Reported alcohol drinking and mental health problems in Hong Kong Chinese adolescents

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Abstract

Objective: To investigate the association between reported alcohol drinking and mental health problems in Hong Kong adolescents.

Methods: In a school-based questionnaire survey in 2012-13 on 4620 Secondary one (US Grade seven) to six students (mean age 14.5, SD 1.6 years; 53.4% boys), alcohol drinking was classified as never drinking (reference), experimental, former, less-than-weekly and weekly drinking. Binge drinking was defined as drinking at least five drinks on one occasion. Mental health was assessed using the Strengths and Difficulties Questionnaire (SDQ) with five subscales (emotional symptoms, conduct problems, hyperactivity, peer relationship problems and prosocial activity) and the total difficulties score (sum of the first four subscales). Multilevel regression was used to analyse the associations of mental health problems with drinking frequency and binge drinking, adjusting for potential confounders.

Results: Compared with never drinking, higher total difficulties scores were associated with less-than-weekly drinking (adjusted odds ratio AOR 1.39, 95% CI 1.01-1.91), weekly drinking (AOR 3.21, 95% CI 2.18-4.70), and binge drinking (AOR 2.18, 95% CI 1.42-3.32). Weekly drinking was most strongly associated with hyperactivity (AOR 6.27, 95% CI 1.42-3.32) among all subscales. Girls were more likely than boys to report emotional problems (AOR 3.36 vs 1.47) and hyperactivity (AOR 19.2 vs 2.31) related to weekly alcohol drinking (both P for interaction <0.05).

Conclusions: In Hong Kong adolescents, less-than-weekly, weekly, and binge

drinking are associated with higher risks of mental health problems based on self-reported data. Prospective studies are warranted to explore the causality between alcohol drinking and mental health problems.

Key words: Alcohol drinking, Adolescents, Mental health problems, Hong Kong

Word count: 249

Highlights (no more than 85 characters for each point)

- Reported alcohol drinking is associated with an abnormal total difficulties score.
- Reported drinking is more strongly associated with mental health problems in girls.

1. Introduction

Alcohol drinking is prevalent worldwide and more common than tobacco and illicit drugs use in adolescents (Johnston et al., 2015; American Academy of Pediatrics, 2001). Underage alcohol drinking is an important public health problem and may lead to severe health and social consequences, such as acute and chronic health problems, injuries and delinquency (Newcomb and McGee, 2002; Powell et al., 2007). Binge drinking, common among adolescent drinkers, is associated with attempted suicide, illicit drug use and car use with a driver who has been drinking (Miller et al., 2007).

Heavy and chronic alcohol drinking kills neurons, decreases neurogenesis, and causes cognitive and affective dysfunction, especially in adolescents, whose brains are undergoing rapid development (Guerri and Pascual, 2010). Laboratory evidence has also shown that decreased neurogenesis leads to depression-like behaviours in rats (Malberg et al., 2000; Santarelli et al., 2003).

Alcohol use disorder (dependence or abuse) and psychiatric disorders, such as depression, anxiety, and conduct disorders are known to co-occur in adults (Burns and Teesson, 2002; Kessler et al., 1997; Kessler et al., 2005). Alcohol abuse has also been linked to psychiatric disorders in American and European adolescents in both epidemiological and clinical studies (Armstrong and E Jane, 2002; Deykin et al., 1987; Fergusson et al., 1994; Rohde et al., 1996; Strandheim et al, 2009; Windle and Davies, 1999; Wittchen et al., 2007). However, only one study, involving a relatively large sample of around 9000 Norwegian adolescents has reported that alcohol intoxication is associated with depressive and anxiety symptoms in girls, and with conduct and attention problems in both sexes (Strandheim et al., 2009). While the co-occurrence of alcohol abuse and depression in adolescents has been consistently reported, the

observed associations between alcohol drinking and other psychiatric disorders vary. Alcohol abuse was associated with depression and behavioural disorders in American and Norwegian adolescents (Rohde et al., 1996; Strandheim et al., 2009), but not associated with behavioural disorders in another study of American college students aged 16-19 (Deykin et al., 1987). Sex differences in mental health have been well documented, with depression more common in girls and conduct disorders in boys (Parker and Roy, 2001; Scott, 1998). Depression is more strongly associated with alcohol disorder in girls than in boys (Deykin et al., 1987), and anxiety is reportedly associated with alcohol use disorder in girls only (Rohde et al., 1996; Strandheim et al., 2009). Similarly, poor concentration and externalizing problems are associated with heavy drinking in Finnish adolescent girls but not boys (Laukkanen et al., 2001; Strandheim et al., 2009). However, these results are subject to confounding, such as by smoking and socioeconomic status.

