Journal of Preventive Medicine and Public Health
May 2011, Vol. 44, No. 3, 118-124
This article is available at http://jpmph.org/.

doi: 10.3961/jpmph.2011.44.3.118
pISSN 1975-8375
eISSN 2233-4521

Original Article

Modifying Effect of Suicidal Ideation on the Relationship Between Asthma and Cigarette Use Behaviors Among Korean Adolescents

Jisuk Bae[1], Eun Young Park[2], Soon-Woo Park[1]

[1]Department of Preventive Medicine, Catholic University of Daegu School of Medicine, Daegu;
[2]Cancer Risk Appraisal & Prevention Branch, National Cancer Center, Goyang, Korea

Objectives: Although cigarette smoking is known to be related to the exacerbation of asthma symptoms, several studies have indicated that the prevalence of cigarette smoking among asthmatic adolescents is similar to or even higher than that among non-asthmatic adolescents. The aim of this study was to evaluate the relationship between asthma and cigarette use behaviors and whether or not the presence of suicidal ideation modifies this relationship among Korean adolescents.
Methods: We analyzed data from the 2008 Korea Youth Risk Behavior Web-based Survey, which included a nationally representative sample of middle and high school students. Multiple logistic regression models were used to calculate odd ratios and 95% confidence intervals of cigarette use behaviors among current asthmatics, former asthmatics, and non-asthmatics, after adjusting for gender, grade, school records, socioeconomic status, current alcohol use, and suicidal ideation.
Results: Of 75 238 study participants, 3.5% were current asthmatics and 4.5% were former asthmatics. Compared with non-asthmatics, asthmatics were more likely to report current cigarette use, frequent and heavy cigarette use, and cigarette use before 13 years of age. There were statistically significant interactions between asthma and suicidal ideation in cigarette use behaviors.
Conclusions: This study demonstrated that asthmatic adolescents are more likely than non-asthmatic adolescents to engage in cigarette use behaviors and the presence of suicidal ideation is an effect modifier of the relationship between asthma and cigarette use behaviors. Particular attention should be paid to the awareness of health risks of cigarette smoking and mental health problems among asthmatic adolescents.

Key words: Adolescent, Asthma, Mental health, Smoking
J Prev Med Public Health 2011;44(3):118-124

INTRODUCTION

Asthma is one of the major chronic respiratory conditions among children and adolescents worldwide. The prevalence of asthma has increased over the last few decades and the increasing burden of asthma has become a major public health concern. Morbidity and mortality from asthma are substantial both in developed and developing countries [1-3]. Asthma is one of the most common reasons for school absence and hospitalization among adolescents [3-5]. Asthma during adolescence is related to impaired social, psychological, and behavioral adjustment [6-8]. Health risk behaviors, such as cigarette smoking, alcohol drinking, and substance use, are also prevalent among asthmatic adolescents [8,9].

Although cigarette smoking is known to increase the symptoms of asthma and decrease lung function [10], studies have indicated that the prevalence of cigarette smoking among asthmatic adolescents is similar to or even higher than that among non-asthmatic adolescents [11-15]. Cigarette use behaviors among asthmatic adolescents have been evaluated in many countries, including the United States [11], the Netherlands [12,13,16,17], Denmark [14,18], and Israel [15]. However, evidence on cigarette use behaviors among asthmatic adolescents in Asian countries, who have different social and cultural backgrounds from asthmatic adolescents in Western countries, is limited.

Suicide is one of the leading causes of death among adolescents in many countries [19]. In the Republic of Korea (ROK) in 2008, suicide was the second leading cause of death among persons 10-19 years of age, which

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Corresponding author : Soon-Woo Park, MD, PhD
3056-6 Daemyung-4dong, Nam-gu, Daegu 705-718, Korea
Tel : +82-53-650-4493, Fax: +82-53-654-3881, E-mail : parksw@cu.ac.kr
Received : 21 December 2010, Accepted : 4 March 2011

The abstract of this study is published in the supplement to the February 2011 issue of the Journal of Adolescent Health and presented in a poster presentation on March 30th at the 2011 Society for Adolescent Health and Medicine Annual Meeting held in Seattle, WA, USA.

comprised 22.1% of all death in this age group [20]. Youths who have attempted suicide are at an increased risk for eventually dying by suicide [21]. Suicidal behaviors, such as suicidal ideation and attempts, are known to be associated with asthma as well [6,22-24]. Moreover, recent studies have suggested that asthmatic adolescents with mental health problems are more likely to engage in health risk behaviors, such as cigarette smoking [25,26]. For instance, in a recent study conducted in the United States, anxiety and depressive disorders were shown to be associated with an increased risk for cigarette smoking among asthmatic adolescents [26].

