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Road traffic injuries and alcohol use in the emergency department in Tanzania: a case-crossover study

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Abstract

Introduction: Alcohol is the leading risk factor for road traffic injury (RTI) globally. The WHO African Region has the second-highest rate of alcohol dependence and the highest road traffic fatality rate. We describe the proportion of injury patients in an emergency department (ED) in Tanzania presenting with RTIs who reported alcohol use prior to injury and determine the dose-response relationship between drinking and RTI risk.

Methods: From 2013 to 2014, data from a large ED in Moshi, Tanzania were collated. Adults presenting to an ED within six hours of an RTI were breathalyzed for (any) alcohol and were asked whether and how much alcohol they had consumed prior to the injury. Data also included self-reported alcohol use during control periods, namely one day and one week prior to the injury. Case-crossover analysis of injury risk immediately pre-injury vs the control periods used logistic regression to determine matched-pair odds ratios (*OR*s) and 95% confidence intervals (*CI*s).

Results: Of the 375 patients who experienced RTIs, 26% reported using alcohol prior to the injury and 29% were breathalyzer-positive for alcohol. Nine percent of RTI patients reported drinking five or more drinks at the time of injury. Drivers of both motorcycles and cars or trucks who self-reported consuming any alcohol (one standard drink or more) had increased odds of experiencing an RTI (*OR* 4.90; *CI* [2.5, 9.5] and *OR* 5.70; *CI* [2.8, 11.6] respectively). While the odds of RTI in car or truck drivers demonstrated a dose-dependent response, that of motorcyclists was highest after 3–4 drinks (*OR* 5.60, *CI* [2.22,14.10]).

Discussion: Any amount of alcohol can increase RTI risk, with risk increasing with increasing dose. Local evidence should be used to leverage and inform national drunk-driving legislation.

Introduction

Road traffic injuries (RTIs) present a major burden of global morbidity and mortality and are a serious public health concern (Global Health Data Exchange [GHDx], n.d.; World Health Organization [WHO], 2018). Currently, RTIs are the leading cause of death among people aged five to twenty-nine years of age, and are the eighth leading cause of death for all ages (WHO, 2018). In 2015–2030, RTIs will cost an estimated $1.8 trillion globally (Chen et al., 2019). These RTIs occur disproportionately in low- and middle-income countries (LMICs). Only 54% of the world's registered vehicles are located in LMICs, yet 90% of road traffic deaths occur in LMICs (Chen et al., 2019; WHO, 2021; WHO, 2022).

Currently, the WHO Afro region (primarily sub-Saharan Africa) has the highest regional road traffic fatality rate of 26.6 deaths per 100,000, and the highest proportion of deaths among pedestrians of 3.4 per 100,000 (Adeloye et al., 2016).

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A systematic review found that of those patients that had reached and were treated at Sub-Saharan hospitals, 32% suffered RTIs with a 5% mortality rate (Vissoci et al., 2017). As vehicle ownership increases, Tanzania is at an even greater risk of increased RTI incidence due to limited road infrastructure, enforcement, and regulation challenges (Staton et al., 2017). There is a lack of high-quality epidemiological and registry-based datasets, widespread underreporting, and poor linkage of hospital and police data. (Ameratunga et al., 2006 ; Chokotho et al., 2013; Salifu & Ackaah, 2012; Samuel et al., 2012)**.**

Among drinkers 15 years of age and older, the WHO Afro region has the highest prevalence of heavy episodic drinking and the second-highest rates of total alcohol consumption per capita (WHO, 2018a). This high-risk use is also associated with increased harm in a dose-dependent manner (Rehm et al., 2017). It is estimated that about 2.4% of deaths and 2.1% of Disability-Adjusted Life Years (DALYs) lost are attributed to alcohol use in Africa (Rehm et al., 2009; Salifu & Ackaah, 2012). The burden is likely even greater due to underreporting in Sub-Saharan African (SSA) countries (Abegaz et al., 2014; Samuel et al., 2012). Lack of consistent alcohol testing and screening also contribute to the prevalence underestimate (Davis et al., 2010; Dawson, 2003). Alcohol use and related harms are expected to increase in the future, since in the last 20 years alcohol-related deaths have increased by more than 40% in Eastern SSA (GHDx, n.d.). While screening for alcohol use should occur at all locations in a health system, the emergency department (ED) may be the ideal location to capture non-fatal, alcohol-related injury events due to limited police testing, lack of appropriate testing infrastructure in other locations, and potential enrollment of these high-risk patients (WHO 2007; Ogazi & Edison 2012).