Although comorbidity of excessive alcohol drinking and mental disorders has been extensively reported, the association between more moderate drinking patterns and mental disorders is understudied. Therefore, we investigated the association between reported alcohol drinking and mental health problems in Hong Kong Chinese adolescents, whose drinking prevalence is much lower than that of their Western counterparts (weekly drinking 4.4% vs 8%-21%) (Bendtsen et al., 2014) and among whom adequate proportions of never, former, moderate and heavier drinkers are available for comparison. The analysis considered potential sex differences, with adjustment for potential confounders, including socioeconomic status, smoking, and illicit drug use.

2. Methods

2.1 Study design

This study is part of a large school-based questionnaire survey on reported adolescent alcohol drinking, conducted during November 2012 to April 2013. Detailed methods have been reported (Huang et al., 2015). Briefly, a total of 44 randomly selected secondary schools (25% response rate at school level) from all the five regions of Hong Kong (Hong Kong Island, Kowloon East, Kowloon West, New

Territory East, New Territory West) participated. All Secondary one (US grade seven) to six students in the selected schools were included. An invitation letter was sent to parents via the students to explain the purpose of the voluntary survey. Declining parents were to ask their children to return a blank questionnaire during the survey. Student participation remained voluntary even with parental consent. A self-administered, anonymous questionnaire was completed in classrooms. A teacher was present to maintain classroom order, but was instructed to avoid patrolling or observing the students' answers. Completed questionnaires were put in an opaque envelope immediately in front of the students to be collected by the research team. Ethics approval was obtained from the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster.
Test-retest reliability of alcohol-related variables was examined, generating intraclass correlation coefficients (ICC) that ranged from 0.46 to 0.97, indicating moderate-to-good test-retest reliability.

2.2 Subjects

The whole survey collected questionnaires from 23096 students (91.0% of 25381 invited; mean age 14.7 years, SD 1.8; 51.6% boys). As most schools preferred a shorter questionnaire due to time issues, several shorter versions of questionnaires containing different sets of items were used and 4620 students (85.9% of 5377; mean age 14.5 years, SD 1.8; 51.6% boys) provided valid data on the study variables after excluding those with: (i) missing sex or age data, or with over 50% of items omitted; (ii) conflicting information on the frequency of reported alcohol drinking (among the 3 items on drinking status, frequency of drinking and binge drinking); or (iii) age 18 years or above (the Strength and Difficulties Questionnaire is for children aged 4-17) (757 of 5377 students were excluded). Students retained in the analyses were similar to those in the original sample (n=5377) in sex (53.4% and 53.8% boys, respectively) and age (mean age 14.5, SD 1.6 vs 14.8, SD 1.8).

2.3 Measurements

Students were asked to "Describe your drinking status" with responses of "I have never drunk alcohol" (never drinkers), "I have only tried once or several times" (experimental drinkers), "I used to drink less than weekly, but have stopped drinking now" (former drinkers), "I used to drink every week, but have stopped drinking now" (former drinkers), "I drink presently" (regardless of frequency) (present drinkers).

According to another question “How often do you drink alcohol?” with responses ranging from “I do not drink” to “I drink every day”, present drinkers were divided into “less-than-weekly drinking” and “weekly or more frequent drinking” (referred to hereafter as weekly drinking). Therefore, drinking frequency was classified as “never drinking”, “experimental drinking”, “former drinking”, “less-than-weekly drinking”, and “weekly drinking”. Binge drinking was assessed by the question “How many days in the past 30 days have you drunk at least 5 drinks on one occasion?” with responses recoded as no (0 day) or yes (any number of days). To compare the differences in mental health between never drinkers and binge drinkers, a new binge drinking variable based on self-report was created with 3 categories of “never drinkers” “non-binge drinkers” and “binge drinkers”. All drinking variables were based on self-report.

