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尾崎米厚	アルコール問題の疫学~労働者を中心に~	樋口進、廣尚典	職場×依存症・アディクション	南山堂	東京	2019	47-55

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尾崎米厚	アルコール依存症患者の大多数は治療につながっていないって本当ですか?	Modern Physician	38(8)	822-825	2018
尾崎米厚	アルコール健康障害の現状と疫学の最新知見	臨床栄養	1336)	777-782	2018
Morioka H, Jike M, Kanda H, Osaki Y, Nakagome S, Otsuka Y, Kaneita Y, Itani O, Higuchi S, Ohida T	The association between sleep disturbance and second-hand smoke exposure: a large-scale, nationwide, cross-sectional study of adolescents in Japan.	Sleep Med	50	29-35	2018
Kinjo A, Kuwabara Y, Minobe R, Maezato H, Kimura M, Higuchi S, Matsumoto H, Yuzuriha T, Horie Y, Kanda H, Yoshimoto H, Osaki Y	Different socioeconomic backgrounds between hazardous drinking and heavy episodic drinking: Prevalence by sociodemographic factors in a Japanese general sample.	Drug Alcohol Depend	193	55-62	2018

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Different socioeconomic backgrounds between hazardous drinking and heavy episodic drinking: Prevalence by sociodemographic factors in a Japanese general sample

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ABSTRACT

Background: Hazardous drinking (HD) and heavy episodic drinking (HED) constitute different types of alcohol-related harm. The socioeconomic status (SES) background of various alcohol consumption behaviors is not clear. The purpose of this study was to clarify existing SES differences between HD and HED.
Methods: The 2013 national survey regarding alcohol use among Japanese adults was utilized. The results from 1193 men and 1503 women aged 20–64 years were included in the analysis. Education attainment, household income, marital status, working status, and occupation were adopted as SES determinants. Binomial logistic regression analysis was conducted to estimate the odds ratios (ORs) of HD and HED for each SES group.
Results: ORs (95% confidence intervals) of HD were higher among persons with less education among both men [1.61 (1.18–2.20)] and women [1.78 (1.19–2.67)]. The OR of HED in men was significantly higher among those who belonged to high household income, were married, and managers or professionals. The OR of HED among women was higher in persons who were employed, as compared with those who engaged in housework. There were no correlations between HED and educational background.
Conclusions: This study showed that in Japan, a lower educational background for both men and women was associated with a higher risk for HD, while higher current SES for men and working women were associated with a higher risk for HED. It is necessary to recognize the SES differences between HD and HED to achieve a policy to reduce alcohol-related harm.

1. Introduction

According to the World Health Organization (WHO) Global Status Report on Alcohol and Health in 2014, harmful alcohol use is a prominent cause of disease and injury (World Health Organization, 2014). The estimate of the 2016 Global Burden of Disease (GBD) showed that alcohol consumption accounted for 4.2% of all disability-adjusted life years (DALYs) in risk behavior and ranked the seventh (GBD 2016 Risk Factors Collaborators, 2017). An increase in alcohol-related GBD was observed between 1990 and 2016. Thus, effective measures to counter harmful alcohol use need to be identified.

Not only the quantity of alcohol consumption but also drinking patterns and alcohol type are associated with alcohol-related harm (ARH) (Rehm et al., 2010). The quantity of alcohol consumed has a dose-response relationship for many diseases, with the habitual use of large quantities increasing the risk for several diseases (Rehm et al.,

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2017). In the same report, it was shown that heavy episodic drinking (HED, consuming > 60 g per day) not only diminishes the effect of morbidity reduction for ischemic heart disease and diabetes mellitus conferred by light-to-moderate drinking but also increases mortality regardless of whether total alcohol consumption is minimal. Additionally, it was reported that the J-curve disappears with HED (Plunk et al., 2014).

Age, gender and familial factors affect alcohol consumption and ARH (World Health Organization, 2014). Socioeconomic status (SES) is one risk factor for mortality (Stringhini et al., 2017) and risk behavior (Mackenbach et al., 1997; Stringhini et al., 2010). The rates of risk behaviors such as smoking, unhealthy diet, and lack of exercise are high among those with lower SES (Ross and Wu, 1995; Kamphuis et al., 2006). Regarding alcohol consumption, the abstinence rate is high among people with lower SES, with the rate of drinking within the last 12-months being high among people with higher SES in higher-income countries (Bloomfield et al., 2006). However, the relationships between harmful alcohol use and risk behaviors vary according to country, indices of drinking behavior (alcohol consumption lifetime, alcohol consumption within the past 12-months, hazardous drinking (HD)) and SES indices (Collins, 2016; Bloomfield et al., 2006; Helasoja et al., 2007). Moreover, few studies have used household income as an SES index to investigate alcohol drinking behavior.

In Japan, there has been no report on the relationship between HED and SES index. In addition, there have been few investigations regarding Japanese women and alcohol consumption. It is important to determine the relationship between SES and harmful drinking patterns in this population to reduce ARH (World Health Organization, 2014). The aim of this study was to determine the existing socioeconomic differences associated with harmful alcohol drinking behaviors.

2. Material and methods

2.1. Design

In this cross-sectional study, the subjects were randomly selected adults from all regions in the country. The respondents were paid for the visits to their homes, where interviews were conducted by trained investigators.

2.2. Subjects

The subjects were selected using a stratified two-stage random sampling approach. The strata were determined by first dividing the survey districts into 11 areas (Hokkaido, Tohoku, Kanto, Hokuriku, Tosan [Yamanashi, Nagano, and Gifu], Tokai, Kinki, Chugoku, Shikoku, Northern Kyushu, and Southern Kyushu), and then into five groups classified by municipality size (large cities, n = 14; cities with populations ≥300,000, ≥100,000, < 100,000, and smaller towns and villages). The survey districts were selected from each stratum in proportion to the population ≥20 years of age. The survey conducted in 2003 gathered data from a total of 3500 subjects; in 2008 from 7500 subjects; and in 2013 from 7052 subjects. This study used the survey dataset in 2013, since it included both questions regarding HED and household income. Since the retirement age is around 65 years in Japan, this analysis included participants younger than 65 years.

2.3. Survey procedures and response rates

The 2013 survey was conducted in July. A survey request document was sent to the municipal office after the surveying district was selected at random. Subjects were randomly selected from the resident register at the municipal office by the investigator. The subjects were asked whether or not they would participate in the survey, and, if consent was obtained, the investigator visited their residence and conducted the interview. The number of participants and response rate were 4153 and 59%, respectively.

2.4. Indicators of alcohol drinking behavior and alcoholism

"Ab12M" was defined as an individual who had not consumed alcohol in the preceding 12 months. A "DRINKER" was defined as one who had consumed alcohol within the preceding 12 months. These indicators were adopted in the Global Information System on Alcohol and Health, which is provided by the WHO (World Health Organization, 2014). HD was defined as the consumption of ≥210 g (men) or ≥140 g (women) of alcohol in a 1-week time period (Piccinelli et al., 1997). HED (sometimes called "opportunistic heavy drinking" or "binge drinking") was defined as drinking ≥60 g of alcohol on a single occasion within the preceding 30 days (World Health Organization, 2014). In the present study, subjects belonging to DRINKER who had only HED but not HD were classified as "HEDONLY". Regarding HD, subjects belonging to DRINKER who had HD with or without HED were classified as "HDALL". Subjects belonging to DRINKER who had both heavy episodic drinking and hazardous drinking were classified as "HED + HD". Subjects in DRINKER who neither belonged to HED nor HD were classified as "DNHH".

Prior to the survey, we asked all participants about their alcohol consumption frequency. Then, interviewers asked those who had consumed alcohol within the past year the typical quantity of alcohol consumption by one item for every type of the following liquors: (1) beer, low-malt beer (happoushu), (2) Japanese sake, (3) distilled liquor (shochu), (4) shochu mixed with soda water (chuhai), (5) cocktail, (6) wine, (7) whiskey, (8) and others (e.g., plum liquor). Subsequently, we calculated the number of drinks for each type of liquor and calculated the total alcohol consumption for a given occasion. The weekly quantity was calculated as the total alcohol consumption for a given occasion multiplied by the weekly alcohol consumption frequency. Alcohol consumption less frequently than once per month was defined as alcohol consumption frequency 0 in a given week. We defined HD based on this weekly quantity.

We defined HED as individuals who answered yes to the following question: "Within 30 days, did you drink alcohol equivalent to 60 g or more of pure alcohol?"

