

Do Eun Park<sup>1</sup>, Seong-Kyung Cho<sup>2</sup> and Jaelim Cho<sup>3\*</sup>

<sup>1</sup>Korean Minjok Leadership Academy, Anheung-myeon, Hoengseong-gun, Gangwon-do, Republic of Korea

<sup>2</sup>Department of Medical Informatics and Biostatistics, Yonsei University College of Medicine, Seoul, Republic of Korea

<sup>3</sup>Department of Occupational and Environmental Medicine, Gachon University Gil Medical Center, Incheon, Republic of Korea

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\*Corresponding author: Jaelim Cho, MD, MPH, Department of Occupational and Environmental Medicine, Gachon University Gil Medical Center, 774 Namdongdae-ro, Incheon, Republic of Korea, Tel: +82-32-820-2240; Fax: +82-32-814-9014; E-mail: chojael@gilhospital.com

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## Research Article

# Association between Perceived Stress and Asthma Symptoms in Adolescents

### Abstract

**Background:** Although the effect of psychological stress on asthma has long been suggested, there is little evidence regarding asthma symptoms such as wheezing in relation to perceived stress in adolescents.

**Objectives:** We investigated the relationship between perceived stress and asthma symptoms in a nationally representative sample of Korean adolescents.

**Methods:** We used the data from the eighth Korean Youth Risk Behavior web-based Survey (KYRBS), which is based on a self-reported questionnaire. Perceived stress was classified into five ratings from very high to very low. Asthma symptoms included wheezing and wheezing on exertion during the last 12 months. We performed multiple logistic regression analysis, adjusting for grade (age), sex, asthma history, drinking experience, smoking experience, exposure to secondhand smoke, physical activity, fast food consumption, snack consumption, subjective health status, body mass index category, and household economic status.

**Results:** Of 72,229 participants, 8,224 (11.4%) and 14,658 (20.3%) adolescents reported experiencing wheezing and wheezing on exertion, respectively, during the last 12 months. Participants who reported very high stress had higher odds of wheezing (Odds ratio, 2.621; 95% confidence interval, 2.040–3.367) and wheezing on exertion (1.960; 1.638–2.344) in reference to those with very low stress. With the increase in subjective stress ratings, ORs of wheezing and wheezing on exertion had a rising trend, and the trends were statistically significant ( $p < 0.001$  for wheezing and  $p < 0.001$  for wheezing on exertion).

**Conclusions:** Perceived stress was positively associated with wheezing and wheezing on exertion in Korean adolescents, both in asthmatics and non-asthmatics.

## Introduction

Asthma is a prevalent allergic disease worldwide, affecting approximately 334 million people, and 14% of children suffer asthma symptoms globally [1]. Reported risk factors for asthma include secondhand smoke [2], traffic-related air pollution [3], trans fatty acids intake [4], obesity [5], infection [6], and pollens [7]. Through interacting with these environmental risk factors, stressful life events or psychosocial stress may play a role in the exacerbation of asthma symptoms [8]. Sandberg and colleagues suggested an increased risk of asthma attack in relation to bereavement in children with asthma [9]. A UK study found that psychosocial factors including adversities in childhood and stressful life events were related to higher rates of hospitalization for asthma [10]. In Denmark, a cohort study showed that those with high perceived stress had approximately two-fold risk of self-reported asthma incidence [11]. Psychological stress can trigger immune responses and subsequent asthma symptom occurrence, which may be involved in the hypothalamus-pituitary-adrenal axis activation and hyperresponsiveness of both the sympathetic and parasympathetic systems [8,12]. Although the effect of psychological stress on asthma has long been suggested, there is little evidence regarding asthma symptoms such as wheezing in relation to perceived stress in adolescents. Therefore, the purpose of this study is to investigate the relationship between perceived

stress and asthma symptoms in a nationally representative sample of Korean adolescents.

## Methods

### Study subjects

We used data from the 8th Korean Youth Risk Behavior web-based Survey (KYRBS), annually conducted by the Ministry of Education, Korea Centers for Disease Control and Prevention, and the Ministry of Health in the Republic of Korea [13]. The KYRBS used proportional allocation and stratified cluster sampling to acquire a national representative sample of Korean adolescents. The 8th survey was conducted in June 2012; 74,186 students (37,297 middle school and 36,889 high school students) participated, and 72,229 were included in statistical analysis after excluding missing values. The KYRBS, an anonymous online survey, was approved by the institutional review board of Korea Centers for Disease Control and Prevention (2014-06EXP-02-P-A).

