two standard deviations from the 30-year average for the respective month.

The yearly summary file for each participant included in the City driving dataset was merged with the corresponding hourly weather data from Environment Canada. Trips with a start and end time that crossed weather points were averaged. For example, if a trip started at 11:50 am and ended at 12:10 pm, the temperature at 11 am and 12 pm was averaged. If conditions differed between the time points (e.g., "mostly cloudy" at 11:00 am and "snowing" at 12:00 pm), both were used. Trips were then coded according to weather condition and categorized as occurring during inclement (four definitions) versus non-inclement weather as shown in Table 2.

[Table 2]

Statistical Analyses

To examine the extent to which winter, inclement weather conditions, and night-time driving explained the variation in trip distance exhibited by older drivers over the course of a year, a multi-level random intercept regression was performed. For this study, the outcome of interest was trip distance, which was nested within participants. Because it was not normally distributed, trip distance was transformed using a natural log. To determine whether trip level variables (i.e., season, weather, time of day) and participant level characteristics (e.g., age, gender, health status, etc.) had an effect on trip distance, a multi-level regression was utilised. SAS 9.3M0 was used for all analyses.

Model building

The model building steps outlined by Bell, Ene, Smiley & Schoeneberger (2013) were used for both the dataset containing All trips (n=279 participants or 377,464 trips), and the dataset consisting of City trips (n=248 participants, or 298,342 trips). First, a sensitivity analysis was run to determine which definitions of winter (All trips and City trips datasets) and inclement weather (City trips) explained the greatest amount of variation in trip distance. Next, the unconditional model was used to confirm the appropriateness of a multi-level regression and to calculate the intraclass correlation coefficient. Finally, using the definitions emerging from the sensitivity analysis, participant level characteristics were added into the model using a forward step-wise approach to determine which if any were significant. The change in deviance or the Likelihood Ratio Test was used to compare the model containing just the trip level characteristics with the model containing both the participant and trip level characteristics to determine which model best fit the data and therefore the final model (Peugh, 2010).

Results

Participants

Of the 279 participants included in the analysis for the All trips dataset, 25% were from Ottawa (site 1), 14% from Toronto (site 2), 10% from Montreal (site 3), 14% from Hamilton (site 4), 10% from Thunder Bay (site 5), 11% from Winnipeg (site 6), and 15% from Victoria (site 7). The sample ranged in age from 70 to 92 (average age at time of enrollment was 77.5 ± 5.2 years), with a relatively equal gender distribution (51% male). Fifty-four percent reported still living in a house, 44% were married, and 39% had some university education. Only 7.9% were working full or part-time, while 53% reported volunteering full- or part-time. Sixty-six percent reported having family or friends that were willing to drive them.

In terms of health, 76% reported their health status as either excellent or very good. The average number of reported medications was 4.7 ± 2.9, and the average CIRS score was 10.9 ± 5.0. The average times to complete the Rapid Pace Walk and Timed Up and Go tests were 6.8 ± 1.7 seconds and 10.4 ± 2.4 seconds, respectively. The sample characteristics for the City trips dataset were essentially the same.

Inclement versus Non-inclement Weather

Of the 107,674 hours of weather data examined, 23.8% met the criteria for inclement weather using the first definition, 26.9% using the second definition, and 30.6% using the third definition (see Table 2 for definitions). No precipitation was recorded for 78% of the hourly data, while 9.8% had some form of rain, 8.3% had some form of snow or frozen precipitation (e.g., freezing drizzle or snow), while 3.2% indicated vision obstructing precipitation (e.g., blowing snow or fog).

Multi-level Regression

Sensitivity Analysis

All trips dataset

A model was run with each definition of winter to determine which definition best explained the variation in trip distance when trips were treated as independent observations. The 4th definition of winter (i.e., starting on the first date of the first four consecutive days of lows below 0°C and ending on the first date of the last four consecutive days of lows below 0°C), explained the most variation at the trip level when controlling for *time of day* and *site*.

City trips dataset

Similar to the All trips dataset, a model with each combination of winter and inclement weather was run to determine which combination explained the most variation in trip distance when each trip was treated as an independent observation. The 6th definition of winter (i.e., starting on the first day of temperatures less than or equal to halfway between the minimum and maximum highs for the year and ending on the last day of temperatures less than or equal to halfway between the minimum and maximum highs for the year), and the 4th definition of inclement weather (i.e., weather conditions indicating precipitation), explained the most variation in trip distance when controlling for *time of day* and *site*.

Regardless of which definition of winter was used, there was a small, but statistically significant decrease in trip distance during winter when compared to non-winter driving when controlling for *weather* (City trips dataset only), *time of day* and *site*.