2.5. Socioeconomic, parental and demographic indicators

Ages were classified in groups of 20–29 years old, 30–39 years old, 40–49 years old, 50–59 years old, and 60–64 years old. The areas of residence were classified into two categories by population size: cities where the population was ≥100,000 people and cities where the population was < 100,000 people (or municipalities). Parental drinking patterns were classified into three categories: neither drank alcohol (NDA), either the father or mother drank a moderate quantity of alcohol (PDA), and at least father or mother was a heavy drinker or alcohol dependent (HDA). Educational attainment, household income, marital status, working status, and occupation type were used as SES indices. Educational attainment was classified into two categories: ≤12 years of education (graduation from junior or senior high school level), and ≥13 years of education (technical school, university, graduate school level). Household income was classified into three categories: < 4,000,000 yen per year, 4,000,000–8,000,000 yen per year, and ≥8,000,000 yen per year (100 yen = 1.01 dollars as at 1 st July 2013). The median and average household incomes in 2013 for Japanese individuals were approximately 4,320,000 yen and 5,372,000 yen, respectively (Ministry of Health, Labour and Welfare, 2013https://www.mhlw.go.jp/toukei/saikin/hw/k-tyosa/k-tyosa13/dl/03.pdf). Marital status was classified into three categories: married or living with a partner, bereaved or divorced, and unmarried. Working status was classified according to six categories: regular employee, self-employed, non-regular employee, student, housework, and unemployed. There was no housework status classification for men. Occupation class for

males was classified into eight categories: industrial labor, clerk, professional, manager, sales work, service work, transport/security work, and agriculture and forestry marine worker. Occupation class for women was classified into nine categories: industrial labor, clerk, profession, manager, sales work, service work, transport/security work, agriculture and forestry marine work, and housework. We included housework in the analysis of women because the number of females who engaged in housework was not thought to be small (Statistics Bureau, Ministry of Internal Affairs and Communications, 2013. http://www.stat.go.jp/data/roudou/report/2013/index.html). When we analyzed occupation class, we excluded individuals who did not work, such as students and the unemployed.

2.6. Statistical analysis

We performed an analysis of gender-specific drinking behavior from reported differences in alcohol consumption behaviors between men and women (World Health Organization, 2014). The data were weighted based on the population of Japan on October 1, 2013, to estimate prevalence. Individuals who did not respond to the household income question were included in the analysis as non-respondents for the crude rate calculation.

Binomial logistic regression was used to estimate odds ratios (ORs) and the associated 95% confidence intervals (CIs) that quantified the associations between alcohol behaviors and SES categories. When we calculated OR, age, residential area and parental drinking pattern were included as model covariates in order to adjust them as confounding factors. Before conducting a binomial logistic regression analysis, we examined each variable with Spearman's rank correlation analysis. SES categories were not included in a model at the same time due to collinearity. In the comparison of drinkers and abstainers, "DRINKER" was the predicted category (1) of the dependent variable and "Ab12M" was the reference category (0) in binomial logistic regression modeling. "DNHH" was used as the reference category (0) of the dependent variables with regard to the estimations of OR for "HEDONLY" or "HDALL" or "HED + HD". The goodness of model fit was checked using the Hosmer-Lemeshow test. For p values lower than 0.05 in the Hosmer-Lemeshow test, only age (10-year stratum) and residential area were used as covariates for binomial logistic regression analysis. When we calculated ORs with regard to gender difference for "DRINKER", "HEDONLY", "HDALL" and "HED + HD", both genders were included in the binomial logistic regression models with age, residential area, and parental drinking pattern.

Those who did not respond to the household income question were excluded at the time of calculation for the binomial logistic regression modeling of household income. Statistical analyses were performed using SPSS statistics software, version 22.0 for Windows (IBM Corp., Armonk, NY, USA).

2.7. Ethical considerations

The study protocol was approved by the ethics committee at the Kurihama Medical and Addiction Center. Consent was obtained from subjects during the investigator's visit, after providing them with an explanation of the purpose of the investigation, its content, and how personal information would be protected. Since the survey data excluded personal information, researchers could not know the personal information of the respondents.

3. Results

Table 1 shows the social economic background and drinking patterns of the study participants. This study included 1193 men, with an average age of 46.4 years, as well as 1503 women, with an average age of 46.1 years. Those with lower and higher educational attainment were nearly equally split between men and women. The number of non-respondents for the household income question was 80 (6.7%) for men and 147 (9.8%) for women. The rate for each household income group was almost 30% for all groups.

Table 1
Basic characteristics of the study participants (< 65 years old).

	Men	Women
Number of participants (n)	1193	1503
Mean age (range, yrs)	46.4 (20–64)	46.1 (20–64)
20–29 yrs (n)	144 (12.1%)	181 (12.0%)
30–39 yrs (n)	213 (17.9%)	290 (19.3%)
40–49 yrs (n)	295 (24.7%)	370 (24.6%)
50–59 yrs (n)	323 (27.1%)	390 (25.9%)
60–64 yrs (n)	218 (18.3%)	272 (18.1%)
Residential area (n)		
Metropolis, ≥100,000 people	769 (64.5%)	984 (65.5%)
Town or village, < 100,000 people	424 (35.5%)	519 (34.5%)
Parental drinking pattern		
NDA	171 (14.3%)	231 (15.4%)
PDA	846 (70.9%)	1062 (70.7%)
HDA	171 (14.3%)	201 (13.4%)
No response	5 (0.4%)	9 (0.6%)
Educational attainment		
≤12 years	532 (44.8%)	700 (46.8%)
≥13 years	656 (55.2%)	797 (53.2%)
Annual household income (n)		
< 4,000,000 yen	38 2(32%)	505 (33.6%)
4,000,000– 8,000,000 yen	470 (39.4%)	536 (35.7%)
≥8,000,000 yen	261 (21.9%)	315 (21%)
Non-respondent	80 (6.7%)	147 (9.8%)
Marital status (n)		
Married	857 (72.2%)	1140 (75.9%)
Bereaved or divorce	58 (4.9%)	132 (8.8%)
Unmarried	272 (22.9%)	230 (15.3%)
Working status		
Employee (regular)	757 (63.7%)	384 (25.6%)
Self-employment	177 (14.9%)	97 (6.5%)
Employee (non-regular)	115 (9.7%)	513 (34.2%)
Student	31 (2.6%)	15 (1%)
housework	0	422 (28.1%)
Unemployment	106 (8.9%)	68 (4.5%)
Others	3 (0.3%)	3 (0.2%)
Occupation (among worker)		
Labor	265 (25.7%)	99 (7.1%)
Clerk	126 (12.2%)	287 (20.6%)
Manager	121 (11.7%)	11 (0.8%)
Profession	203 (19.7%)	213 (15.3%)
Sales work	96 (9.3%)	88 (6.3%)
Service work	108 (10.5%)	245 (17.6%)
Transport/security	86 (8.3%)	12 (0.9%)
Agriculture	26 (2.5%)	18 (1.3%)
Housework	0	422 (30.3%)

NDA = neither parent drank alcohol; PDA = either the father or mother drank a moderate quantity of alcohol; HAD = either the father or mother was a heavy drinker or was alcohol-dependent; Married = married (include NAI-EN) or living with a partner.

The prevalence of alcohol consumption behaviors for each SES category is shown in Table 2. The prevalence of DNHH, HEDONLY, HDALL, and HD + HED were 46.2%, 20.2%, 21.5% and 16.4% for men, and 59.1%, 6.9%, 7.8% and 3.3% for women, respectively. The prevalence of DRINKER, HEDONLY, HDALL, and HD + HED were significantly higher among men than that among women. The ORs for men (95% confidential interval, p-value) belonging to the categories of DRINKER, HEDONLY, HDALL, and women belonging to HD + HED were 2.78 (2.25–3.45, < 0.001), 4.18 (3.18–5.49, < 0.001), 4.00 (3.12–5.12, < 0.001), and 7.56 (5.37–10.65), respectively (data not shown in the Table).

The risk for men according to each SES category adjusted for age, residential area and parental drinking pattern are shown in Table 3. The risk for DRINKER was higher for those in the 30–59-year-old, PDA and HDA, ≥13 years of educational attainment, higher household income, married or living with a partner, and regular employee groups. The risk

Table 2
Crude alcohol consumption rate, weighted by standardized population on October 1, 2013 in Japan.