### Measurements

All information was based on self-reported questionnaire. Perceived stress was evaluated using the question "How much do you usually feel stressed?", and classified into five ratings, from very high to very low. Asthma symptoms included wheezing and wheezing

on exertion during the last 12 months. Past history of asthma was indicated by all participants using the question “Has your doctor ever diagnosed you with asthma?” Household economic status was categorized as very high, high, moderate, low, or very low. Subjective health status was classified as very healthy, healthy, moderate, unhealthy, or very unhealthy. Alcohol consumption and smoking were treated as dichotomous variables of lifetime experience. Self-reported body mass index (BMI) was categorized as underweight (< 18.5 kg/m<sup>2</sup>), normal (18.5–24.9 kg/m<sup>2</sup>), or obese (≥ 25kg/m<sup>2</sup>) according to Asian standards [14]. Because high salt [15] and preservatives such as sulfites [16] in fast food and snacks may also affect airway inflammation, fast food and snack consumption during the last seven days were each considered confounding. The intake frequency was categorized as none, 1–2 times a week, 3–4 times a week, 5–6 times a week, once a day, 2 times a day, or 3 times or more a day. The frequency of physical activity was assessed with the question “How many days did you exercise during the last 12 months?” Exposure to secondhand smoke was evaluated with the question “How many days were you adjacent to others smoking at your home during the last seven days?”, and treated as a dichotomous variable (coded 0 for none; coded 1 for one or more days).

### Statistical analysis

The chi-squared test and the t-test were used. Considering the KYRBS’s sampling rate and response rate, we estimated weighted percentages and standard deviations (SDs). We performed multiple logistic regression analysis and the associations of subjective stress ratings with wheezing and wheezing on exertion were expressed as odds ratios (ORs) and 95% confidence intervals (95% CIs). We adjusted for grade (age), sex, asthma history, drinking experience, smoking experience, exposure to secondhand smoke, physical activity, fast food consumption, snack consumption, subjective health status, BMI category, and household economic status. We generated ORs of asthma symptom associated with perceived stress ratings in reference to the lowest stress group, and examined the statistical significance of the ORs’ trend by including perceived stress as a continuous variable in the statistical models. Additionally, we conducted stratified analyses according to asthma history. All analyses were conducted using SAS version 9.3 (SAS institute, Cary, NC).

### Results

Of the 72229 participants, 8224 (11.4%) and 14658 (20.3%) reported experiencing wheezing and wheezing on exertion, respectively, during the last 12 months (Table 1). The numbers of students with underlying asthma were 6694 (9.2%) in total, 1797 (21.5%) in those with wheezing, and 2464 (16.8%) in those with wheezing on exertion. Adolescents with wheezing or wheezing on exertion were more likely to have drinking experience, smoking experience, exposure to secondhand smoke, lower socioeconomic status, and more frequent fast food and snack consumption.

Those who reported very high stress accounted for 11.5% of the total, those with wheezing 20.5%, and those with wheezing on exertion 17.8% (Table 2). In contrast, the proportions of those with very low stress were 2.5% of the total, those with wheezing 1.2%, and those with wheezing on exertion 1.6%. The differences between those