Alcohol is the leading global risk factor for injury overall and has been associated with increased severity of RTI (Rehm et al., 2009; Lim et al., 2012). It has also been associated with dangerous driving behavior and unintentional injuries. For example, it is estimated that in regions such as Latin America and the Caribbean, 13% of all DALYs for RTIs are attributable to alcohol (Borges et al., 2017). Alcohol has been observed to impair balance, visual focus, reaction time, judgment, and to change behavior (Chikritzhs & Livingston, 2021).

In Tanzania, RTIs account for more than 330,000 serious RTIs per year and a mortality rate of 31 per 100,000 which is higher than the average for SSA (Maroko et al., 2023) . There is a 20–30 times higher risk of getting killed in a traffic crash in Tanzania compared to the US and Europe (Boniface et al., 2016). Limited trauma care systems, ambulances to transfer patients, and delays in patients arriving at health care facilities also contribute to the burden of injuries that the country faces (Sawe et al., 2021). Studies in Tanzania have found alcohol to be one of the contributing factors of RTIs (El-Gabri et al., 2020). Despite the alarmingly high concurrence of alcohol use and RTIs in Tanzania, there is limited high-quality evidence to quantify the burden of injury. Understanding the relationship between RTIs and alcohol risk is critical for the development of effective prevention and treatment strategies.

Through a cross-sectional study in Tanzania, we aimed to describe the proportion of RTI patients admitted to an emergency department (ED), who are breathalyzer-positive to alcohol. In addition, we aimed to determine the dose-response risk relationship between self-reported drinking prior to injury and RTI.

Materials and Methods

Study Setting

Data were collected from a large hospital in the Northern region of Tanzania from August 2013 until July 2014. The hospital is located in Moshi, Tanzania, a medium-size city of 180,000, and serves as a referral center for over 15 million people in the Kilimanjaro region.

Sample

This project followed a protocol previously used in ED studies in the World Health Organization Collaborative Study on Alcohol and Injury that reported the risk of injury from alcohol use (WHO, 2007). Data were collected from a sample of RTI patients aged 18 years or older presenting for care at the ED within six hours of an injury. Consecutive patients were enrolled during rotating representative eight-hour shifts utilizing weighted sampling methods (WHO, 2007). For analysis, we used only study patients who reported that the cause of their injury was a road traffic crash ("Being hit by a vehicle", "Collision as a driver" and "Collision as a passenger"). We obtained ethical approval from the Kilimanjaro Christian Medical Centre (KCMC) and the National Institute for Medical Research in Tanzania, as well as the Duke University Institutional Review Board.

Variables

We collected patient demographic characteristics including age, gender, education, and employment. Injury characteristics included time since injury and RTI type.

Alcohol Use Variables

To determine the proportion of RTI patients who used alcohol prior to the injury event, two types of data were collected: breathalyzer alcohol testing and self-reported alcohol use. All enrolled RTI patients had an alcohol breathalyzer test administered. Breathalyzer testing > 0.0g/dL was determined to be positive. Similarly, each patient was asked about alcohol use prior to the injury.

In order to conduct the case-crossover portion of this project, we compared RTI patients' self- reported alcohol use during the six hours prior to the injury, and one day and one week before the injury. To evaluate alcohol use six hours prior to the injury patients were asked "In the 6 hours before and up to you having your injury/accident, did you have any alcohol to drink – even one drink?". For the crossover controls, patients were asked, "I would like you to think about where you were and what you were doing yesterday at the same time as you had your injury/accident today. Did you have any alcohol to drink in the six hours leading up to this time?" (Yes/No). The same question was asked in recall of their alcohol use approximately one week prior to the date of

injury, asking about their use of alcohol in the same time window of the day (six hours prior to the injury time). Any positive response about alcohol use immediately prior to the injury, or during these two control time periods, prompted questions about the quantity and types of alcohol consumed during those periods. The amount consumed was then converted into pure ethanol and then into a standard alcohol drink (14g of alcohol) following WHO guidelines (WHO, 2018b).

