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RISK OF ROAD TRAFFIC INJURY AFTER ALCOHOL CONSUMPTION IN VIETNAM

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SUMMARY

Traffic injury is among the leading causes of death in Vietnam. Alcohol use is likely to be an important contributing factor, but there is little local information. The objectives of this study were: 1) To measure intoxication among traffic related injured male victims using a breathalyzer, and 2) To estimate the risk of traffic injury after acute alcohol consumption using the case-crossover analysis. ***Methods****: Male patients admitted to hospital following traffic injuries (n=480) were interviewed and their blood alcohol concentration (BAC) were measured. Risk of traffic injuries after drinking was estimated using case-crossover analysis.* ***Results****: 57.5% of male traffic injury patients had a BAC over the legal limit (0.08g/100ml) and 45.6% were above 0.15g/100ml. The odd-ratios of traffic injuries for patients who drank alcohol within 6 hours prior to injury was 8.5 (95% CI = 5.34 – 13.51). The odds-ratios were 8.8 and 13.4 for patients who drank 4-5 drinks and ≥6 drinks respectively (p<0.001).* ***Conclusion****: These data indicate that a high proportion of male accident victims have BAC far above the legal limit, and confirm that risk of injury follows a dose-response function.*

Keywords*: alcohol, traffic injury, case-crossover, drink-driving*

1. Introduction

Road traffic injuries are a major global public health problem but continue to receive inadequate attention. Alcohol influences both risk and consequence of road traffic injury but the scale of the problem is not well understood in many countries.

Vietnam has experienced two decades of significant economic development. The traffic injury pattern has also changed dramatically with road traffic accidents (RTA) being the leading cause of death and morbidity in Vietnam. A national population-based

survey on injuries in eight geographic zones showed a RTA mortality rate of 26.7/100,000 (21,000 deaths in a year, which equates to about 58 deaths daily because of RTA) and a road traffic injuries (RTI) rate of more than 1,400/100,000 annually (equates to more than 3,000 people injured per day) .

Whilst data on drinking and driving are very limited in Viet Nam, what is available indicates a substantial problem. Estimates of alcohol consumption in Viet Nam indicate an average consumption as high as 64g/day, substantially higher than the hazardous consumption threshold of 40g/day. There is little consensus in the role that alcohol plays in traffic crashes amongst available data. Official data suggested that 6% of all road traffic crashes were associated with alcohol while the National Forensic Medicine Institute found in 2001, that in a sample of 500 fatal crashes, 34% were associated with a BAC in excess of national limits.

Drink driving has been prohibited in Vietnam under law since 2001, however enforcement is limited due to a lack of capacity for detection of intoxication. Under the new road traffic legislation issued on 1 July 2009, the legally acceptable level of blood- and breath-alcohol content (BAC) was lowered from the previous BAC threshold of 80mg per 100/ml blood. For motorcyclists, the BAC of 80mg/100ml blood or 40mg/1 litre breath was reduced to 50mg/100ml blood or 0.25mg/1 litre of expired air. For car drivers, the legal BAC was reduced to zero. The Health Insurance law in Viet Nam requires all patients presenting at hospital to be tested for alcohol, however this is rarely implemented underscoring the need for comprehensive epidemiological data.

The current study aims to identify the scale of impact of acute alcohol consumption on risk of traffic injuries in Vietnam.

2. Methodology

The overall research design is the combination of a cross-sectional survey and a prospective study of a subset of cases. A pilot has been completed and reported elsewhere.

This study used case-crossover design in which respondents serving as their own controls and relative risk was estimated by comparing the exposure frequency during a window just before outcome onset with exposure frequencies during control times. The design applies best in studies where the exposure is intermittent, the effect on risk is immediate and transient, and the outcome is abrupt.

2.1. Sample and data collection

A sample of 480 participants was recruited from Emergency Department (ED) of Hue Central Hospital (Hue, Vietnam), the biggest general hospital in the Central Region of Vietnam, with a population catchment of about 3 million people from Thua Thien Hue Province and neighbouring provinces. The Emergency Department of this hospital

is the ‘first point of medical contact’ for patients who have traffic accidents or a medical emergency.

Data were collected during two periods: October - November 2008 and April - June 2009. In the data collection periods, we collected data from 5.00 PM to 7.00 AM the following day of all days (7/7) of the week.

Inclusion criteria were being male aged 18 years and older and being admitted to the Emergency Department following a recent traffic crash (within 6 hours) with any type of injury. Those re-attending for treatment of a previous injury were excluded. Patients who were in police custody, were ventilated, or too severely injured or unconscious, or too intoxicated to cooperate, were excluded from the analysis.

