Consumption of Alcoholic Energy Drinks Is Associated with Work-related Injury or Disease Among Manual Workers in Taiwan

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Abstract

Aims: Alcoholic energy drinks (AEDs) have been popular among Taiwanese manual workers. Study results concerning increased health risks of AED consumption relative to alcohol alone have been inconsistent, and the risk for potential work-related injury or disease has not been studied. Our study goal was to evaluate the association between AED consumption and work-related injury or disease in manual workers in Taiwan.

Methods: National survey data of the working population in 2007 was utilized. A total of 1192 manual workers, who drank alcohol more than once per week, were divided into AED-drinkers and non-AED drinkers. We compared AED drinking behaviors and risk of work-related injury or disease between the two groups.

Results: AED drinkers had a higher risk of work-related injury or disease, with an odds ratio of 1.48 (95% CI: 1.14–1.93), after controlling demographic, smoking and drinking characteristics. The presence of problem drinking (defined by CAGE score equal to or higher than two) was another risk factor of having work-related injury or disease. Compared to non-AED counterparts, AED drinkers had a significantly higher prevalence of work-related injury or disease in the strata of CAGE score of 1 and 2.

Conclusion: AED consumers presented increased risks of work-related injury or disease compared with non-AED drinkers among manual workers in Taiwan. In order to conduct an effective intervention program to protect Taiwanese manual workers from potential risks, the reasons for this increased risk among AED drinkers need to be further studied.

INTRODUCTION

Alcoholic energy drinks (AEDs) have attracted attention in recent years. The surge in energy drink consumption has raised public health concerns in the United States and a number of European countries (Reissig et al., 2009). Besides mixing alcohol and caffeinated beverages by users, there were premixed AED products in the market. The United States Food and Drug Administration already banned several premixed AEDs from the market in 2010 due to safety concerns.
Problem drinkers (Webb et al., 1994), and problem drinkers (Dawson, 1994), and problem drinkers (Plurad et al., 2006). The frequency of heavy drinking (Dawson, 1994), and problem drinkers (Plurad et al., 2006) and disease has not been studied. We aimed to examine the association between AED consumption and alcohol dependence was also noted in the survey (Cheng et al., 2012).

AED drinkers reported alcohol-related consequences more often than non-drinkers, including injuries that required medical treatment (O’Brien et al., 2008). Recent review studies found that energy drinks did not alter alcohol subjective intoxication, and within-subject comparison of alcohol and AED sessions showed that AED consumption was associated with less alcohol amount than in alcohol sessions (Benson et al., 2014; Peacock et al., 2014). However, after controlling for personal risk-taking propensity, high frequency AED consumers were still found to experience more negative consequences compared to less frequent AED drinkers (Brache and Stockwell, 2011). It is still not clear if AED consumers are riskier alcohol drinkers compared with other alcohol drinkers. Furthermore, participants of previous studies were restricted to young adults in Western societies. The health consequences of AED in other drinking contexts and in Asian countries have not been studied.

Alcohol drinking and alcohol-related problems affect a substantial percentage of the working population (Marchand, 2008), especially in manual workers (Hemmingsson et al., 1997). Alcohol drinking in employees continued to cause losses in productivity as well as numerous health problems including work-related injury (Kunar et al., 2008; Plurad et al., 2011). The odds of occupational injury increased with the frequency of heavy drinking (Dawson, 1994), and problem drinkers were more likely to have injury-related absences than non-problem drinkers (Webb et al., 1994). Drinking alcohol can increase the risk of injury by engaging in risk-taking behavior or reducing the perception and responses to hazards (Zuskin et al., 2006; Kunar et al., 2008). While the effect of AED consumption on work-related injury or disease has not been studied, we aimed to examine the association between AED consumption and risk of work-related injury or disease.

