

Traffic related deaths in Nuevo Leon, Mexico: causes and associated factors

Carlos Arreola-Rissa, MD,⁽¹⁾ Jesús Santos-Guzmán, MD, MS,⁽¹⁾
Adol Esquivel-Guzmán, MD,⁽¹⁾ Charles N Mock, MD.⁽²⁾

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Esquivel-Guzmán A, Mock CN.
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Abstract

Objective. The effects of alcohol on mortality due to motor vehicle accidents was studied. **Material and Methods.** During the first semester of 2003, a sample of 243 fatality victims of traffic-related accidents and their blood alcohol levels were analyzed in the state of Nuevo Leon, Mexico. The age-adjusted mortality rate for traffic accidents was 8.9/100 000 pop. (13.2 for males and 3.21 for females, per 100 000). Fatal accidents were more common in the Metropolitan Area (MA). **Results.** Fatalities were four times greater in males and the mean age was 34.7±18.2 years. Blood alcohol was detected in almost half of the victims who were drivers of the vehicles; the other cases of fatalities may be associated with road/car condition, weather and other factors. **Conclusions.** Alcohol intoxication levels were primarily associated with male drivers ages 16 to 45 ($p=0.029$); levels increased with age. In females, alcohol played a lesser role, affecting mostly ages 31 to 45 ($p=0.055$).

Key words: alcohol drinking; accidents traffic; mortality; Mexico

Resumen

Objetivo. Durante seis meses de 2003 se estudió el efecto del alcohol en 243 víctimas fatales relacionadas con accidentes viales del estado de Nuevo León, México. **Material y métodos.** Se realizó autopsia en todos los casos y se determinó el nivel de alcohol en sangre. La tasa de mortalidad ajustada por edad para accidentes viales fue 8.9/100 000 hab. (13.2 para hombres y 3.21 para mujeres, por 100 000). Accidentes fatales fueron comunes en el Área Metropolitana. **Resultados.** Las fatalidades fueron cuatro veces mayores en hombres y la edad promedio fue de 34.7±18.2 años. Se detectaron niveles de alcohol en sangre en casi la mitad de los conductores que fueron víctimas; los otros casos de fatalidad fueron asociados con las condiciones del camino, el auto, factores meteorológicos, entre otros. **Conclusiones.** Los niveles de intoxicación alcohólica fueron básicamente con conductores masculinos, de 16-45 años ($p=0.029$), aumentando con la edad. Entre las mujeres, el alcohol jugó un papel menos preponderante, afectando mayormente las de 31-45 años ($p=0.055$).

Palabras clave: consumo de bebidas alcohólicas; accidentes de tránsito; mortalidad; México

(1) Escuela de Medicina, Instituto Tecnológico y de Estudios Superiores de Monterrey. Nuevo León, México.

(2) University of Washington, Seattle, WA, EUA.

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Address reprint requests to: Carlos Arreola-Rissa. ITESM. Escuela de Medicina. Av. Morones Prieto 3000 Pte., col. Los Doctores. 64710 Monterrey, Nuevo León, México.

E-mail: car@itesm.mx

In 2002, road traffic accidents accounted for 1 203 000 deaths, representing 2.2% of total deaths worldwide, with Disability Adjusted Life Years (DALY) of 38 061 000, which represents 2.6% of total DALYs.^{1,2} Traffic accidents represent one of the top 10 causes of death and disability worldwide.³ They are more common in developing countries, where 85% of traffic-related fatalities in the general population and 96% of children fatalities occur.¹ In 1999, injuries related to road traffic represented 23% of deaths by external causes worldwide and 26.6% in Mexico.⁴ In a report of traffic accidents in American countries, Mexico was situated in a moderate-problem group, along with Argentina, Chile, Costa Rica, Ecuador, Uruguay and other countries with a mortality rate between 10 and 14.9. In Mexico during the previous three years, the number of cases had remained constant. Figure 1 shows the number of deaths related to traffic accidents in Mexico (urban and suburban areas only), Nuevo Leon State and Monterrey County.⁵ In 1998, the national Mexican age-standardized mortality rate per 100 000 pop. due to transportation accidents was 26.9 for males and 7.1 for females, and during 1999 it was 27.9 for males and 7.24 for females.⁶ During 1993, Veracruz, Chiapas and Nuevo Leon were the states with fewer traffic accidents.⁷