Mental health was assessed using the Strengths and Difficulties Questionnaire (SDQ), which has good reliability and validity in Chinese and Caucasian adolescents (Goodman, 2001; Lai et al., 2010). SDQ has been used to screen for child and adolescent psychiatric disorders in European and Asian countries (Woerner et al., 2004), and treated as an outcome in epidemiological studies (Hamer, Stamatakis, & Mishra, 2009). The questionnaire has 25 items, each on a three-point scale (not true, somewhat true, and certainly true). Detailed scoring methods for each item can be found at the SDQ official website www.sdq.com.

The outcomes of the present study consisted of 5 subscales:(i) emotional symptoms (e.g. I worry a lot), (ii) conduct problems (e.g. Often fight with other children or bully them), (iii) hyperactivity (e.g. Easily distracted, concentration wanders),(iv) peer relationship problems (e.g. Generally liked by other children), and (v) prosocial behaviour (e.g. Shares readily with other children), and a total difficulties score, which is the sum of scores of the first four abovementioned subscales.

Each subscale of emotional symptoms, conduct disorders, hyperactivity/inattention, peer relationship problems and the total difficulties score were categorised into 4 groups, which were further dichotomised as “very high” versus “others” (“close to average”, “slightly raised” and “high”) (Black et al., 2010). Similarly, the prosocial activity scale was dichotomised as “very low” versus “others” (“close to average”,

"slightly lowered" and "low"). It should be noted that SDQ is a screening tool based on self-report rather than a diagnostic test.

Information on socio-demographic characteristics including sex, age, perceived family affluence, housing type, place of birth, and marital status of parents, and students' smoking status and illicit drug use was also collected. Socioeconomic status plays an important role in both reported alcohol drinking and mental health (Huang et al., 2015; Muntaner, Eaton, Miech, & O'Campo, 2004). Perceived family affluence and type of housing were used because they could effectively indicate socioeconomic status in Hong Kong and could be reported by adolescents.

2.4 Data Analysis

Exposure variables included frequency of reported alcohol drinking and binge drinking (yes vs no), and dependent variables included emotional symptoms, conduct problems, hyperactivity, peer relationship problems, total difficulties score, and prosocial behaviours. Given the cluster sampling of students, multilevel logistic regression with random intercept was used to adjust for correlation of students within the same school. Crude odds ratios (CORs) and adjusted odds ratios (AORs) for each of the six dependent variables in relation to drinking frequency or binge drinking, and corresponding 95% confidence interval (CI) were computed. The AORs were adjusted for potential confounders of socio-demographic characteristics, smoking status and illicit drug use. The likelihood ratio test was used to examine the interaction between sex and reported alcohol drinking.

3. Results

3.1 Demographics, reported alcohol drinking and mental health

Table 1 shows that 37.1% of the subjects reported experimental drinking, 10.2% reported less-than-weekly drinking, and 4.6% reported weekly drinking. An abnormal total difficulties score and very low prosocial behaviours were identified in 14.2% and 16.6% of the subjects, respectively.

Table 1 Background characteristics of adolescents

		N (%)
Sex	Boys	2466 (53.4)
	Girls	2154 (46.6)
Age	≤12	608 (13.2)
	13	804 (17.4)
	14	840 (18.2)
	15	899 (19.5)
	16	889 (19.2)
	17	580 (12.6)
Place of birth	Hong Kong	3399 (74.1)
	China Mainland	917 (20.0)
	Other places	272 (5.9)
Perceived family affluence	Low	1191 (26.3)
	Medium	2548 (56.3)
	High	788 (17.4)
Type of housing	Public rental housing	1588 (34.9)
	Subsidised private housing	567 (12.5)
	Private housing	1764 (38.7)
	Temporary/others/unknown	637 (14.0)
Marital status of parents	Married	3724 (82.0)
	Separated or divorced	580 (12.8)
	One or both parents deceased	236 (5.2)
Smoking status	Never smokers	4049 (87.9)
	Experimental smokers	304 (6.6)
	Former smokers	119 (2.6)
	Current smokers	133 (2.9)
Illicit drug use	No	4412 (97.5)
	Yes	112 (2.5)
Mental health		
	Abnormal total difficulties score	628 (14.2)

