



## Association of household smoking status in childhood with young adults' educational attainment and smoking status: Results from a series of population-based cross-sectional surveys in Japan

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### ABSTRACT

Smoking in young adulthood is a risk factor for future health-related disabilities and a cause of expanding health inequalities. Education and smoking are inversely associated. Using population-based representative data, this study aimed to clarify how the presence of household smokers during childhood related to both current smoking status and educational attainment among young adults. Surveys were distributed to young adults (19–20 years) invited to coming-of-age ceremonies in 2014–2017 in a rural area in Japan. Data were collected on low educational attainment (defined as  $\leq 12$  years of education), current smoking status, and childhood household smoking status. We used logistic regression models to calculate odds ratios (ORs) of low educational attainment for household smoking status. A total of 17.6% of men ( $n = 1077$ ) and 3.8% of women ( $n = 1021$ ) were current smokers. Current smoking was more common among participants from households with smokers ( $P < 0.001$  for both men and women). The odds of low educational attainment were significantly higher for participants from smoking households (OR: 1.59, 95% confidence interval [CI]: 1.17–2.17 for men; OR: 2.29, 95% CI: 1.61–3.24, for women). All associations were characterized by a dose–response relationship with the number of household smokers. The number of household smokers in childhood was positively associated with current smoking and negatively associated with level of educational attainment among young adults. Controlling for year and geographical area, exposure to family smokers in childhood appears to be a risk factor for the intergenerational transmission of health inequalities.

### 1. Introduction

Socioeconomic circumstances seriously affect health and well-being, and health inequalities remain a major global public health concern, (Marmot, 2001) including in Japan. (Kagamimori et al., 2009) The World Health Organization Commission on Social Determinants of Health has recommended monitoring and evaluating socioeconomic inequalities in health and health behavior, including smoking. (Commission on Social Determinants of Health. Closing the gap in a

generation: Health equity through action on the social determinants of health. Final report of the Commission on Social Determinants of Health. Geneva: World Health Organization, 2008) Tobacco smoking has been shown to be a major contributor to social inequalities in health and is the greatest independent contributor to preventable death and disease, globally and in Japan. (U.S. Department of Health and Human Services. The health consequences of smoking—50 years of progress: A report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention,

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National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2014; Loring B. Tobacco and inequities—Guidance for addressing inequities in tobacco-related harm. Copenhagen: World Health Organization Regional Office for Europe, 2014; Jha and Peto, 2014; Ikeda et al., 2012) In general, groups with lower socioeconomic status use tobacco more often and experience higher levels of mortality and disability from tobacco use than do wealthier groups. (Jha and Peto, 2014) Notably, these inequalities are often generational: The children of socioeconomically disadvantaged parents are much more likely to experience second-hand tobacco smoke exposure and to become smokers themselves. (Loring B. Tobacco and inequities—Guidance for addressing inequities in tobacco-related harm. Copenhagen: World Health Organization Regional Office for Europe, 2014; Hiscock et al., 2012; Johnson et al., 2016; Leonardi-Bee et al., 2011) In Europe, an overall reduction in smoking represents a public health success; however, there are still inequities in tobacco use based on factors including economic status, education, gender, ethnicity, and place of residence. (Jha and Peto, 2014)

Educational attainment is an upstream factor that influences the social determinants of health. (Kagamimori et al., 2009; Ishizaki et al., 2000; Davey Smith et al., 1998; Mirowsky and Ross, 2003; Marmot et al., 2012) Educational level shapes an individual's future occupational opportunities and earning potential, in addition to providing knowledge and skills that allow better-educated persons to gain improved access to information and resources promoting health. (Kagamimori et al., 2009) Increasing educational attainment improves health by increasing individual agency, self-efficacy, and problem-solving capacity, all of which promote healthy lifestyles. (Mirowsky and Ross, 2003) Therefore, improving the education of younger generations will promote health and healthy lifestyles among subsequent generations, thereby decreasing social disparities. (Kagamimori et al., 2009; Gall et al., 2010)