Some of the factors associated with the higher incidence of deaths due to traffic accidents in Mexico and other developing nations are poor road conditions, not enough traffic-related law enforcement, weak drivers education, inadequate pre-hospitalization care, and in many instances there are a wide variety of factors related to access to quality emergency care. In many developing countries, including Mexico, much effort had been directed to the solution of more urgent health problems, such as infectious/hygiene related disease and nutritional problems, but with progress and time a shift in the balance between hygiene-related deaths to other diseases (chronic, metabolic, technology-related deaths) is expected. The objective of the present study is to review the incidence of traffic-related deaths in Nuevo Leon and to analyze the role of alcohol as a main risk factor for traffic deaths.

Material and Methods

The present study was approved by the Research and Ethics Committee at the TEC of Monterrey's School of Medicine and the San Jose de Monterrey Hospital, ITESM. The study includes information on 243 deaths associated with traffic accidents in the state of Nuevo Leon between February 1, 2003 and July 30, 2003. In order to gather more complete information about the causes of mortality and the mechanisms of injuries,

accident information was collected and cross-matched from different public and private sources: police accident reports, death certificates and autopsy reports, ambulance reports and medical reports from hospitals and clinics. The study was divided into deaths occurring in the metropolitan area (MA) and those occurring in the non-metropolitan area (NMA). The city of Monterrey MA (state capital) represented seven counties: Monterrey, San Nicolas de los Garza, Apodaca, Guadalupe, San Pedro Garza Garcia, Santa Catarina and General Escobedo. The NMA area represented the rest of the state and the federal highways. The mechanism for the accidents was classified according to five categories: collision (frontal, side, and rear end), roll-over, impact crashes, mixed-mechanism or unknown.

The information collected included the victim's name, age, gender and birth date, the accident date, time and place, the injury mechanism and specific data about the accident (type of vehicle, vehicle occupant location). The autopsy information included the anatomic description of the injuries and the alcohol blood level. The injuries were classified using the Injury Severity Score (ISS).⁸ This score uses a seven-body region score (skin and soft tissue, head, neck, thorax, abdomen and pelvis, vertebral spine and extremities) that ranges from 0 to 6 (with number 1 representing a minor injury and number 6, a fatal lesion). Only the three highest scores were selected, each value was squared and the sum of the values resulted in the final score. The final score range was from 3 to 75. The exception to the above procedure occurred whenever any individual region of the body received a score of 6 (a fatal lesion), in which case the final score is automatically 75. The alcohol level in blood samples was measured in the Forensic Medicine Department/ Procuraduria General Judicial Lab using an analytical spectrometer with a packed column containing the enzyme alcohol dehydrogenase.

Results

The specific semiannual mortality rate (February-July 2003) with respect to traffic accidents was 8.9/100 000 pop. (13.2 for males and 3.21 for females, per 100 000).⁹ Of the 243 accidents, 144 (59.2%) occurred in the MA and 77 (31.7%) in the NMA. Almost two-thirds of the deaths, 141 (58%), were vehicle occupants and 99 (40.7%) were pedestrians. The male-to-female rate (M/F rate) was 4.1 and the mean age of the victims was 34.7±18.2 years. Most of the victims, 228 (94%), were found dead on the scene or survived less than two hours once reaching the hospital. Only 14 (5.8%) survived more than two hours. It was more common to die on the accident scene in non-metropolitan areas (NMA) compared with metropolitan

areas (MA) ($p>0.001$) (table I). The driver-to-passenger ratio was 6.5 for both genders and death was more common among male drivers; female passengers died more often in the NMA (table I).

Of the 243 cases, 149 (61.3%) died at the accident scene and 94 (38.7%) were transported by ambulance to the hospital. Of the 94 patients that survived, 48.4% were transported to the Instituto Mexicano del Seguro Social (IMSS) (clinics 4, 8, 17 and 21), 39.8% to the University Hospital of the Universidad Autónoma de Nuevo Leon (UANL), 7.5% to institutional or public facilities (ISSSTE, PEMEX, Metropolitan Hospital and Green Cross Clinic in Guadalupe County) and 4.3% to private hospitals.