In a study conducted in the ROK using a nationally representative sample of middle and high school students, suicidal ideation was reported to be significantly associated with cigarette smoking [27]. Psychosocial adjustment problems of asthmatic adolescents, such as suicidal ideation, may contribute to the fact that the prevalence of cigarette smoking among this vulnerable population remains high [25,26]. However, cigarette use behaviors among asthmatic adolescents and the effect of suicidal ideation on the relationship between asthma and cigarette use behaviors have not been evaluated using a nationally representative sample of the ROK. Therefore, the aim of this study was to evaluate the relationship between asthma and cigarette use behaviors and whether or not the presence of suicidal ideation modifies this relationship among Korean adolescents.

METHODS

I. Subjects

The Korea Youth Risk Behavior Web-based Survey (KYRBWS) is a national school-based survey conducted by the Korea Centers for Disease Control and Prevention annually since 2005 to assess the prevalence of health risk behaviors among middle and high school students [28].

We used data from the 2008 KYRBWS, which was conducted between September and October 2008. A stratified multistage cluster sample design was used to obtain a nationally representative sample, which consisted of 400 middle schools and 400 high schools. In each selected school, one class at each grade level was selected. All students in the selected classes were eligible for the sample population. Parental permission was obtained prior to the administration of the survey. The response rate of the survey was 95.1% [28].

II. Instruments and Procedure

In the 2008 KYRBWS, a web-based questionnaire survey, which took 45-50 minutes to complete, was administered in a computer room of each selected school. The students were required to visit the KYRBWS website and logged in with a unique number, which was assigned to each student to assure anonymity. After logging in, the students completed a self-administered questionnaire. The questionnaire included questions about demographic factors, physician-diagnosed asthma, and health risk behaviors, such as cigarette use and suicidal behaviors [28]. A total of 75 238 study participants who provided information on these variables were used for the analyses.

Current cigarette use was defined as smoking on one or more days during the past 30 days before the survey. Current frequent cigarette use was defined as smoking on 20 or more days during the past 30 days before the survey. Current heavy cigarette use was defined as smoking $\geq$ 10 cigarettes per day during the past 30 days before the survey. Cigarette use before 13 years of age was assessed using the following question: When did you smoke cigarettes even one or two puffs for the first time? The responses measured on a 13-point scale were categorized into two groups to assess the prevalence of cigarette use before 13 years of age. Suicidal ideation was defined as a positive response to the following question with the reference period of the past 12 months before the survey: Have you ever seriously considered attempting suicide? Attempted suicide was defined as a positive response to the following question with the reference period of the past 12 months before the survey: Have you ever attempted suicide?

Current asthmatics (CAs) were defined as students who had ever been diagnosed with asthma by a physician, and had treatment for asthma during the past 12 months before the survey. Former asthmatics (FAs) were defined as students who had ever been diagnosed with asthma by a physician, but had no treatment for asthma during the past 12 months before the survey. Non-asthmatics were defined as students who had never been diagnosed with asthma by a physician. When we assessed the interactions between asthma and suicidal ideation in cigarette use behaviors, however, asthma status was categorized into the following two groups: ever-asthmatics (current or former asthmatics); and never-asthmatics (non-asthmatics).

III. Data Analysis

All descriptive statistics are presented as weighted percentages for categorical variables. Multiple logistic regression models were used to calculate odds ratios (ORs) and 95% confidence intervals (CIs) of cigarette use and suicidal behaviors among CAs, FAs, and non-asthmatics, after adjusting for gender, grade, self-rated school records (high, upper middle, middle, lower middle, and low), perceived socioeconomic status (high, upper middle, middle, lower middle, and low), current alcohol use (defined as at least one drink of alcohol on one or more days during the past 30 days before the survey), and/or current cigarette use, and/or suicidal ideation. Likelihood ratio tests were used to assess the interactions between asthma and suicidal ideation in cigarette use behaviors. To evaluate statistical significance, a two-sided significance level of 0.05 was used. Statistical analysis was conducted using Intercooled STATA version 9.2 (STATA Co., College Station, TX, USA), a statistical software that accounts for the complex sampling design and weighting factors in the dataset. This study was approved by the Institutional Review Board of Daegu Catholic University Medical Center.