	Emotional symptoms	442 (9.8)
	Conduct problems	207 (4.6)
	Hyperactivity	64 (1.4)
	Peer relationship problems	882 (19.5)
	Very low prosocial behaviours	751 (16.6)
Reported alcohol drinking		
	Never drinking	2092(45.3)
	Experimental drinking	1712 (37.1)
	Former drinking	133 (2.9)
	Less-than-weekly drinking	471(10.2)
	Weekly drinking	210(4.6)
Binge drinking		
	Never drinking	2092 (45.4)
	Non-binge drinking	2178 (47.3)
	Binge drinking	336 (7.3)

3.2 Mental health problems and alcohol drinking in all students

Table 2 shows that in bivariate analysis emotional symptoms, conduct problems, hyperactivity, and abnormal total difficulties score were significantly associated with both less-than-weekly drinking and weekly drinking, while very low prosocial behaviours were significantly associated with weekly drinking. After adjusting for multiple potential confounders, reported alcohol drinking was still significantly associated with the abovementioned SDQ subscales in general. Less-than-weekly drinking (AOR 1.45, 95% CI 1.01-2.08) and weekly drinking (AOR 2.28, 95% CI 1.40-3.71) were significantly associated with emotional symptoms (P for trend=0.001). The corresponding figures for abnormal total difficulties score were 1.39 (1.01-1.91) and 3.21 (2.18-4.70) (P for trend<0.001). Weekly drinking was significantly associated with conduct problems (AOR 2.28, 95% CI 1.28-4.06) and hyperactivity (AOR 6.27, 95% CI 2.39-16.4). Binge drinking was significantly associated with conduct problems (AOR 2.60, 95% CI 1.57-4.31), hyperactivity (AOR 4.46, 95% CI 1.79-11.1), peer relationship problems (AOR 1.41, 95% CI 1.01-1.98) and abnormal

total difficulties score (AOR 1.98, 95% CI 1.37-2.85). Non-binge drinking was significantly associated with emotional symptoms (AOR 1.44, 95% CI 1.14-1.81), hyperactivity (AOR 2.35, 95% CI 1.23-4.51), and abnormal total difficulties score (AOR 1.33, 95% CI 1.09-1.62). Less-than-weekly drinking and weekly drinking were not associated with either peer relationship problems or very low prosocial behaviours. Former drinking was not associated with any of the 5 subscales.

Table 2 Association between reported alcohol drinking and SDQ subscales in adolescents

