

The importance of socio-environmental and personal factors related with smoking among high school seniors in western Kanagawa Prefecture, Japan

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Objectives The purpose of this study was to identify socio-environmental and personal variables associated with high school students smoking behavior by applying multilevel analyses.

Methods A cross-sectional survey of the first-year students of five public senior high schools in western Kanagawa Prefecture, Japan was conducted using multilevel logistic regression analyses with students at level 1 and schools at level 2. Self-administered questionnaires were returned by 517 out of 597 enrolled students, and information was collected regarding the prevalence of previous and current smoking and socio-environmental, educational and personal variables.

Results The rates of past and current smoking were found to be 25.2% and 12.6% in males and 16.9% and 5.2% in females, respectively. Maternal smoking, having friends or older school-mates who smoked and lower probabilities of high school academic achievement potential were significantly associated with both past (adjusted ORs of 2.37, 4.28 and 2.98, respectively) and current (adjusted ORs 2.46, 5.57 and 3.02) smoking.

Conclusions It is recommended that health professionals in charge of school-based educational programs should tailor the teaching methods to fit the students' backgrounds and specific vulnerabilities. Educational programs for smoking prevention focusing on the students' mothers and classmates or students in high schools with reduced academic achievement potential should be developed.

Key words : adolescent smoking, smoking variables, school-based programs, multilevel logistic regression analyses

Introduction

Cigarette smoking is considered to be the chief preventable cause of premature disease and death.¹⁾ Despite admonitions, an estimated 150 million adolescents worldwide use tobacco, and approximately half of these young smokers will die of tobacco-related diseases in later life.²⁾ Along with increased risks of heart disease, cancer, and premature mortality, adolescent smokers disproportionately develop a host of more immediate health effects, including reduced lung function,³⁾ altered serum cholesterol levels, and nicotine dependence,¹⁾ culminating in a reduction in overall health, fitness, and endurance.⁴⁾

The majority of daily smokers (82%) begin smoking before 18 years of age.⁵⁾ Moreover, the younger an individual begins to smoke, the more likely that individual will be a regular smoker as an adult.¹⁾ Earlier onset is also associated with heavier tobacco use; those who begin to use tobacco as adolescents are among the heaviest users during both adolescence and adulthood.^{1,6)}

Nearly all initiation of tobacco use occurs before high school graduation, suggesting that if adolescents can remain tobacco-free, most will never start the habit.¹⁾ Therefore, a strong case can be made for youth intervention programs that address both prevention and treatment.⁷⁾

Nicotine is one of the most commonly available and widely used drugs, and repeated use often results in nicotine dependence. Use of other drugs, such as marijuana and cocaine, is often preceded by the use of tobacco.^{1,8)} As a consequence, recent reports on preventing drug abuse suggest that approaches effective in preventing tobacco use can also help prevent the use of alcohol and other drugs.⁵⁾

The purpose of the present study was to determine associations between adolescent smoking and social/environmental, educational and personal variables. National surveillance systems for adolescent behavior have been introduced in the United States as well as several European countries and provided insightful associations between smoking and related social variables. In Japan, previous studies attempted to do the same,⁹⁾ although they rarely corrected for multivariate factors.¹⁰⁾ Therefore we focused on confounding in the

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present study, with the aim of finding effective methods to prevent high school students from smoking.

Methods

Design and data collection

Odawara Health and Welfare Centre is a branch office of the Kanagawa Prefecture Office, Japan, which oversees the region comprising Odawara, Hakone, Manazuru and Yugawara municipalities (population of 249,551 as of October 1, 2004). Within the jurisdiction of Odawara Health and Welfare Centre there were five public senior high schools as of October 1, 2004. A cross-sectional survey of the first-year students of these five public senior high schools was conducted.

From October 2004 through November 2004, students from three randomly selected classes in each senior high school ($n = 597$) were enrolled in our study out of a total of 1,347 first-year students in all the senior high schools. The number of first-year classes in each school ranged from five to eight. Students were enrolled regardless of their age. None were in part-time courses. The students enrolled were informed that participation was voluntary, and all questionnaires were self-administered. Students were asked to fill out the questionnaires anonymously and seal them in envelopes before collection by teachers.

