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Title page:

Alcohol drinking and sleep problems in Hong Kong adolescents

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Alcohol drinking and sleep problems in Hong Kong adolescents

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Objective: To investigate the relation between alcohol drinking and sleep problems among Hong Kong adolescents.

Methods: In the 2006/7 Hong Kong Student Obesity Surveillance (HKSOS) project, 33692 secondary students completed an anonymous questionnaire on lifestyles and health. Alcohol drinking was categorized as non-drinkers (reference group), <1 day/week (less-than-weekly drinking) and 1-7 days/week (weekly drinking, including some daily drinking). Students reported whether they had the following sleep problems in the past 30 days: difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS), early morning awakening (EMA), snoring, and difficulty breathing during sleep (DBS). Insomnia was defined as any reports of DIS, DMS or EMA. Logistic regression was used to assess the association between alcohol and each sleep problem. Multiple imputation was used to impute missing data.

Results: Compared with non-drinkers, less-than-weekly and weekly drinkers were more likely to report snoring with adjusted odds ratios of 1.64 (1.40-1.92) and 1.82 (1.55-2.14), respectively (P for trend <0.001). The corresponding figures were 1.24 (1.02-1.50) and 1.50 (1.24-1.82) for DBS (P for trend <0.001), and 1.12 (1.02-1.22) and 1.15 (1.04-1.27) for insomnia (P for trend=0.002). Weekly drinking was positively associated with DMS, but negatively associated with DIS and EMA. Less-than-weekly drinking was positively associated with DIS, DMS, and EMA.

Conclusions: Both less-than-weekly drinking and weekly drinking were associated with snoring, DBS, and insomnia. The association of individual symptoms of insomnia with drinking varied with the frequency of consumption.

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Introduction

Alcohol is the most common substance used in adolescents and its prevalence is increasing.[1-3] More than 40% of 12th grade students drank alcohol in the past 30 days in a national school survey in the US.[1] Adolescent alcohol drinking is linked to many negative consequences, such as intoxication, injuries and violence, and unexpected pregnancy.[2] In addition, as a psychoactive substance, alcohol results in sleep problems.

The association between alcohol drinking and sleep problems in adults have been reported both in experimental and epidemiological studies.[4-6] A bidirectional prospective relation between alcohol use and sleep problems has also been established.[6,7] Alcohol drinking, before bedtime or otherwise, worsen sleep-related breathing.[4,8-10] Likewise, sleep problems, primarily insomnia, predict onset of alcohol drinking and relapse in alcoholics.[6,11] However, studies on alcohol drinking and sleep problems in adolescents are few.

Sleep problems are common in adolescents, especially insomnia.[12,13] Several epidemiological studies have examined the association between sleep problems and substance use, including alcohol,[11,13-16] although the results were mixed. The effect of alcohol drinking in adolescents may be different from that in adults because of different drinking patterns in these two groups.[17] Poor sleep has been associated with impaired daytime performance, and poorer perceived physical and mental health.[18,19] Given the importance of quality sleep to adolescent health, we aimed to investigate the association between alcohol drinking and several sleep problems common in adolescents, including insomnia, snoring, and difficulty breathing during sleep.

Methods

Subjects

Data were from the Hong Kong Student Obesity Surveillance (HKSOS) 2006/7 project. The detailed methods of HKSOS have been reported elsewhere.[20] Briefly, forty-two schools were randomly selected with stratification by district, source of funding, language of instruction (Chinese/English), religious background (Christian/Others/None) and single sex/co-education to represent all mainstream non-international secondary schools in Hong Kong. An anonymous questionnaire on obesity and lifestyle was administered to 33692 students (44.9% boys; mean age 14.8±1.9) aged 11 to 18 in a class period. Invitation letters were sent to parents and only those who declined their child's participation were asked to return a signed reply form. Student participation was voluntary. Ethical approval was granted by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster.

Measures

Alcohol drinking

Alcohol drinking was assessed by the question "How often do you drink alcohol in a typical week?" with response options of "None", "Less-than-weekly", "1-2 days per week", "3-6 days per week", and "Daily". These categories were collapsed into non-drinking (reference), less-than-weekly drinking, and weekly drinking or above (referred to as weekly drinking hereafter for simplicity). Daily drinkers were merged into weekly drinkers because their numbers were small (2.6%).

