ANALYSIS OF HOLIDAY CRASHES IN ALBERTA

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Abstract

Motor vehicle crashes during the statutory holiday festive periods are on the rise in Alberta, Canada. For example, in the year 2004 a total of 6706 collisions occurred during the holidays and long weekends which killed 33 people and injured more than 1500 people. Whereas in 2007, the total number of crashes increased to 11639 in which 48 people were killed and more than 2000 people were injured. Yet little research has been done on this subject matter. Therefore, this research was aimed at shedding some light on the characteristics of the accidents occurring on the holidays on Albertan roadways and find out if these accidents are significantly different from the non-holiday period accidents. Chi-square test of statistical significance has been applied to accident data for the years 2004-2006. In addition, a binary logistic regression model has also been applied to the data to find out the contributing factors affecting the fatality risk of such accidents. Our study showed a decreasing trend in the traffic fatality risk during the holidays. Also season, time, post collision manoeuvre, lighting condition, driver age and gender were found to be the important determinants of the fatal holiday crashes in Alberta.

Keywords: Holiday, Fatality Risks, Logistic Model, Alberta

Introduction

In many countries, national holiday periods are commonly viewed as times of heightened danger on the roads. The holidays are associated with large increase in recreational private travel as people visit family and friends, longer trip distances (inter and intra state travel), and more travel in rural and unfamiliar environments. In the United States, the Bureau of Transportation Statistics reported that the number of long-distance trips increases by 54% during the Thanksgiving period and about 91% of this travel is by personal vehicle.

In addition, motorists are also believed to be more reckless and unmindful of traffic laws and very many of them tend to speed more often and drive while under the influence of alcohol. Consequently, there is greater police enforcement and road safety campaigns are made more aggressive and vocal. Fatal road crashes during these major holiday periods also attract intense media interests.

Motor vehicle crashes during the statutory holiday festive periods are apparently on the rise in Alberta, Canada. For example, in the year 2004 a total of 6706 collisions occurred during the holidays and long weekends which killed 33 people and injured more than 1500 people. Whereas in 2007, the total number of crashes increased to 11639 in which 48 people were killed and more than 2000 people were injured. Yet little research has been done on the subject matter.

Literature Review

Although holiday accidents create a major media buzz, the literature interpreting the public health significance of the crash fatalities occurring during such periods is relatively scarce. Australian Transport Safety Bureau (ATSB) conducted two studies focusing on holiday accidents; one in 2003 and the other in 2006. The goal of both the studies was to examine the characteristics of fatal crashes occurring during the Christmas periods and compare with fatal crashes occurring during the remainder of the year. Both studies found that the observed differences were generally small in size and not statistically significant.

Drinking and driving during the holiday season has been a widely reported phenomenon. Bloch et al. (2004) used crash data of 14 major holidays and special occasions in California to compare the rise in alcohol related crashes (both fatal and injurious) during holidays with that of the non-holiday periods. The authors suggested that drinking and driving was more of a concern during the winter holiday seasons than the summer ones.

Recognizing this trend, police agencies sometimes initiated traffic enforcement campaigns during holiday periods. Such campaigns, when well publicized, had been shown to temporarily reduce crash rates, especially those involving alcohol (Farmer and Williams, 2005).

In one of the few studies found that used rigorous statistical technique to analyze holiday accidents, Alsop et al (2000) used the Negative Binomial Regression technique to examine the temporal trends in the Christmas death toll in New Zealand. The authors found that the toll neither decreased significantly nor improved significantly over the years.

Arnold and Cerrelli (1987) examined the variation in fatalities during holiday periods. They used FARS data for 1975-1985 to determine average daily fatalities for each day of the week in each month (e.g., Mondays in January). For the New Year holiday period, they found that fatalities were about normal on New Year's Eve but were 64% greater than average on New Year's Day.

Liu and Sharma (2006) investigated the effect of statutory holidays on traffic volumes on highways in Alberta, Canada. Their results revealed that holidays substantially contributed to the variability of traffic.

Research Objective

The objective of this research is twofold. Firstly, it aims to shed some light on the characteristics of the accidents occurring on the holidays on Albertan roadways and find out if these accidents are significantly different from the non-holiday period accidents. Secondly, it endeavours to identify the factors associated with the fatality risk of such accidents using logistic regression model.

Data

Crash database for 2004-2007 were extracted from the official traffic crash data provided by Alberta Transportation. The severity of a crash was determined by the person with the most severe injury and a crash was considered as fatal if at least one person involved in the crash died within 30 days of collision. A crash was considered to be an injury crash if at least one person was injured and a property damage crash was defined as a crash associated with no injury but only damages to properties over $1000.

