

## Kava use and risk of car crash injury: a population-based case control study in Fiji

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### Abstract

**Background:** Studies from high income countries attest to the significant contribution of recreational drugs to the risk of road traffic crashes. While rates of road crashes in Pacific Island countries are high, the contribution of kava (a commonly consumed drink with sedative and anaesthetic properties) has received little attention. Using data from the TRIP Project, we aimed to quantify the relationship between acute kava use and car crash injuries in Fiji.

**Method:** We conducted a population-based case-control study in Viti Levu, Fiji. The study included drivers of all four-wheeled vehicles involved in crashes on public roads where at least one person died or was hospitalised (cases) and a random sample of drivers recruited on public roads in the region during the study period (controls). The drivers or their proxies completed a structured interview eliciting data on putative risk and protective factors including kava use, and relevant confounding factors.

**Results:** 154(77%) of the 199 eligible cases and 752 (84%) of the eligible controls completed interviews. Approximately 23% (32/140) of case drivers and 7% (54/749) of control drivers reported drinking kava in the previous 12 hours. After adjustment for major confounders including self-reported alcohol use, consuming kava within 12 hours of driving was associated with a three-fold increase in the odds of crash involvement (OR = 3.15, 95% CI: 1.22 – 8.16).

**Discussion:** Kava use by drivers appears to be an important contributor to serious injury-involved motor vehicle crashes in Fiji and should be an explicit target in road safety strategies in Pacific Island countries where kava use is common. While further studies are required to identify concentrations of kava and patterns of use that pose the greatest risk, this study illustrates the importance of investigating context-specific factors that account for a substantially greater burden of road crashes in some less-resourced settings than currently appreciated.

**Word Count:** 302

**Keywords:** kava use, road traffic crash, Pacific Island nations, case control study

## **1. Introduction**

Road traffic injuries (RTI) are a major public health problem causing death and disability worldwide. (Krug et al., 2000, Peden et al., 2004) Evidence shows that current and projected global burden of RTI is disproportionately borne by low and middle-income countries like Fiji, that can least afford the services and socio-economic challenges associated with this problem. (Odero et al., 2007, Nantulya and Reich, 2002, Nantulya and Reich, 2003, Ameratunga et al., 2006)

Amongst the known major risk factors for RTI in low and middle-income countries, the effects of alcohol and other recreational drugs such as marijuana on driver performance are well-described. (Blows et al., 2005, Norman et al., 2007, Gururaj, 2004, Peden et al., 2004, Jha and Agrawal, 2004)

Kava is a popular intoxicating beverage made from the root extract of the *Piper methysticum* plant and commonly consumed in Fiji. In large doses, kava can produce ataxia, intoxication, sedation, analgesia and paralysis of the extremities without loss of consciousness - these effects are reversible. Historically, kava drinking was used only for special occasions and drunk by an elite few. However, today kava drinking is a commonplace socialisation practice. (Abramson, 2005, Brison, 2001, Cornelius et al., 2004, Cairney et al., 2002). In combination with alcohol, kava has been found to potentiate the acute effects of alcohol and to impair a range of important functions. (Cairney et al., 2003, Cairney et al., 2002, Hocart et al., 1993, Foo and Lemon, 1997)

Given the established neurological effects of kava it is likely that its acute use and potential chronic use may impact on driving performance. The overall goal of this research is to investigate the relationship between kava use and RTI risk in Fiji.

## **2. Methods**

As part of the Traffic Related Injuries in the Pacific (TRIP) Wellcome funded research project, we conducted a population-based case control study of motor vehicles using public roads from July 2005 to December 2006 on Viti Levu, Fiji. Viti Levu is the main island of Fiji and has an estimated population of 650,000. Only around 20% of the public roads on the island are tar-sealed. Around 86% of the driving fleet is made up of cars and commercial vehicles.

The study base comprised motor vehicle 'driving-time' on public roads in Viti Levu. Driving-time is equivalent to person-time. Eligible vehicles included motorised four-wheeled vehicles including: private cars, taxis, minibuses, pick up (open "ute" with tray), trucks, and commercial or government vehicles. Buses, motorbikes, ambulance, Police vehicles, and vehicles of the Diplomatic Corp were excluded.

The study was approved by the Fiji National Research and Ethics Review Committee. The roadside survey was granted approval by the Fiji Police Force Highway Unit.

### **2.1 Recruitment**

Eligible cases comprised drivers (as primary informants) of eligible vehicles involved in a crash on public roads in Viti Levu, where a road user (driver, passenger or pedestrian) died or was hospitalised for 12 hours or more, during the study period. Exclusion criteria included: crashes

after 2am and before 5am (Fiji transport data suggested road crashes were uncommon during this period); road users sustaining injuries due to falling from a vehicle, crashes in private driveways and crashes occurring on roads not included in the control site sampling. Cases were prospectively identified from the Fiji Injury Surveillance in Hospitals (FISH) database, established in all trauma-admitting hospitals throughout Viti Levu during a 12 month period.(Wainiqolo et al., 2011) This system identified injured individuals from accident and emergency registers, admission records, and mortuary registers. Research assistants collaborated with Fiji police and hospital personnel to ensure all eligible cases were identified, case records were accurate and complete. If the driver had died or was unable to participate due to severe injuries, a driver next-of-kin or other suitable proxy respondent was identified and interviewed.

