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The association between family structure and adolescent smoking among multicultural students in Hawaii

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ABSTRACT

Objective. The purpose of this study was to examine whether the prevalence of smoking was associated with family structure among multicultural adolescents and whether there was gender disparity on the association.

Methods. Data were collected from a sample of 7th graders in Hawaii who completed in-class questionnaires in 2004. The final sample included 821 multicultural students from different family structures. Descriptive analyses, Chi-square tests and logistic regression were performed to examine the prevalence of smoking and the association between family structure and smoking prevalence.

Results. This sample contained students who lived in intact (61.7%), single-parent (16.5%), step-parent (15.6%), and no-parent (6.2%) families. The overall prevalence of ever/lifetime smoking was 24.0%, and was not significantly different between genders in each family structure ($P > 0.05$). Compared with living in intact families, living in single-parent, step-parent, or no-parent families was significantly associated with higher odds of ever/lifetime smoking among all students ($P < 0.05$) and living in single-parent and step-parent families was significantly associated with higher odds of ever/lifetime smoking among females ($P < 0.05$) and among males ($P < 0.05$) respectively, after adjusting for covariates.

Conclusions. These findings suggest that family structure is a risk factor for smoking among multicultural students. Anti-smoking programs should consider this factor.

Introduction

Smoking remains the most preventable cause of disease and premature death in the United States. During 2005–2009, an estimated 480,000 Americans died each year as a result of cigarette smoking and smoking-related illness (National Center for Chronic Disease Prevention and Health Promotion Office on Smoking and Health, 2014). Adolescence is a critical time period in the life cycle for the onset of cigarette smoking. In 2010 more than 88% of adult daily smokers started smoking before they were 18 years old, and 99% of them started smoking before the age of 26 years (National Center for Chronic Disease Prevention and Health Promotion Office on Smoking and Health, 2012). In the United States, approximately 3900 youths between the ages of 12 and 17 years smoked their first cigarette and 1000 became daily smokers per day in 2008 (SAMHSA, 2009). In 2004, a total of 11.7% of middle school students and 28.0% of high school students were current tobacco product users (e.g., cigarettes, cigars, smokeless tobacco, pipes, bidis, or kreteks) (CDC, 2005).

Studies have been conducted to examine the factors associated with adolescent smoking (Moolchan, Ernst, and Henningfield, 2000; Schepis and Rao, 2005; Turner, Mermelstein, and Flay, 2004; Tyas and Pederson, 1998). In general, parenting and family factors have played a rather minor role in these studies, with greater emphasis placed on personal, peer and social effects as well as on larger, socially contextual factors such as cigarette advertising. Recently there has been increased interest in family-based interventions both to deter adolescent substance abuse in general and to prevent adolescent cigarette smoking specifically (Simons-Morton and Farhat, 2010).

The negative and long-term effects of divorce on children, particularly during adolescence, have been a topic of frequent investigation. Findings from these studies continue to suggest that adolescents from divorced families experience poorer mental health, as well as more smoking and other drug use, than those from intact families (Fagan and Churchill, 2012). It has been shown that adolescents from non-intact families had higher prevalence of smoking and had earlier onset

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of cigarette use. Adolescents who lived in a step-family structure during their formative years were more likely to use tobacco and to consume alcohol by the age of 18 years (Brown and Rinelli, 2010). Similarly, single-parent households, or households with a mother and a stepfather present, have been shown to pose a risk for substance use (Musick and Meier, 2010).

While many studies have reported the effects of family structures on adolescents' health behaviors, most of these studies were conducted among general population in western countries. Little is known about the effects among Asian Americans and Pacific Islanders, a rapidly growing segment of the US population (US Census Bureau, 2012). Between 2000 and 2010, the Asian American population grew 43%, from 10.2 million to 14.7 million persons comprising 4.8% of the total population (Hoeffel et al., 2012). These statistics are significant in relation to racial and ethnic differences in the prevalence of smoking. For instance, Whites and Hispanics are more likely than African Americans to be smokers throughout adolescence (CDC, 1998) and Whites and Hispanics also appear to initiate smoking habits earlier than African Americans (CDC, 2013). Asian youths tend to exhibit lower rates of smoking than Whites and Hispanics but not African Americans (Chen and Unger, 1999; Epstein, Botvin, and Diaz, 1998). Pacific Islanders, unlike Asian Americans, smoke at high rates (Palmer et al., 2013).