Patients were asked about the context of drinking prior to injury, regular drinking patterns, and demographic information, with standardized data collection via questionnaire. If following consent patients had difficulties in being interviewed but breathalyzer data were available they were then followed up and interviewed once they were stable and/or admitted to a ward. Patients not requiring hospital admission all had data collected before discharge from the Emergency Department.

The Alco Sensor FST breathalyser (Intoximeter Inc., USA) was used to estimate the breath alcohol concentration. This model of breathalyzer is recognized by the National Highway Traffic Safety Administration (USA) as an enforcement standard device and has been used in similar studies.

2.2. Plan of analysis

The study used ‘case-crossover’ analysis in calculating the risk of traffic injuries after drinking alcohol. Respondents served as their own controls and relative risk was estimated by comparing the exposure frequency during a window just before outcome onset with exposure frequencies during control times. The volume of alcohol consumed was calculated by converting the number and sizes of drinks of beverages to pure ethanol, in which a standard drink size is 16 ml. Data were recorded as both ‘consumed alcohol in 6 hours prior to injuries’ (for categorical variable analysis) and BAC level at the time of breath analysis (for continuous variable analysis). The pair matching analysis approach was used in which alcohol use during the 6 hours prior to injuries was compared with alcohol use during the same time period on the same day in the previous week. Conditional logistic regression was used to calculate matched pair relative risks and 95 percent confidence intervals.

3. Results

3.1. Characteristics of the sample

During data collection time, there were 1012 male patients admitted to the Emergency Department with injuries and 66.8% of these were traffic related injuries

(n=676). Among the 676 male patients with traffic related injuries, 28 people were pedestrians, 16 people were driving a car/taxi, 593 people were driving a motorcycle/bicycle, 7 people were passengers in a car/bus/taxi, and 32 people were passengers/pillions on a motorcycle/bicycle/rickshaw (cyclo). There were 196 patients for whom we could not obtain breath analysis and complete interview because they were either ventilated/resuscitated (9), too severely injured or unconscious (77), confused (13), too intoxicated to cooperate (16), did not provide consent (61) or because of other reasons (20) leaving the final sample of size of 480 participants. The distribution of four groups by socio-demographic variables, alcohol dependent and injury-related variables are presented in Table 1.

Table 1. *Characteristics of the sample*

	Patients with recent traffic injuries n (%)				
	Pedestrian	**Car driver**	**Motorcycle / bicycle driver**	**Passenger**	**p value**
Age (Mean ± SD)	43.33 ± 20.551	30.75 ± 8.593	30.78 ± 11.593	26.71 ± 9.987	<0.001
Income (Mean ± SD) (in multiples of Vietnamese minimum annual wage of US $ 410)	3.19 ± 1.424	3.44 ± 1.236	3.30 ± 1.335	2.91 ± 1.571	0.583
Education level					0.772
Secondary school or lower	10 (52.6%)	3 (27.3%)	158 (40.6%)	14 (48.2%)	
High school	6 (31.6%)	6 (54.5%)	147 (37.5%)	9 (31.0%)	
College/University	3 (15.8%)	2 (18.2%)	86 (21.9%)	6 (20.7%)	
Marital status					0.286
Single	8 (40.0%)	7 (61.5%)	209 (52.6%)	20 (66.7%)	
Married	12	5	189	10	

	(60.0%)	(38.5%)	(47.4%)	(33.3%)	
Employment status					0.306
No	4 (19.0%)	1 (7.7%)	67 (17.2%)	9 (29.0%)	
Yes	17 (81.0%)	11 (92.3%)	327 (82.8%)	22 (71.0%)	
Alcohol dependent (AUDIT-C)					0.229
No	5 (41.7%)	3 (37.5%)	159 (49.8%)	16 (69.6%)	
Yes	7 (58.3%)	5 (62.5%)	160 (50.2%)	7 (30.4%)	

The average age was found to be different across groups of victims (pedestrian, car driver, motorcycle/ bicycle driver, passenger), $F(3, 95) = 4.95$, $p<0.001$. The Tukey multiple comparisons performed at the 0.05 significance level found that the mean age of pedestrians ($M = 43.3$, $SD = 20.55$, $N = 21$) was significant higher than that for car drivers ($M = 30.8$, $SD = 8.59$, $N = 12$), motorcycle/ bicycle drivers ($M = 30.78$, $SD = 11.59$, $N = 414$), and passengers ($M = 26.71$, $SD = 9.99$, $N = 31$). The mean age for car drivers, motorcycle/ bicycle drivers, and passengers were not found to be significantly different from each other. The average income level for car drivers, motorcycle/ bicycle drivers, and passengers were not found to be significantly different from each other, $F(3, 95) = 0.650$, $p=0.583$.