Individual-level drinking patterns were derived from the frequency of alcohol consumption and heavy drinking events. Frequency of alcohol consumption was categorized as frequent (≥ weekly) or infrequent (< weekly). Heavy drinking events were defined as alcohol consumption of five or more (5+) drinks on an occasion in the past year. The individual-level drinking pattern was then divided into five mutually exclusive categories based on the combination of alcohol consumption frequency and heavy drinking events: (a) infrequent light/non-heavy (drinks < weekly/never 5+), (b) frequent light/non-heavy (drinks ≥ weekly/never 5+), (c) infrequent light/infrequent heavy (drinks < weekly/5+ < weekly), (d) frequent light/infrequent heavy (drinks ≥ weekly/5+ < weekly), and (e) frequent heavy (5+ ≥ weekly).

Data Analysis

Cross-Sectional Data Analysis

We used descriptive statistics to calculate frequencies of demographic, injury, and alcohol data of all RTI patients.

Case-Crossover Analysis

Mirroring prior WHO Alcohol and Injury Collaboration analyses, and following a self-controlled, matched-pair, case-crossover design, we compared RTI patients' self-reported alcohol use in the six hours prior to the injury to two six-hour control time periods: one day (24 to 30 hours) prior to injury, and one week prior to the injury (WHO, 2007; Borges et al., 2006; Maclure, 1991; Cherpitel, 1988). Since RTI patients are their own controls in this design, we inherently controlled for characteristics that might have affected the risk of an injury but do not change over a short time period. A conditional logistic regression model with 1:1 and 1:2 self-controlled matched-pair case-crossover designs was calculated for each injury. The statistical analysis compared the case time period versus the two control periods. Both control periods were used because while the one-week control period might adjust for weekly drinking patterns, it had more potential recall bias than the one-day control time periods (Lim et al, 2012; Maclure, 1991). All estimates were calculated and reported as odds ratios, 95% confidence intervals, and *p*-values with 5% significance. Subgroup analysis was performed for motorcycle- and car- or truck- related RTIs. Data analysis was performed using R, through the survival package (Nistal-Nuño, 2017).

Results

Demographics

A total of 375 patients who had sustained an RTI were identified during 2013–2014. The majority (74%) of the 375 RTI patients were male, half of those involved in RTIs were young adults, and most RTI patient were employed (80%). The mean number of years of education reported by RTI patients was 8.92 years (*SD* 3.59; see Table 1).

Table 1

Socioeconomic and Alcohol Use Characteristics of ED Patients with RTIs in Tanzania (n = 375)

Socioeconomic variables	RTIs
Male gender, *n* (%)	279 (74.4)
Age, *n* (%)	
18 to 30 years	188 (50.1)
31 or more	186 (49.6)
Years of education, mean (*SD*)	8.92 (3.59)
Employed, *n* (%)	298 (79.5)
Alcohol use	
Self-reported alcohol use (any), *n* (%)	96 (25.6)
Positive breathalyzer, *n* (%)	107 (28.5)
Drinking pattern, *n* (%)	
Don't drink	179 (47.7)
Frequent heavy	9 (2.4)
Frequent light/infrequent heavy	25 (6.7)
Frequent light/nonheavy	131 (34.9)
Infrequent light/nonheavy	28 (7.5)

Alcohol Use Prior To Injury and Road Traffic Injury

Approximately 26% of the 375 patients reported using alcohol prior to their RTI (see Table 1). The prevalence of a positive breathalyzer test for RTI patients was 29% and this was highest for motorcyclists at 36% (see Table 2).

Table 2

Number and Percentage of Self-Reported Alcohol Use, BAC (Breathalyzer) Testing, and Vehicle Type among RTI Patients

	Total RTI *n* (%)	Self-reported alcohol use *n* (%)	Breathalyzer testing *n* (%)
	375 (100.0)	96 (25.6)	107 (28.5)
Motorcycle	169 (45.1)	54 (31.9)	61 (36.1)
Cars/Trucks	193 (51.5)	39 (20.2)	42 (21.8)
Missing	13 (3.4)	3 (23.1)	4 (33.3)

Self-Reported Alcohol Consumption

Regarding alcohol volume, the majority of patients (90%) self-reported drinking less than one standard drink of alcohol in the same period one week before injury. In comparison, 85% reported drinking less than one drink 24–30 hours

before injury, while 77% reported consuming less than one drink at the time of injury (see Table 3). Of those reporting alcohol use, the majority of RTI patients (9%) reported drinking five or more drinks of alcohol at the time of injury, compared to 7% who reported drinking five or more drinks in the 24–30 hours before the injury occurred, and the 2% who reported doing so one week before injury at the same time (Table 3).