Findings from previous studies among general population about the effects of family structures on adolescent smoking may not directly apply to the Asian American and Pacific Islander subgroup, because culture specific differences in household, relationships, and customs may result in differences in effects (Unger et al., 2006). Therefore, the purpose of this study was to examine the association between family structure and the prevalence of smoking among multicultural adolescents in Hawaii. According to the 2000 U.S. census, 239,655 persons living in Hawaii reported a Native Hawaiian ethnicity and 503,868 individuals were of Asian ancestry, among a total population of 1,211,537 (Department of Business and Economic Development and Tourism, 2000). The gender specific association was also investigated.

Methods

Study sample

Data on adolescent smoking patterns were obtained from a baseline survey from a longitudinal school-based smoking prevention program conducted in 2004 in Hawaii. The study population was a sample of 7th graders from six schools in the Island of Hawaii. The schools were selected for their high native Hawaiian representation and all 7th grade students were invited to participate. The schools were first ranked by student population size, ethnic makeup and their location on the island. The largest student populations with ethnic diversity and no single ethnicity exceeding 30% of the school's population were ranked the highest. Single ethnicity refers to disaggregated racial/ethnic groups such as Japanese, Chinese, Filipino, and Native Hawaiian. While ranking the schools, the top schools fell into two of three Complex Areas within the Hawaii Island District. A Complex Area is how the Hawaii State Department of Education organizes their schools under each Island's district. The Hawaii District health resource coordinators provided by the Hawaii State Department of Education served as liaisons between the project and the schools. The resource coordinators helped recruit the top three schools in their respective jurisdictions (East Hawaii District and West Hawaii District). Health and Physical Education classes were chosen as the classes to conduct the survey, because these classes were required courses which allowed the study team to survey all 7th graders.

As a result, a total of 1154 students were invited to participate in this study, among which 93 students declined to participate, 9 students were lost because they moved to other places, and 179 did not provided parental informed consent. Among the remaining 873 students (75.6% of 1154), 52 were absent on the survey day. Therefore, this study ultimately reported the results from 821 students, accounting for 71.1% (821 out of 1154) of those invited to participate, and 94.0% (821 out of 873) of those who consented to participate.

Procedure

Data were collected using a 118-item paper-and-pencil survey with questions about smoking, other health behaviors, and related factors. Parental informed consent and students' assent were obtained beforehand.

Measures

Smoking status

Three measures were used to assess three levels of smoking behaviors: ever/lifetime smoking ("Have you ever tried cigarette smoking, even a few puffs?"), past 30-day smoking ("Think about the last 30 days, on how many of these days did you smoke cigarettes?"), and established smoking ("Have you smoked at least 100 cigarettes in your life?").

Family structure

Family structures were defined with one question: "Which of these people live with you in your home?" Response options for this question included: "Mother", "Stepmother", "Father", "Stepfather", "Sister(s)", "Brother(s)", "Cousin(s)", "Aunt(s)", "Uncle(s)", and "Other: fill in". At analytical stage, students' responses were recoded into four categories representing four types of family structures: intact family (if respondents lived with assumed biological mother and biological father), single-parent family (if respondents lived with one assumed biological parent, but not both, and they did not live with a step-parent), step-parent family (if respondents lived with an assumed biological parent and a step-parent), and no-parent family (if respondents lived with grandparent(s), aunt(s), uncle(s), or others, and they did not live with a biological parent or step-parent).

Covariates

Demographic characteristics and other independent variables that had previously been demonstrated to be associated with smoking were included as covariates in the analyses.

Demographic variables examined included gender, age (years old), and race/ethnicity (students self-identified their race/ethnicity). At analytical stage, mean age was calculated and students' ages were dichotomized into two groups: $<$mean age and $\geq$mean age. Students' responses to race/ethnicity were also recoded into five categories at analytical stage: White, Latino, Asian (Chinese, Japanese, Filipino, Korean, Asian Indian etc.), Pacific Islander (Part/Native-Hawaiian, Marshallese, Samoan, or Guamanian/Chamorro), and Other (African American, American Indian, and other ethnicities).