Types of victims (pedestrian, car driver, motorcycle/ bicycle driver, passenger) were not significantly associated with educational level, $\chi2 (6, N=450) = 3.288$, $p=0.772$, marital status, $\chi2 (3, N=460) = 3.781$, $p=0.286$, employment status, $\chi2 (3, N=458) = 3.615$, $p=0.306$, and alcohol use disorder status, $\chi2 (3, N=362) = 4.315$, $p=0.229$.

3.2. Blood alcohol concentration

Table 2 shows the distribution of BAC among 480 patients admitted to the Emergency Department with recent traffic injuries. Among these patients, 312 (65%) tested positive for alcohol and 276 (57.5%) had a BAC over Vietnam's legal limit of 80 mg/100mL. 219 (45.6%) of the injured patients had a BAC of 150 mg/100 mL or higher.

Table 2. *Distribution of BAC among traffic related injured male patients*

BAC mg/dL	Frequency	Percent	Cumulative %
0	168	35.0	35.0
1-49	22	4.6	39.6
50-79	14	2.9	42.5
80-149	57	11.9	54.4
≥ 150	219	45.6	100.0
Total	480	100.0	

Table 3. *Blood Alcohol Concentration by individual characteristics*

	BAC (mg/100ml) n (%)					Total	p value[a]
	0	**1 – 49**	**50 – 79**	**80 – 149**	**≥ 150**		
Age							<0.05
18-29	90 (33.6%)	9 (3.4%)	13 (4.9%)	31 (11.6%)	(46.6%)	268 (100.0%)	
30-39	38 (35.8%)	10 (9.4%)	0 (0.0%)	12 (11.3%)	46 (43.4%)	125106 (100.0%)	
>=40	40 (37.7%)	3 (2.8%)	1 (0.9%)	14 (13.2%)	48 (45.3%)	106 (100.0%)	
Education level							0.689
Secondary school or lower	62 (33.2%)	8 (4.3%)	6 (3.2%)	28 (15.0%)	83 (44.4%)	187 (100.0%)	
High school	57 (33.9%)	9 (5.4%)	6 (3.6%)	19 (11.3%)	77 (45.8%)	168 (100.0%)	
College/ University	39 (40.2%)	3 (3.1%)	2 (2.1%)	7 (7.2%)	46 (47.4%)	97 (100.0%)	
Marital Status							
Single	86 (35.2%)	9 (3.7%)	10 (4.1%)	28 (11.5%)	111 (45.5%)	244 (100.0%)	0.580
Married	76	12	4	27	99	218	

	(34.9%)	(5.5%)	(1.8%)	(12.4%)	(45.4%)	(100.0%)	
Employment status							
No	32	1	3	11	34	81	
	(39.5%)	(1.2%)	(3.7%)	(13.6%)	(42.0%)	(100.0%)	0.466
Yes	129	20	11	44	175	379	
	(34.0%)	(5.3%)	(2.9%)	(11.6%)	(46.2%)	(100.0%)	
Income (in multiples of Vietnameseminimum wage[b])							
3 wages or less	63	11	4	26	92	196	
	(32.1%)	(5.6%)	(2.0%)	(13.3%)	(46.9%)	(100.0%)	0.729
4 wages and more	58	6	6	21	90	181	
	(32.0%)	(3.3%)	(3.3%)	(11.6%)	(49.7%)	(100.0%)	
Alcohol use disorders (AUDIT-C)							<0.001
No	87	10	10	18	60	185	
	(47.0%)	(5.4%)	(5.4%)	(9.7%)	(32.4%)	(100.0%)	
Yes	34	8	3	20	114	179	
	(19.0%)	(4.5%)	(1.7%)	(11.2%)	(63.7%)	(100.0%)	

[a] Pearson's Chi-square

[b] The minimum wage in Vietnam (2009) is equivalent to an annual income of US $ 410

Table 3 shows the distribution of BAC by different individual characteristics among 480 patients admitted to the Emergency Department with recent traffic injuries.