The effects of educational attainment on health can be partly explained by health behaviors, (Kagamimori et al., 2009) including smoking. Dozens of studies have provided evidence of higher smoking prevalence among groups with lower levels of education. (Nishi et al., 2004; Huisman et al., 2005; Kuper et al., 2007; Mackenbach et al., 2008; Tabuchi and Kondo, 2017) Further, in a variety of contexts worldwide, individuals and households with lower levels of education have been shown to be more likely to smoke, less successful at quitting smoking, and less responsive to anti-smoking public health interventions, subjecting children in these households disproportionately to second-hand smoke. (Gorini et al., 2015; Yang et al., 2015; Vitória et al., 2017; Zaloudíková et al., 2012) Additionally, across generations, parental smoking has a direct and significant influence on children's smoking. (The Japanese Ministry of Health, Labour and Welfare. The National Health and Nutrition Survey in Japan, 2016) Smoking in adolescence/young adulthood, in turn, is associated with health-related risk behaviors such as alcohol consumption, (Wang et al., 2017) poor diet, (Wang et al., 2017; Larson et al., 2007; Wilson et al., 2005) and physical inactivity. (Wang et al., 2017; Larson et al., 2007; Wilson et al., 2005) Smoking in adolescence/young adulthood may also be a key indicator of future health-related disabilities and a cause of expanding health inequalities. (The Japanese Ministry of Health, Labour and Welfare. The National Health and Nutrition Survey in Japan, 2016) However, the mechanisms of smoking initiation in adolescence/young adulthood among those with low educational attainment have not yet been fully clarified. Moreover, interventions that work for young people without family members who smoke may be ineffective for the children of smokers.

In Japan, the minimum legal age for smoking/buying cigarettes is 20 years. The 2016 Japan National Health and Nutrition Survey (response rate = 44.4%) reported the prevalence of “current habitual smoking” among men and women aged 20–29 years as 30.7% and 6.3%, respectively. (The Japanese Ministry of Health, Labour and Welfare. The National Health and Nutrition Survey in Japan, 2016)

Tabuchi et al. reported that the degree of association between low educational attainment and current smoking was stronger in younger participants than in older participants. (Tabuchi and Kondo, 2017) High educational attainment may have the potential to eliminate the intergenerational continuity of smoking status among young people. Therefore, the present study aimed to investigate the associations between the presence of household smokers in childhood and young adults' current smoking status and educational attainment using representative population-based data. Specifically, we aimed to determine 1) whether there was any association between the number of household smokers in childhood and the level of educational attainment reached in young adulthood and 2) whether the number of household smokers in childhood was positively associated with smoking in young adulthood.

## 2. Material and methods

This study was designed as a series of population-based cross-sectional surveys conducted in Hidaka District, a rural area of Wakayama Prefecture, Japan, consisting of seven municipalities. The broader research protocol was approved by the Ethics Committee of Wakayama Medical University (No. 1018). We explained the purpose of the survey to potential participants verbally upon distributing the document, and we obtained written informed consent from all study participants.

### 2.1. Study participants

The estimated population of the study area at the time of the 2015 census was 76,345 people, 12.7% of whom were younger than 15 years old. The target population for this study was “new adults” (young adults aged 19–20 years) invited to coming-of-age ceremonies (*Seijin-shiki*) by the educational boards of the seven municipalities in the study area. In Japan, coming-of-age ceremonies are conducted by the municipal educational boards to encourage and congratulate all young people who have reached the age of majority (20 years) over the past year. The study period was from January 2014 to January 2017. During this four-year study period, there were 3570 “new adults” in the study area; these individuals were born from the fiscal year starting in April 1994 to the fiscal year ending in March 1997. During the study period, 2940 of those young adults attended a *Seijin-shiki* ceremony (overall attendance rate = 82.4%).

### 2.2. Survey method

An anonymous self-report questionnaire was distributed to each attendee during the coming-of-age-day ceremonies. The questionnaire covered participants' basic sociodemographic characteristics (e.g., gender, age, and current occupation), current smoking status, and household smoking status in childhood. Household smoking status in childhood was measured with an item that asked about the number of smokers in the household (not including the participant him/herself) when the participant was a child. Participants' self-report of current smoking status was measured by asking respondents to select one category from the following list that best described their use of any kind of cigarettes: never smoked (*I have never smoked a cigarette—not even just a puff*), former smoker (*I have smoked cigarettes, but not at all in the past 12 months*), or current smoker (*I smoke cigarettes*).

The level of educational attainment at young adulthood was assessed by asking participants about their current occupation. Those who said that they were currently students (e.g., university student, junior college student, vocational school student, or preparatory student) were defined as having a high educational attainment. In Japan, the completion of elementary school (6 years) and junior high school (3 years) is compulsory and is usually accomplished by the age of 15 years. High school is then a further 3 years, meaning that most students completing high school do so by the age of 18. The participants in the present study

were aged 19–20 years, and student status at this age was used as a rough measure of completing high school and continuing on to pursue further education, which we define as having a high educational attainment. Educational attainment was included as a dichotomous variable in the present study: *high* (> 12 years) for those who indicated that they were currently students or *low* (≤12 years) for those who listed other occupations.