Outcome variables

Information was collected regarding prevalence of past and current smoking. Past smokers (users) were defined as those students who reported having smoked cigarettes previously. Current smokers were defined as those students who reported having smoked one or more cigarettes in the 30 days preceding the survey. Outcome variables for both past and current smokers were coded 0 for non-smokers and 1 for smokers.

School-level variables

Data on the rate of advancement of high school graduates in the participant's senior high school to higher-level coursework (such as universities and junior colleges) were obtained from a 2006 survey conducted by the board of education in Kanagawa Prefecture.¹¹⁾ This measure is referred to here as a senior high school's academic achievement potential, and reduced high school academic potential (<50%) was defined as a variable of those students belonging to a school which had less than 50% of new graduates advance to higher-level coursework.

Student-level variables

Enrolled students were asked whether they have ever received any school-based programs on smoking prevention and whether they perceived that either active smoking or exposure to second-hand smoke was harmful. The smoking status of friends/older schoolmates, teachers in their own schools and their parents was also

evaluated. As data on school-based programs or teachers smoking status had also been collected from each student, these variables were treated as student-level variables.

Ethical considerations

Permission to perform this study was given by the ethics committee of Odawara Health and Welfare Center held on June 24, 2004. It was approved that each high school agreed to carry out this survey on the condition that the smoking prevalence among students in each school was kept confidential.

Analyses

Initially, univariate analyses were conducted at a 2-tailed $\alpha = .05$ significance level to evaluate the relationships of prevalence of past or current smoking with variables obtained through the questionnaire. We considered only models for two-level hierarchical structures with students at level 1 and schools at level 2. Then, the following sequences of three models were applied for past/current smokers: null model, two-level random intercept model and two-level random coefficient model. The data were analyzed with the program MLwiN version 2.20. Null models were applied to establish whether students past or current smoking status varied across schools. Two-level random intercept models were applied to see how the student-level variables are related with the students smoking status on the condition that we assume that effects of student-level variables are the same for each school. Two-level random coefficient models were applied to obtain adjusted odds ratios (OR) and 95% confidence intervals for the student-level and school-level variables and to see how these are related with the student past or current smoking status and how their effects vary across schools.

Results

Out of 597 enrolled students, 557 (93.3%) agreed to participate in the study and returned completed questionnaires. Table 1 shows characteristics of the respondents.

Tables 2 and 3 show the estimates and standard errors obtained from the multilevel models for past and current users, respectively. Outcome variables were dichotomous. In the null models, we calculated the Wald statistic for testing the null hypothesis that the school-level variances $\sigma_{u0}^2 = 0$. The null model showed the school-level variances σ_{u0}^2 were not significant for past smokers ($p = 0.146$) or current smokers ($p = 0.175$). In both Tables 2 and 3 there was little change in the estimates of parameters that were common to both two-level random intercept and coefficient models, although reduction was noted in the school-level vari-

Table 1 Characteristics of respondents

	No (%)
Total	514(100.0%)
Student-level variable	
Gender	
Female	213(41.4%)
Male	301(58.6%)
Previous exposure to school-based programs on the prevention of tobacco use	
No	20(3.9%)
Yes	494(96.1%)
Smoking status	
Father	
Non-smoker	259(50.4%)
Smoker	255(49.6%)
Mother	
Non-smoker	375(73.0%)
Smoker	139(27.0%)
Friends and older schoolmates	
Non-smoker	368(71.6%)
Smoker	146(28.4%)
Teachers	
Non-smoker	415(80.7%)
Smoker	99(19.3%)
Perception that active smoking is harmful	
Harmful	399(77.6%)
Not harmful	115(22.4%)
Perception that passive smoking is harmful	
Harmful	436(84.8%)
Not harmful	78(15.2%)
School-level variable	
Senior high school academic achievement potential ^a	
$\geq 50\%$ ^b (Two schools)	200(38.9%)
$< 50\%$ ^c (Three schools)	314(61.1%)

^a Rate of graduates' advancement to higher level coursework

^b Students belonging to the school whose graduates' advancement rate is 50% and over

^c Students belonging to the school whose graduates' advancement rate is under 50%

ances σ_{u0}^2 .

In Tables 4 and 5, adjusted odds ratios and 95% confidence intervals for the variables were converted from the estimates and standard errors in the two-level random coefficient models in Tables 2 and 3.