RESULTS

The demographic and selected characteristics of the study participants are shown in Table 1. Of 75 238 study participants, 53.0% were male students and 47.0% were female students. Middle and high school students comprised 51.7% and 48.3% of the study participants, respectively. Overall, 8.0% of the study participants reported having had asthma diagnosed by a physician; CAs and FAs accounted for 3.5% and 4.5% of the study participants, respectively. Of the study participants, 12.8% reported that they had smoked cigarettes on one or more days during the past 30 days before the survey and 18.9% reported that they had seriously considered attempting suicide during the past 12 months before the survey.

Table 2 shows the weighted percentage and adjusted ORs of cigarette use and suicidal behaviors among CAs, FAs, and non-asthmatics. The prevalence of current cigarette use (CAs: 15.2%; FAs: 16.2%; non-asthmatics: 12.5%), current frequent cigarette use (CAs: 8.6%; FAs: 10.8%; non-asthmatics: 7.6%), current heavy cigarette use (CAs: 4.7%; FAs: 5.5%; non-asthmatics: 2.6%), and cigarette use before 13 years of age (CAs: 10.1%; FAs:

Table 1. Demographic and selected characteristics of the study participants: the 2008 Korea Youth Risk Behavior Web-based Survey

Characteristic	n	Weighted %
Gender		
Male	39 278	53.0
Female	35 960	47.0
Grade		
Middle school 1st	13 037	17.2
Middle school 2nd	13 056	17.2
Middle school 3rd	12 850	17.3
High school 1st	12 720	17.3
High school 2nd	12 375	16.4
High school 3rd	11 200	14.6
Self-rated school record		
High	8669	11.5
Upper middle	17 224	23.0
Middle	20 578	27.4
Lower middle	19 341	25.8
Low	9426	12.3
Perceived socioeconomic status		
High	4640	6.5
Upper middle	16 161	22.5
Middle	35 770	47.2
Lower middle	13 692	17.6
Low	4975	6.2
Asthma status[1]		
Current	2629	3.5
Former	3250	4.5
Non	69 359	92.0
Current cigarette use[2]		
Yes	9645	12.8
No	65 593	87.2
Current frequent cigarette use[3]		
Yes	5720	7.8
No	69 518	92.2
Current heavy cigarette use[4]		
Yes	2041	2.8
No	73 197	97.2
Cigarette use before 13 years of age[5]		
Yes	6689	8.5
No	68 489	91.5
Unknown	60	
Considered attempting suicide[6]		
Yes	14 259	18.9
No	60 979	81.1
Attempted suicide[7]		
Yes	3649	4.7
No	71 589	95.3

[1] Current asthmatics were defined as students who had ever been diagnosed with asthma by a physician, and had treatment for asthma during the past 12 months before the survey. Former asthmatics were defined as students who had ever been diagnosed with asthma by a physician, but had no treatment for asthma during the past 12 months before the survey. Non-asthmatics were defined as students who had never been diagnosed with asthma by a physician.
[2] Smoked cigarettes on one or more days during the past 30 days before the survey.
[3] Smoked cigarettes on 20 or more days during the past 30 days before the survey.
[4] Smoked $\geq$ 10 cigarettes per day during the past 30 days before the survey.
[5] Tried cigarette smoking even one or two puffs for the first time before 13 years of age.
[6] Seriously considered attempting suicide during the past 12 months before the survey.
[7] Attempted suicide during the past 12 months before the survey.

Table 2. Weighted percentages and adjusted odds ratios[1] of cigarette use and suicidal behaviors according to asthma status[2]: the 2008 Korea Youth Risk Behavior Web-based Survey