Final Model

Table 3 presents the final models for the All trips and City trips datasets. Given that trips are nested within participants for both, the multi-level model was an appropriate method for analysis [(All trips: trip level variance estimate = 1.53 (Z=434.27, p<0.001), and participant level variance estimate = 0.11(Z=11.65, p<0.001); City trips: trip level variance estimate = 1.15 (Z=349.74, p<0.001), and participant level variance estimate = 0.08 (Z=9.97, p<0.001)]. From the level 1 and level 2 variance, the ICC was calculated [All trips: 0.11/(0.11+1.53)=0.07, City trips: 0.08/(0.08+1.15)=0.07], indicating that only 7% of the variation in trip distance could be explained by the participant characteristics (e.g., age, gender). Most of the variation in trip distance occurred at the trip level for both datasets.

Participant level characteristics were then added to the unconditional model to determine which if any were significant predictors of trips distance. It was determined for the All trips dataset that marital status and for the City trips dataset that living arrangements were the only participant level characteristics that were significant. When these characteristics were added to their respective model containing *season, weather* (City trips dataset only)*, time of day, and site* they did not improve the fit of the models and were therefore excluded from the final models.

[Table 3]

The final models can be interpreted as:

- All trips dataset:
    - In the winter (compared to non-winter) there was a 7% decrease in trip distance when controlling for *time of day* and *site*.
    - For night-time driving, there was a 33% increase in trip distance when controlling for *site* and *winter*.
- City trips dataset:
    - In the winter there was a 1% decrease in trip distance when controlling for *weather*, *time of day*, and *site*.
    - There was a 5% increase during rain, and no change during snow or vision obstructing precipitation when controlling for *season*, *time of day*, and *site*.
    - There was a 29% increase in trip distance during night-time driving when controlling for *weather*, *site* and *season.*

Discussion

As noted at the outset, only a few studies to date have objectively examined the naturalistic driving practices of older adults and fewer still have examined weather conditions. Although the findings were informative, monitoring periods were short (one to two weeks) and samples were limited. The current study is the first to examine a full year of driving for a sample of older adults from seven locations across Canada, to determine if older drivers reduce their trip distance based on season or weather. The study employed strict exclusion criteria such as driving only one vehicle and examined trip level rather than aggregate data.

As expected, there was a decrease in trip distance in the winter (compared to non-winter), when all trips were examined (7%) or even for trips within their city (1%), although the decrease was relatively small. As noted by other researchers, in harsh climates like Finland (Kilpelainen & Summala, 2007) and Canada (Myers et al., 2011) people must deal with winter driving conditions if they wish to maintain their activities. This might explain why there was no difference in city trip distance when there was snow or vision obstructing precipitation. In addition, it was surprising that participants actually drove farther when it was raining. It is possible that people chose to take longer trips for indoor activities (e.g., to the mall across town) when it was raining as opposed to doing outdoor activities such as walking or gardening. In the only other study to objectively examine weather-related driving practices of older drivers, Myers et al. (2011) found that 70% drove on days with inclement weather (snow or rain) and poor road conditions.

One of the most interesting and unexpected findings of this study was the increase in trip distance (about 30%) at night compared to daytime driving. Prior naturalistic studies using shorter monitoring periods have found older drivers make proportionately fewer trips at night and drive shorter distances than in the daytime (Myers et al., 2011; Crizzle & Myers, 2013). However, these studies used shorter monitoring periods (two weeks) and did not compare seasons. Crizzle & Myers (2013) found that the number of night trips and duration were significantly correlated with leisure trips in their healthy group of older drivers. Although we did not assess trip purposes in this study, it is possible that night driving trips might be more discretionary in nature, and may take someone further from home than they would normally travel (e.g., to watch a grandchild's hockey game).

Together these results suggest that older Canadian drivers may alter their trip distances based on weather, season and time of day, although not always in the expected direction. As Lindstrom-Forneri et al. (2010, pg. 283) propose "Decisions made at the strategic, tactical, and operational levels must be viewed within the social/physical environmental context…". For older North Americans transportation and hence community mobility are "synonymous with being able to operate an automobile", and is "inextricably linked to independence, autonomy and quality of life" (Dickerson et al., 2007, pg. 579). Therefore, an older driver might choose to make longer trips even if the weather is poor or it is night, in order to maintain their community mobility. City planners, transportation engineers, health practitioners, and those offering programs and events (e.g., concerts) that older adults attend need to consider the travel patterns of older drivers.