Sleep problems

Students were asked whether they had the following sleep problems in the past 30 days: "difficulty initiating sleep (DIS)", "difficulty maintaining sleep (DMS)", "early morning awakening (EMA)", "difficulty breathing during sleep (DBS)", and "snoring". These items were used to assess sleep problems in adolescents in several epidemiological studies.[15,21,22] A simple yes or no response was required for each item. In epidemiological surveys, insomnia was usually defined as having any of DIS, DMS or EMA.[15,23] The one-month test-retest reliability study of sleep problems showed fair or modest agreement: insomnia (kappa=0.26), snoring (kappa=0.25), and difficulty breathing during sleep (kappa=0.48).[20] The validity of these self-reported sleep problems was indirectly supported by their statistically significant positive associations with health problems (headache, dizziness, and frequent fatigue) and average/poor perceived health (versus good/very good perceived health).[20]

Confounding factors

Information on sex, age, parental education, smoking, physical activity, height, weight, felling depressed, and feeling anxious was also collected. Highest parental education level (primary or

below/secondary/tertiary or above) was the highest education level attained by either parent. Smoking status was classified as never smoker, experimental smoker (tried just a few puffs), former smoker, and current smoker. Weekly frequency of physical activity (duration of at least 30 minutes) was categorized as none, less than once, 1-3 times, 4-6 times, daily, and twice per day or more. Weight status was defined based on International Obesity Task Force standards based using self-reported height and weight.[24] Feeling anxious and feeling depressed were measured by single items with yes/no responses. Previous data showed that delayed bedtime was associated with difficulty initiating sleep and alcohol use[21,23] and was a potential confounder, therefore, bedtime was also adjusted for in the association of alcohol use with difficulty initiating sleep and insomnia. The average bedtime reported at the weekend was about one hour later than on weekdays.[25] Therefore, bedtime at weekday was categorized into 11 pm or earlier and after 11 pm, while bedtime at the weekend was categorized into midnight or earlier and after midnight.

Statistical analysis

Logistic regression yielded crude odds ratios (COR) and adjusted odds ratios (AOR) of each sleep problem for weekly drinking and less-than-weekly drinking (cf. non-drinking) and corresponding 95% confidence interval (CI). In model 1, the AORs were adjusted for potential confounders of sex, age, highest parental education, smoking status, physical activity, weight status, feeling depressed, and feeling anxious. In model 2, bedtime was additionally adjusted for in regression analyses with difficulty initiating sleep and insomnia as outcomes. In addition, sex difference in the association between alcohol drinking and each sleep problem was also tested. A significant sex difference was found in the association of alcohol drinking with difficulty initiating sleep and difficulty maintaining sleep. Thus, sex-stratified analysis was conducted for these two outcomes. Missing values in the variables in the regression model were observed in 39% of the subjects: weight status (27%), alcohol drinking (14%), smoking status (13%), and others (9%). Multiple imputation was used to impute the missing data in the exposure and outcome variables.[26] Such non-response may result in less efficient estimation of the associations due to reduced sample size, and more importantly, the respondents may be different from non-respondents, therefore, bias may result if the analysis was restricted to subjects without any missing values in the regression analysis.[31] Multiple imputation is a reasonable way to deal with non-response in survey and is now increasingly used. The missing values were estimated 10 times (5-10 times is recommended) using "aregImpute" function in the "Hmisc" package in R using additive regression, bootstrapping, and predictive mean matching.[27] Multiple imputation takes into account the uncertainty in the missing values by approximately drawing repeated predicted values based on a full Bayesian predictive distribution, and thus this method is considered to be superior to single imputation, such as mean substitution and regression imputation.[28] Variables in the logistic regression models and additional auxiliary variables in the database were included in the imputation model. The function "aregImpute" in R, developed especially to deal with missing data in surveys, was used. We conducted separate logistic regression analysis for each imputed dataset, and then combined the estimates based on Rubin's rule.[31] All statistical analyses were conducted using STATA 10.0 (Stata Corporation, College Station, TX) and R. We also conducted complete-case analysis, which gave similar results. Therefore, all risk estimates presented were based on the imputed data.