Table 4 shows the results of data analyses regarding past users. Out of 514 respondents, 112 (21.8%) reported smoking in the past. As to the associations of student-level variables with past use, paternal and maternal smoking and having friends or older schoolmates who smoked were found to be significantly associated with adjusted odds ratios of 0.56, 2.37 and

4.28, respectively. Although univariate analyses indicated a significant association of past use with the male gender, teachers' smoking, and the perception of a hazardous effect on health by active smoking or passive smoking, these associations were lost in the two-level random coefficient model.

Table 5 shows the results of the survey for current smokers. Out of 514 respondents, 49 (9.5%) reportedly had smoked cigarettes in the 30 days preceding the survey.

As to the associations of student-level variables with current smokers, male gender, maternal smoking and having friends or older schoolmates who smoke were associated with adjusted odds ratios of 2.28, 2.46 and 5.57, respectively. Although the results of univariate analyses indicated a significant association of current smoking with the perception of hazardous effect on health by active/passive smoking, this was lost in the two-level random coefficient model.

As shown in Tables 4 and 5, when a school-level variable (senior high school academic achievement potential) was introduced in two-level random coefficient models, associations did not significantly vary across schools for past smokers ($p=0.731$) or current smokers ($p=0.983$). However, significant associations between high school academic achievement potential and past and current smokers were found with adjusted odds ratios of 2.98 and 3.02, respectively.

Discussion

This study found that 25.2% and 12.6% of males and 16.9% and 5.2% of females in the first year of senior high schools were past and current smokers, respectively. In comparison, nationwide surveys conducted in Japan between 1990–2004^{9,12~14}) revealed that 30.9–47.7% of males and 12.1–30.6% of females in the first year of senior high schools were past tobacco smokers while 11.3–24.9% of males and 3.0–10.9% of females were current smokers. Although the prevalence of past and current smokers was found to be lower than that of nationwide surveys, there might be differences in sampling representativeness of senior high schools. Furthermore, there is possibility that students falsely reported their smoking status during completion of the questionnaires despite being asked to return them in a sealed envelope, owing to the presence of teachers.

Social, environmental, behavioral, and personal factors determine the onset of tobacco use among adolescents.¹⁾ It was previously shown that these include lower socioeconomic status, parental smoking, sibling smoking, friends smoking, lower self-esteem, and lower scholastic performance.^{1,15,16)} It is also known that simply believing that smoking is harmful is negatively associated with being a smoker.¹⁷⁾ In the present study we examined additional factors, including prior history of tobacco-related education, and teachers' smoking behavior, both of which may influence smok-

Table 2 Estimates of past users from null, random intercept and random coefficient logit models

Parameter	Null model		Two-level random intercept model		Two-level random coefficient model	
	Est.	SE	Est.	SE	Est.	SE
Constant (β_0)	-1.301	0.369	-2.402	0.785	-3.156	0.779
Student-level variable						
β_1 (Gender)			0.055	0.265	0.111	0.270
β_2 (Previous exposure to school-based programs)			0.357	0.726	0.350	0.732
β_3 (Father)			-0.556	0.250	-0.587	0.254
β_4 (Mother)			0.861	0.269	0.864	0.267
β_5 (Friends and older schoolmates)			1.410	0.263	1.453	0.264
β_6 (Teachers)			0.003	0.296	-0.007	0.302
β_7 (Perception that active smoking is harmful)			0.480	0.286	0.498	0.289
β_8 (Perception that passive smoking is harmful)			0.111	0.344	0.039	0.337
School-level variable						
β_9 (Senior high school academic achievement potential)					1.091	0.366
σ_{u0}^2 (intercept variance)	0.622	0.428	0.297	0.232	0.000	0.000
σ_{u9}^2 (slope variance)					0.098	0.124
σ_{u09} (intercept-slope covariance)					0.000	0.000
Est.	Estimate					
SE	Standard Error					

Table 3 Estimates of current users from null, random intercept and random coefficient logit models