	Men					Women				
	Ab12M	DRINKER				Ab12M	DRINKER			
		DNHH	HEDONLY	HDALL	HED + HD		DNHH	HEDONLY	HDALL	HED + HD
Age-adjusted prevalence	12.1%	46.2%	20.2%	21.5%	16.4%	26.2%	59.1%	6.9%	7.8%	3.3%
Age (yrs)										
20–29	11.2%	52.6%	25.7%	10.5%	9.1%	20.6%	59.5%	15.4%	4.5%	3.6%
30–39	8.6%	52.1%	24.8%	14.6%	13.2%	23.0%	58.5%	7.7%	10.8%	4.2%
40–49	11.3%	42.4%	22.5%	23.9%	19.3%	22.1%	63.9%	4.6%	9.3%	3.8%
50–59	13.1%	41.7%	14.1%	31.2%	21.4%	28.2%	61.1%	4.7%	6.0%	2.6%
60–64	19.8%	41.5%	9.7%	29.0%	18.4%	43.0%	47.4%	2.2%	7.4%	1.5%
Residential area										
Metropolis, ≥100,000 people	11.3%	47.0%	21.9%	19.8%	14.8%	24.9%	60.0%	7.0%	8.1%	3.3%
Town or village, < 100,000 people	13.6%	44.7%	17.0%	24.8%	19.4%	28.7%	57.4%	6.6%	7.3%	3.2%
Parental drinking pattern										
NDA	28.7%	49.8%	9.5%	12.0%	7.2%	49.7%	44.5%	3.5%	2.4%	1.0%
PDA	9.8%	47.5%	21.3%	21.3%	15.8%	22.5%	61.8%	7.2%	8.4%	3.1%
HDA	7.6%	37.1%	24.4%	30.9%	27.4%	19.9%	60.4%	9.1%	10.5%	7.0%
No response	43.0%	21.6%	21.6%		13.8%	34.1%	53.4%		12.4%	
Educational attainment										
≤12 years	17.6%	41.7%	13.6%	27.1%	20.4%	32.3%	52.4%	6.0%	9.3%	3.4%
≥13 years	8.1%	49.8%	25.0%	17.2%	13.3%	21.4%	64.3%	7.6%	6.7%	3.2%
Annual household income										
< 4,000,000 yen	16.7%	47.7%	15.7%	19.9%	15.3%	32.0%	52.4%	6.8%	8.8%	3.0%
4,000,000–8,000,000 yen	9.1%	46.5%	23.3%	21.1%	16.4%	23.7%	62.4%	5.0%	8.9%	4.2%
> 8,000,000 yen	7.5%	43.5%	23.1%	25.9%	19.2%	18.5%	64.2%	9.8%	7.5%	3.3%
Non-respondent	22.1%	45.6%	14.3%	18.1%	12.3%	32.8%	58.2%	7.7%	1.4%	0.8%
Marital status										
Married	9.6%	44.4%	20.5%	25.6%	19.2%	28.5%	58.6%	5.2%	7.7%	2.9%
Bereaved or divorced	22.2%	27.0%	10.3%	40.4%	26.9%	25.9%	54.7%	4.1%	15.4%	6.5%
Unmarried	16.6%	52.8%	20.9%	9.7%	8.6%	17.8%	62.8%	14.0%	5.4%	3.4%
Working status										
Employee (regular)	6.9%	47.3%	23.2%	22.7%	17.6%	16.8%	64.8%	10.6%	7.9%	3.6%
Self-employment	22.8%	36.2%	13.0%	28.0%	20.3%	29.6%	50.5%	4.4%	15.6%	6.3%
Employee (non-regular)	17.3%	52.5%	13.7%	16.5%	12.5%	24.3%	61.3%	7.2%	7.2%	2.7%
Student	6.5%	45.1%	38.8%	9.7%	9.7%	14.1%	60.6%	18.2%	7.1%	7.1%
Housework						36.8%	53.6%	2.0%	7.7%	3.1%
None	34.6%	46.6%	5.2%	13.6%	8.1%	34.1%	52.7%	8.9%	4.3%	1.6%
Others	37.1%	62.9%				71.9%	28.1%			
Occupation (among worker)										
Labor	9.9%	48.6%	18.3%	23.2%	17.6%	35.5%	55.3%	1.1%	8.0%	3.7%
Clerk	8.9%	47.8%	26.0%	17.2%	15.2%	18.2%	64.6%	8.6%	8.6%	3.6%
Manager	5.7%	37.0%	29.6%	27.6%	22.1%	7.4%	59.8%	32.8%	0.0%	
Profession	6.6%	44.2%	26.7%	22.6%	15.6%	12.5%	71.7%	11.1%	4.7%	2.0%
Sales work	14.6%	46.5%	18.8%	20.2%	13.4%	30.3%	56.4%	7.8%	5.4%	1.3%
Service work	17.1%	52.1%	10.2%	20.6%	16.6%	25.7%	53.6%	8.4%	12.2%	5.5%
Transport/Security	9.6%	46.2%	16.0%	28.2%	24.1%	33.3%	58.3%		8.4%	
Agriculture	27.4%	42.3%		30.3%	20.5%	28.5%	54.7%		16.7%	
Housework		46.2%				36.8%	53.6%	2.0%	7.7%	3.1%

Ab12 M = abstainer, no alcohol consumption in the past 12 months; DRINKER = has consumed alcohol within the past 12 months. DNHH = has consumed alcohol within the past 12 months without heavy episodic drinking or hazardous drinking; HEDONLY = heavy episodic drinker; HDALL = hazardous drinker (men ≥210 g/week); HED + HD = persons who have tendencies of both heavy episodic drinking and hazardous drinking; NDA = neither parent drank alcohol; PDA = either the father or mother drank a moderate quantity of alcohol; HAD = either the father or mother was a heavy drinker or was alcohol dependent; Married = married (include NAI-EN) or living with a partner.

for HEDONLY was higher for individuals aged 20–49 years, PDA and HDA, with higher income, married or living with a partner, and manager or professional occupation class. The risk for HDALL was higher among individuals 60–64 years old, PDA and HDA, with ≤12 years of educational attainment, with higher income, and bereaved or divorced. The risk for HED + HD almost coincided with that of HEDALL.

The risk for women according to each SES category, adjusted for age, residential area and parental drinking pattern, is shown in Table 4. The risk for DRINKER was higher in participants aged 20–59 years, PDA and HDA, with ≥13 years of educational attainment, higher household income, regular employee, clerk, professional, and service work groups. The risk for DRINKER was low among those whose occupation was housework. The risk for HEDONLY was higher among younger participants. Furthermore, the risk for HEDONLY was higher among regular employees, as well as those in clerk, manager, professional, sales work and service work employment type groups, than that for those who engaged in housework. The risk for HDALL was higher among those with PDA and HDA, ≤12 years of educational attainment, bereaved or divorced marital status, self-employment working status, and engaged in service work. The risk for HED + HD was higher among women with HAD, bereaved or divorced and with self-employment working status.

4. Discussion

4.1. Hazardous drinking

In this study, we analyzed the association between drinking behavior and SES characteristics. The results showed that HD risk was higher among people of both sexes with lower educational attainment. This result is similar to other high-risk behaviors such as smoking, poor diet,

Table 3
Odds ratios (ORs) for each socioeconomic status class (men).

	Versus Ab12M				Versus DNHH											
	DRINKER[c]				HEDONLY[d]				HDALL[d]				HED + HD[d]			
	OR	95% CI	p value	GOF[e]	OR	95% CI	p value	GOF[e]	OR	95% CI	p value	GOF[e]	OR	95% CI	p value	GOF[e]
Age (yrs)				0.958				0.816				0.700				0.643
20–29	1.78	(0.93- 3.40)	0.081		2.04	(1.10- 3.80)	0.024		0.29	(0.15- 0.56)	< 0.001		0.41	(0.20- 0.83)	0.014	
30–39	2.23	(1.22- 4.07)	0.009		1.91	(1.07- 3.41)	0.030		0.39	(0.23- 0.65)	< 0.001		0.56	(0.31- 0.99)	0.045	
40–49	1.75	(1.06- 2.91)	0.030		2.22	(1.26- 3.92)	0.006		0.81	(0.52- 1.27)	0.362		1.06	(0.64- 1.76)	0.813	
50–59	1.69	(1.04- 2.74)	0.033		1.44	(0.80- 2.58)	0.227		1.07	(0.70- 1.63)	0.766		1.14	(0.70- 1.86)	0.599	
60–64	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Residential area[a]																
Metropolis, ≥100,000	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Town or village, < 100,000	0.90	(0.62- 1.29)	0.554		0.81	(0.57- 1.14)	0.232		1.31	(0.96- 1.79)	0.085		1.43	(1.01- 2.00)	0.041	
Parental drinking pattern[a]																
NDA	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
PDA	3.78	(2.52- 5.65)	< 0.001		1.99	(1.12- 3.52)	0.019		2.18	(1.30- 3.67)	0.003		2.43	(1.30- 4.54)	0.006	
HDA	4.76	(2.51- 9.04)	< 0.001		2.78	(1.41- 5.49)	0.003		3.66	(1.98- 6.75)	< 0.001		4.94	(2.44- 9.99)	< 0.001	
Educational attainment[b]				0.745				0.879				0.951				0.290
≤12 years	0.54	(0.37- 0.78)	0.001		0.72	(0.51- 1.02)	0.066		1.61	(1.18- 2.20)	0.002		1.58	(1.12- 2.22)	0.009	
≥13 years	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Annual household income[b]				0.700				0.530				0.934				0.594
< 4,000,000 yen	0.36	(0.21- 0.64)	< 0.001		0.50	(0.31- 0.79)	0.003		0.65	(0.43- 0.99)	0.044		0.62	(0.39- 0.99)	0.044	
4,000,000–8,000,000 yen	0.65	(0.36- 1.16)	0.140		0.84	(0.56- 1.27)	0.407		0.72	(0.49- 1.07)	0.104		0.70	(0.45- 1.08)	0.108	
≥8,000,000 yen	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Marital status[b]																
Married	1 (Reference)			0.654	1 (Reference)			0.980	1 (Reference)			0.746	1 (Reference)			0.477
Bereaved or divorced	0.48	(0.24- 0.96)	0.038		1.01	(0.38- 2.70)	0.980		2.20	(1.12- 4.32)	0.022		1.95	(0.92- 4.13)	0.082	
Unmarried	0.32	(0.20- 0.52)	< 0.001		0.59	(0.38- 0.94)	0.025		0.40	(0.24- 0.67)	0.001		0.42	(0.24- 0.74)	0.003	
Working status[b]				0.385				0.962				0.409				0.426
Employee (regular)	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Self-employment	0.28	(0.18- 0.45)	< 0.001		0.69	(0.40- 1.20)	0.189		1.22	(0.79- 1.88)	0.364		1.25	(0.77- 2.02)	0.362	
Employee (non-regular)	0.35	(0.19- 0.65)	0.001		0.58	(0.31- 1.09)	0.090		0.62	(0.35- 1.09)	0.098		0.65	(0.35- 1.22)	0.178	
Student	1.04	(0.21- 5.09)	0.960		1.74	(0.70- 4.31)	0.231		1.12	(0.28- 4.49)	0.868		1.44	(0.35- 5.88)	0.614	
None	0.17	(0.09- 0.29)	< 0.001		0.30	(0.12- 0.74)	0.009		0.51	(0.27- 0.97)	0.039		0.45	(0.21- 0.97)	0.043	
Others	0.12	(0.01- 1.40)	0.091													
Occupation[b] **(among workers)**				0.776				0.574				0.558				0.882
Labor	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Clerk	1.13	(0.55- 2.35)	0.735		1.67	(0.95- 2.94)	0.076		0.68	(0.38- 1.23)	0.201		0.83	(0.44- 1.55)	0.553	
Manager	1.85	(0.79- 4.35)	0.159		2.50	(1.37- 4.58)	0.003		1.16	(0.66- 2.04)	0.606		1.37	(0.74- 2.52)	0.319	
Profession	1.57	(0.78- 3.14)	0.208		1.65	(1.00- 2.72)	0.048		1.08	(0.67- 1.73)	0.755		0.95	(0.56- 1.61)	0.836	
Sales work	0.71	(0.34- 1.47)	0.356		1.15	(0.58- 2.28)	0.686		1.09	(0.59- 2.03)	0.784		0.95	(0.46- 1.94)	0.885	
Service work	0.52	(0.27- 1.02)	0.057		0.62	(0.29- 1.31)	0.209		0.91	(0.51- 1.65)	0.762		1.00	(0.53- 1.90)	0.994	
Transport/security	1.06	(0.46- 2.43)	0.896		1.08	(0.52- 2.24)	0.842		0.98	(0.53- 1.80)	0.943		1.12	(0.59- 2.15)	0.730	
Agriculture	0.29	(0.10- 0.80)	0.017						1.28	(0.47- 3.52)	0.629		1.20	(0.38- 3.80)	0.758	