**MATERIALS AND METHODS**

The Ministry of Labor of Taiwan has conducted nationwide surveys of the working population every 3–5 years since 1988, to understand safety and health issues in the workplace. Participants were selected through a two-stage random sampling process. In the first stage, all districts and villages throughout Taiwan were grouped into strata according to their levels of urbanization. A random sample of districts and villages was chosen from each stratum. In the second stage, a random sample of households was selected within each district or village, and residents of the sampled households who were currently working at the time of survey were identified and invited to participate. More detailed information with regards to the sampling scheme of the survey can be found elsewhere (Yeh et al., 2009). Subjects who were not economically active (such as students, homemakers, retirees, unemployed, etc.) were not eligible for the survey. Self-administered questionnaires were delivered to the selected households by trained interviewers. After 1 week, completed questionnaires were collected and on-site checking was performed by the same interviewer. A total of 28,716 subjects were sampled, including 22,476 employees and 6240 employers and self-employed workers combined. Among the sample subjects, 24,996 subjects completed and returned questionnaires, with a response rate of 87%. In this study, we excluded subjects who were aged younger than 25 or older than 65 years, based on the consideration that workers in these age groups were more likely to be in a transitional stage and their working conditions might not be stable or causally relevant to their drinking behaviors. Information on occupations was based on self-reported job titles. Employees were classified in the following six categories—Grade 1: administrators and managers; Grade 2: professionals; Grade 3: non-manual skilled; Grade 4: non-manual low-skilled; Grade 5: manual skilled; Grade 6: manual low-skilled. AED consumption was most prevalent among grade 3 and 6 manual workers, e.g. farmers, construction workers, metal and machine workers, drivers, cleaners etc. We restricted the study subjects to 2020 female and 4914 male manual workers because their work contents and health risks were very different from workers from other work categories. Those who were totally abstinent or drank less than once or per week were excluded. This resulted in a combined sample of 1192 subjects, including 1143 men and 49 women.

The national survey collected demographic information including age, sex, marital status and education. Health behaviors questions included drinking and smoking behaviors. For drinking behavior, the participants were asked (a) to check their frequency of drinking as 1–2 times, 3–4 times or more than 5 times per week; (b) to complete the Chinese version of CAGE questionnaire for problem drinking screening, which was found to be equivalent to the original English questionnaire and has been proven to have good validity and reliability in terms of workplace screening (Ewing, 1984; Kuo et al., 1999); (c) to check whether they drank energy drinks more than once per week, and if yes and (d) to check whether they drink AED or alcohol-free energy drinks. Among all regular alcohol drinkers, those who drank AED more than once a week were defined as AED drinkers, whereas those who drank alcohol other than AED were defined as non-AED drinkers. For smoking behavior, they were asked to check if they have never smoked, were abstinent for more than 6 months, or were current smokers. We categorized them into current smokers and non-smokers including those who were abstinent for more than 6 months. Regarding work-related injury or disease, the subjects were asked whether they have been injured or diseased because of their work in the past year. If the answer is ‘yes’, we defined they have ‘work-related injury or disease’.

Descriptive statistics were used to display demographic characteristics, and drinking and smoking behavior variables. We used the Chi-square test for categorical variables and t-test for continuous variables to examine the differences between AED drinkers and non-AED drinkers. Next, we established a logistic regression model, in which work-related injury or disease was the dependent variable, and age, sex, education, smoking, the presence of problem drinking, which was defined as CAGE equal to or higher than two, alcohol drinking frequency, and types of drinking were independent variables, to test the associations between the risk of work-related injury or disease and demographic, smoking and drinking variables. We further stratified the subjects by their CAGE scores and used the Chi-square test to compare the difference of the percentage of work-related injury or disease among AED drinkers and non-AED drinkers in each stratum. All statistical analyses were performed utilizing SAS software version 9.2 (SAS Institute, Cary, NC, USA).

**RESULTS**

Among the 1192 manual workers who were regular alcohol drinkers, 1143 (95.9%) were men and 633 (53.5%) were problem drinkers.
Four hundred and eleven of the subjects (34.7%) consumed AED, and 369 (31.1%) reported work-related injury or disease in the past year. The mean age of the sample was 42.4 ± 9.3 years old.