Of the cases that were transported to the hospital, 83 (88.3%) died in the first three hours, eight died in the first 24 hours after the accident and only three survived more than 24 hours, but died soon after. Only three patients survived more than one day, but died before the first week of convalescence. A legal autopsy was required for all the fatality victims and most of them were performed at the University Hospital (UANL) or clinic 21(IMSS). The most common vehicle accident

mechanism was frontal, side and rear crashes (47%), followed by roll-overs (22%), impacts (15%) and mixed-mechanisms (14%) (table II).

The mean ISS score in all locations was 35.2 ± 16.2 , in MA it was 34.4 ± 14.6 , and in the NMA, 38.3 ± 18.7 , with no significant differences ($p=0.088$). The ISS for vehicle occupant fatalities was 34.4 ± 16.7 and 36.3 ± 15.4 for pedestrian fatalities related with vehicles, with no significant difference ($p=0.349$). In the NMA, 71% of the cases occurred in March, May and June (24, 17 and 14, respectively) and in the MA 63% in June, July and April (35, 30 and 26 cases, respectively). In both the MA and the NMA, June was the month with more fatalities, accounting for 49 cases (20.2%). Almost two-thirds (59.6%) of vehicle occupant fatalities occurred during March, May, June and July (30, 26, 18, and 28 cases, respectively) and 75.8% of pedestrian fatalities occurred in February, April, May and June (19, 16, 16 and 24 cases, respectively). The single day with the most fatalities was Monday (17.2%, 43 fatalities), followed by Sunday (16.1%, 39 fatalities). In the NMA more fatalities occurred on Sundays, with 12 cases (15.6%),

Table I
DESCRIPTIVE ANALYSIS (N=243 AUTOPSIES), TRAFFIC ACCIDENTS. MONTERREY, 2003

	Total	MA	NMA	p-value*	NK
Type of death (%)	243	144(59.25%)	77 (31.69%)	0.001	22
Death rate by gender (M/F rate)	194/47 (4.1)	116/28 (4.1)	58/18 (3.2)	0.067	20
Age (mean \pm S.D.)	34.7 \pm 18.2	36.9 \pm 18.4	32.5 \pm 15.3	0.649	20
Died on the accident scene					
Vehicle occupant	100	41	56	>0.001	3
Pedestrian	47	31	13	0.015	3
Not known	2	0	1	0.223	1
Victims who survived less than 2 h					
Vehicle occupant	133	69	57	0.022	7
Pedestrian	93	66	16	0.940	11
Not known	17	9	4	0.223	4
Driver/Passenger death rate (D/P rate)					
Male (D/P rate)	111/17 (6.5)	57/9 (6.3)	45/8 (5.6)		9
Female (D/P rate)	89/6 (14.8)	49/5 (9.8)	40/1 (40)		9
Female (D/P rate)	12/11 (1.1)	8/4 (2.0)	4/7 (0.6)		0

* Pearson χ^2

M= male
F= female
SD= standard deviation
MA= metropolitan area
NMA= non metropolitan area
NK= not known

Table II
ACCIDENT MECHANISM (VEHICLE OCCUPANTS)
AND INJURY SEVERITY SCORE (ISS). MONTERREY, 2003

Accident mechanism	ISS	No. of deaths	%
Frontal, side, and rear end crashes	30.9	69	47
Roll-overs	40.5	31	22
Impact	36.6	21	15
Mixed-mechanism	38.3	20	14
Not known	29.0	3	2
Total	35.2	144	100

