

Population characteristics and behavior of caffeinated alcoholic beverage consumption

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ABSTRACT

Background: Caffeinated alcoholic beverage (CAB) consumption has been suggested to be associated with adverse health outcomes. There are various CAB drinking behaviors and CAB is consumed by populations like the underage, soldiers, and Taiwanese manual workers. Their drinking patterns may lead to different health effects, but CAB drinking behaviors have never been reviewed.

Methods: We performed systemic qualitative review to literatures about population characteristics and drinking behavior of CAB consumption, and compared them between users in Western countries and Taiwanese manual workers.

Results: CAB consumption was more prevalent in young male, and those with risk-taking tendency. Lower socioeconomic status was associated with CAB consumption in Taiwan but not in Western countries. Compared to college students in Western countries, Taiwanese manual workers drink CAB with a higher frequency and cumulative amount of alcohol, but with lower episodic drinking amount. Drinking motives were alcohol intoxication facilitation among college students but to boost energy and socializing among Taiwanese manual workers.

Conclusions: CAB consumption behaviors varied across different populations and should be taken into account in researching for the causal relationship between CAB consumption and health outcomes.

Keywords

Alcohol, Caffeine, Drinking behavior, Taiwan

Introduction

Caffeinated alcoholic beverage (CAB) consumption is common among young adults in Western countries [1,2]. Possible side effects of CAB consumption have been warned, including risky behaviors and alcohol dependence [3-6]. These concerns had made several “premixed” alcoholic energy drinks prohibited for sale in the United States [7]. While debates have not been settled if CAB users present more health risks than alcohol consumers [8,9], it is noticeable

that various CAB consumption behaviors has been decontextualized in studies of its health effect. CAB drinking studies were limited to a small group of people with high risk-taking propensity, and failed to reveal the broad health effects of CAB consumption.

It has been reported that CAB can be consumed in various ways by different populations. CAB has been found to be consumed through self-mixing or premixed products, and dozens of alcohol and caffeinated products were used for

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mixing [10]. The health risks are higher with premixed CAB than self-mixed CAB [10]. On the other hand, CAB use among underage youth, young adults in nightlife scenes, and army soldiers has been reported [10-12]. Six percent community population used CAB in past year in the U.S. [13]. In Taiwan, CAB was introduced to the market in the late 1960s. The 2 best-sellers are Whisbi® and Paolyta B® and more products are coming. Both of them contain 300 mg of caffeine and 48 g of alcohol (10%) per bottle of 600 ml. According to a nationwide survey in 2007, 6% of Taiwanese male workers drink CAB more than one bottle per week [14]. The prevalence was relatively high in occupations such as constructors (21.9%), movers, packers (17.8%) and fishermen and farmers (14.4%) [14].

Review articles focused on health consequences related with CAB [8,9,15,16], and psychological constructs of CAB use which could act as mediators or moderators of drinking behavior and consequences [17]. However, the casual inference between CAB consumption and health consequences can hardly be established without understanding the exact consumption behaviors in each population. Hence, this study aimed to systemically review CAB drinking behavior and characteristics of drinking population from existing literatures.

Methods

Studies were identified by author WJC by PubMed (last search May 7, 2014). The terms “Caffeinated” and “Energy” were combined with the term “alcohol” and 244 studies were identified. The searching and data extraction process was completed solely by author WJC and the protocol is presented in *Supplementary material*. Twenty duplicates were removed and eligibility screened based on publication criteria, which further removed 49 studies. Abstracts, title, and contents (if necessary) were read and 149 studies were excluded based on topic criteria. Finally 26 articles were selected for qualitative review. (Figure 1) Due to the scarcity of studies in Asian populations, we included one article published in 2015, which focused on the CAB drinking behavior in Taiwanese manual workers [18].

The publication criteria require the studies to be descriptive or observational analytic. Animal studies, experimental studies, commentaries, opinions, reviews, methodological studies, and case reports were excluded. Peer-reviewed journal articles published (or E-pub ahead) in

English between January 1982 and May 2014 were collected. Topic criteria require the studies to contain descriptions about CAB drinking population and behaviors. Studies concerning energy drink only rather than premixed or self-mixed CAB were excluded. We defined CABs as self-mixed alcoholic beverages and caffeine pills or caffeinated beverages, e.g. coffee, tea, or soda, as well as premixed alcoholic energy drinks.