Although this study provided an extremely detailed analysis of trip distances of older drivers, there were several limitations. Very low R^2 values were observed indicating that when each trip was treated as an independent observation the covariates chosen did not explain much of the variation and therefore other factors may be more predictive. While studies of shorter duration (two weeks) have examined driver perceptions of weather and driving trip purposes using logs (e.g., Crizzle & Myers, 2013; Myers et al., 2011), it was unrealistic to ask our participants to record such information for every trip, 365 days a year over several years. Driving diaries can quickly become burdensome and thus compliance becomes an issue (Marshall et al., 2007). Another major challenge was defining winter and inclement weather in a consistent manner across sites. Individuals likely have different perceptions about what constitutes "winter" and "inclement weather" based on where they live, and these perceptions in turn could affect changes in driving patterns. Road conditions were also not considered in this analysis as there are no databases that contain historical records on road conditions, especially within cities. This is important because road conditions can be affected not only by current precipitation but also by past precipitation, temperature and wind related factors. For example, in Winnipeg the weather could be clear, but the roads could be extremely slippery due to low temperatures and wind polishing the roads. Finally, weather data was only collected from one location for each of seven different sites. Thus, the weather data was likely more accurate for trips that occurred near the respective weather stations, and less accurate for trips made further from these stations. Furthermore, although the weather data was reported once per hour, weather can change quickly and it is possible that conditions were not always accurately captured (e.g., a short downpour).

Trip distance (measured once people got into their vehicle, i.e., chose to drive) was the variable of interest in this study examining winter and weather. Older drivers may adjust to adverse driving conditions by choosing not to drive (i.e., cancelling or postponing trips) or adopt other strategies (e.g., taking alternate routes or reducing their speed) rather than reducing their trip distance. Participant characteristics such as health or mobility did not seem to explain much of the variation in trip distance. If the number of trips had been examined then participant characteristics may have played more of a role. In future, self-regulation can be explored further by examining numbers of trips taken, distance from home, and speed, using Candrive data. Additionally, objectively measured driving data could be combined with information on older drivers' attitudes towards driving and perceived comfort level to try to better understand the mechanisms of self-regulation.

Conclusion

This study provides a detailed examination of seasonal/weather-related driving trip distances by a large sample of older adults at seven Canadian sites over a full year. Although older adults drove slightly shorter trip distances during winter conditions, trip distance was slightly longer during both rain and vision obstructing precipitation types (as compared to no precipitation), and substantially longer at night. Additional research is clearly needed to further understand the driving patterns of older drivers, including reasons for trip cancellation/postponement and route changes especially in relation to season and weather in different geographical areas.

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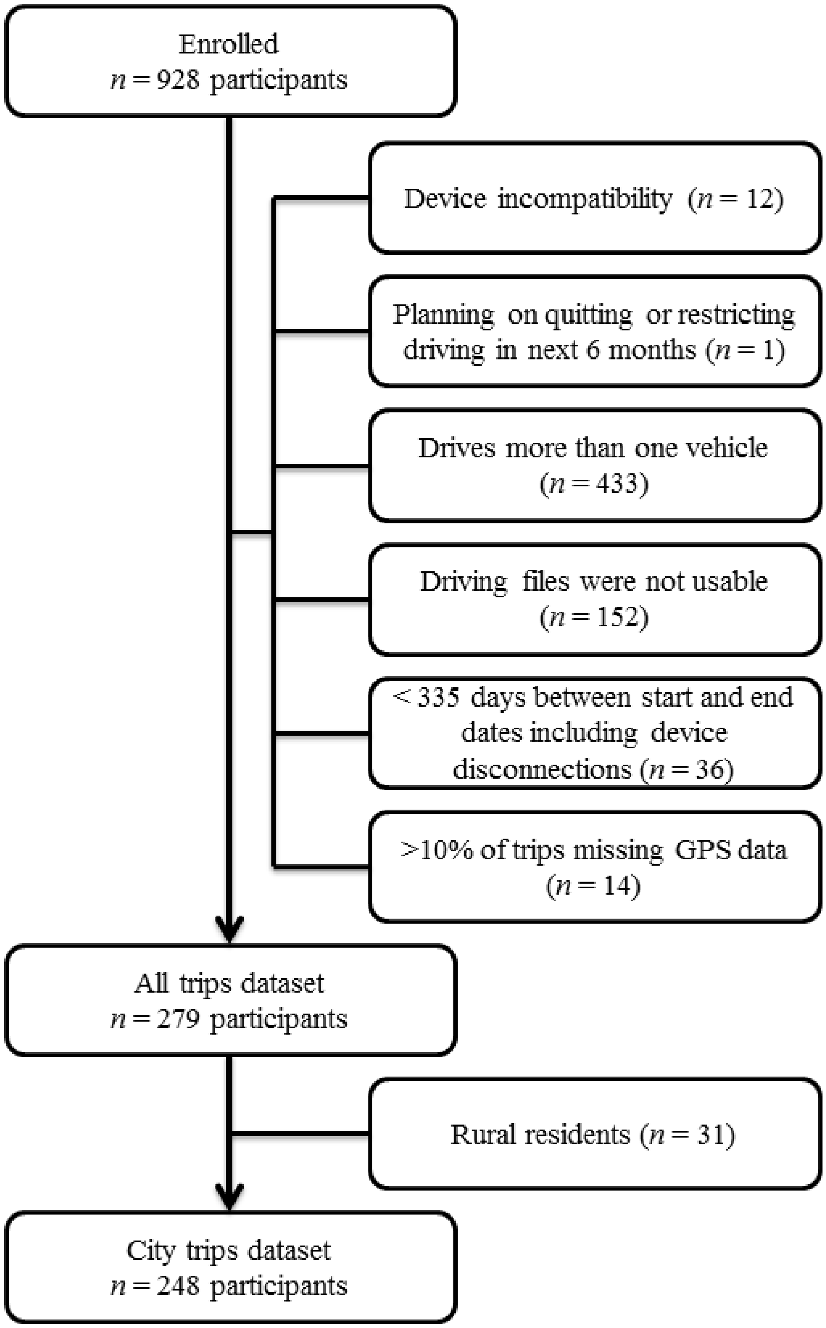