### 2.3. Statistical analyses

First, we used chi-squared tests to conduct descriptive analyses of the participants' characteristics, including educational attainment and current smoking status, by household smoking status in childhood. Next, we used logistic regression analyses to calculate the odds ratios (ORs) of young adults' educational attainment for household smoking status (smokers present/not present; number of household smokers: 0, 1, 2, or ≥ 3). Through these analyses, crude ORs and 95% confidence intervals (CIs) were estimated for the presence of household smoker(s) (reference group: smokers not present). We then estimated a model adjusting for the potential confounders of survey year (four years) and geographical area (seven municipalities). Finally, we estimated a model that added adjustment for participant's current smoking status. In all models, we calculated the ORs of low educational attainment (≤12 years of education) for childhood household smoking status (smokers present/not present and number of smokers: 0, 1, 2, or ≥ 3). All the analyses were stratified by gender because previous reports have highlighted gender differences in smoking initiation among children and adolescents. (Okoli et al., 2013)

All statistical analyses were performed using SPSS Statistics, Version 23 (IBM Corp., Armonk, NY, USA). Statistical significance was defined as two-tailed *P*-values < 0.05.

## 3. Results

### 3.1. Participants' characteristics and current smoking

In the current study, the overall response rate was 90.2% (2652/2940). After excluding participants with missing data on gender (n = 86), household smoking status in childhood (n = 57), current smoking status (n = 101), or occupation (n = 439), our study included 2098 participants (1077 men and 1021 women), yielding an effective response rate of 71.4%. This represented 58.8% of "new adults" in the study area during the study period. Table 1 presents the participants' characteristics. Overall, 65.9% (1383/2098) of the participants had lived with household smokers in childhood, with no significant difference by gender. The overall percentage of participants who currently smoked was 10.9% (229/2098), and we found a statistically significant difference between men and women (*P* < 0.001). The overall percentage of participants with higher educational attainment was 73.0% (1531/2098), and there was no significant gender difference in educational attainment. Our results appear to be quite similar to national-level findings for Japan from the School Basic Survey, which reported that, of 1,069,568 high school graduates in 2017, 758,860 (approximately 71%) immediately continued on to a higher level of education, excluding specialized training colleges and public human resources development facilities. (Statistics Bureau, 2019)

Table 2 shows the association between participants' current smoking status and educational attainment. For both men and women, the proportion with higher educational attainment was significantly lower among current smokers than among non-smokers (*P* < 0.001 for both men and women).

### 3.2. Associations between household smoking status, participants' current smoking status, and educational attainment

As shown in Table 3, the proportions of participants (both men and

**Table 1**  
Characteristics of the study participants (n = 2,098).

	Men (n = 1077)	Women (n = 1021)	<i>P</i> -value*
Survey year, n (%)			
2014	268 (24.9)	251 (24.6)	0.79
2015	261 (24.2)	258 (25.3)	
2016	293 (27.2)	260 (25.5)	
2017	255 (23.7)	252 (24.7)	
Survey area, n (%)			
A	327 (30.4)	320 (31.3)	0.22
B	116 (10.8)	77 (7.5)	
C	126 (11.7)	117 (11.5)	
D	156 (14.5)	149 (14.6)	
E	166 (15.4)	181 (17.7)	
F	115 (10.7)	115 (11.3)	
G	71 (6.6)	62 (6.1)	
Number of household smokers in childhood, n (%)			
≥ 3	65 (6.0)	61 (6.0)	0.17
2	165 (15.3)	194 (19.0)	
1	472 (43.8)	426 (41.7)	
0	375 (34.8)	340 (33.3)	
Current smoking, n (%)			
Yes	190 (17.6)	39 (3.8)	< 0.001
No	887 (82.4)	982 (96.2)	
Educational attainment, years, n (%)			
> 12	770 (71.5)	761 (74.5)	0.12
≤ 12	307 (28.5)	260 (25.5)	

\* Chi-squared test.

Note: Study conducted 2014–2017 among young adults (19–20 years) in Hidaka District, Wakayama Prefecture, Japan.

**Table 2**

Association between current smoking status and educational attainment, stratified by gender.