Location of the study, year of publication, study population and study design were extracted. The characteristics of drinking population were described qualitatively regarding gender, age, ethnicity, and socioeconomic status. The information was often described as quantitative statistics in selected studies, and only statistically significant results were extracted. We took alcohol drinking behaviors as reference, and explored the following dimensions of CAB drinking behavior [19-22]: *when* do they drink (drinking frequency, regularity, drinking time in a day), *what* do they drink (ingredients of premixed CAB product, or self-mixed beverages), *where* do they drink (place), *how* they drink CAB (drinking amount per episode, served size of the product or mixed beverages), and *why* do they drink (motivations, benefits). Contents of the selected studies were extracted and reallocated according to these dimensions.

Results

The first study concerning interactions of alcohol and caffeine were found as early as in the 1980s [23], but the first CAB consumption survey was done in 2008 [5]. Almost two-third of the selected 26 studies for review were from the United States [2,5,6,10,11,13,24-32], 4 from Central and South America [22,33-35], 2 from Australia [1,36], 2 from Italy [37,38], 1 from Canada [4] and 1 from Taiwan [14], which is the only Asian study (Tables 1 and 2). Study designs were mainly self-administered questionnaire filled by college/university students, and only half adopted random sampling to confirm representativeness. Three studies focused on secondary school students in Italy, Trinidad and Tabago, and Brazil [33,35,37]. Two studies utilized field survey and interview in nightlife scenes [11,36]. Only one study utilized telephone interview to survey community population [13].

■ Drinking population characteristics

Among college and secondary school students, several characteristics were associated with CAB

consumption: male, white, young adults, and impulsive personality or risk taking tendency [2,4,5,24,25,27,30,31,34]. It was found that there was a socioeconomic gradient in CAB consumption among Brazilian secondary school students, with the highest socioeconomic class drank most commonly, probably due to the availability of financial resources [35]. Community study in the United States found CAB drinkers were more likely to be younger (18-29 years old), single, unemployed and have moderate or higher household income than energy drinkers [13].

The Taiwanese study revealed a totally different picture that among working population, a significantly higher percentage of manual workers drank CAB than non-manual workers [14]. Construction workers are the most well-known population who drinks pre-mixed CAB in Taiwan [18]. Foreign workers, mostly from Southeast Asian countries, work with Taiwanese construction workers and they learn to drink CAB with domestic workers. Pre-mixed CAB was identified as a beverage for people with low socioeconomic status.

■ **Drinking behavior**

When The frequency of CAB use among university students was fewer than 5 days per month [25,26], but information on average drinking days per week was not available. Drinking time was assumed to be at night in studies from Australia and the United States [11,29,36,39]. In contrast, Taiwanese male manual workers drank CAB right before or at work [14]. They drink 2 to 5 times in a day, and most drinkers consume CAB every working day [18].

What Studies consistently showed that cola-mixed CAB was more popular than energy drink-mixed CAB [29,39], and premixed CAB were less popular than self-mixed CAB [10,25]. According to a survey to underage drinkers in the United States, the most common caffeinated beverage added to alcohol was soda, followed by energy drinks, tea, and coffee [10]. A small proportion of consumers use energy shots and caffeine pills [10]. Rum, Vodka, Whisky, Bourbon and Whisky were popular for mixing with Coke® [39]. In the case of alcohol mixed with energy drinks, common mixing recipe was 10 g of alcohol mixed with 125ml energy drink (40 mg caffeine). Commonly used alcohol included Vodka, Jagermeister, and Cointreau; while in Argentina champagne was the second