Social economic status variables included: parents' highest levels of education, parent's employment, and household income. Because youth may know little or nothing about parents' absolute income, we used the following two questions as proxy measures of income: "How many people live in your home where you spend most of your time (including you)?" and "How many rooms does your house or apartment have (count every room EXCEPT the kitchen, bathrooms and closets)?". At analytical stage, a new variable, called housing status, was created by dividing the number of people living in the household by the number of rooms. This is a widely accepted proxy measure of income and has been validated as such (Rutstein and Johnson, 2004).

Other covariates include: mother smoking ("On an average day, about how many cigarettes does your mother smoke?"), father smoking ("On an average day, about how many cigarettes does your father smoke?"), friends smoking ("How many of your friends have ever tried smoking a cigarette?"), and alcohol drinking ("During your life, on how many days have you had at least one drink of alcohol?").

Statistical analyses

Frequencies were calculated to describe the demographic characteristics, social economic status, family structures, smoking status (ever/lifetime, past 30-day, and established smoking), parent smoking, friends smoking, and alcohol drinking of the sample. The calculation of smoking variables included only 796 students, because 25 surveyed students did not report their smoking status. Given that the prevalence rates of past 30-day smoking and established smoking were very low, only the measure of ever/lifetime smoking was used for further analyses to assure sufficient power for the testing.

The prevalence of ever/lifetime smoking and the 95% confidence intervals were calculated for all students and by gender and the above-mentioned variables. Chi-square tests were performed to examine the gender differences on the variables.

Unconditional univariate logistic regression was performed to examine the associations between adolescent smoking and family structure and other variables. Unconditional multivariate logistic regression was also performed to examine the association between adolescent smoking and family structure among all students and among females and males respectively, considering demographic characteristics, social economic status variables, parent smoking, friends smoking, and alcohol drinking as potential confounders. If any of the potential confounders contributed a 10% or more change on the odds ratios for family structures, it was kept in the model (Hernan, Hernandez-Diaz, Werler, and Mitchell, 2002). Otherwise, the variable was excluded.

In a multivariate model that included both genders, interactions between gender and family structures were tested with Wald Chi-Square tests. A significance level of $\alpha = 0.05$ was used throughout. All analyses were conducted using SAS 9.3 (SAS Institute, 2011).

Results

Characteristics of the sample

The characteristics of the sample are presented in Table 1. Of the 821 students surveyed, 4 students refused to report their gender. The remaining sample contained 817 students, among which 49.2% were females. The mean age was 12.7 years old (SD = 0.46). 59.2% of the students were Asian, others were White (10.8%), Latino (11.8%), Pacific Islander (14.0%), and other (4.2%).

Family structure breakdown showed that 61.7% of the students were from intact families, 16.5% were from single-parent families, 15.6% were from step-parent families, and 6.2% were from no-parent families. There

Table 1
Characteristics of the study sample by gender.