For this study, the holidays considered were: New year's day, Family day long weekend, Easter long weekend, Victoria day long weekend, Canada day, August long weekend, Labour day long weekend, Thanksgiving long weekend, Remembrance day and Christmas. These 10 holidays were chosen because they were routinely highlighted in Alberta Transportation annual collision reports. Of the 1,303,788 crashes that occurred on the Albertan roadways during the years 1996-2007, 109,313 occurred during the holiday seasons, representing around 8.5% of the total reported accidents.

Methodology

Chi Square Test

The χ^2 test is one type of goodness-of-fit test that has been widely used. This test statistic results from a comparison of expected and observed frequencies.

(1) $\chi^2 = \sum_{all\ cells} \frac{(observed\ -expected\ )^2}{expexted}$

This test is often used to the independence between two categorical variables. It will be used to test for differences in crash characteristics between holiday and non holiday crashes. The tests are conducted at a 95% confidence level using the excel programme of the Microsoft office package.

Logistic Regression Model

The binary logistic regression belongs to the group of regression methods for describing the relationship between explanatory variables and a discrete response variable. It is developed to predict a binary dependent variable as a function of predictor variables. The binary logistic regression has been widely used in transportation and safety studies where the dependent variable is binary (Al-Ghamdi, 2002, Abdel-Aty et al., 2004). Since the dependent variable in the present study is binary in nature (fatality or no fatality), the binary logistic regression model is an appropriate method of analysis.

In this study, the logit is defined as the natural logarithm of the odds or the likelihood ratio of the dependent variable being equal 1 (fatal) as opposed to 0 (non-fatal). The probability P of a fatal crash is given by:

(2) $Y = logit\ (P) = \ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p + \varepsilon_i$

where Y is a latent variable measuring injury severity
$x_1, x_2, ..., x_n$ are explanatory variables
$\beta_1, \beta_2, ..., \beta_n$ are unknown parameters
ε_i is the error term with extreme value type I distribution

In developing the logistic regression model to identify the factors affecting the fatality risk of holiday collisions, several roadway features, crash characteristics, driver attributes and environmental conditions were considered. Note that all the factors considered in this study were recorded as categorical data. Therefore, several dichotomous variables were created for each factor.

Two approaches were used to select the appropriate factors. The first approach of sorting out these factors is to deliberate upon similar research works where those factors have been used and second approach was to focus on some local factors thought to have influence on the injury risk. Initially 19 factors were selected for investigation. After performing correlation tests, several factors were dropped from the model. Finally, 9 factors were selected in the final model and their summary statistics is reported in Table 1.

Table 3: Summary Statistics of Variables

Explanatory Variables	**Mean**	**Std Dev**
Time Trend (2004 = 1 to 2007 = 4)	2.71	1.05
Season		
Winter	0.42	0.49
Spring	0.18	0.38
Summer	0.21	0.40
Fall	0.19	0.39
Time of Day		
Peak hours (6-9 am and 3-6 pm)	0.29	0.45
Off Peak (9am – 3 pm)	0.32	0.47
Night (6pm – 6 am)	0.39	0.49
Number of Vehicles Involved		
Single vehicle	0.33	0.47
Two vehicle	0.63	0.48
More than two vehicle	0.033	0.18
Primary Event		
Struck object	0.34	0.47
Off road	0.09	0.29
Right angle	0.08	0.27
Passing	0.01	0.12
Left turn across path	0.04	0.20
Sideswipe	0.09	0.28
Rear end	0.17	0.38
Backing	0.09	0.30
Other events	0.07	0.25
Driver age		

Age below 25	0.34	0.47
Age 25 – 44	0.53	0.50
Age 45-69	0.39	0.49
Age 70 and above	0.06	0.24
Driver Sex		
Male	0.78	0.42
Female	0.22	0.50
Vehicle Type Involved		
Car	0.62	0.48
Van or Minivan	0.59	0.49
Truck or Truck tractor	0.07	0.25
Motorcycle	0.01	0.11
Pedestrian	0.01	0.09
Bicycle	0.005	0.007
Bus	0.006	0.078
Fixed object	0.13	0.34
Heavy vehicle	0.06	0.08
Other vehicles	0.14	0.35
Lighting Condition		
Daylight	0.63	0.48
Sun-glare	0.01	0.09
Dark and Unlit	0.13	0.34
Dark but Lighted	0.15	0.36
Dark but Light Condition Unknown	0.42	0.49
Note: All variables except time trend are binary variables.		