Ab12 M = abstainer, no alcohol consumption in the past 12 months; DRINKER = has consumed alcohol within the past 12 months; DNHH = has consumed alcohol in the past 12 months without heavy episodic drinking or hazardous drinking. HEDONLY = heavy episodic drinker. HDALL = hazardous drinker (men ≥210 g/week); HED + HD = persons who have both heavy episodic drinking and hazardous drinking; NDA = neither parent drank alcohol; PDA = either the father or mother drank a moderate quantity of alcohol; HAD = either the father or mother was a heavy drinker or was alcohol dependent; Married = married (include NAI-EN) or living with a partner.

[a] Age (10-year stratum), residential area and parental drinking pattern were used as independent variables for binomial logistic regression analysis in order to calculate ORs.

[b] Each variable was used as the independent variable, and adjusted age (10-year stratum) and residential area was used in binomial logistic regression analysis to calculate ORs.

[c] Abstainer was used as the reference for dependent variable.

[d] Alcohol consumer, past 12 months without both heavy episodic drinking and hazardous drinking was used as the reference for dependent variable.

[e] Goodness of fit (GOF) is indicated by the p value of the Hosmer-Lemeshow test.

Table 4
Odds ratios (ORs) for each socioeconomic status class (women).

	Versus Ab12M				Versus DNHH											
	DRINKER[c]				HEDONLY[d]				HDALL[d]				HED + HD[d]			
	OR	95% CI	p value	GOF[e]	OR	95% CI	p value	GOF[e]	OR	95% CI	p value	GOF[e]	OR	95% CI	p value	GOF[e]
Age (yrs)				0.779				0.979				0.374				0.934
20–29	2.41	(1.55- 3.75)	< 0.001		5.11	(2.02- 12.9)	0.001		0.47	(0.20- 1.10)	0.083		1.78	(0.49- 6.53)	0.383	
30–39	1.94	(1.32- 2.83)	0.001		2.62	(1.03- 6.67)	0.044		1.08	(0.59- 2.00)	0.800		2.09	(0.65- 6.68)	0.215	
40–49	2.41	(1.69- 3.44)	< 0.001		1.49	(0.57- 3.88)	0.413		0.87	(0.48- 1.59)	0.657		1.85	(0.59- 5.78)	0.289	
50–59	1.64	(1.16- 2.30)	0.005		1.55	(0.60- 4.02)	0.366		0.59	(0.31- 1.12)	0.105		1.27	(0.39- 4.17)	0.690	
60–64	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Residential area[a]																
Metropolis, ≥100,000	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Town or village, < 100,000	0.82	(0.64- 1.04)	0.105		0.92	(0.57- 1.49)	0.746		0.96	(0.63- 1.47)	0.860		1.16	(0.62- 2.18)	0.646	
Parental drinking pattern[a]																
NDA	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
PDA	3.39	(2.50- 4.60)	< 0.001		1.48	(0.62- 3.56)	0.382		2.55	(1.01- 6.48)	0.048		2.13	(0.50- 9.09)	0.309	
HDA	3.89	(2.51- 6.02)	< 0.001		2.40	(0.90- 6.39)	0.080		3.58	(1.30- 9.88)	0.014		5.60	(1.23- 25.45)	0.026	
Educational attainment[b]				0.862				0.516				0.510				0.384
≤12 years	0.65	(0.50- 0.82)	< 0.001		1.11	(0.7- 1.77)	0.659		1.78	(1.19- 2.67)	0.005		1.58	(0.86- 2.92)	0.145	
≥13 years	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Annual household income[b]				0.859				0.844				0.351[f]				0.602
< 4,000,000 yen	0.55	(0.39- 0.79)	0.001		0.84	(0.47- 1.52)	0.569		1.36	(0.79- 2.37)	0.272		1.14	(0.48- 2.70)	0.764	
4,000,000–8,000,000 yen	0.77	(0.54- 1.10)	0.151		0.59	(0.33- 1.07)	0.083		1.09	(0.64- 1.86)	0.748		1.22	(0.56- 2.69)	0.617	
≥8,000,000 yen	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Marital status[b]				0.952				0.996				0.072				0.283
Married	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Bereaved or divorced	1.18	(0.77- 1.81)	0.438		0.67	(0.24- 1.93)	0.461		2.26	(1.30- 3.94)	0.004		2.40	(1.05- 5.52)	0.039	
Unmarried	1.45	(0.95- 2.20)	0.083		1.37	(0.73- 2.58)	0.329		0.80	(0.39- 1.62)	0.531		0.88	(0.32- 2.42)	0.805	
Working status[b]				0.618				0.385				0.766				0.631
Employee (regular)	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Self-employment	0.66	(0.39- 1.14)	0.139		0.84	(0.28- 2.55)	0.756		2.84	(1.37- 5.91)	0.005		3.16	(1.09- 9.21)	0.035	
Employee (non-regular)	0.67	(0.48- 0.95)	0.025		0.85	(0.51- 1.42)	0.534		0.99	(0.58- 1.68)	0.970		0.84	(0.37- 1.89)	0.668	
Student	1.34	(0.28- 6.49)	0.713		1.21	(0.29- 5.01)	0.797		1.47	(0.16- 13.39)	0.731		1.97	(0.20- 19.78)	0.563	
None	0.43	(0.30- 0.61)	< 0.001		0.30	(0.13- 0.67)	0.003		1.16	(0.66- 2.02)	0.615		1.30	(0.57- 2.96)	0.536	
Others	0.40	(0.22- 0.72)	0.002													
Occupation[b] **(among workers)**				0.924				0.999				0.725				0.072
Housework	1 (Reference)				1 (Reference)				1 (Reference)				1 (Reference)			
Clerk	2.20	(1.51- 3.21)	< 0.001		3.33	(1.42- 7.82)	0.006		0.99	(0.56- 1.77)	0.981		0.94	(0.40- 2.20)	0.880	
Manager	4.73	(0.59- 38.15)	0.144		13.95	(2.85- 68.33)	0.001									
Profession	3.40	(2.13- 5.41)	< 0.001		3.63	(1.54- 8.59)	0.003		0.44	(0.20- 0.96)	0.040		0.30	(0.08- 1.08)	0.065	
Sales work	1.01	(0.60- 1.68)	0.985		3.68	(1.24- 10.94)	0.019		0.76	(0.28- 2.08)	0.590		0.32	(0.04- 2.55)	0.281	
Service work	1.46	(1.02- 2.10)	0.041		3.65	(1.49- 8.93)	0.005		1.82	(1.03- 3.21)	0.038		1.69	(0.72- 3.95)	0.225	
Labor	1.01	(0.63- 1.64)	0.956		0.59	(0.07- 4.89)	0.627		0.99	(0.41- 2.39)	0.975		1.09	(0.29- 4.08)	0.898	
Transport/security	1.01	(0.28- 3.73)	0.986										0.94	(0.40- 2.20)	0.880	

Ab12 M = abstainer, no alcohol consumption in the past 12 months; DRINKER = has consumed alcohol within the past 12 months; DNHH = has consumed alcohol in the past 12 months without heavy episodic drinking or hazardous drinking. HEDONLY = heavy episodic drinker. HDALL = hazardous drinker (men ≥210 g/week); HED + HD = persons who have both heavy episodic drinking and hazardous drinking; NDA = neither parent drank alcohol; PDA = either the father or mother drank a moderate quantity of alcohol; HAD = either the father or mother was a heavy drinker or was alcohol dependent; Married = married (include NAI-EN) or living with a partner.