Parameter	Null model		Two-level random intercept model		Two-level random coefficient model	
	Est.	SE	Est.	SE	Est.	SE
Constant (β_0)	-2.263	0.401	-4.247	1.134	-5.085	1.191
Student-level variable						
β_1 (Gender)			0.690	0.393	0.825	0.385
β_2 (Previous exposure to school-based programs)			0.335	1.081	0.369	1.090
β_3 (Father)			-0.227	0.348	-0.241	0.341
β_4 (Mother)			0.991	0.360	0.900	0.351
β_5 (Friends and older schoolmates)			1.750	0.365	1.717	0.365
β_6 (Teachers)			-0.442	0.407	-0.454	0.401
β_7 (Perception that active smoking is harmful)			0.427	0.384	0.402	0.377
β_8 (Perception that passive smoking is harmful)			0.472	0.435	0.295	0.424
School-level variable						
β_9 (Senior high school academic achievement potential)					1.104	0.522
σ_{u0}^2 (intercept variance)	0.688	0.507	0.147	0.183	0.000	0.000
σ_{u9}^2 (slope variance)					0.016	0.086
σ_{u09} (intercept-slope covariance)					0.000	0.000
Est.	Estimate					
SE	Standard Error					

ing among adolescents. Furthermore, it appears that the school environment represents a broader contextual factor that is associated with youth smoking, although it is not clear how school characteristics directly or indirectly influence smoking behavior.¹⁸⁾ It is important to identify whether school-level variables are associated with variability.

This study showed that males had a significantly higher rate for either previous or current smoking as compared to females, in agreement with previous nationwide surveys in Japan.^{9,12~14)} The same situation is prevalent in many countries, as the Global Youth Tobacco Survey (GYTS) also showed that males were significantly more likely than females to

Table 4 Odds ratios (OR) and 95% confidence intervals (95% CI) for past users

Variables	Past users (n = 112)	No past use (n = 402)	Past users' rate (%)	Crude OR	95% CI ^a	Adjusted OR ^b	95% CI ^a
Total	112	402	21.8%				
Student-level variable							
Gender							
Female [†]	36	177	16.9%	1.00		1.00	
Male	76	225	25.2%	1.66	(1.07–2.59)*	1.12	(0.66–1.90)
Previous exposure to school-based programs on the prevention of tobacco use							
No [†]	3	17	15.0%	1.00		1.00	
Yes	109	385	22.1%	1.60	(0.46–5.58)	1.42	(0.34–5.96)
Smoking status							
Father							
Non-smoker [†]	56	203	21.6%	1.00		1.00	
Smoker	56	199	22.0%	1.02	(0.67–1.55)	0.56	(0.34–0.91)*
Mother							
Non-smoker [†]	62	313	16.5%	1.00		1.00	
Smoker	50	89	36.0%	2.84	(1.83–4.41)*	2.37	(1.41–4.00)*
Friends and older schoolmates							
Non-smoker [†]	47	321	12.8%	1.00		1.00	
Smoker	65	81	44.5%	5.48	(3.50–8.57)*	4.28	(2.55–7.17)*
Teachers							
Non-smoker [†]	79	336	19.0%	1.00		1.00	
Smoker	33	66	33.3%	2.13	(1.31–3.45)*	0.99	(0.55–1.79)
Perception that active smoking is harmful							
Harmful [†]	73	326	18.3%	1.00		1.00	
Not harmful	39	76	33.9%	2.29	(1.44–3.64)*	1.65	(0.93–2.90)
Perception that passive smoking is harmful							
Harmful [†]	87	349	20.0%	1.00		1.00	
Not harmful	25	53	32.1%	1.89	(1.11–3.22)*	1.04	(0.50–2.01)
School-level variable							
Senior high school academic achievement potential ^c							
≥ 50% ^{†d}	16	184	8.0%			1.00	
< 50% ^e	96	218	30.6%			2.98	(1.45–6.10)*

[†] : Reference category

^a Confidence interval of odds ratio 95%

^b Odds Ratio adjusted

^c Rate of graduates' advancement to higher level coursework

^d Students belonging to the school whose graduates' advancement rate is 50% and over

^e Students belonging to the school whose graduates' advancement rate is under 50%

* $P < 0.05$

smoke cigarettes in the African, southeast Asian, and western Pacific regions.¹⁹⁾ In contrast, no significant differences were observed in current cigarette smoking by gender in the Americas, eastern Mediterranean, and Europe.²⁰⁾ Interestingly, in 13 out of 32 countries (41%) of Europe, the prevalence of 15-year-old male smoking (smoking at least once a week) is higher than that of females.²¹⁾ Thus, it seems that the association between smoking and gender varies according to countries and regions.