Since dichotomous variables were used to represent the various categories for each factor considered in the analysis, one of the dichotomous variables had to be omitted and used as reference to avoid perfect multicollinearity. The estimates obtained for the other variables are then interpreted with reference to the default or reference case. The STATA program, LOGIT, was used for model development and the related hypothesis testing based on a 5% significant level.

Results

Descriptive Analyses and Chi-Square Tests

Figure 1 represents the comparison of the average daily collision rates between the national holidays and the remainder of the year. It is quite evident that the average collision rate plot of the holiday seasons does not manifest any discernable trend. Rather it tends to follow the pattern broadly similar to the plot of the average collision rate of the remainder of the year.

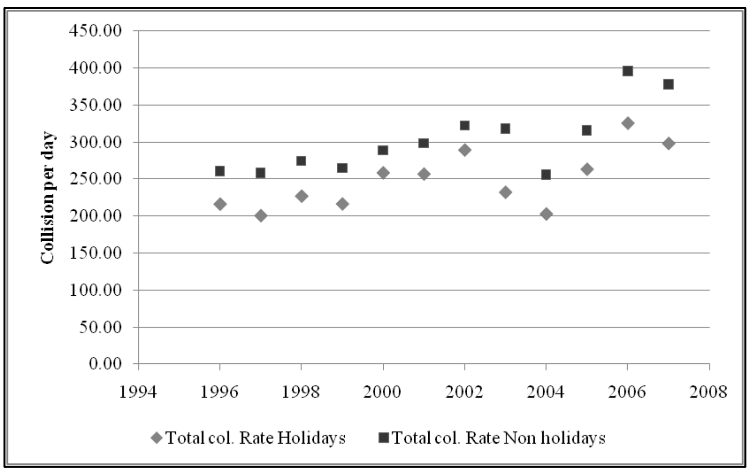

Figure 1: Average daily collisions comparison

More importantly, the number of collision per day did not appear to be significantly higher during the holidays, and in fact, appeared to be lower. Therefore, the hypothesis that the crash rates are higher during holiday periods was not supported by the evidence.

To check if the holiday accidents have changed significantly over the years, a chi-square was performed using the data shown in Table 1. The χ^2 value found was 61.93 for 6 degrees of freedom. Since it was greater than the critical χ^2 value (12.6) at 5% significant level, the null hypothesis was rejected, i.e. the different injury accidents during the holidays did not have the same distribution over the years. The number of PDO crashes increased at relatively faster rate than both the fatal and injury collision accidents.

Table 1: Holiday and non-holiday weekend accidents

Year	Holiday Accidents				Non holiday Weekend Accidents			
	Fatal	Injury	PDO	# days	Fatal	Injury	PDO	# days
2004	26	1047	5633	33	77	1814	10055	90
2005	45	1494	8478	38	78	1796	11146	86
2006	51	1676	10982	39	83	3886	25260	86
2007	40	1413	10186	39	80	3298	24500	86
Total	162	5630	35279	149	318	10794	70961	348

A second test was done to check if the total number of fatal and injury collisions during the holidays significantly differed from the normal weekend holidays. The χ^2 value found was 0.005 for 1 degree of freedom. Since it was smaller than the critical χ^2 value (3.84) at 5% significant level, the null hypothesis could not be rejected, indicating there was no special association between occurrence of injury accidents and holidays.

Overall, our results put into question the extra effort and expenditure that were routinely spent for holiday road safety campaigns because neither the frequency nor severity of crashes were found to have increased during the holidays.

Logistic Regression Model

The estimation results for the logistic regression model were reported in Table 2. As suggested by Kockelman and Kweon (2002), variables with low statistical significance might also be retained in the model if they belonged to factors that had some significant effect. Although this approach might reduce the efficiency of estimates, it was adopted for ease of comparison and interpretation of the estimates. Based on the p-values of the t-tests, 9 variables from 12 factors were found to be significant ($p \leq 0.05$) or marginally significant ($p \leq 0.1$).