[a] Age (10-year stratum), residential areas and parental drinking pattern were used as independent variables for binomial logistic regression analysis in order to calculate ORs.
[b] Each variable was used as the independent variable, and adjusted age (10-year stratum) and residential area was used in binomial logistic regression analysis to calculate ORs.
[c] Abstainer was used as the reference for dependent variable.
[d] Alcohol consumer, past 12 months without both heavy episodic drinking and hazardous drinking was used as the reference for dependent variable.
[e] Goodness of fit (GOF) is indicated by the p value of the Hosmer-Lemeshow test.
[f] Age (10-year stratum) and residential areas were used as coefficients for binomial logistic regression analysis if GOF was less than 0.05 when parental drinking pattern was included in the model.

and lack of exercise (Ross and Wu, 1995; Kamphuis et al., 2006). The higher risk of HD associated with men of lower educational attainment in Japan was consistent with reports from various other countries (Bloomfield et al., 2006; Helasoja et al., 2007; Peña et al., 2017). Moreover, an analysis of men conducted between 1991 and 1993 also showed similar findings between HD risk and lower educational attainment (Martikainen et al., 2001).

Regarding HD among women, the current study obtained a different result compared to previous reports. HD is more prevalent among women with higher educational attainment in many European countries (Bloomfield et al., 2006; Helasoja et al., 2007). There has been no previous report examining the association between HD and educational attainment in Japanese women, which makes it impossible to compare this trend over time. However, a study did report that Korean women with lower educational attainment had a higher risk for HD (Chung et al., 2012). From this, it is inferred that the association between HD and educational attainment in Asia differs from that in Europe. Originally, Japanese women had low alcohol consumption rates, but consumption in this group has been increasing recently (Osaki et al., 2016). Being female is a major risk factor for ARH (Wilsnack et al., 2013), while the lower educational attainment is a risk factor for mortality (Stringhini et al., 2017). Therefore, having both HD and lower educational attainment might decrease the survival rates of these women. Practical measures to reduce HD and ARH should consider the population's literacy level.

Studies from Korea and England reported no relationship between HD and household income for either sex (Chung et al., 2012; Lewer et al., 2016). However, the present study showed that the HD risk was higher in men with the highest income level. Particularly, the HD risk was highest in men who belonged to the lower education and higher income groups (Table 3). Higher income may allow men to easily buy alcohol, whereas higher educational attainment may be related to the preventive behavior. In contrast, no correlation between HD risk and household income was found among women. One reason for this gender difference is that the household income sometimes reflects men's income in Japan while women's income is affected by life events such as marriage and childbearing (Statistics Bureau, Ministry of Internal Affairs and Communications. http://www.stat.go.jp/data/roudou/report/2013/index.html). Furthermore, the gender gap in hourly wages is high in Japan, such that women who obtain higher income among women are not classified in the higher household income category (International Labour Organization, 2016. http://www.ilo.org/wcmsp5/groups/public/—dgreports/—dcomm/—publ/documents/publication/wcms_537846.pdf). Regarding HD and marital status, the OR for HD was high among bereaved or divorced men and women. This finding is similar to that of a previous study conducted in 2001 (Fukuda et al., 2005). Parental drinking pattern was strongly associated with HD in both genders as well as in the previous study (Rossow et al., 2016). The ORs of parental drinking pattern for HD were higher than the ORs of educational attainment.

4.2. Heavy episodic drinking

HED showed differing SES characteristics from HD. For HED, a significant association between educational attainment, for either sex, was not found. In studies of cohorts from other countries, mostly European, HED risk was higher in men with lower educational attainment, while no relationship was found in some other countries (Helasoja et al., 2007).

Factors associated with higher HED risk among men were higher household income and manager or professional employment class, whereas unmarried and unemployment statuses yielded lower risks of HED among men. No previous study examined the association between HED and household income, but it is presumed that HED is higher in men with higher social status. HED has different adverse effects from HD such as heart attack (Rehm et al., 2010; Plunk et al., 2014; Rehm et al., 2017). At present, the Japanese government does not have an established policy to reduce HED. Therefore, a government-led policy to reduce HED is thought to be necessary.

In women, HED risk was higher among those who worked outside, as compared to those who performed housework. Household income did not show any association with HED. Considering the Japanese custom of going drinking with colleagues, working outside may increase the opportunity for drinking. Considering that parental drinking pattern was not associated with HED in women, it is speculated that HED among women is acquired by the increase in relationships outside the home. With an increase in the working rates of Japanese women, it is anticipated that the HED rate of women will increase in the future (Statistics Bureau, Ministry of Internal Affairs and Communications. http://www.stat.go.jp/data/roudou/report/2013/index.html). The present study showed that HED was higher among younger women, who are concerned with pregnancy, delivery, and child care. Therefore, actions to reduce ARH are necessary for such women in particular.

4.3. Study limitations

The current study has several limitations. Primarily, a causal relationship between alcohol drinking behaviors and SES cannot be established, due to the cross-sectional design. Individuals who became unemployed or had a reduction in income, due to alcohol consumption, may have been incorrectly categorized. However, with regard to the relationship between drinking behavior and educational attainment, the influence by misclassification should be minimal. If the low household income group included a considerable number of misclassifications, the prevalence of HD would be higher, but this was not found in the current study. A second limitation is a bias from self-reporting and non-response. Alcohol consumption based on self-reported surveys is likely to be less than the total alcohol consumption per capita of Japan, with both types of biases probably being larger in heavy drinkers (Townshend and Duka, 2002; Zhao et al., 2009; Studer et al., 2013; Midanik et al., 2013). Questions that seemed difficult to answer were asked by paper-based questionnaire, in order to reduce non-respondent bias. Regarding the quantity of alcohol consumption, in terms of reducing self-reporting bias, trained-interviewers were utilized to ask the participants the relevant questions and calculated the results. The rate of non-response to questions regarding drinking behavior, educational attainment, marital status, working status, and occupation class was found to be less than 1%. The other limitation is that we adjusted for only a limited number of covariates such as age, residential area and parental drinking pattern in estimating the ORs. The current questionnaire did not have questions regarding mental health status, and we could not adjust for mental health status as a covariate; however, a review of the previous literature shows that alcohol problems are more common in depression (Sullivan et al., 2005). In addition, parental drinking pattern could not be included as a covariate in the statistical model when we estimated the OR of household income for HD among women because the model fit was not good.

5. Conclusion

The current study found that HD was more prevalent among people with lower educational attainment, for both sexes, while HED was higher in men with higher social status, as well as working women in Japan. It is necessary to recognize that SES is different between individuals with HD and HED, which can impact policies aimed at reducing ARH. Practical policies for the reduction of ARH should consider the literacy of subjects. In addition, it is necessary to provide accurate health information regarding HED.

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Contributors

All authors have materially participated in the research or article preparation. Mitsuru Kimura, Susumu Higuchi, Hiroshi Matsumoto, Takefumi Yuzuriha, Yoshinori Horie, Hideyuki Kanda, Hisashi Yoshimoto and Yoneatsu Osaki designed the survey. Aya Kinjo contributed in analyzing and interpreting the data and writing the report. Yuki Kuwabara, Ruriko Minobe and Hitoshi Maezato contributed in analyzing and interpreting the data. All authors approved the final manuscript before submission.

Conflict of interest

All authors declare that they have no conflict of interest.

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Original Article

The association between sleep disturbance and second-hand smoke exposure: a large-scale, nationwide, cross-sectional study of adolescents in Japan

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ABSTRACT

Objective: This study investigated the association between secondhand-smoke (SHS) exposure and sleep disturbance symptoms.
Methods: This study was a cross-sectional survey of junior and senior high school students throughout Japan. A total of 85,931 adolescents responded, and 84,988 questionnaires were included in the analysis.
Results: Adolescents who had never smoked accounted for 88.0% of respondents; among that group 39.1% reported having been exposed to SHS over the previous week. The results of multiple logistic regression analyses indicated that the adjusted odds ratios for insomnia symptoms such as difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS) and early morning awakening (EMA), as well as sleep disturbance symptoms such as subjectively insufficient sleep and short sleep duration (<6 h), tended to be higher both among never-smoking adolescents with SHS exposure and among smoking adolescents, as compared with never-smoking adolescents without SHS exposure. When adolescents with one or more of DIS, DMS, and EMA were defined as having insomnia, the adjusted odds ratio for insomnia was highest for adolescents who smoked, followed in descending order by those exposed to SHS both inside and outside the home, those exposed to SHS only inside the home, those exposed to SHS only outside the home, and never-smoking adolescents without SHS exposure ($p < 0.001$).
Conclusions: The present study has revealed that SHS exposure is associated with sleep disturbance. Thus, in addition to smoking cessation programs, it is also necessary to endorse measures to protect adolescents from SHS exposure in order to promote good sleep in this population.