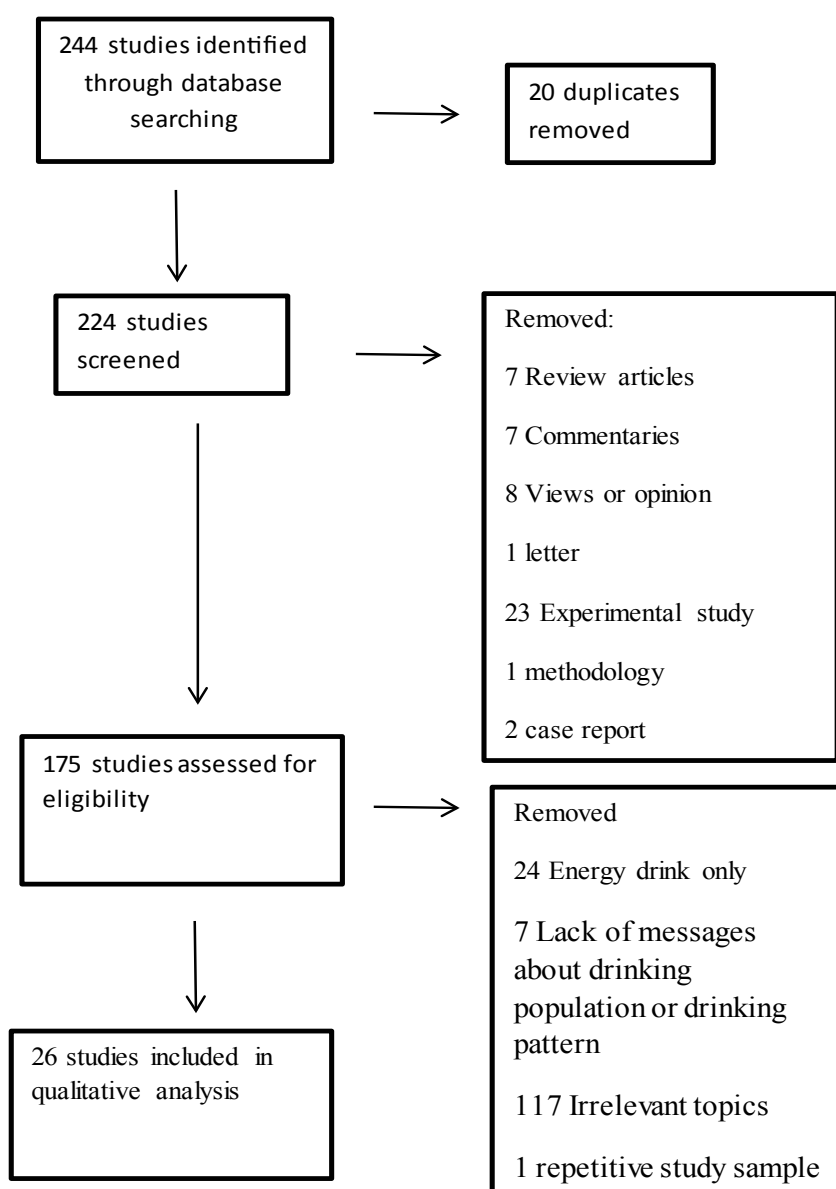


Figure 1. Flow diagram of number of records included at the identification, screening, eligibility and synthesis stages.

most popular. The most popular energy drink for mixing was Redbull® [5,39]. Commonly used pre-mixed CABs are Four Loco®, Torque®, Liquid Charge®, and Joose®(28, 32). Pre-mixed CAB in Taiwan is made by blending edible alcohol (10%), caffeine (50 mg/100 ml), herb tincture, vitamin B complex, taurine, and amino acids, and they were sold in dark glass bottles as herb tincture products. No manual workers consumed self-mixed CABs.

How Typically, university students in the United States consumed 2 to 5 drinks of alcohol (each drink mixed with 125ml energy drink)

Table 1: Characteristics of CAB drinking population in studies.