Outcomes/alcohol drinking	N (%)	Crude odds ratio (95% CI)	[#]Adjusted odds ratio (95% CI)
Emotional symptoms			
[a]Drinking frequency			
Never drinking	158 (7.7)	1	1
Experimental drinking	184 (11.0)	1.49 (1.19-1.86)**	1.36 (1.07-1.73)*
Former drinking	15 (11.6)	1.61 (0.92-2.84)	1.70 (0.93-3.10)
Less-than-weekly drinking	65 (12.3)	1.55 (1.11-2.16)**	1.45 (1.01-2.08)*
Weekly drinking	36 (15.5)	2.24 (1.47-3.41)***	2.28 (1.40-3.71)**
P for trend		<0.001	0.001
Binge drinking			
Never drinking	158 (7.7)	1	1
Non-binge drinking	247 (11.6)	1.57 (1.27-1.94)***	1.44 (1.14-1.81)**
Binge drinking	32 (10.9)	1.49 (1.01-2.21)*	1.35 (0.86-2.14)
Conduct problems			
Drinking frequency			
Never drinking	81 (3.9)	1	1
Experimental drinking	60 (3.6)	0.89 (0.63-1.26)	0.83 (0.57-1.19)
Former drinking	11 (8.6)	2.17 (1.12-4.21)*	1.56 (0.73-3.34)
Less-than-weekly drinking	29 (6.3)	1.59 (1.02-2.48)*	1.31 (0.79-2.16)
Weekly drinking	26 (12.8)	3.37 (2.09-5.44)***	2.28 (1.28-4.06)**
P for trend		<0.001	0.01
Binge drinking			
Never drinking	81 (3.9)	1	1
Non-binge drinking	81 (3.8)	0.95 (0.69-1.30)	0.86 (0.61-1.21)
Binge drinking	37 (12.4)	3.47 (2.32-5.18)***	2.60 (1.57-4.31)**
Hyperactivity/inattention			
Drinking frequency			
Never drinking	14 (0.7)	1	1
Experimental drinking	28 (1.7)	2.49 (1.31-4.75)**	2.31 (1.18-4.52)*
Former drinking	2 (1.6)	2.27 (0.51-10.1)	2.01 (0.43-9.43)
Less-than-weekly drinking	9 (1.9)	2.94 (1.26-6.87)*	2.45 (0.96-6.21)
Weekly drinking	11 (5.4)	8.55 (3.80-19.2)***	6.27 (2.39-16.4)***
P for trend		<0.001	0.001
Binge drinking			
Never drinking	14 (0.7)	1	1
Non-binge drinking	37 (1.7)	2.59 (1.39-4.81)**	2.35 (1.23-4.51)*
Binge drinking	13 (4.4)	6.15 (2.85-13.3)***	4.46 (1.79-11.1)**
Peer relationship problems			
Drinking frequency			
Never drinking	396 (19.3)	1	1

Experimental drinking	319 (19.0)	0.99 (0.84-1.17)	1.05 (0.88-1.25)
Former drinking	35 (26.9)	1.51 (1.00-2.28)*	1.33 (0.83-2.11)
Less-than-weekly drinking	74 (16.0)	0.75 (0.57-0.99)*	0.80 (0.59-1.09)
Weekly drinking	58 (28.6)	1.54 (1.10-2.14)*	1.40 (0.95-2.05)
P for trend		0.55	0.76
Binge drinking			
Never drinking	396 (19.3)	1	1
Non-binge drinking	397 (18.5)	0.95 (0.81-1.11)	1.00 (0.84-1.19)
Binge drinking	73 (24.7)	1.44 (1.09-1.90)*	1.41 (1.01-1.98)*
Abnormal total difficulties score			
Drinking frequency			
Never drinking	231 (11.5)	1	1
Experimental drinking	235 (14.3)	1.30 (1.06-1.58)*	1.25 (1.02-1.55)*
Former drinking	25 (20.0)	1.93 (1.21-3.08)**	1.51 (0.90-2.55)
Less-than-weekly drinking	72 (15.9)	1.41 (1.05-1.88)*	1.39 (1.01-1.91)*
Weekly drinking	65 (32.8)	3.70 (2.65-5.18)***	3.21 (2.18-4.70)***
P for trend		<0.001	<0.001
Binge drinking			
Never drinking	231 (11.5)	1	1
Non-binge drinking	320 (15.2)	1.38 (1.15-1.66)**	1.33 (1.09-1.62)**
Binge drinking	66 (23.2)	2.38 (1.76-3.23)***	1.98 (1.37-2.85)***
Low prosocial behavior			
Drinking frequency			
Never drinking	363 (17.7)	1	1
Experimental drinking	251 (15.0)	0.81(0.68-0.98)*	0.86(0.71-1.04)
Former drinking	26 (20.2)	1.12(0.72-1.76)	1.05(0.64-1.73)
Less-than-weekly drinking	67 (14.5)	0.74 (0.56-0.99)*	0.77 (0.56-1.06)
Weekly drinking	43 (21.3)	1.14 (0.80-1.64)	0.85 (0.56-1.31)
P for trend		0.36	0.13
Binge drinking			
Never drinking	363 (17.7)	1	1
Non-binge drinking	322 (15.1)	0.82 (0.69-0.96)*	0.84 (0.70-1.01)
Binge drinking	58 (19.5)	1.06 (0.78-1.44)	0.93 (0.65-1.35)