Characteristic	All	Female	Male	Gender difference
	n (%)	n (%)	n (%)	
		402 (49.2)	415 (50.8)	
Age (years)				
<12.7	337 (43.3)	171 (44.1)	166 (42.6)	$X^2(1) = 0.2$,
≥12.7	441 (56.7)	217 (55.9)	224 (57.4)	$P = 0.67$
Ethnicity				
White	88 (10.8)	36 (9.0)	52 (12.6)	
Latino	96 (11.8)	57 (14.2)	39 (9.5)	
Asian	481 (59.2)	241 (60.1)	240 (58.3)	$X^2(4) = 9.5$,
Pacific Islander	114 (14.0)	48 (12.0)	66 (16.0)	$P = 0.05$
Other	34 (4.2)	19 (4.7)	15 (3.6)	
Parent education				
Father and mother ≤ HS	174 (31.2)	92 (33.8)	82 (28.8)	$X^2(1) = 1.7$,
At least one parent > HS	383 (68.8)	180 (66.2)	203 (71.2)	$P = 0.20$
Parent employment				
Not both employed	176 (27.1)	98 (30.2)	78 (24.0)	$X^2(1) = 3.2$,
Both employed	473 (72.9)	226 (69.8)	247 (76.0)	$P = 0.07$
Housing status[a]				
≥1 people/room	563 (70.7)	296 (74.7)	267 (66.8)	$X^2(1) = 6.1$,
<1 people/room	233 (29.3)	100 (25.3)	133 (33.3)	$P = 0.01$
Ever/lifetime smoking				
No	604 (76.0)	287 (73.6)	317 (78.3)	$X^2(1) = 2.4$,
Yes	191 (24.0)	103 (26.4)	88 (21.7)	$P = 0.12$
Past 30-day smoking				
No	725 (94.2)	351 (93.6)	374 (94.7)	$X^2(1) = 0.4$,
Yes	45 (5.8)	24 (6.4)	21 (5.3)	$P = 0.52$
Established smoking				
No	783 (98.5)	382 (97.9)	401 (99.0)	$X^2(1) = 1.5$,
Yes	12 (1.5)	8 (2.1)	4 (1.0)	$P = 0.22$
Mother smoking				
No	594 (79.8)	284 (77.8)	310 (81.8)	$X^2(1) = 1.8$,
Yes	150 (20.2)	81 (22.2)	69 (18.2)	$P = 0.18$
Father smoking				
No	535 (75.6)	252 (75.0)	283 (76.1)	$X^2(1) = 0.1$,
Yes	173 (24.4)	84 (25.0)	89 (23.9)	$P = 0.74$
Friends smoking				
No	368 (47.4)	154 (40.1)	214 (54.5)	$X^2(1) = 16.0$,
Yes	409 (52.6)	230 (59.9)	179 (45.5)	$P < 0.001$
Alcohol drinking				
Not drinking	543 (70.1)	263 (68.7)	280 (71.4)	$X^2(1) = 0.7$,
Ever drinking	232 (29.9)	120 (31.3)	112 (28.6)	$P = 0.40$
Family structure				
Intact family	504 (61.7)	240 (59.7)	264 (63.6)	
Single-parent family	135 (16.5)	69 (17.2)	66 (15.9)	$X^2(3) = 1.4$,
Step-parent family	127 (15.6)	66 (16.4)	61 (14.7)	$P = 0.71$
No parent family	51 (6.2)	27 (6.7)	24 (5.8)	

[a] Family members/rooms.

was no gender difference on the distributions of family structures ($P \geq 0.05$).

Prevalence of smoking

The prevalence of the ever/lifetime, past 30-day, and established smoking was 24.0%, 5.8%, and 1.5% respectively (Table 1).

The detailed prevalence of ever/lifetime smoking and the 95% confidence intervals by gender and other variables are shown in Table 2. In general, the smoking prevalence was higher among older students (28.1%) than among younger students (19.0%). The smoking prevalence was higher among students whose parents had lower education levels (33.7%) than others whose parents had higher education levels (20.3%), was higher among students whose parents were not both employed (25.0%) than others whose parents were both employed (21.9%), and was higher among students who lived in housing with one or more people per room (27.3%) than others who lived in housing with less than one person per room (16.7%). The smoking prevalence was also higher among students whose mothers, fathers, or friends smoked than other students whose mothers, fathers, or friends did not smoke (38.0% vs 19.7%, 33.1% vs 19.0%, and 40.0% vs 6.2%, respectively). Students who had ever drunk alcohol had higher smoking prevalence than others who had not drunk alcohol (54.4% vs 11.3%). Among all ethnicities, Pacific Islander students had the highest smoking prevalence (31.3%), while White students had the lowest smoking prevalence (12.9%).

The prevalence of ever/lifetime smoking was 16.9% among students living in intact families, but it was much higher among students who lived in single-parent families (32.8%), step-parent families (35.7%), and no-parent families (42.0%). There was no gender difference on the smoking prevalence in each family structure.

Multivariate logistic regression analyses of associations with ever/lifetime smoking

After adjusting for covariates, in the multivariate model that contained both genders, all of the tested interaction terms between family structure and gender (e.g., single-parent family structure with gender, step-parent family structure with gender, and no-parent family structure with gender) were statistically insignificant (Wald $x^2 = 0.27$, $P = 0.60$; Wald $x^2 = 1.22$, $P = 0.27$; and Wald $x^2 = 0.22$, $P = 0.64$, respectively). Despite the insignificance, we moved forward to the testing of logistic regression models among females and males respectively, because of our interest in the gender disparities.

The results from final multivariate logistic regression models are shown in Table 3, with comparisons with results from unadjusted models. Several independent variables were retained in final multivariate logistic regression models. However, the retained covariates were not the same in different models for all, male, and female students, respectively.