An association between age group and BAC at hospital admission was found, χ^2 (8, N=480) = 15.763, $p<0.05$. Examination of the cell frequency showed that the percentage of the group aged 18-29 years that had a BAC of 50 mg/100mL or greater (63%) was higher than that of the group aged 30-39 (54.8%) and the group aged 40 or older (59.5%). There was also an association between alcohol use disorder status and BAC level, χ^2 (4, N=370) = 43.983, $p<0.001$. People with alcohol use disorders (i.e. having AUDIT-C score of 5 of more) were more likely to have positive BAC results at hospital admission. The percentages of patients with alcohol use disorders who had a BAC of 50 mg/100mL or greater (76.6%) and BAC of 150 mg/100mL or greater

(63.7%) were higher than those of patients without alcohol use disorders (47.5 and 32.4%, respectively).

Blood alcohol concentration; however, was not significantly associated with educational level, χ^2 (8, N=452) = 5.623, p=0.689, marital status, χ^2 (4, N=462) = 2.867, p=0.580, employment status, χ^2 (4, N=460) = 3.576, p=0.466, and income level, χ^2 (4, N=377) = 2.038, p=0.729.

3.3. Risk of traffic injuries after alcohol consumption estimated by case-crossover analysis

Among 480 patients with recent traffic injuries admitted to the Emergency Department, there were 313 patients (65.2%) reported drinking during the period 6 hours prior to the traffic injuries. Using pair matching strategy for control data in case-crossover analysis, risk of traffic injuries after alcohol consumption was estimated by comparing alcohol use during the 6 hours prior to injuries with alcohol use during the same time period on the same day in the previous week. The results showed that a total of 186 patients consumed alcohol during the period 6 hours prior to the traffic injuries but did not drink during the control period and 22 patients drank during the control period but did not drink in the 6 hours prior to injuries (classified as discordant pairs). The odds ratios (OR) for sustaining a traffic injury if participants had consumed alcohol in the 6 hours prior to being injured was 8.5 (95% CI = 5.34 – 13.51, p<0.001). Using the conditional logistic regression to calculate the odds ratios for matched pairs (controlling for potential factors of age, education, marital status, employment status, income level, alcohol use disorders), participants who consumed alcohol in the 6 hours prior to traffic injuries were 8.9 (95% CI = 5.10 – 15.39) times more likely to sustain a traffic injury than participants who did not drink.

Table 4. *Matched pair analyses of alcohol consumption 6 hours prior to traffic injury and one week prior to injury by number of drinks consumed among participants*

Number of standard drinks consumed in 6h prior to injury	**Number of standard drinks consumed at the same period, same day in the week before injury**					**OR**	**95% CI**	**p**
	0	**1**	**2-3**	**4-5**	**≥6**			
0	133	5	9	5	5	1		
1	4	1	1	1	0	0.80	0.18 – 3.41	1.000
2-3	66	2	11	3	3	7.33	3.54 – 15.75	<0.001
4-5	44	2	7	6	2	8.80	3.35 – 25.19	<0.001
≥ 6	67	1	9	1	26	13.40	5.20 – 37.69	<0.001

Table 4 shows the cross-tabulation of the number of drinks consumed in the 6 hours prior to the injury and the number of drinks consumed in the control period. The OR for each level of consumption is presented. Risk of traffic injuries was correlated with the number of drinks consumed ($p<0.001$), except at the level of one drink, suggesting a dose-response relationship. In particular, the risk increased nearly 9 fold after consuming 4 or 5 drinks and to more than 13 fold if the respondent reported consuming 6 drinks or more.

For the validity of results in case-crossover analysis, the agreement between self-reported alcohol consumption and BAC results was examined. Among 472 patients completing both BAC and interviews, 6 were negative for self-reported consumption within 6 hours prior to the injury but had positive BACs, while 9 of the 165 patients with negative BACs reported drinking during the 6 hours prior to injuries. The Kappa coefficient was 0.930 (95% CI = 0.894 - 0.965), suggesting a very good agreement between BAC and self-report. Furthermore, an analysis using Pearson's correlation coefficient indicated that there is a strong linear relationship between reported number of drinks consumed in the 6 hour period prior to traffic injuries and BAC of patients at admission, $r(463) = 0.68$, $p<0.001$.

4. Discussion

This is the first study in Vietnam to systematically collect the blood alcohol concentration and estimate the risk of traffic injury after alcohol consumption among patients admitted to Emergency Department. This is also one of few studies that apply case-crossover analysis to estimate the risk of road traffic injuries after alcohol use.