According to the Surgeon General report, the social

environment of adolescents, including the functions, meanings, and images of smoking that are conveyed through cigarette advertising, sets the stage for them to begin using tobacco. As tobacco products are available and as peers begin to try them, these factors become personalized and relevant, and tobacco use may begin. This process most affects adolescents who have lower self-esteem and self-images, are less involved with school and academic achievement and have fewer skills to resist the offers of peers. Smoking onset may be seen as a way to improve ones external self-image. Smoking

Table 5 Odds ratios (OR) and 95% confidence intervals (95% CI) for current smokers

Variables	Current smokers (n = 49)	Not current smokers (n = 465)	Current smokers' rate (%)	Crude OR	95% CI ^a	Adjusted OR ^b	95% CI ^a
Total	49	465	9.5%				
Student-level variable							
Gender							
Female [†]	11	202	5.2%	1.00		1.00	
Male	38	263	12.6%	2.65	(1.32– 5.32)*	2.28	(1.07– 4.85)*
Previous exposure to school-based programs on the prevention of tobacco use							
No [†]	1	19	5.0%	1.00		1.00	
Yes	48	446	9.7%	2.05	(0.27–15.60)	1.45	(0.17–12.25)
Smoking status							
Father							
Non-smoker [†]	22	237	8.5%	1.00		1.00	
Smoker	27	228	10.6%	1.28	(0.71– 2.31)	0.79	(0.40– 1.53)
Mother							
Non-smoker [†]	25	350	6.7%	1.00		1.00	
Smoker	24	115	17.3%	2.92	(1.61– 5.32)*	2.46	(1.24– 4.89)*
Friends and older schoolmates							
Non-smoker [†]	16	352	4.3%	1.00		1.00	
Smoker	33	113	22.6%	6.43	(3.41–12.11)*	5.57	(2.72–11.39)*
Teachers							
Non-smoker [†]	35	380	8.4%	1.00		1.00	
Smoker	14	85	14.1%	1.79	(0.92– 3.47)	0.64	(0.29– 1.39)
Perception that active smoking is harmful							
Harmful [†]	30	369	7.5%	1.00		1.00	
Not harmful	19	96	16.5%	2.43	(1.31– 4.51)*	1.49	(0.71– 3.13)
Perception that passive smoking is harmful							
Harmful [†]	36	400	8.3%	1.00		1.00	
Not harmful	13	65	16.7%	2.22	(1.12– 4.41)*	1.34	(0.59– 3.08)
School-level variable							
Senior high school academic achievement potential ^c							
≥ 50% ^{†d}	5	195	2.5%			1.00	
< 50% ^e	44	270	14.0%			3.02	(1.11– 8.39)*

[†] : Reference category

^a Confidence interval of odds ratio 95%

^b Odds Ratio adjusted

^c Rate of graduates' advancement to higher level coursework

^d Students belonging to the school whose graduates' advancement rate is 50% and over

^e Students belonging to the school whose graduates' advancement rate is under 50%

* $P < 0.05$

can become a self-enhancement mechanism.¹⁾

It was earlier found that students in senior high schools who have been taught the harmful effects of tobacco are less likely to smoke.¹²⁾ This indicates the potential utility of school-based programs for prevention of smoking. In the present study, however, school-based programs on prevention of tobacco use did not appear to have influenced potential smokers. However, we should be cautious in judging the results because there were three constraints. Firstly, previous exposure

to school-based programs was estimated through self-reports, rather than past records or other written documents. Secondly, the number of students who were not exposed to the program was reportedly so few that responding errors might happen. Thirdly, it would naturally be difficult to identify any association if the school-based programs were provided for all the enrolled students.

The Cochrane Database of Systematic Reviews identified 23 high quality randomized controlled trials of

school-based programs that aimed to prevent children from smoking. In summary, there is little evidence that education alone is effective. The majority of studies evaluated social influences and interventions. Although half of the high quality studies in this group found short-term effects on children's smoking behavior, the highest quality and longest trial (the Hutchinson Smoking Prevention Project) found no long-term effect from 65 lessons over eight years.^{22~24)} School-based programs vary according to the intervention type, instructor type, the time of instruction, and evaluation methods. In order to obtain more evidence of the effectiveness of school-based programs, further studies are needed.