Controls were a sample of vehicle drivers representative of motor vehicle driving-time on Viti Levu public roads during the study period. The controls were recruited at about the same time as the cases using a prospective two-stage cluster sample roadside survey of motor vehicles at 50 randomly selected road sites. The sampling method aimed to recruit controls in proportion to the amount of driving undertaken given that exposure to risk of a crash only occurs when driving. The day of week, time of day and direction of travel for each survey site were randomly selected. There was one roadside survey per week and random recruitment of drivers was done over a 2-hour period at each site. Consistent with established protocols in the country, traffic police stopped drivers and managed traffic at each roadside survey site. During each survey, traffic counts were recorded for all vehicles travelling in the same direction as motor vehicles selected for the study. This enabled a weighting to be assigned to controls from each site that was the inverse of the proportion of all vehicles selected as controls.

All potential participants received an information brochure providing an overview of the study and an invitation to participate.

## **2.2 Data collection**

Case drivers completed an interviewer-administered questionnaire either face-to-face in hospital, at home, or via telephone. For control drivers, interviews were conducted either on-site face-to-face or at a time convenient for the driver via telephone. Permission was sought from control drivers to have an alcohol breath test done on site.

The 72-item questionnaire captured information about vehicle details, circumstances of the crash or survey, lifestyle factors, driving experience and habits, socio-demographic characteristics and alcohol and recreational drug use (including kava).

In relation to drug and alcohol use, drivers were asked if they had consumed alcohol or kava in the 12 hours before the crash/survey, how much they consumed and how long before the crash/survey did they stop drinking alcohol/kava. In addition, drivers were asked about the frequency of kava use in the past 12 months. Acute kava consumption relied on self-reported. Blood alcohol levels were obtained on some case and control drivers but in insufficient numbers for this variable to be included in the case-control analyses.

The questionnaire for control drivers was very similar to the case questionnaire excluding questions related to the case crash.

## 2.3 Analysis

Odds ratios (ORs) and confidence intervals (CIs) were calculated using unconditional logistic regression models. The inclusion of potential confounders in the multivariable model was assessed using Greenland's change in estimate model with a cut point of 10%. (Greenland, 1989) To account for the cluster sampling method, weighting was done on control data. Variables with greater than 10% missing data in the 'case' group were excluded from the models because these impacted the point estimates.

## 3. Results

Of the 199 eligible cases (i.e. drivers involved in serious injury crashes) identified during the study period, 154 completed interviews (77%), 8 refused participation (4%), 5 consented but did not complete the interview (2.5%) and 32 (16%) could not be contacted. Eighteen (12%) of the case interviews were completed by a proxy respondent. Of the 892 control vehicles selected, 752 drivers completed interviews (84%), 72 declined (8%), 68 deferred interviews or were untraceable from the details given at the roadside survey, (7.6%).

Approximately 23% (32/140) of case drivers reported drinking kava in the previous 12 hours compared with 7% (54/749) of control drivers. There was a significant association between the risk of road traffic injury crash and acute kava consumption after controlling for age, gender, ethnicity, household income and this remained following adjustment for usual kava use, acute alcohol use (past 12 hours), car type, wet road conditions, type of driving license, and if the driver was involved in a crash in the past 5 years. The odds ratios for drinking kava in the previous 12 hours compared with not drinking kava was 3.2 (95% CI, 1.2, 8.16) (Table 1). Usual kava use was not associated with an increase in odds of injury crash. There were no significant interactions observed between acute kava consumption and acute alcohol consumption (OR 0.36, 95% CI, 0.03, 4.65) and between acute kava consumption and usual kava use (OR 2.12, 95% CI, 0.27, 16.71).

The population attributable risk (PAR) for crashes associated with driving while having consumed kava was 14% (CI: 8% - 20%).

**Table 1: Association of variables related to self-reported kava use with risk of car crash resulting in injury. Estimates are adjusted odds ratios with 95% confidence intervals**

Variable	Model 1: Adjusted OR (95% CI)*	Model 2: Adjusted OR (95% CI) †
<b>Acute kava use (previous 12h)</b>		
No	1.0 (reference)	1.0
Yes	6.32 (2.78, 14.35)	<b>3.15 (1.22, 8.16)</b>
<b>Usual kava use (past 12 months)</b>		
None to monthly	1.0 (reference)	1.0
Greater than monthly to daily	2.15 (1.21, 3.82)	1.70 (0.95, 3.03)

\*Model 1 adjusted for age, gender, ethnicity and household income

†Model 2 adjusted for variables in Model 1 and acute kava use (previous 12hrs), usual kava use (past 12 months), acute alcohol use (previous 12 hrs), car type, wet conditions, type of driving licence and driver in a crash in past 5 yrs

## 4. Discussion

Our findings suggest that drinking kava in the previous six hours major contributor to serious injury-involved motor vehicle crashes in Fiji. This relationship remained significant when

associations were adjusted for potential confounding factors. The avoidance of kava use is estimated to reduce the number of these injuries by up to 14%. This apparent risk factor has received relatively limited attention and should be an explicit target in road safety strategies in Pacific Island countries where kava use is common.