Table 1 shows the demographic characteristics and drinking behavior variables in AED drinkers and non-AED drinkers. The two groups were not significantly different in age, sex ratio, marital status and the percentage of problem drinking. However, AED drinkers had a significantly lower educational attainment and a higher alcohol drinking frequency. On the other hand, a higher percentage of them were smokers. The logistic regression analysis showed that both AED consumption and presence of problem drinking increased the risk of work-related injury or disease, while higher educational attainment and older age lowered the risk (Table 2). We further stratified the sample by CAGE scores to compare the percentage of work-related injury or disease in AED and non-AED drinkers in each stratum. Figure 1 shows that AED drinkers had a significantly higher prevalence of work-related injury or disease than non-AED drinkers in strata of CAGE score of 1 and 2, but not in other strata.

**DISCUSSION**

This is the first study to compare work-related injury or disease between AED drinkers and non-AED drinkers. We found that AED consumption was associated with a higher risk of work-related injury or disease after controlling for the presence of problem drinking and alcohol use frequency. When compared with their non-AED counterparts, the increased risk of work-related injury or disease was significantly higher in AED drinkers with a CAGE score of 1 and 2, but not in subjects with other CAGE scores.

It has been postulated that energy drinks may increase alcohol priming and lead to higher amount of drinking (Price et al., 2010; Marczinski et al., 2013), but within-subject comparison found that consumers drank less alcohol and had fewer alcohol-related consequences in AED session compared to alcohol sessions (De Haan et al., 2012). In our study, we did not evaluate the amount of alcohol consumption in the questionnaires, but presence of problem drinking was not more prevalent in AED drinkers than in non-AED drinkers. Though a trend of higher drinking frequency was noted in AED drinkers, AED drinkers remained to have a higher risk of work-related injury or disease after controlling for the frequency of alcohol use and presence of problem drinking. Hence, the increased risk in AED drinkers was not solely attributable to more frequent alcohol consumption or more severe alcohol use problems.

Lower educational attainments were found in AED drinkers in our study. A community survey did not report an association between educational attainment and AED consumption (Berger et al., 2011), and a Brazilian study even found a higher prevalence of lifetime AED use in students with higher socioeconomic background (Locatelli et al., 2012). The inconsistency might reflect a cultural difference in AED consumption between drinkers in Taiwan and Western societies. Nonetheless, lower educational attainment has been found to be associated with work injury (Kunar et al., 2008), and the clustering of risks including substance use and less education in Taiwanese AED drinkers highlights the imperativeness to intervene.

We found that presence of problem drinking (CAGE score equal to or higher than two) is a risk factor of having work-related injury or disease. When compared to non-AED drinkers, a significantly higher risk of work-related injury or disease occurred in AED drinkers with a CAGE score of 1 and 2, but not CAGE score of 3 and 4. As patients with more severe problem drinking may develop tolerance to alcohol,

### Table 2. Multivariate logistic regression analysis of work-related injury or disease among manual workers who drank more than once per week (n = 1192)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Work-related injury or disease</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
</tr>
<tr>
<td>25–45</td>
<td>1</td>
</tr>
<tr>
<td>45–65</td>
<td>0.74 (0.54–1.00)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1</td>
</tr>
<tr>
<td>Male</td>
<td>1.36 (0.69–2.71)</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
</tr>
<tr>
<td>Single, divorced or widowed</td>
<td>1</td>
</tr>
<tr>
<td>Married</td>
<td>1.14 (0.86–1.51)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>Elementary school and lower</td>
<td>1</td>
</tr>
<tr>
<td>Middle school</td>
<td>0.64 (0.44–0.93)</td>
</tr>
<tr>
<td>High school and higher</td>
<td>0.59 (0.40–0.87)</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
</tr>
<tr>
<td>Non-smoker</td>
<td>1</td>
</tr>
<tr>
<td>Current smoker</td>
<td>0.89 (0.64–1.25)</td>
</tr>
<tr>
<td>Alcohol drinking frequency</td>
<td></td>
</tr>
<tr>
<td>&lt;twice/week</td>
<td>1</td>
</tr>
<tr>
<td>3–4 times/week</td>
<td>1.24 (0.92–1.66)</td>
</tr>
<tr>
<td>≥5 times/week</td>
<td>1.40 (0.94–2.08)</td>
</tr>
<tr>
<td>Presence of problem drinking</td>
<td></td>
</tr>
<tr>
<td>CAGE &lt;2</td>
<td>1</td>
</tr>
<tr>
<td>CAGE ≥2</td>
<td>1.54 (1.19 to 1.99)</td>
</tr>
<tr>
<td>Alcohol drinking</td>
<td></td>
</tr>
<tr>
<td>Alcohol other than AED</td>
<td>1</td>
</tr>
<tr>
<td>AED (with or without other alcohol)</td>
<td>1.48 (1.14–1.93)</td>
</tr>
</tbody>
</table>