Table 3

Self-Reported Alcohol Consumption within six hours of (1) injury, (2) 24–30 hours prior to RTI, and (3) one week prior to RTI for Alcohol-Positive RTI Patients.

Alcohol use (# standard drinks[a])	Time of RTI *n* (%)[b]	24–30 hours pre-RTI *n* (%)[b]	1 week before RTI *n* (%)[b]
0	289 (77.1)	320 (85.3)	339 (90.4)
1-2	18 (4.8)	17 (4.5)	11 (2.9)
3-4	33 (8.8)	13 (3.5)	17 (4.5)
5 or more	35 (9.3)	25 (6.7)	8 (2.1)

[a] Standard drink is 12 ounces 5% alcohol beer, 8 ounces 7% malt liquor, 5 ounces 12% alcohol wine or 1.5 ounces 40% alcohol liquor obtained by self- reporting; [b] All time periods include the six-hour window prior to the stated event: the injury, 24–30 hours before injury, and one week before injury.

Case-Crossover Analysis

The matched-pair analysis with self-controlled case-crossover design, showed increased odds of RTI due to alcohol of 5.3 (95% *CI* [3.2, 8.5]; see Table 4**)**. Those reporting drinking prior to injury who were injured on a motorcycle, and those injured in a car or truck both had higher odds of injury: respectively 4.9 *OR* (95% *CI* [2.5, 9.5]) and 5.7 *OR* (95% *CI* [2.8, 11.6]), than those not reporting drinking. For car or truck drivers, an increase in the volume of alcohol consumed during the six-hour period was associated with an increase in the risk of injury, with greater than five drinks associated with the highest risk (*OR* 9.3; 95% *CI* [2.9, 30.5]).

Table 4

Dose-Response of Risk of RTI in Case-Crossover Analysis using Multiple Matched Control Periods

Number of Standard Drinks[b]	All RTIs *OR* [95% *CI*]	M/cycles *OR* [95% *CI*]	Cars/Trucks *OR* [95% *CI*]
Any alcohol vs. no alcohol	5.3 [3.2, 8.5]*	4.9 [2.5, 9.5]*	5.7 [2.8, 11.6]*
1–2 drinks[a]	2.2 [1.1, 4.5]*	1.34 [0.5;3.7]	3.8 [1.3;11.6]*
3–4 drinks[a]	4.9 [2.4, 9.8]*	5.6 [2.2;14.1]*	3.8 [1.3;11.2]*
5 or more drinks[a]	5.3 [2.6, 11.1]*	3.3 [1.3;8.4]*	9.3 [2.9;30.5]*

[a] Reference = 0 drinks; [b] A standard drink is 12 ounces of 5% alcohol beer, 8 ounces of 7% malt liquor, 5 ounces of 12% alcohol wine or 1.5 ounces of 40% alcohol liquor obtained by self-report; *$p < 0.01$

In contrast, the odds of injury for motorcycle drivers were highest after consuming three to four drinks in the six-hour period. Our results highlight that self-reported alcohol use prior to the RTI was associated with increased risk for RTI when compared to a control period without alcohol use. In other words, in a case-crossover design, comparing the individual alcohol use at the moment of the injury with a similar time period in the past when the participant was not injured, we identified that the exposure to injury was, on average, five times higher for participants with positive self-report of alcohol use compared to the self-report of alcohol use at a moment when injury did not happen.

Discussion

Overall, we found that reporting of any level of alcohol use greater than one drink was associated with an increased risk of RTI in Tanzania. The percentages of RTI patients who self-reported alcohol use were similar among those with motorcycle- and car- or truck-related injuries, as well as to those who were breathalyzer positive. For the case-crossover data, we found that the odds of injury due to alcohol were six-fold higher with a dose-dependent response, excluding motorcycles which had a higher odds of injury after having 3–4 drinks of alcohol. A previous study also found a dose-response relationship with increased amount of alcohol drinks consumed six hours prior to injury (Cherpitel et al., 2018).