	Educational attainment, years		<i>P</i> -value*
	≤12	> 12	
<b>Men (n = 1077)</b>	(n = 307)	(n = 770)	
Current smoker, n (%)			
Yes	97 (31.6)	93 (12.1)	< 0.001
No	210 (68.4)	677 (87.9)	
<b>Women (n = 1021)</b>	(n = 260)	(n = 761)	
Current smoker, n (%)			
Yes	22 (8.5)	17 (2.2)	< 0.001
No	238 (91.5)	744 (97.8)	

\* Chi-squared test.

Note: Study conducted 2014–2017 among young adults (19–20 years) in Hidaka District, Wakayama Prefecture, Japan.

women) who were current smokers were significantly higher among those who had lived with household smokers in childhood than among those who had not (*P* < 0.001 for both men and women). In addition, we observed dose–response relationships, with participants' likelihood of being current smokers increasing as the number of household smokers increased. The analysis of the relationship between the presence of household smokers in childhood and participants' educational attainment showed that the proportion of participants with low educational attainment was significantly higher among those who had lived with household smokers in childhood than among those who had not (*P* < 0.001 for both men and women). Again, there was a dose–response relationship; greater numbers of family smokers corresponded to a higher likelihood of a participant having low educational attainment (Table 3).

**Table 3**  
Association of household smoking status in childhood with current smoking status and educational attainment, stratified by gender.

	Current smoker		P-value*	Educational attainment, years		P-value*
	Yes	No		≤ 12	> 12	
<b>Men (n = 1077)</b>	(n = 190)	(n = 887)		(n = 307)	(n = 770)	
Number of household smokers, n (%)						
≥ 3 (n = 65)	29 (44.6)	36 (55.4)	< 0.001	38 (58.5)	27 (41.5)	< 0.001
2 (n = 165)	48 (29.1)	117 (70.9)		68 (41.2)	97 (58.8)	
1 (n = 472)	73 (15.5)	399 (84.5)		123 (26.1)	349 (73.9)	
0 (n = 375)	40 (10.7)	335 (89.3)		78 (20.8)	297 (79.2)	
<b>Women (n = 1021)</b>	(n = 39)	(n = 982)		(n = 260)	(n = 761)	
Number of household smokers, n (%)						
≥ 3 (n = 61)	6 (14.8)	55 (90.2)	< 0.001	25 (41.0)	36 (59.0)	< 0.001
2 (n = 194)	13 (6.7)	181 (93.3)		68 (35.1)	126 (64.9)	
1 (n = 426)	19 (4.5)	407 (95.5)		116 (27.2)	310 (72.8)	
0 (n = 340)	1 (0.3)	339 (99.7)		51 (15.0)	289 (85.0)	

\*Chi-squared test.

Note: Study conducted 2014–2017 among young adults (19–20 years) in Hidaka District, Wakayama Prefecture, Japan.

### 3.3. Association between household smoking status and low educational attainment

The logistic regression analysis showed that, for men, after adjusting for current smoking status in Model 2, the odds of low educational attainment were significantly higher among participants who had lived with household smokers in childhood than among those who had not (OR = 1.59, 95% CI: 1.17–2.17; data not shown). However, there was no statistically significant difference in the odds of low educational attainment for men who had lived with only one household smoker vs. those who had lived with no smokers. There was a dose–response relationship between the number of household smokers and low educational attainment (Table 4).

For women, after adjusting for current smoking status in Model 2, the odds of low educational attainment were significantly higher among participants who had lived with household smokers in childhood than among those who had not (OR = 2.29, 95% CI: 1.61–3.24; data not shown). In contrast to men, the odds of low educational attainment did

**Table 4**  
Logistic regression models predicting low educational attainment using the number of household smokers in childhood, stratified by gender.

	Crude model		Adjusted models			
	OR	(95% CI)	Model 1		Model 2	
			OR	(95% CI)	OR	(95% CI)
<b>Men (n = 1077)</b>						
Number of household smokers						
≥ 3	5.36	(3.08–9.31)	5.29	(3.01–9.29)	3.97	(2.21–7.12)
2	2.67	(1.79–3.97)	2.64	(1.77–3.96)	2.22	(1.47–3.36)
1	1.34	(0.97–1.85)	1.31	(0.94–1.81)	1.24	(0.89–1.73)
0	1	reference	1	reference	1	reference
<b>Women (n = 1021)</b>						
Number of household smokers						
≥ 3	3.94	(2.18–7.10)	3.71	(2.03–6.78)	3.36	(1.83–6.20)
2	3.06	(2.01–4.65)	3.11	(2.03–4.78)	2.90	(1.88–4.46)
1	2.12	(1.47–3.06)	2.04	(1.41–2.96)	1.93	(1.33–2.81)
0	1	reference	1	reference	1	reference

OR: odds ratio; CI: confidence interval.