Authors/year	Study country	Study subjects	Study design	Characteristics of CAB drinkers
Flotta et al./2014 [43]	Italy	616 secondary school students	Self-administered questionnaire survey, random sampling	*male>female *binge drinker *smoker *marijuana user *risky behaviors
Babwah et al./2014 [39]	Trinidad and Tabago	561 secondary school students	Self-administered questionnaire survey, stratified random sampling	*male>female *play sport for school
Snipes et al./2014 [36]	The United States	798 university students in introductory psychology course	Self-administered questionnaire survey, no sampling procedure	*male>female
Wells et al./2013 [18]	The United States	1824 adults active in various nightlife scenes	Interviewed survey, time-space sampling	*male>female *younger adults
Amlung et al./2013 [30]	The United States	273 regularly drinking undergraduate students	Self-administered questionnaire survey, convenient sampling	*Impulsivity trait
Eckschmidt et al./2013 [40]	Brazil	12711 college students	Questionnaire survey	*male>female *single *high-risk drinking behaviors
Cheng et al./2012 [22]	Taiwan	22085 working people	Self-administered questionnaire survey, two-stage random sampling	*Most popular among physical workers rather than white collar workers
Locatelli et al./2012 [41]	Brazil	2613 high school students	Self-administered questionnaire survey, multiple stage random sampling	*male>female *CAB was most common in students from highest socioeconomic class decreased gradually with socioeconomic class.
MacKillop et al./2012 [31]	The United States	409 undergraduate, past 30-day drinkers	Self-administered questionnaire survey, convenient sampling	*male>female
Miller/2012 [33]	The United States	648 sexually active undergraduate students	Questionnaire survey, convenient sampling	*male>female
Velazquez/2012 [37]	The United States	2,971 university students	Web-based survey, random sampling	*male>female *white>non-white
Brache et al./2011 [6]	Canada	465 university students	Web-based survey, convenient sampling	*younger>older *undergraduate>graduate *lived on campus>off campus *high risk taking tendency
Marczinski et al./2011 [4]	The United States	706 college students, psychological department	Web-based survey, convenient sampling	*rare among Asian students
Berger et al./2011 [20]	The United States	946 household residents	Telephone survey, random sampling	*white *younger (18–29 years old) *unemployed *single (compared with energy drink users)
O'Brien et al./2008 [7]	The United States	4271 college students, past 30-day drinkers	Web-based survey, stratified random sampling	*male>female *white *intramural athletes *fraternity or sorority members or pledges *younger

per drinking episode [24,28]. CAB drinkers in universities used averagely 4 drinks per week, measured by modified Daily Drinking Questionnaire [32]. In Italy, only one-third of CAB users in college drink more than 3 CABs per month [38]. Patrons in the United States and Australia averagely used 2 to 12 CABs in one night, averagely 9 CABs [6,36]. Largest number consumed per episode among patrons was between 7 and 12, higher for cola-mixed CAB than energy

drink-mixed CAB [29,39]. In Taiwan, drinkers usually mix it with soft beverages or rice liquor by half. A bottle of CAB will give 8 cups of diluted CAB, often shared by 2 to 4 people in a drinking episode. In total, each person often consumes 2 to 8 drinks of alcohol a day [18].

Where It was found that people consume energy drinks in bars and recreational areas [21], and field studies have consistently chose nightlife

Table 2: Descriptions of CAB drinking behavior in selected studies.