Results

The subjects in the present study were representative of Hong Kong adolescents.[20] Table 1 shows that 13% of the subjects drank alcohol less-than-weekly and 14% drank weekly. Insomnia was reported by 31.6% of subjects: DIS (17.2%), DMS (12.2%), EMA (9.3%). Besides, 4.4% and 6.8% of adolescents reported DBS and snoring.

Table 2 shows that adolescents who drank less-than-weekly and weekly were more likely to report DBS and snoring. Table 3 shows that weekly drinking was positively associated with insomnia, while less-than-weekly drinking was negatively associated with it. For individual symptoms of insomnia, DMS was associated with alcohol drinking regardless of frequency. However, the associations of alcohol drinking with DIS and EMA depend on frequency. For instance, less-than-weekly drinking was associated with a higher odds of EMA, but weekly drinking a lower odds.

Table 3 shows that alcohol drinking was generally associated with higher odds of insomnia, DBS, and snoring after adjusting for multiple confounding factors. Less-than-weekly drinking (AOR 1.12, 95% CI 1.02-1.22) and weekly drinking (1.15, 1.04-1.27) were significantly associated with insomnia (P for trend=0.002). Similar patterns of increasing AORs were observed for DBS, with corresponding figures of 1.24 (1.02-1.50) and 1.50 (1.24-1.82) (P for trend <0.001). Snoring was also significantly associated with less-than-weekly drinking (1.64, 1.40-1.92) and weekly drinking (1.82, 1.55-2.14) (P for trend <0.001). For the associations between individual symptoms of insomnia and alcohol drinking, weekly drinking was positively associated with DMS in boys (1.72, 1.50-1.97) and in girls (1.23, 1.03-1.46), but negatively associated with EMA (0.67, 0.58-0.78) and DIS in girls (0.83, 0.71-0.97) but became non-significant after adjusting for bedtime at weekday and weekend; less-than-weekly drinking was significantly and positively associated with individual insomnia symptoms only in boys: DIS (1.18, 1.02-1.36), DMS (1.23, 1.04-1.44).

Discussion

Alcohol drinking seems more common than illicit drug use and smoking in our adolescents,[29,30] with approximately 27% reported having either less-than-weekly or weekly alcohol drinking, while the prevalence of sleep problems in this study varied from 4% for DBS to 32% for insomnia. Direct comparisons of the prevalence of sleep problems with other studies are difficult as different measuring methods were used. Nevertheless, the prevalence of insomnia in this study was similar to that reported in two epidemiological studies among Japanese adolescents using the same definition,[13,15] but smaller than that reported by Chung & Cheung in Hong Kong adolescents due to different measuring methods of DIS.[25]

Less-than-weekly and weekly drinking were positively associated with insomnia in a dose-response fashion, after adjusting for socio-demographic characteristics, other behavioural variables and bedtime. A positive association between insomnia and alcohol drinking has been reported but without considering the frequency of drinking.[15] To our knowledge, the present study is the first to demonstrate the association with dose-response relation. The mechanism underlying such association is uncertain. Alcohol first induces sleep through depressing brain activities, but then its stimulating effects set in to disturb normal sleep stages. Adolescence is a key transitional period for cognitive and physical development,[31] and more sleep is needed.[32]

Given the potential harms of alcohol on sleep, such as restless sleep and poor sleep quality, adolescents should avoid alcohol drinking. Nonetheless, further studies are needed to confirm the harms of alcohol drinking on sleep in adolescents.

In terms of individual symptoms of insomnia, in general, less-than-weekly drinking was positively associated with DIS and EMA, while weekly drinking was negatively associated with DIS and EMA. Sex difference was found in the association between alcohol drinking and difficulty initiating sleep (DIS) and difficulty maintaining sleep (DMS).