Table 4: Estimation Results of the Fatality Risk Model

Explanatory Variables	**Co-efficient**	**P-value**
Time Trend	-0.07	0.02
Season (Ref: Winter)		
Spring	0.38	0.00
Summer	0.48	0.00
Fall	0.31	0.00
Time of Day (Ref: Off Peak)		
Off-Peak	-0.62	0.00
Night	-0.33	0.00
Number of Vehicles Involved (Ref: Single vehicle)		
Two vehicle	0.47	0.00
More than two vehicle	1.49	0.00
Primary Event (Ref: Struck object)		
Off road	1.31	0.00
Right angle	0.95	0.00
Passing	-0.11	0.71
Left turn across path	1.02	0.00
Sideswipe	-0.37	0.06
Rear end	-0.15	0.33
Backing	-1.75	0.00
Other events	1.21	0.00
Driver age(Ref: Age below 25)		
Age 25 - 44	0.10	0.18
Age 45-69	0.10	0.15
Age 70 and above	0.22	0.09
Driver Sex (Ref: Male)		
Female	-0.15	0.02
Vehicle Type Involved (Ref: Car)		
Van or Minivan	-0.16	0.02
Truck or Truck tractor	0.16	0.15
Motorcycle	2.34	0.00
Pedestrian	3.51	0.00
Bicycle	1.83	0.00
Bus	-0.13	0.75
Fixed object	0.40	0.00

Heavy vehicle	0.48	0.15
Other vehicles	-0.82	0.00
Lighting Condition (Ref: Daylight)		
Sun-glare	0.28	0.33
Dark but lighted	0.002	0.98
Dark and unlit	0.41	0.00
Dark but light condition unknown	-0.01	0.88
Constant	-3.08	0.00
Number of observations = 32101 LR chi2(34) = 2110.48 Prob > chi-square = 0.0000 Log likelihood = -4026.8796 Pseudo R2 = 0.2076		

In contrast to the univariate analyses, results from the logistic model showed a decreasing fatality trend. This decrease would likely be due to other contributing factors that were not included in the model. Possible external influences included the beneficial effects of the increased road safety campaign by the government and media as well as more stringent law enforcement by the police.

Compared to the winter season, holiday crashes occurring in summer, fall and spring seasons were more likely to be fatal. Since the weather tended to be good during these times, drivers tended to drive faster than in winter. This speeding tendency would be aggravated by the heavy drinking during holiday festiviiesy (Keall et al., 2005). Also, tourist activities noticeably increased during these times, leading to more unfamiliar driver and pedestrians on the roads which increased the fatality risk in the event of a crash.

As expected, the multivehicle crashes were more likely to be fatal in the event of a crash. During holidays, not only would vehicular traffic increase on the roadways, but the vehicle occupancy would also increase. Obeng (2009) reported that the probability of the occupants sustaining injuries increased with the increase in their numbers due to increased exposure.

Our results showed that the fatality risk was higher in case of run-off-road, right angle and left turn across path collisions. Holiday travels usually involved long hours on monotonous stretch of road. This might induce fatigue and inattentiveness in drivers leading to fatal run-off-road crashes.

The study results found that being a male elderly driver increased the likelihood of being involved in a crash during holidays that resulted in fatality. Older individuals tended to have longer perception and reaction times, more physically fragile, and might suffer from various medical conditions and complications, all of which might contribute to their higher risk of suffering a fatal injury in a crash.

The collisions tended to be fatal when van or minivan, motorcycle, pedestrians and bicycles were involved compared to cars. The holiday seasons would generate higher volume of pedestrians and cyclists as the shopping activities increased. Also, similar to drinking and driving, drinking and walking had become a serious problem in these seasons. In fact, the anti drink driving campaigns during the holidays might lead to a decline in drinking and driving crashes but they had been reported to be associated with a parallel increase in drinking-related pedestrian accidents (Shinar, 2007).

The model showed that the fatality risk of holiday collisions was significantly higher during unlighted dark period than daylight period. Darkness would impair vision by reducing the distance to impact and increasing impact speed. Hence, the risk of a fatality in an accident would higher in dark without light. Elvik and Vaa (2004) reported that road lighting reduced fatal accidents in the dark by 64% and injury accidents by 30%.

Conclusion

Every day of the year experiences many motor vehicle deaths. Yet the ones occurring during the holidays create a major stir amongst the media and some government agencies. This study attempts to examine the characteristics of the accidents occurring during the holidays on Albertan roadways to find out if these accidents are significantly different from the non-holiday period accidents.

From the descriptive statistics and univariate analyses, we found that the extent of crashes and death tolls varied from year to year but were not higher during the holiday seasons. Also, the holiday crash severities (fatal and injurious) did not differ significantly from the non-holiday weekend crashes.

The logistic regression model identified weather, older drivers, speeding, dangerous manoeuvres by drivers, lighting condition to be significant factors in determining the fatality risk in a holiday crash. However, these were similar factors which existed in many studies of other fatal crashes in general.

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