and Mondays, 13 cases (16.9%). In the MA, 26 fatalities (18.1%) occurred on Sundays and 28 (19.4%) on Mondays. Vehicle occupant deaths were more common on Mondays and Thursdays, with 26 cases (18.4%) each, and the pedestrian fatalities were more common on Sundays (19.2%, 19 cases), Saturdays (18.2%, 18 cases) and Mondays (16.2%, 16 cases). The classification of fatalities according to time period, in order of frequency, is: 74 cases from 12 noon to 5:59pm, 54 cases from 6:00 pm to 11:59 pm, 50 cases from midnight to 5:59 am and 35 cases from 6:00am to 11:59am. The distribution of cases by geographic area (MA or NMA) and type of accident (vehicle occupants or pedestrians) is as follows: in the MA, the time period with more vehicle occupant fatalities was midnight to 5:59am, with 27 cases (36.9%), followed by 17 cases (23.3%) in each of two time periods (noon to 5:59pm and 6:00pm to 11:59pm); from 6:00am to 11:59am there were eight cases (10.9%). In the NMA, the period with more vehicle occupant fatalities was noon to 5:59pm, with 25 cases (42.4%), followed by 15 cases (25.4%) from 6:00pm to 11:59pm, 11 cases (18.6%) from 6:00am to 11:59am and six cases (10.3%) from midnight to 5:59am. In pedestrian fatalities, the time period with more cases was noon to 5:59pm, with six cases (35.3%) in the NMA and 26 cases (37.1%) in the MA, followed by the time period 6:00pm to 11:59pm (five cases (29.4%) in the NMA and 17 (24.3%) in the MA). In the period midnight to 5:50am, there were 15 cases (21.4%) in the MA and two cases (11.8%) in the NMA. In the 6:00am to 11:59am period there were 12 (17.1%) cases in the MA and four (23.5%) in the NMA.

Table III shows the injury mechanisms. Craniocervical trauma (CET) (single and combined diagnosis) was the more common cause of death and was found more commonly among vehicle occupants as compared with pedestrian fatalities ($p=0.0329$). CET was reported more often in MA victims compared with

Table III
DEATHS BY INJURY MECHANISM AND TYPE OF ACCIDENT.
MONTERREY, 2003

Mechanism of injury	Vehicle	%	Pedestrian	%
Thoracic trauma, abdominal trauma	2	1.4	0	0.0
Thoracic trauma, hemorrhage	8	5.6	2	2.0
Thoracic trauma	12	8.3	7	7.1
Craniocervical trauma, thoracic trauma	5	3.5	0	0.0
Craniocervical trauma, hemorrhage	1	0.7	1	1.0
Craniocervical trauma	83	57.6	55	55.6
Abdominal trauma, hemorrhage	5	3.5	3	3.0
Abdominal trauma	3	2.1	3	3.0
Not known	17	11.8	9	9.1
Other	0	0.0	1	1.0
Hemorrhage	8	5.6	18	18.2
Total	144	100.0	99	100.0

Vehicle= vehicle occupants deaths
Pedestrian= pedestrian deaths caused by a vehicle

NMA victims, but it was not statistically significant ($p=0.0695$). The other diagnoses, in order of frequency are: hemorrhage, thoracic trauma and abdominal trauma.

Alcohol levels were determined from blood samples of all of the victims (vehicle occupants and pedestrians), and it was detected in 77 cases (31.68%). The mean alcohol level was 170 ± 71.7 . Seven cases were reported under alcohol influence (blood alcohol level 80 mg/dl or less), 34 were classified as partial intoxication (blood alcohol concentration between 81 and 180 mg/dl) and 36 cases were complete intoxication (blood alcohol concentration of 181 mg/dl or more). In 104 cases, the victim was the driver and almost half of these (54 cases, 49%) were reported as having some level of blood alcohol. Of these 54 cases, four were under the influence of alcohol and the remaining 50 had intoxication levels over 80 mg/dl. Table IV shows the variables associated with alcohol levels. In the MA, there was a difference in alcohol levels between vehicle occupants and pedestrian fatalities ($p>0.001$). More than half of vehicle victims (57%) had intoxication levels >180 mg/dl (table IV).

In the MA, collision and roll-over mechanisms were associated with alcohol intoxication levels and only a few pedestrian victims showed intoxication levels ($p>0.001$). In the NMA, one-quarter of the male victims had alcohol intoxication levels. The alcohol intoxication levels were associated with females ages 31 to 45 (27.3%) and were roughly 50% in males ages 16 to 45 (table IV).