Among all students, family structure was significantly associated with the prevalence of ever/lifetime smoking. Compared with students living in intact families, students living in single-parent families (adjusted OR = 3.5; 95% CI = 1.4, 8.7), step-parent families (adjusted OR = 2.4; 95% CI = 1.1, 5.3), or no-parent families (adjusted OR = 7.0; 95% CI = 1.1, 42.7) were significantly more likely to have smoked. Family

Table 2
Prevalence of ever/lifetime smoking and 95% confidence interval.

Characteristic	All	Female	Male	Gender difference
	% (95% CI)	% (95% CI)	% (95% CI)	
	24.0 (21.0, 27.0)	26.4 (22.0, 30.8)	21.7 (17.7, 25.8)	$P = 0.12$
Family structure				
Intact family	16.9 (13.6, 20.2)	17.5 (12.7, 22.3)	15.5 (11.2, 19.9)	$P = 0.52$
Single-parent family	32.8 (24.7, 41.0)	37.7 (26.2, 49.1)	24.2 (13.9, 34.6)	$P = 0.06$
Step-parent family	35.7 (27.3, 44.1)	33.3 (21.9, 44.7)	37.7 (25.5, 49.9)	$P = 0.56$
No parent family	42.0 (28.3, 55.7)	48.1 (29.3, 67.0)	33.3 (14.4, 52.2)[b]	$P = 0.40$
Age (years)				
<12.7	19.0 (14.8, 23.3)	22.2 (16.0, 28.5)	15.1 (9.6, 20.5)	$P = 0.09$
≥12.7	28.1 (23.8, 32.4)	28.6 (22.5, 34.6)	25.9 (20.1, 31.6)	$P = 0.50$
Ethnicity				
White	12.9 (5.8, 20.1)[b]	8.3 (0.0, 17.4)[b]	15.4 (5.6, 25.2)[b]	$P = 0.32$
Latino	29.5 (20.3, 38.7)	33.3 (21.1, 45.6)	23.1 (9.8, 36.3)[b]	$P = 0.31$
Asian	22.9 (19.1, 26.7)	23.7 (18.3, 29.0)	20.8 (15.7, 26.0)	$P = 0.40$
Pacific Islander	31.3 (22.6, 39.9)	39.6 (25.7, 53.4)	24.2 (13.9, 34.6)	$P = 0.10$
Other	31.2 (15.2, 47.3)[b]	26.3 (6.5, 46.2)[b]	33.3 (9.4, 57.2)[b]	$P = 0.81$
Parent education				
Father and mother ≤ HS	33.7 (26.6, 40.9)	33.7 (24.0, 43.4)	31.7 (21.6, 41.8)	$P = 0.92$
At least one parent > HS	20.3 (16.2, 24.4)	19.4 (13.6, 25.2)	20.2 (14.7, 25.7)	$P = 0.99$
Parent employment				
Not both employed	25.0 (18.4, 31.6)	21.4 (13.3, 29.6)	26.9 (17.1, 36.8)	$P = 0.42$
Both employed	21.9 (18.1, 25.6)	24.3 (18.7, 29.9)	18.6 (13.8, 23.5)	$P = 0.12$
Housing status[a]				
≥1 people/room	27.3 (23.5, 31.0)	29.7 (24.5, 34.9)	23.2 (18.1, 28.3)	$P = 0.07$
<1 people/room	16.7 (11.9, 21.6)	14.0 (7.2, 20.8)[b]	18.0 (11.5, 24.6)	$P = 0.39$
Mother smoking				
No	19.7 (16.5, 23.0)	18.3 (13.8, 22.8)	20.6 (16.1, 25.2)	$P = 0.48$
Yes	38.0 (30.2, 45.8)	46.9 (36.0, 57.8)	27.5 (17.0, 38.1)	$P = 0.02$
Father smoking				
No	19.0 (15.7, 22.4)	20.2 (15.3, 25.2)	17.7 (13.2, 22.1)	$P = 0.43$
Yes	33.1 (26.1, 40.2)	35.7 (25.4, 46.0)	30.3 (20.8, 39.9)	$P = 0.48$
Friends smoking				
No	6.2 (3.7, 8.7)	4.5 (1.2, 7.8)[b]	7.0 (3.6, 10.4)[b]	$P = 0.33$
Yes	40.0 (35.2, 44.9)	40.0 (33.7, 46.3)	38.5 (31.4, 45.7)	$P = 0.70$
Alcohol drinking				
Not drinking	11.3 (8.6, 14.0)	11.0 (7.2, 14.8)	11.1 (7.4, 14.8)	$P = 0.99$
Ever drinking	54.4 (47.9, 60.9)	58.3 (49.5, 67.2)	47.3 (38.1, 56.6)	$P = 0.07$

[a] Family members/Rooms.
[b] Estimate has a relative standard error ≥23%.