Notes: Model 1 adjusted for year of survey and geographical area; Model 2 adjusted for Model 1 + current smoking status.

Study conducted 2014–2017 among young adults (19–20 years) in Hidaka District, Wakayama Prefecture, Japan.

differ significantly for women who had lived with only one household smoker vs. those who had lived with no smokers. In addition, there was a dose–response relationship between the number of household smokers and the odds of low educational attainment (Table 4). All this information is useful in understanding the complex relationship between the measured items and current smoking status.

### 4. Discussion

This study investigated associations between the presence of household smokers in childhood and current smoking status and educational attainment in young adulthood using population-based data representative of a rural area in Japan. Specifically, we aimed to determine whether there was any association between the number of household smokers in childhood and young adults’ level of educational attainment and current smoking status. Our findings indicated that the number of household smokers in childhood was positively associated with young adults’ current smoking status and negatively associated with their level of educational attainment.

In the selected rural area in Japan, we found that 17.6% of participating young men and 3.8% of participating young women were current smokers. These numbers are much higher than the results of a previous study conducted among high school students in Japan, which reported the prevalence of daily smoking as 1.6% for men/boys and 0.5% for women/girls. (Health, 2018) Unfortunately, there is very little empirical information on smoking status in early adulthood, especially among young adults aged 19–20 years. (The Japanese Ministry of Health, Labour and Welfare. The National Health and Nutrition Survey in Japan, 2016; Health, 2018) To our knowledge, our study is the first to present a population-based estimate of the proportion of current smokers in this age group in Japan. One strength of our study was that the participants were relatively representative of the larger population, and the sample included > 60% of all young adults aged 19–20 years in the selected region. However, direct comparisons between our results and those of previous studies are difficult because of variation among studies in the definition and assessment of current smoking status.

The present study also clarified the association of childhood household smoking status with the young adult participants’ current smoking status, finding that current smoking was more common among participants from households with smokers. This finding is consistent with previous work indicating a strong link between parents’ smoking and their children’s current smoking (Pan and Han, 2017; Mays et al., 2014; Naito et al., 2009) and smoking initiation, (Gilman et al., 2009; Bricker et al., 2007) and with Szabo et al.’s finding that smoking bans at home reduced the likelihood of adolescents experimenting with smoking. (Szabo et al., 2006) Further, we explored the relationship

between childhood household smoking status and the level of educational attainment in early adulthood. Even after adjusting for current smoking status, the presence of household smokers in childhood appeared to be a significant predictor of low educational attainment. We found a clear difference in these results by gender.

Educational attainment is a well-established social determinant of health, and our findings regarding household smoking in childhood and participants' educational attainment as young adults are consistent with existing work. Previous studies have reported an inverse relationship between current smoking and educational attainment among people who are middle-aged or older, (Mackenbach et al., 2008; Fujino et al., 2005; Anzai et al., 2000; Smedberg et al., 2014) and women with low education levels have been found to be more likely to smoke before and during pregnancy. (Smedberg et al., 2014) Additionally, high school students with lower academic attainment have been demonstrated to exhibit significantly more health-related risk behaviors. (Rasberry et al., 2017) In terms of the mechanisms linking adolescent smoking and lower educational attainment, the associations are bidirectional and negative (Latvala et al., 2014).

Our study was one of the first to investigate the contribution of the presence of household smokers in childhood to educational attainment, finding that, among young adults in Japan aged 19–20 years, the presence of household smokers in childhood was associated with low educational attainment. We also found that there was a dose–response relationship between the number of smokers in the household and the odds of low educational attainment.

#### 4.1. Study limitations

This study had several limitations. A main limitation is that we were unable to fully analyze all potential confounding factors associated with participants' smoking status and educational attainment. Most crucially, these include socioeconomic status, parental educational attainment, and peer smoking status at school or in the workplace. Socioeconomic status, in particular, has repeatedly been shown to play a key role in determining educational attainment. Thus, although our results are suggestive of a strong relationship between smokers in the childhood household and both current smoking status and educational attainment in young adulthood, it is important that future studies confirm these findings, taking into account socioeconomic status and other potential confounding variables. Given that there is little research on the association between childhood household smoking status and smoking and educational outcomes in young adulthood, it is our hope that the present study will motivate future work that can better clarify these associations.