The strengths of the study include the selection of control drivers representative of the population from which the case drivers arose. The study was population-based and attempted to identify all case drivers involved in an injury crash arising from the study base. The study had few exclusion criteria. Case ascertainment is likely to be complete because cases were recruited from all hospitals admitting trauma patients of this nature in the region, and from the mortuaries that investigate all injury-related fatalities in Fiji. Using this approach to case ascertainment helped minimise selection bias.

The use of proxy interviews may have introduced systematic error in the measurement of some exposures. Relatively few case records had missing information in key variables relevant to this analysis (acute kava consumption measures  $n=14$ ), it is unlikely that the effect estimates were substantially affected. The control driver information was derived from a sample of the study data base (drivers of 4 wheeled vehicles on public roads in Viti Levu, Fiji). Selection bias may have arisen from the sampling method employed or from the selective participation of subjects. Bias from non-response in case drivers could arise if those who declined to take part differed systematically from those who did with respect to relevant exposures. Adjusting for factors known to be associated with poor response, including age and socio-economic status, should have reduced these biases to some extent. Differential recall of information relating to a situation by cases and controls can result in recall bias. (Rothman and Greenland, 1998) The methods used to minimise recall bias in this study included the standardised administration of identical exposure questions for case and control drivers. We undertook adjusted analyses to reduce confounding by a range of relevant demographic, lifestyle and other variables. However, as with all observational study designs, residual confounding remains a threat to the internal validity of this study. (Rothman and Greenland, 1998)

The study was insufficiently powered to explore if a dose response relationship exists in relation to kava use and risk of road traffic injury. Future studies with sufficiently large sample sizes are required to investigate which sub-groups are at increased risk of road traffic injury associated with acute kava use (e.g., by age, gender, ethnicity, type of road traffic crash), the relationships between patterns of kava drinking and the severity of road traffic injuries, and the inter-relationships between other factors such as alcohol use and co-morbidities and the effects of acute kava consumption. Research protocols should particularly focus on incorporating objective measures of acute kava use.

No other studies were located in the published literature that has explored the relationship between car crash injury and acute kava use. However, the findings of this study are consistent with studies that have explored the use of alcohol and recreational drug use and risk of car crash injury. (Blows et al., 2005, Norman et al., 2007, Gururaj, 2004, Peden et al., 2004, Jha and Agrawal, 2004) A large case-control study conducted in the US involving 14 985 drivers showed that the relative risk of crash involvement starts to increase significantly at a BAC level of 0.04 g/dl. With the risk almost five fold with a BAC of 0.1 g/dl. (Peden et al., 2004) A New Zealand study by Blows et al. found an almost four fold increase in risk of car crash injury associated with acute marijuana use after controlling for the confounders age, gender, ethnicity, education level, passenger carriage, driving exposure and time of day. (Blows et al., 2005) A case-control study conducted in France, found a higher prevalence of alcohol, cannabis and a

combination of the two in blood samples from drivers involved in road crashes than in those from controls.(Mura et al., 2003) A study in the United Kingdom showed a clear reduction in driver capability following the use of alcohol and cannabis together, compared with control data.(Sexton BF et al., 2002)

In the present study, 14.3% of case drivers reported having consumed alcohol in the 12 hours preceding injury. A review of studies conducted in low-income countries, found that alcohol was present in 33% to 69% of fatally-injured drivers, and in 8% to 29% of drivers involved in crashes who were not fatally injured.(Odero and Zwi, 1995) A survey of hospitalised patients in Kenya, revealed that 40% of drivers and 20% of pedestrians being treated for traffic-related injuries, reported being under the influence of alcohol at the time of the crash.(Odero et al., 2003) In South Africa, it is estimated that almost half of all motor vehicle driver fatalities are over the legal blood alcohol limit. (Norman et al., 2007) A cross-sectional survey of Pakistani commercial drivers, found alcohol while driving was reported by 6% of drivers with higher usage seen among truck drivers. Marijuana use was almost 30% in some groups, with statistically different patterns of usage seen between population subgroups based on ethnicity, age, education, and marital status.(Mir et al., 2012)

A recent review of the neurobehavioural effects associated with kava use found that despite the consumption of kava in various forms globally and its classification as a 'world drug, there are no comprehensive models to explain the cognitive or neuropsychiatric consequences of the chronic or acute use of kava. The authors conclude that further investigation is necessary to gain an understanding of kava's immediate neuropsychiatric and long-term cognitive effects.(Cairney et al., 2002)

This study illustrates the importance of investigating context-specific factors that account for a substantially greater burden of road crashes in some less-resourced settings than currently appreciated. The findings should be used to inform policies regarding the misuse of kava and the associated harms not only in road traffic injury prevention strategies and health promotion, but also in the traffic, law enforcement, religious and cultural arenas.

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