Table IV
VARIABLES ASSOCIATED WITH ALCOHOL CONSUMPTION IN TRAFFIC ACCIDENTS. MONTERREY, 2003

Variables	Alcoholic breath < 81 mg/dL	Partial intoxication 81-180 mg/dL	Complete intoxication >180 mg/dL	p-value*
MA Vehicle occupants	30 (41.1%)	1 (1.4%)	42 (57.2%)	p> 0.001
Pedestrians	61 (85.9%)	1 (1.4%)	9 (12.7%)	
NMA Vehicle occupants	41 (69.5%)	4 (6.8%)	14 (23.7%)	p= 0.484
Pedestrians	15 (83.3%)	1 (5.6%)	2 (11.1%)	
MA Collision	26 (43.3%)	1 (1.7%)	33 (55%)	p> 0.001
Roll-over	4 (30.8%)	0	9 (69.2%)	
Pedestrian injury caused by car	61 (87.1%)	1 (1.4%)	8 (11.4%)	
NMA Collision	29 (70.7%)	3 (7.3%)	9 (22%)	p> 0.826
Roll-over	12 (66.7%)	1 (5.6%)	5 (27.8%)	
Pedestrian injury caused by car	14 (82.4%)	1 (5.9%)	2 (11.8%)	
MA Female	21 (75%)	0	7 (25.6%)	p=0.314
Male	70 (60.3%)	2 (1.7%)	44 (37.9%)	
NMA Female	18 (100%)	0	0	p= 0.051
Male	37 (63.8%)	5 (8.6%)	16 (27.6%)	
Female <16 y	1 (100%)	0	0	p=0.055
16-30 y	8 (72.7%)	0	0	
31-45 y	2 (33.3%)	0	3 (27.3%)	
46-60 y	4 (100%)	0	0	
>60 y	6 (100%)	0	0	
Male <16 y	9 (100%)	0	0	p=0.029
16-30 y	23 (48.9%)	2 (4.3%)	22 (46.8%)	
31-45 y	15 (51.7%)	0	14 (48.3%)	
46-60 y	12 (85.7%)	0	2 (14.3%)	
>60 y	11 (78.6%)	0	3 (21.4%)	

* Pearson χ^2

MA= Metropolitan area
 NMA= Non-metropolitan area
 y= year of age alpha value accepted for significance was 0.05

The month, day of the week and time of day show no significant difference between alcohol consumption and number of victims (data not shown in tables).

Discussion

During 2002 in the state of Nuevo Leon, the mortality rate associated with traffic accidents was 4.5/100 000 pop., compared with the national estimate of 13.85/100 000 pop.^{10,11} In the present study, the specific semiannual mortality rate (February-July 2003) related with traffic accidents was 8.9/100 000 pop. The differences between 2002

and 2003 in the Nuevo Leon mortality rate attributable to traffic accidents can be explained by more detailed information collected by the present study and by the different classification system used by the Secretary of Health. Alcohol was an important factor that was associated more with males ages 16 to 45. The prevalence of alcohol consumption in Mexico during 1998 was 58.1% (77% males and 44.6% females). More than two-thirds of the males and almost half of the females reported alcohol consumption.¹² Alcohol consumption increases the risk of traffic accidents, lowers the drivers' response time, impedes the critical decision-making