	Asthma status		
	Current	Former	Non
Cigarette use behaviors (95% CI)			
Current cigarette use[3]			
Weighted %	15.2 (13.4 - 17.0)	16.2 (14.5 - 17.9)	12.5 (11.8 - 13.2)
Adjusted OR	1.25 (1.06 - 1.48)	1.30 (1.13 - 1.49)	1.00
Current frequent cigarette use[4]			
Weighted %	8.6 (7.1 - 10.0)	10.8 (9.4 - 12.3)	7.6 (7.0 - 8.1)
Adjusted OR	1.15 (0.93 - 1.42)	1.45 (1.20 - 1.74)	1.00
Current heavy cigarette use[5]			
Weighted %	4.7 (3.7 - 5.7)	5.5 (4.3 - 6.7)	2.6 (2.3 - 2.8)
Adjusted OR	1.93 (1.51 - 2.46)	2.14 (1.62 - 2.84)	1.00
Cigarette use before 13 years of age[6]			
Weighted %	10.1 (8.7 - 11.5)	11.6 (9.9 - 13.4)	8.3 (8.0 - 8.6)
Adjusted OR	1.13 (0.95 - 1.33)	1.35 (1.14 - 1.61)	1.00
Suicidal behaviors (95% CI)			
Considered attempting suicide[7]			
Weighted %	22.7 (20.5 - 25.0)	24.0 (22.1 - 25.8)	18.6 (18.1 - 19.0)
Adjusted OR	1.36 (1.19 - 1.55)	1.40 (1.27 - 1.54)	1.00
Attempted suicide[8]			
Weighted %	6.8 (5.6 - 8.0)	6.9 (5.8 - 8.1)	4.5 (4.3 - 4.7)
Adjusted OR	1.55 (1.25 - 1.92)	1.54 (1.29 - 1.84)	1.00

OR: odds ratio, CI: confidence interval.

[1] Multiple logistic regression models were used to calculate ORs and 95% CIs of cigarette use and suicidal behaviors, after adjusting for gender, grade, self-rated school records, perceived socioeconomic status, current alcohol use, and/or current cigarette use, and/or suicidal ideation.

[2] Current asthmatics were defined as students who had ever been diagnosed with asthma by a physician, and had treatment for asthma during the past 12 months before the survey. Former asthmatics were defined as students who had ever been diagnosed with asthma by a physician, but had no treatment for asthma during the past 12 months before the survey. Non-asthmatics were defined as students who had never been diagnosed with asthma by a physician.

[3] Smoked cigarettes on one or more days during the past 30 days before the survey.

[4] Smoked cigarettes on 20 or more days during the past 30 days before the survey.

[5] Smoked ≥ 10 cigarettes per day during the past 30 days before the survey.

[6] Tried cigarette smoking even one or two puffs for the first time before 13 years of age.

[7] Seriously considered attempting suicide during the past 12 months before the survey.

[8] Attempted suicide during the past 12 months before the survey.

11.6%; non-asthmatics: 8.3%) was higher among CAs or FAs than among non-asthmatics. After controlling for important covariates, CAs and FAs were more likely than non-asthmatics to report current cigarette use (CAs: OR, 1.25; 95% CI, 1.06 to 1.48; FAs: OR, 1.30; 95% CI, 1.13 to 1.49). Compared with non-asthmatics, FAs tended to smoke cigarettes frequently (≥ 20 days during the past 30 days before the survey; OR, 1.45; 95% CI, 1.20 to 1.74). Compared with non-asthmatics, CAs and FAs tended to smoke cigarettes heavily (≥ 10 cigarettes per day; CAs: OR, 1.93; 95% CI, 1.51 to 2.46; FAs: OR, 2.14; 95% CI, 1.62 to 2.84). FAs were more likely than non-asthmatics to report cigarette use before 13 years of age (OR, 1.35; 95% CI, 1.14 to 1.61).

With regard to suicidal behaviors, the prevalence of suicidal ideation (CAs: 22.7%; FAs: 24.0%; non-asthmatics: 18.6%) and attempts (CAs: 6.8%; FAs: 6.9%; non-asthmatics: 4.5%) was higher among CAs or FAs than among non-asthmatics. After controlling for important covariates, CAs and FAs were more likely than non-asthmatics to consider attempting suicide seriously (CAs: OR, 1.36; 95% CI, 1.19 to 1.55; FAs: OR, 1.40; 95% CI, 1.27 to 1.54), and to attempt suicide (CAs: OR, 1.55; 95% CI, 1.25 to 1.92; FAs: OR, 1.54; 95% CI, 1.29 to 1.84)(Table 2).