[#]Adjusting for age, perceived family affluence, place of birth, family structure, housing type, smoking, and illicit drug use.
[a]"Drinking frequency" and "binge drinking" were exposure variables in different models

3.3 Sex-stratified association between mental health problems and alcohol drinking

Stratified models in Table 3 show stronger association of reported alcohol drinking with emotional symptoms and hyperactivity in girls. Among girls, emotional symptoms were significantly associated with experimental drinking (AOR 1.48, 95% CI 1.09-2.01), less-than-weekly drinking (AOR 1.82, 95% CI 1.17-2.82) and weekly drinking (AOR 3.36, 95% CI 1.76-6.42). The corresponding figures for hyperactivity were AOR 5.28 (95% CI 1.73-16.1), AOR 7.65 (95% CI 1.99-29.5), and AOR 19.2 (95% CI 4.38-83.7). Binge drinking was also more strongly associated with hyperactivity in girls (AOR 19.0, 95% CI 5.17-69.8). The association of

conduct problems with less-than-weekly drinking and weekly drinking was significant only in girls, although the interaction did not reach significance (P=0.08).

Table 3. Association between reported alcohol drinking and mental health by sex

Outcomes/alcohol drinking	Sex ([#]Adjusted odds ratio (95% CI))		[b]P value from likelihood ratio tests
	Boys	Girls	
Emotional symptoms			
[a]Drinking frequency			0.037
Never drinking	1	1	
Experimental drinking	1.18 (0.79-1.75)	1.48 (1.09-2.01)*	
Former drinking	1.98 (0.83-4.73)	1.49 (0.65-3.41)	
Less-than-weekly drinking	0.92 (0.46-1.83)	1.82 (1.17-2.82)**	
Weekly drinking	1.47 (0.67-3.22)	3.36 (1.76-6.42)***	
P for trend	0.49	<0.001	
Binge drinking			0.55
Never drinking	1	1	
Non-binge drinking	1.22 (0.84-1.77)	1.60 (1.19-2.14)**	
Binge drinking	1.07 (0.49-2.34)	1.57 (0.88-2.79)	
Conduct problems			
Drinking frequency			0.08
Never drinking	1	1	
Experimental drinking	0.95 (0.60-1.51)	0.67 (0.37-1.21)	
Former drinking	1.62 (0.61-4.27)	1.20 (0.33-4.44)	
Less-than-weekly drinking	0.76 (0.35-1.66)	2.22 (1.11-4.47)*	
Weekly drinking	1.67 (0.77-3.63)	4.19 (1.70-10.30)**	
P for trend	0.55	0.001	
Binge drinking			0.99
Never drinking	1	1	
Non-binge drinking	0.87 (0.56-1.37)	0.82 (0.48-1.40)	
Binge drinking	2.13 (1.06-4.25)*	3.39 (1.61-7.12)**	
Hyperactivity/inattention			
Never drinking	1	1	0.002
Experimental drinking	1.17 (0.46-2.96)	5.28 (1.73-16.1)**	
Former drinking	1.03 (0.12-9.21)	5.47 (0.57-52.4)	
Less-than-weekly drinking	0.82 (0.16-4.07)	7.65 (1.99-29.5)**	
Weekly drinking	2.31 (0.56-9.50)	19.2 (4.38-83.7)***	
P for trend	0.81	<0.001	
Binge drinking			<0.001
Never drinking	1	1	
Non-binge drinking	1.30 (0.55-3.09)	5.03 (1.67-15.2)**	
Binge drinking	0.55 (0.09-3.26)	19.0 (5.17-69.8)***	
Peer relationship problems			
Never drinking	1	1	
Experimental drinking	1.07 (0.85-1.35)	0.99 (0.74-1.31)	0.85
Former drinking	1.26 (0.70-2.29)	1.40 (0.67-2.94)	
Less-than-weekly drinking	0.78 (0.52-1.17)	0.80 (0.50-1.29)	
Weekly drinking	1.44 (0.90-2.29)	1.26 (0.63-2.52)	
P for trend	0.64	0.73	
Binge drinking			0.83