1. Introduction

Sleep disturbances include insomnia (such as difficulty initiating sleep [DIS], difficulty maintaining sleep [DMS], and early morning awakening [EMA]), subjectively insufficient sleep (SIS), and short sleep duration (SSD). These are associated with various problems, such as depression, anxiety [1–4], attempted suicide [5], poor academic performance [6,7], and substance abuse [8–10] (including smoking and drinking alcohol). Insomnia has been reported among 10.7–23.5% of adolescents in various countries [5,6,9–12], although the prevalence varies depending on the definition of insomnia and the survey method employed. The United States' National Institutes of Health has recommend an average sleep duration of 9–10 h for teenagers [13]. However, the reported actual sleep duration is approximately 8 h in Europe [11], 7.3 h in the US [2], 6.3 h in Japan [14], and 5–6 h in Korea [15]. Thus, sleep disturbance in adolescents is a serious public health issue.

Three mechanisms have been proposed to explain the effects of smoking on sleep: (1) nicotine in tobacco smoke stimulates the release of neurotransmitters involved in control of the sleep–wake

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cycle [16–18]; (2) nicotine withdrawal causes symptoms that prevent sleep [19]; and (3) smoking can cause diseases associated with airway obstruction, such as asthma, which may disrupt the continuity of sleep [20,21]. In addition, a cohort study reported that smoking could be a predictor of DIS and DMS in adolescents [22]. As both active and passive smoking result in exposure to the nicotine in tobacco smoke, exposure to second-hand smoke (SHS) may also affect sleep. Epidemiological associations between SHS exposure and sleep disturbance symptoms among adult men [23], pregnant women [24], and children with asthma [25] have been reported. However, few studies have assessed the associations between SHS exposure and sleep in adolescents. Although Schwartz et al., have reported dose–response relationships between SHS exposure and restless sleep and between SHS exposure and sleep duration [26], to our knowledge, no other study has evaluated the associations between SHS exposure and insomnia symptoms (DIS, DMS, and EMA) in adolescents.

According to the nationally representative Global Youth Tobacco Surveys (GYTS) conducted from 1999 to 2008 in 168 countries, approximately one-third and two-fifths of never-smoking adolescents were exposed to SHS inside and outside their homes, respectively [27]. SHS exposure depends on the presence of smokers at places where individuals spend their time. At various stages of life (early childhood, adolescence, adulthood, etc.), the places where individuals spend their time changes. For example, adolescents spend most of their time in school, both while attending classes and participating in extracurricular activities. This distribution differs between adolescents and young children, although both are categorized as minors. It is important to clarify the status of SHS exposure and its effects on sleep among non-smoking adolescents in order to establish measures to remedy these conditions.

Therefore, the present study was performed to clarify the status of SHS exposure inside and outside the home among Japanese junior and senior high school students and to elucidate the associations between SHS exposure and sleep disturbance. This study is one of a series of nationwide surveys on lifestyle habits of Japanese junior and senior high school students, including alcohol consumption, smoking, eating, sleep, and school life, and was preceded by six surveys conducted in 1996 [28], 2000 [8], 2004 [9], 2008 [29], 2010 [10] and 2012 [30].

2. Methods

2.1. Participants

A single-stage cluster sampling method was employed. First, 10,547 junior and 4807 senior high schools (15,354 in total) in Japan were registered for this study in May 2013. Next, 140 junior high (selection rate: 1.3%) and 124 senior high (selection rate: 2.6%) schools (a total of 264 schools, selection rate: 1.7%) were randomly selected. Probability-proportional-to-size sampling was employed such that the probability of selection was determined in proportion to the number of enrolled students. The sample size was determined based on the school response rates and 95% confidence intervals for the prevalence of alcohol consumption and smoking that had been observed in our previous nationwide surveys on lifestyle habits of junior and senior high school students (op.cit.).

In the Japanese education system, children enter primary school at six years of age for six years of education. Students then attend junior and senior high schools for three years each.

2.2. Survey procedure

The principal of each selected school was sent a package containing a letter requesting cooperation with the survey, as well as enough questionnaires and envelopes for the students enrolled in the school at that time. At each school where the principal approved participation, homeroom teachers delivered the questionnaires to the students. To safeguard student privacy and to obtain frank responses, the teachers were requested to abide by explicit guidelines. In addition, each questionnaire stated that the completed questionnaire would not be seen by the teacher. All of the students were requested to place their completed questionnaire in the supplied envelope and seal it with an adhesive flap. The sealed envelopes were returned to the School of Medicine of Nihon University. The survey was conducted between October 2014 and March 2015. This study was approved by the Ethics Committee of Nihon University School of Medicine.

2.3. Response rates

This study included 65,688 and 99,581 students enrolled in 140 and 120 randomly selected junior and senior high schools, respectively (a total of 165,269 students in 260 schools). Among them, 79 junior high and 77 senior high schools (156 in total) participated in the survey. The school cooperation rates were 56.4% and 64.2% for junior and senior high schools, respectively (overall rate: 60.0%). The total number of junior and senior high school students who responded were 31,769 and 54,162, respectively (85,931 in total). The response rates were 48.4% and 54.4%, respectively (overall rate: 52.0%). From the collected questionnaires, 943 were excluded because sex was not specified or the responses were inconsistent. Data from the remaining 84,988 questionnaires (31,474 and 53,514 from junior and senior high schools) were analyzed. The effective response rates were 47.9% for junior high and 53.7% for senior high schools (overall rate: 51.4%). The basic characteristics of the included respondents are shown in Table 1.

2.4. Measures

The questions included in the questionnaire were created based on those used in our previous nationwide surveys. First, with regard to smoking status, the following question was added to the questionnaire:

"Which best describes your current smoking status?"

The answer options were as follows: I have never smoked; I have previously smoked, but do not currently smoke; I sometimes smoke; and I smoke often. Those who selected "I have never smoked." were defined as never-smoking adolescents, while those who selected other responses were defined as smoking adolescents.

The possible responses to the questions, "During the past week, on how many days have people smoked in your home, in your presence?" and, "During the past seven days, on how many days have people smoked in your presence, in places other than in your home?" included 0, 1–2, 3–4, 5–6, and 7 days. Those who selected one day or more in response to the above questions were categorized as having been exposed to SHS inside or outside the home. The above questions regarding SHS and the dichotomized measures were the same as those used in the GYTS [27].

With regard to sleep status, the following questions were added to the questionnaire in order to investigate whether the participants had experienced corresponding insomnia symptoms in the previous 30 days:

"Do you have difficulty falling asleep at night?" (DIS), "Do you wake up during the night after you have gone to sleep?" (DMS), and "Do you wake up too early in the morning and have difficulty getting back to sleep?" (EMA).

The following five response options were provided: never, rarely, sometimes, often, and always. Those who selected often and always for each question were defined as having each insomnia symptom (DIS, DMS, and EMA). Those with one or more of the three insomnia symptoms were defined as having insomnia. These definitions have also been used in other reports [6,9,10,29].

Table 1
Background factors of the sample.

	N	%
Sex		
Boys	41,225	48.5
Girls	43,763	51.5
Grade		
Grade 7	10,528	12.4
Grade 8	10,481	12.3
Grade 9	10,465	12.3
Grade 10	19,048	22.4
Grade 11	17,738	20.9
Grade 12	16,728	19.7
Having breakfast		
Everyday	70,688	83.2
Sometimes	7,281	8.6
Seldom	3,974	4.7
Unknown	3,045	3.6
Bedtimes		
Before or at midnight	44,863	52.8
After midnight	37,438	44.1
Unknown	2,687	3.2
Intending study at university		
Yes	33,655	39.6
No	38,242	45.0
Not decided	10,466	12.3
Unknown	2,625	3.1
Participating in extracurricular activities		
Yes	56,689	66.7
No	25,470	30.0
Not decided	2,829	3.3
Unknown		
Smoking		
No	78,971	92.9
Yes (Currently smoker and ever smoker)	5,156	6.1
Unknown	861	1.0
Currently drinking (past 30 days)		
No	76,605	90.1
Yes	6,812	8.0
Unknown	1,571	1.8
Mentalhealth status		
Good	35,615	41.9
Bad	46,666	54.9
Unknown	2,707	3.2

Abbreviations: SHS, secondhand smoke.

With regard to sleep disturbance symptoms other than insomnia experienced in the previous 30 days, the following questions were added to the questionnaire: 1) "Do you always get sufficient sleep?" (SIS), with the possible responses very good, fairly good, fairly bad, and very bad. Those who selected fairly bad and very bad were defined as having SIS. 2) "How many hours on average do you sleep at night?" (SSD). As in our past nationwide surveys, those who selected <5 h and 5–6 h were defined as having SSD [8,10,29].