Table 3 shows the weighted percentage and adjusted ORs of cigarette use behaviors according to asthma status and suicidal ideation. The adjusted OR of current cigarette use among ever-asthmatics with suicidal ideation was 2.61 (95% CI, 2.15 to 3.16) compared to never-asthmatics without suicidal ideation. There was a statistically significant interaction between asthma and suicidal ideation in current cigarette use ($p_{interaction}$ = 0.002). The adjusted OR of cigarette use before 13 years of age among ever-asthmatics with suicidal ideation was 2.49 (95% CI, 1.99 to 3.12) compared to never-asthmatics without suicidal ideation. There was a statistically significant interaction between asthma and suicidal ideation in cigarette use before 13 years of age ($p_{interaction}$ = 0.035). Synergistic effects between asthma

Table 3. Weighted percentages and adjusted odds ratios[1] of cigarette use behaviors according to asthma status[2] and suicidal ideation[3]: the 2008 Korea Youth Risk Behavior Web-based Survey

	Suicidal ideation (+)		Suicidal ideation (-)	
	Ever-asthmatics	Never-asthmatics	Ever-asthmatics	Never-asthmatics
Current cigarette use[4] (95% CI)				
Weighted %	25.2 (22.2 - 28.5)	18.0 (16.9 - 19.1)	12.9 (11.7 - 14.2)	11.3 (10.6 - 11.9)
Adjusted OR	2.61 (2.15 - 3.16)	1.56 (1.45 - 1.68)	1.14 (1.00 - 1.30)	1.00
		$p_{interaction}$[8] = 0.002		
Current frequent cigarette use[5] (95% CI)				
Weighted %	16.1 (13.5 - 19.1)	10.6 (9.7 - 11.5)	7.9 (7.0 - 9.0)	6.9 (6.4 - 7.5)
Adjusted OR	2.55 (1.98 - 3.29)	1.43 (1.30 - 1.57)	1.14 (0.97 - 1.34)	1.00
		$p_{interaction}$[8] = 0.003		
Current heavy cigarette use[6] (95% CI)				
Weighted %	10.4 (8.1 - 13.2)	4.3 (3.8 - 4.9)	3.6 (3.0 - 4.3)	2.2 (1.9 - 2.4)
Adjusted OR	5.31 (3.81 - 7.40)	1.83 (1.60 - 2.10)	1.67 (1.32 - 2.11)	1.00
		$p_{interaction}$[8] = 0.005		
Cigarette use before 13 years of age[7] (95% CI)				
Weighted %	18.1 (15.0 - 21.6)	12.7 (11.9 - 13.4)	8.8 (7.9 - 9.8)	7.3 (7.0 - 7.6)
Adjusted OR	2.49 (1.99 - 3.12)	1.68 (1.55 - 1.83)	1.15 (1.02 - 1.31)	1.00
		$p_{interaction}$[8] = 0.035		

OR: odds ratio, CI: confidence interval.
[1] Multiple logistic regression models were used to calculate ORs and 95% CIs of cigarette use behaviors, after adjusting for gender, grade, self-rated school records, perceived socioeconomic status, and current alcohol use.
[2] Ever-asthmatics were defined as students who had ever been diagnosed with asthma by a physician. Never-asthmatics were defined as students who had never been diagnosed with asthma by a physician.
[3] Seriously considered attempting suicide during the past 12 months before the survey.
[4] Smoked cigarettes on one or more days during the past 30 days before the survey.
[5] Smoked cigarettes on 20 or more days during the past 30 days before the survey.
[6] Smoked ≥ 10 cigarettes per day during the past 30 days before the survey.
[7] Tried cigarette smoking even one or two puffs for the first time before 13 years of age.
[8] Likelihood ratio tests.

and suicidal ideation were also observed on current frequent or heavy cigarette use (for current frequent cigarette use, $p_{interaction}$ = 0.003; for current heavy cigarette use, $p_{interaction}$ = 0.005). The adjusted OR of current frequent cigarette use among ever-asthmatics with suicidal ideation was 2.55 (95% CI, 1.98 to 3.29) compared to never-asthmatics without suicidal ideation. The adjusted OR of current heavy cigarette use among ever-asthmatics with suicidal ideation was 5.31 (95% CI, 3.81 to 7.40) compared to never-asthmatics without suicidal ideation.

DISCUSSION

This study demonstrated that asthmatic adolescents are more likely than non-asthmatic adolescents to report current cigarette use, frequent and heavy cigarette use, cigarette use before 13 years of age, and suicidal ideation and attempts. Furthermore, this study indicated that the presence of suicidal ideation is an effect modifier of the relationship between asthma and cigarette use behaviors. That is, the effect of asthma on cigarette use behaviors differs depending on the presence of suicidal ideation. The presence of suicidal ideation strengthened the effect of asthma on cigarette use behaviors in our study.