Less-than-weekly drinking was significantly positively associated with DIS only in boys (OR, 1.18, 95% CI, 1.02-1.36), and weekly drinking was significantly negatively associated with DIS only in girls (0.83, 0.71-0.97). However, these associations became marginally significant or non-significant after adjusting for bedtime. Mediation analysis showed that around 39% of the effect of alcohol drinking on DIS in girls was mediated by later bedtime at weekend. Adolescents who enjoyed night parties may go to bed late on that night, drink alcohol during the parties, and also will probably be more likely to have sleep problems due to erratic circadian rhythms. The sex difference in the association between alcohol drinking and DIS may be partly because girls tend to achieve higher blood alcohol concentration than boys with the same amount of ethanol due to a lower proportion of body water for the same weight.[33] It is possible that our male adolescents had developed tolerance of the initial sleep-induction effects of alcohol due to their higher frequency of alcohol drinking as observed in our data. Thus, the effect of sleep induction was more evident in girls who drank weekly compared with boys. Similar to the association between alcohol drinking and DIS, less-than-weekly drinking was positively associated with EMA, while weekly drinking was negatively associated with EMA. Although we lack information about the quantity and speed of alcohol consumed, which affect the extent to which alcohol slows down the activity of the brain, those who drank weekly were more likely to have depressed brain activity.

In contrast, both less-than-weekly and weekly drinking were positively associated with DMS. The association between less-than-weekly alcohol drinking and DMS was only significant in boys (1.23, 1.04-1.44), and the association between weekly drinking and DMS was significant in both sexes, although it was stronger in boys (1.72, 1.50-1.97) than girls (1.23, 1.03-1.46). The positive association between alcohol drinking and DMS may reflect alcohol's stimulant effect. Ethanol disturbs sleep stages, such as suppressing the rapid eye movement, which is a contributor of nightmare and recall of dreams.[7] Additionally, alcohol could influence physical function by suppressing pharyngeal dilator muscle activation and thus result in arousals and fragmented sleep.[34] Although the quantity of alcohol consumed among boys and girls is unavailable in the present study, previous studies showed a higher proportion of binge drinking and daily use of alcohol in boys.[35] Moreover, the metabolism of ethanol is faster in women than in men.[36] Therefore, the stimulant effect of alcohol is likely to last longer in boys than in girls.

No prospective study on the effects of alcohol drinking on sleep problems is available. In one of the few cross-sectional studies conducted, alcohol drinking in the past month was positively associated with DIS, DMS, EMA, and insomnia (often/always vs. never/seldom/sometimes) with odds ratios ranging from 1.34 (1.23-1.46) to 1.46 (1.31-1.63).[15] In another study, alcohol drinking in the past year was associated with trouble sleeping in the past 6 months, however,

such association became non-significant after adjusting for illicit drug use.[20] The present study has extended the investigation into various sleep problems and using different frequency of alcohol consumption.

Unlike the Japanese study that found alcohol drinking positively associated with all insomnia symptoms in adolescents, we found the associations differed by specific symptoms of insomnia and frequency of drinking. For example, weekly alcohol drinking was positively associated with DMS but inversely with EMA. It is generally believed that alcohol acts as a depressant of the brain in the first few hours after drinking, and then a stimulant. Also, alcohol can enter the brain, interfere with the system controlling the sleep-wake cycle and impair sleep quality. These mechanisms are particularly relevant if drinking occurs during night-time. Further studies should therefore collect more detailed information about the time and the amount of alcohol drinking.

Alcohol drinking was associated with DBS and snoring both in a dose-response manner, and the association was stronger for snoring than DBS. DBS and snoring could exist independently or as common symptoms of sleep-disordered breathing (SDB).[37] Our findings are consistent with those reported by Peppard et al. that habitual moderate alcohol drinking was positively associated with mild or worse SDB in men,[5] suggesting alcohol drinking is associated with breathing disorders during sleep whether or not it is consumed before bedtime. DBS and snoring may share the same mechanisms. Alcohol could suppress the pharyngeal muscle activation and abnormally relax the pharyngeal, resulting in DBS and snoring.[34,38] Our findings of the positive associations of alcohol drinking with SDB symptoms extend the effect of alcohol use on SDB in adults to adolescents. However, the association between alcohol drinking and snoring has been controversial. Shin et al. reported that alcohol intake (defined as ≥3 days per month) was not associated with habitual snoring which was defined as snoring ≥3 nights per week in high school students.[28]