Never drinking	1	1	
Non-binge drinking	1.01 (0.81-1.25)	0.96 (0.73-1.26)	
Binge drinking	1.53 (1.00-2.37)	1.18 (0.69-2.03)	
Abnormal total difficulties score			
Never drinking	1	1	
Experimental drinking	1.16 (0.87-1.53)	1.41 (1.02-1.95)*	0.44
Former drinking	1.53 (0.77-3.04)	1.60 (0.71-3.61)	
Less-than-weekly drinking	1.04 (0.65-1.65)	1.83 (1.16-2.88)**	
Weekly drinking	2.90 (1.77-4.73)***	4.35 (2.31-8.18)***	
P for trend	0.002	<0.001	
Binge drinking			0.48
Never drinking	1	1	
Non-binge drinking	1.19 (0.92-1.55)	1.53 (1.13-2.09)**	
Binge drinking	2.04 (1.25-3.33)**	2.05 (1.18-3.58)*	
Prosocial behaviour			
Never drinking	1	1	0.61
Experimental drinking	0.79 (0.63-1.00)*	1.01 (0.72-1.41)	
Former drinking	1.26 (0.71-2.25)	0.59 (0.20-1.80)	
Less-than-weekly drinking	0.75 (0.51-1.11)	0.82 (0.46-1.45)	
Weekly drinking	0.85 (0.52-1.40)	0.99 (0.43-2.28)	
P for trend	0.37	0.79	
Binge drinking			0.44
Never drinking	1	1	
Non-binge drinking	0.77 (0.62-0.96)*	1.01 (0.72-1.40)	
Binge drinking	1.18 (0.77-1.81)	0.56 (0.26-1.19)	

[#]Adjusting for sex, age, perceived family affluence, place of birth, family structure, housing type, smoking, and illicit drug use.
[a]"Drinking frequency" and "binge drinking" were exposure variables in two different models
[b]P value of less than 0.05 indicates that interactions between sex and drinking variables were significant.

4. Discussion

Over half of Hong Kong adolescents have reported ever drinking alcohol, although weekly drinking and binge drinking were still low compared with Caucasian adolescents (Eaton et al., 2012). The prevalence of mental health problems ranged from 1.4% (hyperactivity) to 19.5% (peer relationship problems). About 14% of adolescents were categorised as having an abnormal or very high total difficulties score. Direct comparisons with other studies are difficult due to differences in sample characteristics and cutoff values used, but our prevalence of 14% seems to be similar to that of 12.2% in Finnish adolescent girls (Sourander et al., 2012) but much higher than that of 4% in New Zealand adolescents aged 13-17 (Black et al., 2010).

Generally, less-than-weekly and weekly drinking were positively associated with abnormal SDQ total difficulties score after adjusting for socio-demographic

characteristics and behavioural variables. For the subscales of SDQ, weekly drinking was significantly associated with emotional symptoms, conduct problems and hyperactivity, and less-than-weekly drinking was significantly associated with emotional symptoms only. A positive association between reported alcohol use in the past 30 days and higher SDQ total difficulties score has also been reported in New Zealand adolescents aged 13-17 (Black et al., 2010). However, drinking frequency, binge drinking, SDQ subscale measures and potential behavioural confounders were not considered and the sample size was small (Black et al., 2010). Previous studies have linked psychiatric disorders to alcohol abuse/dependence, but not to light-to-moderate drinking (Berglund and Ojehagen, 1998). Our study suggests that even light-to-moderate drinking is associated with mental health problems in adolescents.

Our study found that although former drinkers had elevated risk of mental health problems compared with never drinkers, the risk was generally lower than that of weekly drinkers. Abstinence might contribute to reduced risk of mental health problems, but for those who continue to drink, less frequent drinking might also help as the likelihood of having an abnormal total difficulties score increased with the frequency of drinking (P for trend<0.001).