Asthmatic adolescents may be expected to be less likely than their healthy peers to report cigarette smoking, because smoking exacerbates the symptoms of asthma and physicians may advise asthmatic adolescents not to smoke [10]. However, our study demonstrated that asthmatic adolescents are more likely than their healthy peers to engage in cigarette use behaviors, and this finding is consistent with increasing evidence in previous cross-sectional and longitudinal studies [11,13,14]. Longitudinal studies have suggested that the relationship between asthma and cigarette smoking appears to be bidirectional as well. For instance, in a longitudinal study among Dutch adolescents [13], having asthma predicted smoking behaviors, and baseline smoking increased the risk of developing asthma and the symptoms of asthma. This longitudinal study also proposed that although asthmatic adolescents appeared to be reluctant to start smoking, if they started smoking, they were more often regular smokers than non-asthmatics. The authors mentioned that these results could be explained by the short-term anti-inflammatory effects of smoking on allergic inflammation and the higher susceptibility to develop nicotine dependence among asthmatics [13].

Several studies have indicated that youths with chronic illnesses are more likely than their healthy peers to engage in health risk behaviors, such as cigarette use behaviors [8,9]. Youths with chronic illnesses, including asthma, may feel that they have to compensate for their disease so as not to feel left out of the group [18]. Therefore, they may be more likely to be susceptible to peer pressure regarding cigarette smoking.

Interestingly, our study revealed that FAs were more likely than non-asthmatics, or even CAs, to engage in cigarette smoking. A comparison study among 67 asthmatic and 62 non-asthmatic adolescents in Israel indicated that FAs were a high-risk group for becoming smokers in the future [29]. Youths whose self-image was threatened by the stigma of being asthmatic in the past may try to improve their self-image and prove their good health; this may explain the engagement in cigarette smoking among FAs [29].

One of the most intriguing facts in our study is that the presence of suicidal ideation modifies the relationship between asthma and cigarette use behaviors among Korean adolescents. Previous studies have suggested that cigarette smoking among asthmatic adolescents might be mediated by mental health problems, such as anxiety and depressive disorders [25,26]. Possible causal pathways have been proposed explaining the relationships among asthma, mental health problems, and health risk behaviors (or non-compliance with treatment) [9]. Asthma may increase the risk for development of metal health problems, such as depressive moods and suicidal tendencies. Mental health problems may provoke the symptoms of asthma through non-compliance with treatment or other health risk behaviors, such as cigarette smoking. Additionally, mental health problems may introduce physiologic changes that increase inflammation and the symptoms of asthma [9].

Although the findings of our study were derived from a nationally representative sample with a large sample size and a high response rate, several limitations should be taken into account for an accurate interpretation of the results. First, asthma status was not confirmed by medical records or clinical tests. Although the diagnosis of asthma was based on physicians, the validity of the diagnosis is not substantiated. Second, there is the possibility of under-reporting of physician-diagnosed asthma or health risk behaviors, such as cigarette use and suicidal behaviors. Finally, this study was cross-sectional, which cannot present any causal relations or the directionality of the relationship between asthma and health risk behaviors. The possibility of the reverse causation between asthma and health risk behaviors should be considered when drawing a conclusion from our study results. As an alternative causal relation, cigarette smoking might contribute to the risk of developing asthma and the symptoms of asthma among Korean adolescents.

In conclusion, this study demonstrated that asthmatic adolescents are more likely than non-asthmatic adolescents to engage in cigarette use behaviors and the presence of suicidal ideation modifies the effect of asthma on cigarette use behaviors. Further research is needed to elucidate the directionality of the relationships between asthma and health risk behaviors, such as cigarette use and suicidal behaviors, and the interactions among these factors. A better understanding of the relationships between asthma and health risk behaviors may allow school health practitioners to identify and treat adolescents at an increased risk for inadequately controlled asthma. Particular attention should be paid to the awareness of health risks of cigarette smoking and mental health problems among asthmatic adolescents.

ACKNOWLEDGEMENTS

This study was funded by a grant from the Korea Centers for Disease Control and Prevention.

CONFLICT OF INTEREST

The authors have no conflicts of interest with the material presented in this paper.

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