Authors/year	Study country	Study subjects	Study design	Drinking behavior
Kponee et al./2014 [17]	The United States	1031 underage drinkers, > 1 drink of alcohol/30days	Web-based survey, random sampling	What: *self-mixed CAB involves alcohol and soda, energy drink, tea, coffee, energy shot, and caffeine pill *Self-mixing was more prevalent than pre-packaged CAB use
Flotta et al./2014 [43]	Italy	616 secondary school students	Self-administered questionnaire survey, random sampling	Why: *For celebrating or partying
Mallett et al./2014 [38]	The United States	195 university students, CAB users	Web-based survey, systemic randomized sampling	How: *3.93 drinks per week.
O'Brien MC et al./2013[34]	The United States	4907 college students from 8 universities, past 30-day drinkers	Web-based survey, stratified random sampling	How: *Typically 5.4 drinks in a single episode
Amlung et al./2013[30]	The United States	273 regularly drinking undergraduate students	Self-administered questionnaire survey, convenient sampling	When: *1-5 days per month How: *1.73 CAB beverages per episode
Pennay et al./2012[42]	Australia	25 hours of observation and interview to 10 CAB consumers	Observation and in-depth interview, purposive sampling	What: *10 g of alcohol mixed with 125 ml energy drink (40 mg caffeine) * " bombs " such as Jagerbombs (Jagermeister and energy drinks) and Skittlebombs (Cointreau and energy drinks), or vodka and energy drinks How: *typically 2 to 5 drinks in one night Where: *licensed venue environments, such as nightclubs, bars, and pubs as well as home Why: * wakefulness and energy; taste; counteracting the drowsy effects of alcohol; facilitating alcohol intoxication, and social bonding.
Cheng et al./2012[22]	Taiwan	22085 working people	Self-administered questionnaire survey, two-stage random sampling	When: * right before or at work
Jones et al./2012[3]	Australia	21 university students	Focus group, convenient sampling	Why: * keep drinking and socializing longer *easy to obtain *associated with being socially popular *sweetness *physical appearance of the cans
MacKillop et al./2012 [31]	The United States	409 undergraduate students, past 30-day drinkers	Self-administered questionnaire survey, convenient sampling	When: *1-5 days per month What: *self-mixing is more popular than premixed CAB Why: * expected effect was stimulation augmentation
Rosshiem et al./2011[35]	The United States	413 bar patrons	Secondary analysis of data from field studies, random sampling	What: cola-caffeinated alcoholic drinks were more popular than alcohol mixed with energy drinks. How: *largest number of CAB consumed per episode was 7 to 12
Thombs et al./2011[45]	The United States	328 bar patrons	Interviews and questionnaire survey in a college bar district, systemic random sampling	What: *cola-caffeinated CAB (Rum or Whisky+Coke) were more popular than energy drinks mixed CAB (Jägerbombs (Jägermeister+ Red Bull and Vodka+Redbull) How: *largest 10 CABs in the drinking occasion
Marczinski et al./2011 [4]	The United States	706 college students, psychological department	Web-based survey, convenient sampling	Why: * feel less tired *get drunk faster *drink more *common drink
Thombs et al./2010 [8]	The United States	1255 bar patrons	Interviews and questionnaire survey in a college bar district, mixed sampling procedure	How: *9 CAB in one night
O'Brien et al./2008 [7]	The United States	4271 college students	Web-based survey, stratified random sampling	Why: *hide the flavor of alcohol *drink more and not feel as drunk *availability
Ballistreri et al./2008 [27]	Argentina	211 4 th year college students in a physical education course	Self-administered questionnaire survey, non-probabilistic sampling	What: *Vodka is the most popular alcohol mixed with energy drinks, followed by champagne
Oteri et al./2007 [44]	Italy	450 college students	Self-administered questionnaire survey, convenient sampling	How: *32% CAB users ingest 1 CAB in the last month, 30% ingest 2-3 CAB and 38% users ingest more than 3 CAB in the last month
Malinauskas et al./2007 [32]	The United States	496 college students	Self-administered questionnaire, convenient sampling	When: * 1-4 days per month How, Why: *Using more than 3 energy drinks was a common practice to drink with alcohol while partying.

venues as their research field: bars, clubs, and lounges [11,38,39]. However, there has been few study exploring where do people drink CAB, and one study pointed out that drinkers use CAB in nightlife venues and home as well [36]. Taiwanese manual workers drink at the worksite, either at the entrance or grocery stores near their worksites or by roadside [18].

Why CAB was mainly used in situations like celebrating or partying in the United State and Italy [26,37], but in Taiwan it was used during work [14]. The most common reasons for CAB consumption included stimulation effect and alcohol intoxication facilitation [1,2,5,25,36]. Studies pointed out that the CABs were more expected to bring positive effects as intoxication enhancement, e.g. to stay alert, augment energy during alcohol intoxication and quicker intoxication, rather than to avoid negative consequences [25]. However, CABs were popular not only for the psychophysiological effects of caffeine and alcohol, but also the pleasurable social contexts and product designs. Consumption of CAB facilitated social interaction by virtue of attending the bar together in a group and were linked to positive social experiences with friends [1,36]. CABs were associated with being popular or cool among Australian university students [1]. Consuming CAB has been normalized and it was possible to purchase CAB in all licensed venues in Australia [36]. Drinkers use CAB partly for its high availability [1,5]. People looking for alcohol intoxication switched from other alcohol to CAB for better taste or hide the flavor of alcohol [1,5,36]. The physical appearance of CAB cans was attractive to young people [1].