In addition, questions regarding lifestyle habits and mental health status were also added, such as current alcohol use, consumption of breakfast, participation in extracurricular activities, and future plans for higher levels of education. With regard to mental health status, two questions from the Japanese version of the 12-item General Health Questionnaire (GHQ-12) were employed. The GHQ-12 is a self-administered questionnaire designed as a screening tool for mental diseases [31,32]. It measures two factors, "depression and anxiety" and "decrease in positive feeling," using a total of 12 items (six items for each factor). One point and 0 points are scored for poor and good status, respectively, for each item. The sum of the 12-item scores ranged from 0 to 12 points. Previous studies set a cutoff value of four points; subjects with scores of four points or higher are defined as having poor mental health [9,33,34]. One study reported high sensitivity and specificity (87.0% and 85.1%, respectively) when one question each was extracted from each of the two factors, and a cutoff of one point was regarded as indicative of poor mental health [35]. Subsequent epidemiological studies used this criterion for analyses of mental health [10,29]. Therefore, after considering the ease of filling out a questionnaire, the present study included the following two items: "Have you felt unhappier and more depressed than usual in the past 30 days?", and "Have you enjoyed your normal daily activities more than usual?", with scores of one point or greater regarded as indicative of poor mental health.

2.5. Data analysis

First, the percentages of adolescent participants with various smoking statuses (never-smoking without SHS exposure, never-smoking with SHS exposure only outside the home, never-smoking with SHS exposure only inside the home, never-smoking with SHS exposure both inside and outside the home, and smoking) and the prevalence of DIS, DMS, EMA, insomnia, SIS, and SSD were calculated based on sex. Next, the prevalence of DIS, DMS, EMA, insomnia, SIS, and SSD were calculated, based on both sex and smoking status. Finally, using logistic regression analysis, the associations between smoking status and sleep disturbance (DIS, DMS, EMA, insomnia, SIS, and SSD) were examined, with DIS, DMS, EMA, insomnia, SIS, and SSD as the dependent variables. In addition to smoking status, sex, grade in school, having breakfast, bedtime, intending to study at university, participating in extracurricular activities, and current mental health status were used as independent variables, based on our previous nationwide surveys [8–10,29]. No significant correlations were recognized among the independent variables used in each analysis; all correlation coefficients among the independent variables were below 0.5. All analyses were performed using IBM SPSS Statistics version 20 J for Windows (IBM Corp., Somers, NY, USA).

3. Results

The prevalence of smoking statuses are shown in Table 2. The prevalence of never-smoking adolescents without SHS exposure, never-smoking adolescents with SHS exposure only outside the home, never-smoking adolescents with SHS exposure only inside the home, never-smoking adolescents with SHS exposure both inside and outside the home, and smoking adolescents were 57.1%

Table 2
Prevalence of smoking statuses.

	Total		Boys		Girls		P Value*
	N	%	N	%	N	%	
Smoking status							<0.001
Never-smoking adolescents without SHS exposure	46,163	57.1	22,835	58.8	23,328	55.4	
Never-smoking adolescents with SHS exposure only outside the home	9,767	12.1	4,151	10.7	5,616	13.3	
Never-smoking adolescents with SHS exposure only inside the home	8,243	10.2	3,716	9.6	4,527	10.8	
Never-smoking adolescents with SHS exposure both inside and outside the home	11,583	14.3	4,759	12.3	6,824	16.2	
Smoking adolescents	5,156	6.4	3,369	8.7	1,787	4.2	

*P value was calculated by χ^2-test, 2(Sex; boys or girls) × 5(Smoking status).
Subjects with missing data were excluded from the analysis.
With SHS exposure: A student who responded that someone close to them had smoked one day a week or more was defined as "with SHS exposure." However, students who had ever smoked or currently smoked were excluded.
Abbreviations: SHS, second-hand smoke.

(boys: 58.8%, girls: 55.4%), 12.1% (boys: 10.7%, girls: 13.3%), 10.2% (boys: 9.6%, girls: 10.8%), 14.3% (boys: 12.3%, girls: 16.2%), and 6.4% (boys: 8.7%, girls: 4.2%), respectively.

The prevalences of insomnia symptoms DIS, DMS, and EMA, insomnia, and sleep disturbance symptoms SIS and SSD [<6 h] are shown in Table 3. These were 13.8% (boys: 13.4, girls: 14.1), 9.1% (boys: 9.0%, girls: 9.2%), 4.9% (boys: 5.2%, girls: 4.6%), 21.0% (boys: 21.1%, girls: 20.9%), 38.8% (boys: 37.4%, girls: 40.1%), and 31.0% (boys: 27.9%, girls: 33.9%), respectively.

The prevalences of insomnia symptoms, insomnia, and sleep disturbance symptoms, based on sex and smoking status, are shown in Table 4. For both boys and girls, these prevalence rates were highest among smoking adolescents, followed in order by never-smoking adolescents with SHS exposure both inside and outside the home, except for the prevalence of SSD among girls.

The results of multiple logistic regression analysis with regard to the associations between smoking status and insomnia symptoms, insomnia, and sleep disturbance symptoms are shown in Table 5. The adjusted odds ratios (AORs) of insomnia symptoms, insomnia, and sleep disturbance symptoms for never-smoking adolescents with SHS exposure (only inside the home, only outside the home, or both inside and outside the home) and smoking adolescents were significantly higher than the AORs for never-smoking adolescents without SHS exposure ($p < 0.001$). When compared with the AOR for never-smoking adolescents without SHS exposure, the AOR of insomnia was significantly highest for smoking adolescents, followed in descending order by never-smoking adolescents with SHS exposure both inside and outside the home, never-smoking adolescents with SHS exposure only inside the home, and never-smoking adolescents with SHS exposure only outside the home ($p < 0.001$).

4. Discussion

We believe that the sample used in the present study is representative of Japanese adolescents because the participating schools were selected randomly from among junior and senior high schools nationwide and because the sample size was large (approximately 90,000 students). Our study revealed for the first time that approximately 40% of never-smoking adolescents in Japan have been exposed to SHS (Table 2).

The present study revealed that the risk of sleep disturbance (including insomnia) was higher among adolescents exposed to SHS inside and/or outside the home (Table 5). Several definitions of insomnia have been used in epidemiological studies; the definition used in the present study was the presence of any one of DIS, DMS, or EMA. To our knowledge, this is the first study to have used this definition for investigating the associations between SHS exposure and insomnia in adolescents. Parental and peer smoking behaviors are strongly associated with exposure to SHS in never-smoking adolescents [27,36] and the combination of both factors reportedly strengthens these associations [27]. Anti-smoking measures directed at both adolescents and their parents are important in order to prevent sleep disturbance (including insomnia) in adolescents.

The AOR of insomnia in the present study was significantly highest among smoking adolescents, followed in descending order by those with SHS exposure both inside and outside the home, those with SHS exposure only inside the home, and those with SHS exposure only outside the home and ($P < 0.001$) (Table 5). The risk of insomnia was higher among never-smoking adolescents with SHS exposure inside the home than among those with SHS exposure outside the home. However, it remains unknown whether this result reflected the amount of tobacco smoke to which never-smoking adolescents were exposed. Levels of cotinine, a biomarker of nicotine contained in tobacco, have been associated with the number of days that non-smokers are exposed to tobacco smoke [37] and hair cotinine levels are reportedly higher among young children exposed to SHS inside the home than among those exposed outside the home [38]. However, one report has indicated that urine cotinine levels among non-smoking adults exposed to SHS in public spaces such as workplaces and transportation stations were higher than in those exposed to SHS inside the home [37]. Those reports indicated that cotinine levels were dependent on the length of time a person spent in places where tobacco smoke was present. Therefore, data on the cotinine levels among never-smoking adolescents exposed to SHS inside and outside the home will be required in order to better quantify differences in exposure to tobacco smoke; to our knowledge, no previous studies have provided such data. Therefore, we cannot say with certainty that the amount of SHS exposure among never-smoking adolescents inside the home was greater than that outside the home. Without cotinine data, the amount of SHS to which adolescents are exposed is considered to increase in ascending order from non-smoking adolescents without SHS exposure, those with SHS exposure either inside or outside the home, those with SHS exposure both inside and outside the home, and smoking adolescents. The present study showed that the risk of insomnia increased in a dose-dependent manner indicating a close association between the amount of exposure to tobacco smoke and insomnia among adolescents.

A study using polysomnography has reported that nicotine contained in tobacco smoke stimulated the release of aminergic neurotransmitters (eg, dopamine and serotonin), resulting in increased sleep latency, shallow sleep caused by reduced slow wave sleep in non-REM sleep, and short sleep [39,40]. In our study, exposure to SHS was associated with DIS, DMS, and SSD. Such associations may be caused by the above-mentioned influences of nicotine on sleep. Another effect of nicotine on sleep is a withdrawal effect that can be explained as follows: excessive release of dopamine caused by nicotine induces a negative feedback loop, resulting in a decreased capability for dopamine release and a reduction of dopamine receptors. Thus, dopamine neurotransmission is possible only when there is sufficient nicotine. Thus, a craving for nicotine may arise, for example, early in the morning after background nicotine has been withdrawn [41]. However, it seems improbable that exposure to SHS would induce nicotine dependence, and subsequently EMA. Rather, diseases associated with airway obstruction, such as asthmatic attacks (another effect of nicotine), might better explain the associations between SHS

Table 3
Prevalence of insomnia symptoms, insomnia, and sleep disturbance symptoms.