Among ED patients with RTIs in this study, 26% self-reported alcohol use in the six hours preceding injury, and 29% were alcohol positive on breathalyzer testing. This is consistent with small studies in Eastern Tanzania that have demonstrated that approximately 20–35% of all RTIs are alcohol-related (Boniface et al., 2016; Staton et al., 2017; Chalya et al., 2014). The World Health Organization reports that in Tanzania 35.8% of RTI deaths in men, and 25.4% in women, are attributable to alcohol use (WHO, 2021). In the same report, seven SSA countries had higher rates than those seen in Tanzania. This number is also comparable to other injury groups. A WHO study found that 20.4% of international injury patients reported consuming alcohol six hours prior to injury (WHO, 2007). The inter-country range was significant with Canada reporting that 6% of injuries were alcohol-related while South Africa had 45% (WHO, 2007). Similar work has been done in Mozambique where less than a quarter (17.1%) of injury patients reported recent alcohol use (Cherpitel & Ye, 2019). Blood-alcohol content (BAC) testing followed a similar pattern within these three SSA countries, with the positivity rate in Tanzania of 30%, thus between those reported for South Africa (45.5%) and Mozambique (16.1%; Cherpitel & Ye, 2019).

RTI patients had six times the odds of injury with consumption of any alcohol greater than one standard unit compared to those who had no alcohol. We also found a dose-dependent increase in the odds of RTI for crashes involving a car or truck. Our findings mirror results from a 2011 international systematic review which demonstrated a monotonic relationship between increasing alcohol consumption and risk of injury (Taylor et al., 2010). While the dose-dependent relationship was present for all vehicles

in combined analyses, the effect was not present when evaluating motorcyclists separately. In comparison to car or truck drivers, motorcycle users had a higher proportion of injury at lower alcohol doses (De Craen et al., 2011). Therefore, any, including low, amounts of alcohol appear to substantially increase the odds of injury for motorcycle drivers. This is also likely due to the vulnerability of drivers using this mode of transportation often without protective equipment and employing higher risk-taking behavior (De Craen et al., 2011; Falco et al., 2013; Zimmerman et al., 2015; Constant & Lagarde, 2010).

Strict rules regarding drunk-driving and enforcement policies have been shown to be effective in high-income countries, and may potentially be employed in Tanzania. (Bougueroua & Carnis, 2016; Shults et al., 2001). There is strong evidence that reducing the legal BAC limit to 0.05% or lower has a great impact on alcohol-related injuries (WHO, 2015). While Tanzania has drunk-driving laws with BAC limits of 0.08g/dl for the general population, and 0.0g/dl for commercial drivers, which can be enforced through police check points and breathalyzer testing, the enforcement of the laws has a ranking of two on a scale of 0-10 which is low (El-Gabri et al., 2020).

In particular, low- or zero-tolerance policies have shown moderate efficacy in other LMICs in reducing drunk-driving behaviors (Nistal-Nuño, 2013). This type of stringent policy should be considered for motorcycle drivers in Tanzania. However, it remains unclear how strict alcohol limits and zero-tolerance policies will translate to the Tanzanian environment and the capacity of the police to enforce new regulations.

Based on our findings, we recommend providing education and motivational interviewing to RTI patients to bring about behavior change and reduce RTIs. Research initiatives and subsequent policy changes that focus on drunk-driving and motorcyclists' behaviors are also important.

Limitations

There are some limitations to this study such as possible unmeasurable variables that may have biased associations. We did not collect or compare data on patient comorbidities or illicit drug use which may also impact risk of RTI. Finally, alcohol data for the case-crossover analysis was based on self-reported use only, and recall bias may have impacted the validity of self-reported alcohol use. While BAC is not commonly done, we observed higher rates of BAC-positive than self-reports, which could indicate that self-reporting is underestimating alcohol use prior to injury. However, due to the inconsistency in its use, further evaluations on the quality of this information are warranted.

Conclusion

Overall, we found that alcohol use was associated with an increased risk of an RTI in Tanzania. Motorists have six times the odds of sustaining an RTI due to alcohol with a dose-dependent response, while motorcyclists have higher odds of injury with even lower quantities of alcohol. We suggest that legislation incorporates strict alcohol regulation for drivers, including low or zero-tolerance policies, and that these be directed towards motorcyclists in particular.

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