process and decreases the ability to follow traffic signs and regulations. In Acapulco (a tourist city in southern Mexico), drinking moderate amounts of alcohol (10 to 99 mg/100 dl) produced an odds ratio of 8.96 (95% CI) for traffic related accidents. In this study, blood alcohol was present in 37% of the victims, with a gender distribution of 28.8% in males and 2.9% in females, but only seven victims were reported as having blood alcohol levels in the range of 10-99 mg/dl. In a study of a city highway in Cuernavaca, alcohol consumption produced an odds ratio of 6.1 for risk of being in an accident and for severity of the event. In regard to this important problem, the state of Nuevo Leon had implemented several programs to prevent alcohol-related accidents and mortality. Random breath tests in selected streets during the nights or weekend days in non-fixed sites ("Operativos antialcoholicos", "Operacion Carrusel", "Operacion Blanca Navidad", "Conductor designado", night schedules for alcohol-related expenditure, proposals for raising the legal age for drinking and purchasing alcohol, etc) has accomplished low to moderate results in reducing alcohol-related morbidity/mortality. A law was proposed to prohibit the selling of alcohol and probably one of the most effective measures that has been seen recently in the state is the toughening of alcohol-related laws and imposing higher monetary fines (from a few dollars to a few hundred dollars). This last measure, together with better police control and less corruption, has produced a community change with respect to drinking alcohol and driving. Slowly but steadily a change in community values towards alcohol is expected. One challenge is to teach younger drivers good habits, but the bigger challenge will be to change the values of adult drivers who have a chronic habit of drinking and driving.

Other factors that increase the risk of accidents and their severity were age 54 or older $OR=6$ (95%) and night schedule $OR=2.6$ (95%).¹³ In the present study, there were more accidents during the night schedule but the amount of accidents was not significantly different from those that occurred during other time periods. In the analysis of fatal pedestrian injuries in Mexico City from 1994 to 1997, 57% of traffic accidents were pedestrian injuries caused by vehicles. For males the mortality rate was 10.6/100 000 and for females, 4.0/100 000.¹⁴ In 1997 in the US, the proportion of pedestrian deaths due to traffic accidents was 12.6%,¹⁵ as compared with the Mexico City mortality rate for pedestrians of 57%. Much of the difference was attributed to lack of road safety knowledge and road safety practices (lack of marked crosswalks, jaywalking, crossing the street without watching for vehicle traffic and lack of formal traffic education).^{16,17} In the present

study pedestrian victims represented 40.7% of traffic-related accidents and the mortality rate was 5.4/100 000 for males and 1.4/100 000 for females. Pedestrian deaths and vehicle occupant deaths were similar in the MA (70 and 73 deaths, respectively), and in the NMA vehicle occupant deaths were more than three times pedestrian deaths (59 and 17, respectively). Both vehicle occupant and pedestrian deaths occurred predominately in the MA. In another study, the mean prevalence of alcoholism was 12.8% (12.5-13.2 95%CI) in different clinics nationwide at the Instituto Mexicano del Seguro Social (IMSS) and male alcoholism was higher than female (22.2% and 3.4%, respectively) and was more common in the productive adult population; males ages 30 to 34 showed the highest "hazardous alcohol consumption" (20.2%) and the highest harmful alcohol consumption (6.6%) was in males 45 to 49 years of age. In females, the highest prevalence of hazardous alcohol consumption was among 12 to 19 year-olds, followed by 45 to 49 year-olds (3.7% and 3.4%, respectively).¹⁸ In the present study, male victims with the highest alcohol levels were in their mid-productive-ages, 35 to 45 and 46 to 60 years old (46.8 and 48.3%, respectively); among female victims, only the 30-to-45-year-old age group was associated with alcohol levels of more than 180 mg/dl (27.3%). Alcohol was a factor in one-third of the victims. Seven victims between the ages of 16 and 21 had blood alcohol levels and five were intoxicated (levels of 80 mg/dl or more). In a study in Taiwan, alcohol intoxication levels and the severity of lesions were not associated with ISS, but rather, with morbidity after injury.¹⁹ In the present study, morbidity was not measured because the outcome was death, but the ISS did not vary significantly between alcohol levels, accident mechanism, vehicle occupant location, gender or age.

Conclusions

Alcohol was present in almost half of the vehicle occupant victims, predominately in male drivers. Frontal, side, and rear-end crashes were the main accident mechanisms, and roll-over had a higher injury severity score. In seven victims, the ages were between 16 and 21 years. New legislative proposals would raise the legal age for consuming and purchasing alcohol to 21 years. For the other two-thirds of the victims, a major emphasis should be placed on improving road conditions, signaling, traffic law enforcement, and especially, road safety education and prevention programs for the general population in the state. Only joint citizen and governmental efforts will result in lowering the loss of life as a consequence of traffic-related injuries.

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