Table 3
Crude and adjusted odds ratios of ever/lifetime smoking.

Characteristic	All		Female		Male	
	Crude OR (95% CI)	Adjusted OR[a] (95% CI)	Crude OR (95% CI)	Adjusted OR[b] (95% CI)	Crude OR (95% CI)	Adjusted OR[c] (95% CI)
Gender						
Female	1.0	1.0	N/A	N/A	N/A	N/A
Male	0.8 (0.6, 1.1)	2.3 (1.2, 4.2)	N/A	N/A	N/A	N/A
Family structure						
Intact family	1.0	1.0	1.0	1.0	1.0	1.0
Single-parent family	2.4 (1.6, 3.7)	3.5 (1.4, 8.7)	3.1 (1.7, 5.7)	5.1 (1.2, 22.0)	1.8 (0.9, 3.4)	4.2 (0.9, 18.9)
Step-parent family	2.7 (1.8, 4.2)	2.4 (1.1, 5.3)	2.3 (1.2, 4.2)	1.5 (0.4, 5.2)	3.3 (1.8, 6.1)	3.6 (1.0, 12.1)
No-parent family	3.6 (1.9, 6.6)	7.0 (1.1, 42.7)	4.2 (1.8, 9.6)	9.0 (0.7, 123.0)	3.0 (1.2, 7.7)	2.1 (0.1, 47.0)
Age (years)						
<12.7	1.0	1.0	1.0	N/A	1.0	1.0
≥12.7	1.7 (1.2, 2.4)	2.2 (1.2, 4.0)	1.4 (0.9, 2.3)	N/A	2.0 (1.2, 3.4)	3.1 (1.2, 7.7)
Ethnicity						
White	1.0	1.0	1.0	1.0	1.0	1.0
Latino	2.8 (1.3, 6.1)	3.2 (0.8, 12.1)	5.3 (1.4, 19.7)	3.4 (0.4, 32.5)	1.6 (0.6, 4.7)	2.7 (0.4, 18.6)
Asian	2.0 (1.0, 3.9)	3.8 (1.2, 11.8)	3.5 (1.0, 11.8)	3.0 (0.5, 18.9)	1.4 (0.6, 3.2)	4.1 (0.9, 19.2)
Pacific Islander	3.1 (1.4, 6.5)	6.3 (1.6, 24.5)	7.0 (1.9, 26.1)	8.0 (0.8, 85.1)	1.7 (0.7, 4.5)	8.6 (1.5, 49.9)
Other	3.1 (1.1, 8.1)	6.7 (1.3, 35.4)	4.4 (0.9, 21.5)	6.6 (0.5, 94.8)	2.6 (0.7, 9.8)	4.2 (0.4, 43.4)
Parent education						
Father and mother ≤ HS	1.0	1.0	1.0	1.0	1.0	1.0
At least one parent > HS	0.5 (0.3, 0.8)	1.1 (0.6, 2.1)	0.5 (0.3, 0.9)	1.3 (0.5, 3.7)	0.5 (0.3, 0.9)	0.8 (0.3, 1.9)
Parent employment						
Not both employed	1.0	N/A	1.0	N/A	1.0	1.0
Both employed	0.8 (0.6, 1.3)	N/A	1.1 (0.6, 2.0)	N/A	0.6 (0.3, 1.1)	0.8 (0.3, 2.5)
Housing status[d]						
≥1 people/room	1.0	1.0	1.0	1.0	1.0	N/A
<1 people/room	0.5 (0.4, 0.8)	0.5 (0.2, 0.9)	0.4 (0.2, 0.7)	0.5 (0.1, 1.8)	0.7 (0.4, 1.2)	N/A
Mother smoking						
No	1.0	1.0	1.0	1.0	1.0	N/A
Yes	2.5 (1.7, 3.7)	1.4 (0.6, 3.0)	3.9 (2.3, 6.6)	2.8 (0.8, 9.7)	1.4 (0.8, 2.6)	N/A
Father smoking						
No	1.0	1.0	1.0	1.0	1.0	1.0
Yes	2.1 (1.4, 3.1)	0.9 (0.5, 2.0)	2.2 (1.3, 3.7)	0.7 (0.2, 2.4)	2.0 (1.2, 3.5)	1.0 (0.3, 2.8)
Friends smoking						
No	1.0	1.0	1.0	1.0	1.0	1.0
Yes	10.2 (6.3, 16.4)	11.6 (5.1, 26.4)	14.0 (6.3, 31.3)	12.7 (2.6, 63.1)	8.2 (4.5, 15.1)	8.0 (2.9, 21.9)
Alcohol drinking						
Not drinking	1.0	1.0	1.0	1.0	1.0	1.0
Ever drinking	9.4 (6.4, 13.6)	8.8 (4.7, 16.5)	12.0 (7.0, 20.5)	27.8 (9.1, 85.4)	7.3 (4.3, 12.4)	6.6 (2.7, 16.5)