	Total		Boys		Girls		P Value*
	N	%	N	%	N	%	
DIS	11,139	13.8	5,297	13.4	6,042	14.1	0.003
DMS	7,518	9.1	3,574	9.0	3,944	9.2	0.403
EMA	4,052	4.9	2,071	5.2	1,981	4.6	<0.001
Insomnia	17,243	21.0	8,313	21.1	8,930	20.9	0.466
SIS	31,893	38.8	14,756	37.4	17,137	40.1	<0.001
SSD(<6 h)	25,525	31.0	11,006	27.9	14,519	33.9	<0.001

*P value was calculated by χ^2-test2, (Sex; boys or girls) × 2(Insomnia symptoms, insomnia and sleep disturbance symptoms; yes or no).
Subjects with missing data were excluded from the analysis.
Insomnia: Subjects who had one or more symptoms of insomnia (DIS or DMS or EMA) were diagnosed as having insomnia.
Abbreviations: DIS, difficulty initiating sleep; DMS, difficulty maintaining sleep; EMA, early morning awaking; SIS, subjectively insufficient sleep; SSD, short sleep duration.

Table 4
Associations between insomnia symptoms, insomnia, and sleep disturbance symptoms and smoking status.

	Total	Never-smoking adolescents without SHS exposure		Never-smoking adolescents with SHS exposure only outside the home		Never-smoking adolescents with SHS exposure only inside the home		Never-smoking adolescents with SHS exposure both inside and outside the home		Smoking adolescents		P Value*
	N	N	%	N	%	N	%	N	%	N	%	
Boys												
DIS	5,151	2,648	11.7	563	13.6	501	13.5	787	16.6	652	20.3	<0.001
DMS	3,468	1,802	7.9	362	8.8	366	9.9	508	10.7	430	13.4	<0.001
EMA	2,020	1,047	4.6	191	4.6	198	5.3	289	6.1	295	9.2	<0.001
Insomnia	8,085	4,024	18.6	876	21.3	812	22.0	1,196	25.4	997	31.1	<0.001
SIS	14,383	7,693	33.9	1,728	41.8	1,431	38.7	2,001	42.3	1,530	47.6	<0.001
SSD(<6 h)	10,759	6,028	26.5	1,195	28.9	962	26.0	1,404	29.6	1,170	36.3	<0.001
Girls												
DIS	5,896	2,765	11.9	785	14.0	621	13.8	1,226	18.0	499	28.9	<0.001
DMS	3,872	1,797	7.7	475	8.5	444	9.8	840	12.3	316	18.3	<0.001
EMA	1,928	890	3.8	224	4.0	211	4.7	416	6.1	187	10.8	<0.001
Insomnia	8,735	4,134	17.8	1,129	20.2	974	21.7	1,820	26.8	678	39.4	<0.001
SIS	16,794	8,513	36.7	2,413	43.1	1,793	39.8	3,102	45.7	973	56.4	<0.001
SSD(<6 h)	14,270	7,377	31.7	2,134	38.1	1,422	31.5	2,526	37.2	811	47.0	<0.001

*P value was calculated by χ^2-test2, (Insomnia symptoms, insomnia and sleep disturbance symptoms; yes or no) × 5 (Smoking status).
Subjects with missing data were excluded from the analysis.
Insomnia: Subjects who had one or more symptoms of insomnia (DIS or DMS or EMA) were diagnosed as having insomnia.
With SHS exposure: A student who responded that someone close to them had smoked one day a week or more was defined as "with SHS exposure." However, students who had ever smoked or currently smoked were excluded.
Abbreviations: SHS, second-hand smoke; DIS, difficulty initiating sleep; DMS, difficulty maintaining sleep; EMA, early morning awaking; SIS, subjectively insufficient sleep; SSD, short sleep duration.

Table 5
Multiple logistic regression analysis of the association between smoking status and sleep disturbance.

	DIS			DMS			EMA			Insomnia			SIS			SSD (<6h)		
	AOR	95%CI	P Value	AOR	95%CI	P Value	AOR	95%CI	P Value	AOR	95%CI	P Value	AOR	95%CI	P Value	AOR	95%CI	P Value
Smoking status			**<0.001**			**<0.001**			**<0.001**			**<0.001**			**<0.001**			**<0.001**
Never-smoking adolescents without SHS exposure	1.00	Referent		1.00	Referent		1.00	Referent		1.00	Referent		1.00	Referent		1.00	Referent	
Never-smoking adolescents with SHS exposure only outside the home	**1.10**	**1.03–1.18**		1.06	0.98–1.15		0.98	0.88–1.09		**1.10**	**1.04–1.16**		**1.20**	**1.14–1.26**		**1.11**	**1.06–1.17**	
Never-smoking adolescents with SHS exposure only inside the home	**1.08**	**1.00–1.16**		**1.21**	**1.11–1.31**		1.10	0.98–1.23		**1.16**	**1.09–1.23**		**1.14**	**1.08–1.20**		0.99	0.93–1.05	
Never-smoking adolescents with SHS exposure both inside and outside the home	**1.36**	**1.28–1.44**		**1.39**	**1.30–1.49**		**1.25**	**1.17–1.40**		**1.40**	**1.34–1.48**		**1.28**	**1.22–1.34**		**1.15**	**1.10–1.21**	
Smoking adolescents	**1.46**	**1.34–1.58**		**1.50**	**1.36–1.65**		**1.64**	**1.45–1.84**		**1.57**	**1.46–1.69**		**1.30**	**1.21–1.39**		**1.13**	**1.05–1.22**	

For calculation of the P values, a multivariate analysis model was used.
Subjects with missing data were excluded from the analysis.
Insomnia: Subjects who had one or more symptoms of insomnia (DIS or DMS or EMA) were diagnosed as having insomnia.
With SHS exposure: A student who responded that someone closed to them had smoked one day a week or more was defined as "with SHS exposure." However, students who had ever smoked or currently smoked were excluded.
Smoking status, Sex, Grade, Intention to study at university, Participating in Extracurricular activities, Having breakfast, Bedtimes, Currently drinking, and Mental health status were used as covariate values.
Abbreviations: SHS, second-hand smoke; DIS, difficulty initiating sleep; DMS, difficulty maintaining sleep; EMA, early morning awaking; SIS, subjectively insufficient sleep; SSD, short sleep duration; AOR, adjusted odds ratio; CI, confidence interval.

exposure and EMA. Further investigations will be necessary to clarify the mechanisms by which SHS exposure affects sleep.

The present study had several limitations. First, because it was cross-sectional in design, the causal relationship between sleep disturbance and SHS exposure could not be determined. Second, the use of a self-administered questionnaire raises the possibility of bias. The potential for systematic bias with regard to sex, age, and other factors has been reported for self-reported data on sleep [42]. In addition, data on SHS collected by means of self-administered questionnaires are subjective, unlike objective test results obtained using biomarkers such as cotinine [43]. Nonetheless, for a large-scale epidemiological study like ours, the self-administered questionnaire is a useful methodology for reducing cost and ensuring a large pool of participants. In addition, a previous study indicated that a majority of workers who reported having been exposed to SHS answered correctly [44]. Third, there may be confounding factors other than those that were considered in the present study, regarding the associations between SHS exposure and sleep disturbance in adolescents. An example is respiratory diseases such as asthma. A study of children aged approximately nine years with asthma demonstrated an association between SHS exposure and sleep problems [25]. A recent study has reported the association between asthma and sleep disturbance in adolescents [45]. Thus, future studies must consider confounding factors including asthma symptoms in addition to those that were examined in the present study. Fourth, a non-response bias may exist, as certain schools and students chose not to participate. The response rate in this study was only 52.0%. More schools chose not to participate in our present study than in previous surveys, perhaps to safeguard personal information about students. However, despite this, the present study included nearly 90,000 respondents and the response rate exceeded 50%. Future studies should consider ways in which response rates may be increased.

5. Conclusions

This large-scale epidemiological study of Japanese adolescents has revealed that approximately 40% of those who had never smoked were exposed to SHS. In addition, insomnia, insomnia symptoms such as DIS, DMS, and EMA, and sleep disturbance symptoms such as SIS and SSD were increased even among never-smoking adolescents who were exposed to SHS. Thus, in order to improve good sleep in adolescents, it is necessary to promote measures to protect them from SHS exposure, in addition to promoting smoking cessation.

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Conflict of interest

This was not an industry-supported study. Drs. Morioka, Jike, Kanda, Osaki, Nakagome, Otsuka, Kaneita, Itani, Higuchi and Ohida have stated no financial conflicts of interest.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2018.04.014.

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