Nevertheless, SDB and snoring were important risk factors for neurocognitive and cardiovascular diseases, as well as impaired daytime performance, social and emotional functioning,[9] the associations between alcohol drinking and sleep problems further suggested the harms of alcohol. Our findings could be used to dissuade alcohol drinking among adolescents as sleep problems are much more relevant to them than alcohol-related chronic illness in later life. Parents should also be targeted as they are the most common source of alcohol in adolescents; many parents are ambivalent about providing alcohol to their child.[39,40] The alcohol drinking prevalence is relatively low in Hong Kong compared with many Western cities in the UK and US,[41-43] nonetheless, many parents are permissive about infrequent or small quantities of alcohol drinking by adolescents, and one quarter of parents find the introduction of alcohol to adolescents at home a good idea.[44]

Our study has several limitations. First, sleep problems were based on adolescents' self-reports, although subjective reports of sleep problems were commonly used in epidemiological studies.[13,14,16,18] Self-reported SDB symptoms allowed general estimation of the prevalence of sleep problems even without polysomnographic tests which seem to be impractical for large-

scale epidemiological studies.[18,20] Snoring was likely to be under-reported because it was difficult for adolescents to be aware of it. Therefore, the association between snoring and alcohol drinking might have been underestimated. Second, information on the time and quantity of alcohol drinking was lacking, which limited our ability to understanding the mechanism of how alcohol affects sleep. However, as most of Hong Kong youths (mean age 18.9 ±1.1 years) were not binge or regular drinkers, and nearly 90% were occasional drinkers (defined as <= 1-3 days/month),[45] adolescents were unlikely to consume large quantities of alcohol regularly. Therefore, sleep problems were likely to be associated with small quantities of alcohol drinking. Third, residual confounding could not be ruled out. A number of factors, such as disruption in circadian rhythm and puberty status, were not measured in the present study. One review concluded that disturbance in circadian rhythms relates to both substance use and sleep pattern, and thus could play a role in the substance-sleep interaction.[46] Additionally, studies also show that puberty status may also confound the association between sleep problems and alcohol use, as adolescents with advanced puberty status are more likely to have both sleep problems and alcohol use.[16] Finally, causal effects cannot be ascertained due to the cross-sectional design. Bi-directional relation between alcohol drinking and sleep problems was reported in alcoholics.[7] We can not rule out the possibility that sleep problems lead to alcohol drinking in adolescents. A recent longitudinal study has shown that sleep pattern and sleep duration predict alcohol use.[47] And sleep pattern is known to be a key determinant of sleep hygiene, which is closely correlated with sleep problems. Besides, it is possible that adolescents who had trouble sleeping may self-medicate to use alcohol to aid sleep. In addition to the biological pathway from alcohol drinking to sleep problems, alcohol drinkers may be those who attended night parties more often, and thus they were more likely to have larger discrepancy between weekday bedtime and weekend bedtime, which resulted in sleep disturbance.[25] Future prospective studies should be able to clarify this issue.

Conclusions

Adolescent alcohol drinking in a low prevalence but lightly westernized Chinese city was related to a number of sleep problems, such as insomnia, snoring and difficulty breathing during sleep. Sex difference was found in the association of alcohol drinking with difficulty initiating sleep and difficulty maintaining sleep. Generally, compared with non-drinkers, both less-than-weekly and weekly drinkers were more likely to experience DMS in a dose-response manner, while less-than-weekly drinkers were more likely to experience DIS and EMA, but weekly drinkers were less likely to experience two sleep problems. Additionally, alcohol drinking was positively associated with insomnia, snoring and DBS. Parents should also pay attention to the quality of sleep in adolescent drinkers and be aware of the potential harms of alcohol drinking on sleep.

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Table 1. Basic characteristics, lifestyle, and sleep problems of subjects