[a] Among all population, Hosmer–Lemeshow Goodness-of-Fit Test: $X^2 = 7.2159$, $P = 0.5135$, indicating fit the model well.
[b] Among female, Hosmer–Lemeshow Goodness-of-Fit Test: $X^2 = 2.2896$, $P = 0.9708$, indicating fit the model well.
[c] Among male, Hosmer–Lemeshow Goodness-of-Fit Test: $X^2 = 7.5469$, $P = 0.4789$, indicating fit the model well.
[d] Family members/rooms.

structure was also significantly associated with ever/lifetime smoking among females and males, respectively. Compared to students living in intact families, students living in single-parent families were more likely to have smoked among females (adjusted OR = 5.1; 95% CI = 1.2, 22.0), and students living in step-parent families were more likely to have smoked among males (adjusted OR = 3.6; 95% CI = 1.0, 12.1). Hosmer and Lemeshow Goodness-of-Fit Tests indicated that the models were in good fit ($P > 0.10$).

Discussion

The overall prevalence of ever/lifetime smoking was 24.0% in this study, which is comparable to what has been reported by other studies involving adolescents conducted in other regions of the United States. For instance, the ever/lifetime smoking was 27.6% among a sample of seven graders in Wisconsin (Palmersheim et al., 2005). However, among Asian students which accounted for the majority of the sample (59.2%), the prevalence of ever/lifetime smoking was 22.9%, which is higher than that in another sample of ethnically diverse students in California (16.1%) (Chen et al., 1999).

From 1991 to 2009, the percentage of children in the United States under the ages of 18 years who lived with two biological parents decreased steadily from 72.8% to 68.6%. During this period, the percentage of children living in mother-only families increased from 21.2% to 23.6%, and those living in father-only families increased from 2.7% to 3.7%. But the percent of children living in no-parent families (with other relatives or with non-relatives) stayed fairly constant at about 3.3%–4.2% (Kreider and Ellis, 2011). In this Hawaii sample, 61.7% of students lived with both parents in an intact family structure, while 16.5% lived in single-parent families, and 15.6% lived in step-parent families. Interestingly, 6.2% of students were in no-parent families, which is higher than the national data shown above (3.3%–4.2%). This may be particular to Polynesia where children are often raised in an extended family.

This study indicates that family structure was associated with adolescent smoking. Students who lived in single-parent families, step-parent families, or no-parent families had higher odds of ever/lifetime smoking than other students who lived with both biological parents. These results are consistent with findings from many other studies. For example, Razaz-Rahmati et al. (2012) reported that, among respondents aged 12–19 years who participated in the Canadian Community Health Survey, the odds of smoking in single-parent households was 1.78 times greater than the odds of smoking in two-parent households, and the odds of smoking in no-parent households was 1.47 times greater than the odds of smoking in two-parent households (Razaz-Rahmati, Nourian, and Okoli, 2012). Brown and Rinelli (2010) reported that adolescents in two biological married parent families were less likely to smoke than adolescents in single-mother families, married stepfamilies,

and cohabiting stepfamilies (Brown and Rinelli, 2010). Bjarnason et al. (2003) reported that adolescents living with both biological parents smoked less than those living with single parent, mothers–stepfathers or neither biological parent (Bjarnason et al., 2003). Similar findings were even obtained from special population. For example, a study investigating smoking among asthmatic adolescents revealed that asthmatic adolescents who resided in the household of a non-intact family had a 1.90 times greater risk of smoking compared with those who lived with both biological parents (Vazquez-Nava et al., 2010).