AED, alcoholic energy drinks; CI, confidence interval; OR, odds ratio.
they may consume products with higher alcohol strength. This could mask the effect of AED on work-related injury or disease in heavy drinkers. Hence, preventive interventions should not only focus on severe problem drinkers, but also on light to moderate problem drinkers.

The association between AED drinkers and work-related injury or disease may also be mediated by other risk factors in AED drinkers. Previous studies found that AED drinkers engaged in more stimulant drug use, more drinking and more high-risk drinking behaviors compared with current drinkers who did not report consuming AED (Arria et al., 2010; Brache & Stockwell, 2011). In addition, a higher risk-taking tendency was noted in AED drinkers including impulsive sensation seeking and childhood conduct problems (Arria et al., 2011). However, drinkers reported less risk-taking in AED versus alcohol sessions (Peacock et al., 2012). Whether consuming AED really increases risk-taking behavior needs to be verified. The implications for disease or injury prevention are therefore not only to focus specifically on AED consumption behavior, but also to identify risk factors among AED drinkers. For example, in Taiwan, AED has been promoted as a beverage to combat tiredness due to heavy workloads and sleepiness caused by long working hours and irregular work shifts. As a result, AED consumption may be more prevalent among workers with adverse work conditions in which the risk of work-related injury or disease is higher than average work conditions. It has been reported that the rates of on-the-job injury during the preceding year were higher for workers who engaged in repeated strenuous physical activity at work (Dawson, 1994). The timing of drinking, the tendency of workers to consume alcohol before going to work during the night shift was associated with work injury in Indian coal miners (Zuskin et al., 2006). Hence, to adjust contextual conditions in the study of AED consumption and injury or accidents is imperative in future studies.

Limitations in our study include the following: first, it is noticeable that only on-the-job rather than general alcohol use was associated with work accidents when adjusting for the other work factors (Ames et al., 1997; Frone, 1998; Rasmussen et al., 2011). Our study participants were not asked if AED consumption was associated with their work-injury or disease, so we were unable to clarify the temporality of AED consumption and work-related injury or disease. Second, the survey did not include some important questions, such as personality impulsivity, other drug use, quantity of alcohol consumption and working contextual conditions, which might be correlated with work-related injury or disease. We did not know the associations between these confounding factors and risk of work-related injury or disease.

Third, the questionnaire in this survey only asked subjects about work-related injury or disease, while the exact type of work-related injury or disease, for example accident or chronic disease, was unclear. Therefore, the increased risk of work-related injury or disease among manual workers in the current study needs to be verified using a more comprehensive questionnaire that includes participants’ personality, other substance use, time of drinking, types and amount of alcohol consumed, working contextual conditions and types of work-related injury or disease when injury or disease occurs in the future.

In conclusion, this is the first study showing that AED drinkers had a higher risk of work-related injury or disease. Clearly some type of intervention program must be implemented to prevent potential harm in AED drinkers. In Taiwan, several AED regulatory measures, such as labeling alcohol strength and warning signs on AED packaging, banning advertisements using workplace as the background in such promotions and restricting their sales to pharmacies, have been implemented since 2006. However, the prevalence of AED consumption before/at work remained as high as 60% among the drinkers in a recent survey (Cheng et al., 2012). Hence, in addition to controlled experiments to study the effect of AED on health, field studies are needed to delineate the drinking context of AED in each vulnerable population to find out other risk factors and to formulate relevant and effective intervention strategies.

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CONFLICT OF INTEREST STATEMENT

None declared.

REFERENCES