The study also had all the limitations inherent in cross-sectional studies, particularly in that it only examined associations; causal effects between parental smoking and participants' smoking status and educational attainment could not be assessed. A related point is that we were unable to examine the effect of the participants' current household smoking status. Moreover, the lack of specificity on family history of smoking should be noted. The length of time participants lived with a smoking family member or the period of childhood in which smoking occurred may be important influences. Prospective longitudinal studies are needed to consider these factors.

Another significant set of limitations involves our assessment of educational attainment and cigarette use. We compared young adults with low educational attainment ( $\leq 12$  years) with those with high educational attainment ( $> 12$  years) using reported current occupation. Clearly, occupation is only a rough proxy for the participants' current educational attainment. We also recognize that educational attainment may be in flux between the ages of 18 and 22. Given the age range of the participants in this study (19–20 years), this is a further limitation of our assessment of education. Future work should seek to measure educational attainment directly and among somewhat older participants (e.g., aged  $\geq 30$  years). Further, it would be useful to test these

associations with more detailed information on individuals' smoking practices. For example, future studies should endeavor to examine differences between daily smokers and those who smoke less frequently. Additionally, we assessed only the use of any kind of cigarettes, but it might be fruitful to examine differences between different types of cigarettes, as well as the use of other tobacco products. We also used self-report questionnaires, which may have introduced social desirability bias and recall bias. However, a systemic review and meta-analysis of the smoking literature reported that most studies have relied on self-reported data. (Leonardi-Bee et al., 2011) Self-report data have been shown to be good indicators of true smoking status overall, but they may underestimate smoking prevalence among adolescents (Newell et al., 1999). Therefore, we may have underestimated or misclassified participants' current smoking status and household smoking status in childhood. Although the present study lacked objective measures to support self-reported active and passive smoking status, previous work using objective measures has supported the validity of the specific questions used in this study, particularly the self-reported items assessing active or passive smoking status (Vartiainen et al., 2002; Tsutsumi et al., 2002).

Finally, the present study sample, which was limited to a single rural area in Japan, may not be representative of the entire population of Japan. However, studies on smoking and its public health consequences in Japan are often carried out in major population centers, and less is generally known about these issues in rural areas, making research in this type of context especially important. Nevertheless, the results should be interpreted with caution because their generalizability may be limited. Future studies using datasets covering multiple regions are required to determine whether our results also apply to other populations.

#### 4.2. Public health implications

Our findings suggest that the presence of household smokers in childhood is a risk factor for the transmission of health inequalities across generations. To reduce both smoking initiation and health inequalities in various cultural contexts, there is a need to develop robust public health strategies for smoking prevention and health education that consider the social determinants of health for use in schools and other settings. In particular, our finding of a clear relationship between childhood exposure to household smoking and smoking status in young adulthood suggests that interventions to reduce smoking in households with children are crucial. It may be useful to target these interventions particularly toward providing smoking cessation support to parents who are smokers and have young children, are pregnant, or are planning to have children. We believe that our results will serve to inform public health interventions to reduce childhood exposure to smoking at home, especially in rural areas.

The present findings also underscore the potential importance of education for public health. Ross et al. have suggested that adolescents who attain higher educational levels can close the health inequalities gap, even when they come from disadvantaged family backgrounds. (Ross and Mirowsky, 2011) Further, a previous study investigating the causal relationship between educational attainment and smoking status reported that more education led to a reduced likelihood of smoking initiation, a reduced amount of smoking, and a greater likelihood of smoking cessation among smokers. (Gage et al., 2018) Although the data used in the present study were drawn from cross-sectional surveys, our findings, considered in conjunction with the other research summarized above, suggest that promoting higher educational attainment may also contribute to disrupting the intergenerational transmission of negative health behaviors.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial

interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Author Contributions

NK conceptualized and designed the study, coordinated all the logistics, closely supervised the collection and analysis of the data, and was involved in writing the first version of the manuscript and revising the manuscript. TS was involved in the data collection and organization, as well as performing the statistical analysis. TS and MT drafted the first version of the manuscript. KS supervised the study and reviewed the manuscript for important intellectual content. TY and MU reviewed the manuscript. MT, on behalf of the School Health Board of the Hidaka Medical Association, coordinated the data collection and reviewed the manuscript for important intellectual content. All the authors read and approved the final manuscript.

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