However, a few inconsistent results can be found elsewhere. For example, Wagner et al. (2008) conducted a study with 9-grade students from predominantly Latino Los Angeles area high school and found that there was no significant difference between students living with both parents and other students living with single parent, siblings, other relatives, or non-related individuals (Wagner, Ritt-Olson, Soto, and Unger, 2008). One study conducted in eleven European countries ever demonstrated that the effects of living with single parent or with neither biological parents on smoking were stronger in countries where such family types were less common (Bjarnason et al., 2003). Based on this finding, we may infer that the reason why the effect of other family structures on adolescent smoking was smaller in Wagner et al. study may be partially due to the study sample overwhelmingly consisted of Latino students (83% of the total), among whom not living with both biological parents might be more common.

This study indicates that there was gender disparity on the association between family structure and adolescent smoking. Some previous studies reported that adolescent girls had a stronger and negative reaction to a parent's remarriage than boys (Hethrington, Bridges, and Insabella, 1998; Vuchinich, Hethrington, Vuchinich, and Clingempeel, 1991) and remarriage has been associated with increased drug use by adolescent girls (Needle, Su, and Doherty, 1990). However, in the present study, male adolescents living in step-parent families were more likely to have ever smoked than female adolescents, which indicates that remarriage might have stronger influence on smoking among male adolescents instead in this study. On the contrary, female adolescents living in unmarried single-parent families were more likely to smoke.

The findings of this study may have some theoretical implications. Research indicates that parental problems and behaviors exert important and sometimes enduring influences on children (Bahr and Hoffmann, 2010; Bahr, Hoffmann, and Yang, 2005). Parental divorce and living in single parent, step-parent, or no parent families may be associated with decreased family attachment and less adult supervision. This may result in a higher likelihood of hanging along with smoking peers and friends, which is associated with initiation of smoking (Wang, Fitzhugh, Westerfield, and Eddy, 1995).

In summary, the present study examines the association between family structure and smoking among multicultural adolescents in Hawaii. It indicates that family structure is a risk factor of ever/lifetime smoking. Living in single-parent families, step-parent families, and no-parent families are all associated with higher odds of ever/lifetime smoking and the association differ between genders. Future anti-smoking programs, especially targeting similar multicultural adolescents, should take into account family structure, pay special attention to those adolescents who are not living with both biological parents, and consider adding family-based and gender specific interventional components to make smoking prevention programs more effective.

We should acknowledge several limitations of this study. First, the sample size was relatively small which hindered more in-depth analyses. For example, the measures of past 30-day smoking and 100 + cigarette smoking are commonly used in childhood and adolescence research. However, the small numbers of subjects reporting such smoking status precluded analysis of these variables as the outcomes for this study. Although no-parent family structure was significantly associated with higher prevalence of ever/lifetime smoking among all students of this study, the association became insignificant when the analyses were conducted by gender. While the results could be true, it could also be possible that the sample size, as well as the percentage of students living in no-parent families, was too small such that there was not sufficient power to detect the association. The relatively small sample size also did not allow us to conduct more analyses to investigate ethnic variations. Therefore, future studies with more sufficient sample sizes will be valuable for the testing of the association between family structure and more advanced smoking behaviors within different ethnic groups. Second, in this study we assumed that students who said they lived with "Mother" or "Father" were living with their biological mother or biological father, because otherwise they could have chosen other options on the questionnaires, such as "Stepmother" or "Stepfather". Future studies can be clearer by specifying "Biological Mother" and "Biological Father" in response options to avoid any possible confusion even if it is minimal. Third, this study was based on adolescents' self-reporting on their own smoking behavior as well as of their family structures, and thus may suffer from possible recall and social desirability biases (Tennekoon and Rosenman, 2013). However, self-administered questionnaires are often used to measure smoking behavior among adolescents and have been found to be as valid and reliable as a more objective method such as biochemical verification for smoking (Perez-Stable, Benowitz, and Marin, 1995; Rebagliato, 2002). Finally, these cross-sectional data only report associations from an epidemiological perspective and cannot offer an explanation as to why family structure may affect differences in smoking patterns. Longitudinal data may provide more insight into family structures and subsequent initiation of smoking in adolescents.

Conflict of interest

All authors declare that they have no conflicts of interest.

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