Alcohol drinking could indirectly affect mental health by decreasing the time one engages in age-appropriate activities, such as social gatherings and sports activities attended by adolescents (Hansell and White, 1991). Adolescents who drink alcohol are also more likely to be involved in interpersonal conflicts and violence (Miller et al., 2007; Nagoshi et al., 1991), which in turn may be associated with adolescents' bad mood. However, the association between alcohol use disorder and mental health problems could be bi-directional. It has been reported that the onset of psychiatric disorders preceded the onset of alcoholism (Deykin et al., 1987; Rohde et al., 1996), but another study also reported that depression followed alcoholism (Berglund and Ojehagen, 1998). Further prospective studies are warranted to ascertain the harmful effects of alcohol on adolescent mental health and the underlying mechanisms.

We found that experimental drinking, less-than-weekly drinking and weekly drinking

were significantly associated with emotional symptoms in girls only. This is consistent with the few studies that have examined sex-specific associations between reported alcohol drinking and mental health in adolescents. Deykin et al. has reported a stronger association between alcohol abuse and depression in adolescent girls than in boys aged 16-19 without adjustment for confounders (crude odds ratio 6 vs 3) (Deykin et al., 1987). It has also been reported that Norwegian girls aged 13-19 who have experienced alcohol intoxication were more than 10 times as likely to report anxiety and depression (Strandheim et al., 2009), and girls who drank heavily were more likely to experience anxiety (Laukkanen et al., 2001).

The sex difference in the association between reported alcohol drinking and hyperactivity was the largest, with significant associations observed only in girls. Laukkanen et al. has also found heavy drinking associated with concentration problems in girls and suggested that heavy drinking is a way to externalise developmental problems (Laukkanen et al., 2001). Attention deficit hyperactivity disorder has also been linked to emotional dysregulation (Shaw et al., 2014). It is possible that both reported alcohol drinking and subsequent emotional symptoms contribute to hyperactivity. Nevertheless, the large odds ratios and wide confidence interval for hyperactivity in girls in the present study may be due to its low event rate and insufficient sample size, which in logistic regression may produce biased results (Cepeda et al., 2003).

We found binge drinking significantly associated with conduct problems and abnormal total difficulties score in the total sample, and with hyperactivity in girls. It seems that adolescent binge drinking is more related to externalizing than internalizing problems. The association between binge drinking and conduct problems (e.g. I fight a lot) might be partly mediated by alcohol intoxication-related violence and fighting (Miller et al., 2007). In addition, such an association could also be confounded by the common characteristics of those who binge drink and those who have externalising behaviours, such as risk-taking and sensation seeking (Patrick & Schulenberg, 2014), which were not assesed in the present study. Binge drinking may be particularly harmful to the adolescent brain by causing more extensive neural damage (Tapert et al., 2004).

Our study has several limitations. First, the temporality between reported alcohol drinking and mental health problems could not be ascertained using cross-sectional data, and bidirectional associations such as those between anxiety and alcohol use disorders have been reported (Kushner et al., 2000). Second, SDQ and alcohol drinking data were self-reported by the students only. SDQ data were not supported by reports from parents and teachers, although self-reported alcohol drinking by adolescents has been described as reliable (Clark et al., 2006; Lintonen et al., 2004). Anonymity and other survey arrangements were also adopted to encourage candid reporting by students. Third, residual confounding could not be ruled out. The association between reported alcohol drinking and emotional/behavioural problems may reflect some common background characteristics in adolescents with both alcohol drinking behaviours and mental health problems (Jessor, 1987).

5. Conclusions

Both reported less-than-weekly and weekly drinking are associated with emotional symptoms, conduct problems and hyperactivity in Hong Kong adolescent girls. Reported weekly drinking is associated with abnormal total difficulties score in both sexes. The associations of reported alcohol drinking with some mental health problems are stronger in Hong Kong adolescent girls than boys. Reported binge drinking was more strongly associated with conduct problems and hyperactivity, than emotional symptoms and peer relationship problem. Our study suggests even non-binge current drinking is associated with increased mental health problems in adolescents, especially in girls. Prevention of underage drinking in Hong Kong and other regions with low adult drinking prevalence is an important public health challenge.

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