	[a]N (%)
Sex	
Boy	14981 (44.9)
Girl	18409 (55.1)
Age (years)	
11	871 (2.6)
12	5309 (15.8)
13	5989 (17.8)
14	5929 (17.6)
15	5535 (16.4)
16	4912 (14.6)
17	3058 (9.1)
18	2089 (6.2)
Highest parental education	
Primary or below	4234 (12.7)
Secondary	20556 (61.5)
College or above	4293 (12.8)
Don't know	4335 (13.0)
Weight status based on IOTF standards	
Underweight	2146 (8.6)
Normal weight	19436 (78.2)
Obesity	3277 (13.2)
Drinking	
Non-drinker	21066 (72.7)
Less-than-weekly drinker	3822 (13.2)
Weekly drinker	4073 (14.1)
Smoking	
Never smoker	22681 (77.4)
Experimental smoker	3302 (11.3)
Former smoker	1618 (5.5)
Current smoker	1690 (5.8)
Physical activity (≥30 min)	
None	7107 (22.7)
Less than once a week	8460 (27.1)
1-3 times a week	9753 (31.2)
4-6 times a week	2671 (8.5)
Daily	2032 (6.5)
2+ times/day	1241 (4.0)
Sleep problem	
Difficulty initiating sleep	5691 (17.2)
Difficulty maintaining sleep	4026 (12.2)
Early morning awakening	3073 (9.3)
Insomnia	10440 (31.6)
Difficulty breathing during sleep	1462 (4.4)
Snoring	2241 (6.8)
Feeling anxious	2014 (6.0)
Feeling depressed	1193 (3.6)

[a]The number of subjects differed slightly across different outcomes

Table 2 Crude and adjusted odds ratios for sleep problems by alcohol drinking status

Drinking	Difficulty initiating sleep				Difficulty maintaining sleep				Early morning awakening	
	Boy		Girl		Boy		Girl		Overall	
	COR (95%CI)	AOR (95%CI)	COR (95%CI)	AOR (95%CI)	COR (95%CI)	AOR (95%CI)	COR (95%CI)	AOR (95%CI)	COR (95%CI)	AOR (95%CI)
Non-drinking	1	1	1	1	1	1	1	1	1	1
<weekly drinking										
[a]Model 1	1.11 (0.96-1.27)	1.18* (1.02-1.36)	1.08 (0.97-1.21)	1.03 (0.91, 1.16)	1.32** (1.12-1.54)	1.23** (1.04, 1.44)	1.27** (1.12-1.44)	1.11 (0.98, 1.27)	1.22* (1.10-1.36)	1.11 (0.99, 1.25)
[b]Model 2		1.19* (1.00, 1.40)		0.97 (0.86, 1.11)						
Weekly drinking										
Model 1	0.76** (0.67-0.86)	0.96 (0.83-1.11)	0.75** (0.65-0.86)	0.83* (0.71, 0.97)	1.78** (1.57-2.02)	1.72** (1.50, 1.97)	1.25* (1.08-1.45)	1.23* (1.03, 1.46)	0.65** (0.57-0.74)	0.67** (0.58, 0.78)
Model 2		0.91 (0.76, 1.10)		0.87 (0.72, 1.04)						
P for linear trend		NA		NA		<0.001		0.007	NA	NA

* p<0.05, ** p<0.01

[a] Model 1: adjusted for sex, age, parent education, weight status, physical activity, smoking, internalizing symptoms. Model 2: additionally adjusted for the bedtime weekday and bedtime weekend. COR=crude odds ratio, AOR=adjusted odds ratio.

Table 3. Crude and adjusted odds ratios for sleep problems by alcohol drinking status

Alcohol drinking	Insomnia		Difficulty breathing during sleep		Snoring	
	COR (95% CI)	AOR (95%)CI	COR (95% CI)	AOR (95%)CI	COR (95% CI)	AOR (95%)CI
Non-drinker	1	1	1	1	1	1
<Weekly drinker (Model1)	1.17**(1.09-1.26)	1.13** (1.04, 1.23)	1.84**(1.59-2.13)	1.24* (1.02, 1.50)	2.15**(1.90-2.42)	1.64** (1.40, 1.92)
Model 2		1.12* (1.02, 1.22)				
Weekly drinker (Model1)	1.03 (0.96-1.10)	1.14* (1.03, 1.26)	2.48**(2.18-2.83)	1.50** (1.24, 1.82)	3.40**(3.06-3.77)	1.82**(1.55, 2.14)
Model 2		1.15** (1.04, 1.27)				
P for linear trend (Model 1)		0.002		<0.001		<0.001
Model 2		0.002				

* p<0.05, ** p<0.01

[a] Model 1: adjusted for sex, age, parent education, weight status, physical activity, smoking, internalizing symptoms. Model 2: additionally adjusted for the bedtime weekday and bedtime weekend. COR=crude odds ratio, AOR=adjusted odds ratio.