Our results showed the rate of patients with BAC above limit of 0.05g/100mL (60.4%) is much higher compared to results in other countries such as in South Africa (26 - 31%), in Thailand (44%), or in the study of WHO in 10 countries (18,1%). Our figures on the proportion of patients who reported drinking prior to injuries (65.2%) were also higher compared to the estimations in the "World report on road traffic injury prevention" of the World Health Organization in 2004 in which about 8-29% traffic related injured drivers (non-fatal) reported drinking before their road traffic crashes. What is more striking is the high prevalence of injured patients who had a BAC of 150 mg/100 mL or greater in our study (45.6%). This is the intoxication level at which driving skills are strongly affected and diminished. This prevalence provides a clear explanation for the high prevalence of traffic injuries in Vietnam and reveals the magnitude of alcohol as a risk factor to the population of the country.

In the case-crossover analysis, our results indicated that the risk of traffic injury increased when patients consumed alcohol before driving and there was a more than 13 fold increase when six or more drinks were consumed. Results from our study that showed there was not a significant increase when patients had a single drink was

consistent with previous studies from Mexico. However, in a larger study, Vinson et al. identified a dose–response relationship between consuming as few as 1–2 alcoholic drinks and risk of injury (OR = 1.8; 95% CI =1.3–2.6). A recent study, with a large sample of patients with nonfatal injuries attending 10 emergency departments worldwide found that the risk of injury increased when patients had a single drink (OR = 3.3; 95% CI = 1.9–5.7). Taken the data on risk at different levels together, findings in our study were consistent with results from previous studies in developed countries and indicate a dose–response relationship between alcohol consumption and the risk of traffic injury.

A concern in using case-crossover design is the validity of self-reported alcohol consumption. In our study, there was a very good agreement between BAC and self-reported alcohol consumption (Kappa coefficient of 0.930; 95% CI = 0.894 - 0.965) and a significantly strong linear relationship between reported number of drinks consumed in the prior 6 hours and BAC of patients at admission (Pearson's correlation coefficient $r(463) = 0.75$, $p<0.001$).

Prevention implications

The high proportion of patients with recent traffic injuries who had a high level of BAC has implications for prevention strategies. Clearly, education on responsible drinking and planning to avoid drink-driving is an imperative. In Vietnam, the most productive intervention would be to encourage people not to drive to drinking events and when driving to the event is necessary, people should either have a plan for limiting drinking, or have prearranged alternative travel.

Furthermore, rather than solely targeting driving decisions after drinking, a reasonable option would be to focus on encouraging alternative transport both to and from the venue, relieving drinkers of their anxieties around leaving their vehicles unprotected. Given that public transport is still not widespread and taxis are still not commonly used due to cost, our suggestion is to promote the local motorbike taxis ("xe om") as a potential means of alternative transportation. Motorbike taxis are very popular in Vietnam for their cheap fares and widespread availability. Nonetheless, warnings about the safety of impaired passengers when using this means of transport should be developed.

Policy implications

The evidence for high prevalence of patients with BAC above the legal limit in this study is consistent with the cautious acknowledgement of the topic as a public problem in the countries' policy agenda, as well as the poor traffic law enforcement in Vietnam. Evidence from other countries has shown that upgrading drink-driving to a criminal offence may affect the social environment values, the individual's moral awareness and influence behavior, particularly if appropriate educational and

enforcement efforts take place. Lessons from developed countries show that the existence of statutes impacts only those least likely to drink and drive, while perceptions of the likelihood of arrest and individual agreement with the goals of drinking and driving laws significantly reduce the propensity for almost everyone. Media campaigns and national coverage of law enforcement are particularly important to increase the perceived probability of being caught or suffering punishments, which is what actually influences the credibility of sanctions. The current inconsistency between legal BAC for drivers of motorcycles, compared to cars, needs addressing. Given the existence of the law and the recent lowering in the legally acceptable level from the previous BAC threshold in Vietnam, it would seem critical to strengthen the enforcement along with mass media campaigns and news coverage in order to decrease the widespread perception of impunity and thereby, to reduce the level of drink-driving.

5. Conclusion

This is the first study of its kind in Vietnam to examine the risk of traffic injuries after alcohol consumption. These data indicate that a high proportion of traffic related male patients have BAC far above the legal limit, and confirm that risk of injury follows a dose-response function. There was an urgent need for a multi sectoral approach to curtail drink-driving in Vietnam, especially programs to raise community awareness and effective legal enforcement.

COMPETING INTERESTS

The authors declare no competing interests. The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the funding agency.

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