Figure 1. Participant flow chart.

Table 1. Winter definitions.

Winter1	Start date – date of first snowfall. End date – date of last snowfall.
Winter2	Start date – date of first winter precipitation followed by 4 consecutive days of highs below 0°C. End date – first date of last 4 consecutive days of highs below 0°C.
Winter3	Start date – first date of winter precipitation followed by 4 consecutive days of lows below 0°C. End date – first date of last 4 consecutive days of lows below 0°C.
Winter4	Start date – first date of first 4 consecutive days of lows below 0°C. End date – first date of last 4 consecutive days of lows below 0°C.
Winter5	Start date – first day of temperatures less than or equal to halfway between the warmest and coldest lows. End date – last day of temperatures less than or equal to halfway between the warmest and coldest lows.
Winter6	Start date – first day of temperatures less than or equal to halfway between the warmest and coldest highs. End date – last day of temperatures less than or equal to halfway between the warmest and coldest highs.

Table 2. Inclement weather and precipitation type definitions.

Precipitation definitions	
No Precipitation	Clear, cloudy, mainly clear, and mostly cloudy
Snow	Freezing drizzle, freezing rain, ice crystals, ice pellet showers, ice pellets, snow, snow grains, snow pellets, and snow showers
Rain	Drizzle, rain, rain showers, and thunderstorms
Vision Obstructing	Blowing snow, freezing fog, fog, haze, smoke
Inclement weather definitions	
Inclement1	Weather condition indicating snow or rain or a windchill value of less than or equal to -28, or a humidex value of greater than or equal to 30.
Inclement2	Inclement1 with the addition of weather conditions indicating vision obstructing precipitation
Inclement3	Inclement2 with the addition of extreme temperatures (greater than or less than 2 standard deviations from the standardized temperature, where temperature was standardized to the monthly norms for the corresponding site).
Inclement4	Weather conditions indicating precipitation (snow, rain, and/or vision obstructing)

Table 3. Final model for the All trips and City trips datasets.

	All trips	City trips
Trips	376157	244590
AIC	1222086	727624
-2LL	1222082	727620
Variance		
Level 2	0.11	0.08
Level 1	1.53	1.15
Intercept	1.56 (0.04)***	1.31 (0.37)***
Winter	-0.07 (0.00)***	-0.01 (0.00)**
Precipitation (ref = 0)		
Vision	--	0.01 (0.01)
Rain	--	0.05 (0.01)***
Snow	--	0.00 (0.01)
Day	-0.33 (0.01)***	-0.29 (0.01)***
Site (ref=1)		
7	-0.11 (0.06)*	--
6	0.02 (0.07)	0.12 (0.07)*
5	-0.10 (0.07)	-0.07 (0.07)
4	0.06 (0.06)	0.04 (0.06)
3	0.04 (0.71)	0.12 (0.07)*
2	0.03 (0.06)	0.14 (0.06)**

Note: Variance values are the variance estimate (all variances were significant at $p < 0.0001$), and regression values are the parameter estimate (standard error). Site 1 = Ottawa, site 2 = Toronto, site 3 = Montreal, site 4 = Hamilton, site 5 = Thunder Bay, site 6 = Winnipeg, site 7 = Victoria. *$p \leq 0.1$, **$p \leq 0.05$, ***$p \leq 0.01$