Our study established that maternal smoking and having friends or older schoolmates who smoke were significantly associated with past and current smoking. A number of previous studies support the notion that parents' and older siblings' smoking are predictors of various levels of children's smoking.^{1,25~29)} Furthermore, there is evidence that the current smoking behavior of parents influences their children's smoking behavior.^{16,30~38)} Having friends who smoke was strongly associated with smoking after controlling for age, gender, parental smoking status, and perception of the adverse risks of smoking (OR = 33; 95%CI (11.6, 95.6)), in line with previous observations.¹⁷⁾ However, our study demonstrated paternal smoking was negatively associated with past smoking, inconsistent with previous reports. The reasons need to be further examined.

Although our initial univariate analysis that smoking in the past was significantly associated with teachers' smoking behavior, there was no influence on smoking status of students after adjustment of variables in a multilevel statistical model. In contrast, Poulsen et al. found that adolescent smoking behavior was influenced by teachers' smoking behavior during school hours even after adjusting for other variables.³⁹⁾ Therefore, although it is possible that teachers' smoking behaviors may have less of an impact than parents' or friends' smoking, more studies including the survey of teachers' smoking status in each school need to be done.

Even though significant relationships between both past and current smoking and the perception of hazardous smoking effects were found before multivariate adjustment, it was lost after this correction. Regarding the association between the perception of hazard of smoking and smoking behavior among junior and senior high school students in Japan, smokers were more likely to answer "There is no harm." or "There is little harm."¹⁰⁾ Likewise, the current study indicated that students who perceive that smoking is not harmful are more likely to smoke than those who do not.

The null models showed past or current smoking status of students does not vary significantly across schools. Two-level random coefficient models indicated

that associations between students smoking status and the variables such as maternal smoking do not vary across schools significantly for past smokers or current smokers. If the target of inference is between-school differences in general, a large number of schools would be required in order to obtain a reliable estimate. In the educational literature it has been suggested that, given the size of effects that are commonly found for between-school differences, a minimum of 25 schools is needed to provide a precise estimate of between-school variance, with a preference for 100 or more schools.⁴⁰⁾ Thus, we should bear in mind that it is not possible to generalize the findings because of our small sample of schools.

It has been reported that adolescent smoking is associated with poorer academic performance.^{15,41)} Ideally, we should have obtained data on students' personal academic performance. In reality, this was not easy to do it because of confidentiality. Instead, we used academic achievement potential as a school-level variable and found lower values for this potential to be associated with past or current smoking. This suggested that we should make an intervention by providing smoking prevention programs for the students in schools with reduced high school academic achievement potential.

With regard to limitations, firstly, in the present study, the only school-level variable was senior high school academic achievement potential. Other variables might be considered to be associated with the effect of school such as school smoking policy, school-based smoking programs, school locations, teachers' smoking rate of each school, classmates' characteristics. In future studies these variables need to be collected from each school and examined. The second limitation of the present study was its cross-sectional design. Ideally, either a longitudinal or a randomized controlled study of school-based programs that aimed to prevent children from smoking would be conducted. Thirdly, biomedical verification (such as by using cotinine or carbon monoxide levels) was not employed in order to protect students' privacy and maximize unbiased replies. Finally, a selection bias related to non-respondents regarding gender disclosure might have existed as 7.3% of non-respondents to the question on gender was noted. However, they might have overlooked the question on gender because it was listed outside the main frame of the questionnaire sheet.

Conclusions

In conclusion, health professionals who educate students about tobacco should not only provide general guidance regarding smoking prevention, but also tailor the teaching methods to fit the students' backgrounds and vulnerabilities. Particularly, when students attend senior high schools where close friends or older schoolmates have a history of smoking or which indicate reduced high school academic potential, school-based

programs should focus on students at all levels of education concurrently. Finally, regarding the association of tobacco use and maternal smoking, it may be important to provide information regarding this relationship to the mothers of students. In case the mothers are smokers, we should make an effort to spend more time and energy to take comprehensive measures not only for the students themselves but also the smoking mothers. Smoking status and the associations of variables do not appear to vary across schools but we cannot generalize due to the small sample assessed here.

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Authors' contributions

JS was involved in carrying out the statistical analysis and wrote the paper. KS was involved in planning and supervision during the study.

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