Taiwanese manual workers drink pre-mixed CAB for energy boosting, socializing and health improving. The primary reason for drinking CAB is to enhance physical strength and boost energy, which is also the effect declared by CAB producers. Collective drinking is not seen as problem drinking in the worksite. Workers and workplace supervisors reported that a closer relationship is built in these drinking occasions. Another special characteristic of CAB is its herb content and they take it as herb tonic to improve health. The instructions on CAB bottles and advertisements: “3 times a day, each time 30 to 40 ml” is based on the identity of herb tonic. Drinkers believe that pre-mixed CAB is good to their health and liver if they drink moderately since it contains Chinese herb [18].

Discussion

This is the first study to compare CAB use behavior in Taiwan and users in Western countries. We found that the drinking population and their use pattern were very different. There are 2 important findings, first, CAB is popular among Taiwanese manual workers and they drink during work. Studies from America, Europe, and Australia mainly focused on college students and patrons appeared in college districts. The only community survey found that CAB use was also prevalent among individuals in mid-life (30 to 54 years old) as well [13]. In the United States and Brazil, People from higher socioeconomic class use more CAB [13,35], while working populations from the lower occupational level drink more CAB in Taiwan [14]. Further studies are needed to find out other CAB-prevalent populations and characteristics in Western societies rather than college students. Second, Both students and manual workers use CAB to socialize; but among the former CAB is used for recreational purpose while among the latter, CAB is used to boost energy during hard work. The consumption frequency and the cumulative amount of alcohol and caffeine ingested per day are several times higher in Taiwanese manual workers than in students in Western societies, but drinking amount per episode is lower.

One longitudinal study found that energy drink consumption is strongly associated with alcohol dependence [3], while it is unknown if CAB has a stronger association with alcohol dependence than other alcohol. Taiwanese manual workers consumed high cumulative amount of alcohol through daily consumption of CAB at work. The unintended consequence of alcohol dependence needs attention, especially when they think that they drink for energy boosting. College students in Western societies consume CAB in bars and they drink for alcohol intoxication facilitation, which suggested that they intended to drink alcohol in these CAB drinking episodes. However, Taiwanese manual workers drink CAB to boost energy and facilitate work, or socializing during breaks. It becomes a daily routine for manual workers rather than special drinking occasions. Furthermore, CAB is linked with positive experiences, such as thirst quenching and breaks after physically hard work, rewards from employers, and socializing with friends. It is more like the “banalized” drinking type or “wet society” type, in which drinking is woven into the fabric of daily life [19,40]. In this drinking

culture, the dominant alcoholic beverage is defined as a foodstuff or thirst quencher rather than an intoxicant [19]. Drinking is a part of everyday life and drinkers developed tolerance to alcohol, hence there is rare intoxication and drinking has a poor relationship with violence [40]. Within this culture, the most concerned health consequences of CAB among Taiwanese manual workers are chronic liver diseases and alcohol dependence. Although they drink other alcohol as well, CAB may play a role for introducing workers with vulnerable genotype and personality to the pathway of alcohol abuse. It has also been suggested that energy drinks may serve as a gateway to other substances dependence, but more evidence is warranted [41].

Limitation

The major limitation of this study was that we only included articles published in English. Unpublished data, government reports, and articles in other languages may have reported various drinking patterns in other drinking populations. Another limitation was that articles reviewed in this study had different definitions of CAB, and the estimated frequency and amount used different standards.

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Studies used modified questionnaires for alcohol, such as Daily Drinking Questionnaire [42], but caffeine dose was poorly estimated. Due to the various mixing recipe of CAB, a more sophisticated tool to estimate drinking behavior is needed.

Conclusion

In sum, Taiwanese manual workers use CAB in a totally different context to young adults in Western societies. They use a lower episodic amount but a higher cumulative amount in long term with very high frequency. Future research about health effects of CAB should take the drinking population and their drinking context into consideration.

Declaration of interests

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