**Table 1:** General characteristics of study population.

	Total (N=72,229)		Wheezing (N=8,224)		Wheezing on exertion (N=14,658)	
<b>Grade</b>						
Middle school 1 <sup>st</sup>	12,076	(15.84)	1,108	(12.52)	2,324	(15.14)
Middle school 2 <sup>nd</sup>	12,080	(16.30)	1,256	(15.10)	2,378	(15.80)
Middle school 3 <sup>rd</sup>	12,211	(16.98)	1,313	(16.05)	2,497	(17.23)
High school 1 <sup>st</sup>	12,150	(17.10)	1,543	(18.46)	2,628	(17.99)
High school 2 <sup>nd</sup>	11,984	(17.12)	1,540	(19.15)	2,539	(17.86)
High school 3 <sup>rd</sup>	11,728	(16.66)	1,464	(18.71)	2,292	(15.99)
Females, N (%)	35,000	(47.51)	4,284	(51.55)	8,041	(54.22)
Asthma history, N (%)	6,694	(9.23)	1,797	(21.52)	2,464	(16.75)
Drinking experience, N (%)	33,964	(46.84)	4,745	(57.44)	7,825	(53.11)
Smoking experience, N (%)	17,644	(24.31)	2,831	(34.23)	4,459	(30.09)
Exposure to secondhand smoke, N (%)	24,068	(32.50)	3,389	(40.26)	5,840	(39.30)
<b>Subjective health ratings, N (%)</b>						
Very healthy	14,147	(19.73)	1,038	(12.37)	2,068	(14.20)
Healthy	34,955	(48.56)	3,427	(42.09)	6,553	(44.98)
Moderate	18,145	(24.92)	2,573	(31.26)	4,335	(29.45)
Unhealthy	4,748	(6.46)	1,123	(13.54)	1,611	(10.76)
Very unhealthy	234	(0.32)	63	(0.74)	91	(0.61)
<b>Household economic status, N (%)</b>						
Very high	4,563	(6.56)	467	(5.94)	835	(5.97)
High	17,136	(24.14)	1,847	(22.89)	3,434	(23.92)
Moderate	34,153	(46.95)	3,611	(43.54)	6,624	(44.61)
Low	12,803	(17.47)	1,713	(20.51)	2,885	(19.49)
Very low	3,574	(4.88)	586	(7.13)	880	(6.01)
<b>Body mass index, N (%)</b>						
Underweight	18,675	(25.78)	2,006	(24.54)	3,490	(23.80)
Normal	47,013	(65.13)	5,432	(65.93)	9,728	(66.56)
Obese	6,541	(9.10)	786	(9.52)	1,440	(9.64)
<b>Fast food consumption</b>						
None	25,011	(34.04)	2,538	(30.08)	4,678	(31.19)
1–2 times a week	39,137	(54.61)	4,450	(54.44)	8,029	(55.28)
3–4 times a week	6,457	(9.03)	952	(11.80)	1,501	(10.36)
5–6 times a week	973	(1.41)	171	(2.25)	249	(1.76)
Once a day	360	(0.49)	58	(0.72)	104	(0.72)
Twice a day	146	(0.21)	28	(0.37)	50	(0.37)
Three times or more a day	145	(0.21)	27	(0.34)	47	(0.32)
<b>Snack consumption</b>						
None	12,103	(17.30)	1,264	(16.04)	2,203	(15.53)
1–2 times a week	30,999	(43.15)	3,398	(41.36)	6,201	(42.64)
3–4 times a week	20,068	(27.42)	2,297	(27.28)	4,197	(28.07)
5–6 times a week	5,039	(6.78)	664	(8.13)	1,074	(7.17)
Once a day	2,703	(3.64)	380	(4.58)	645	(4.37)
Twice a day	847	(1.12)	136	(1.65)	210	(1.39)
Three times or more a day	470	(0.60)	85	(0.97)	128	(0.83)
Physical activity days during the last week, mean (SD)	1.81	(0.02)	1.90	(0.03)	1.87	(0.03)

SD: standard deviation  
 All percentages were weighted.  
 Differences between those with and those without wheezing were all significant (p=0.045 for body mass index and p<0.001 for remainders).  
 Differences between those with and those without wheezing on exertion were all significant (p=0.001 for grade and p<0.001 for remainders).

with and without asthma symptoms were all statistically significant ( $p < 0.001$  for wheezing;  $p < 0.001$  for wheezing on exertion).

Participants who reported very high stress had higher odds of wheezing (OR, 2.621; 95% CI, 2.040–3.367) and wheezing on exertion (OR, 1.960; 95% CI, 1.638–2.344) relative to those with very low stress (Table 3). ORs of wheezing were 1.208 (95% CI, 0.939–1.555), 1.442 (1.130–1.840), and 1.909 (1.493–2.440) in low, moderate, and high stress groups, respectively ( $p$  for trend  $< 0.001$ ). For wheezing on exertion, ORs were 1.003 (0.844–1.193), 1.170 (0.988–1.386), and 1.530 (1.289–1.816) in low, moderate, and high stress groups, respectively ( $p$  for trend  $< 0.001$ ).

In adolescents with asthma history (Table 4), ORs of wheezing were 1.247 (95% CI, 0.729–2.132), 1.491 (0.898–2.477), 1.676 (1.002–2.804), and 2.011 (1.171–3.452) in low, moderate, high, and very high stress groups, respectively ( $p$  for trend  $< 0.001$ ). The OR of wheezing on exertion was 1.746 (95% CI, 1.110–2.748) in those with very high stress.

## Discussion

In this cross-sectional study using a nationally representative sample of Korean adolescents, we found the positive association of perceived stress with wheezing and wheezing on exertion in

adolescents aged 13 to 18 years. Those with the highest rating of stress had roughly three-times odds of wheezing compared to those with the lowest rating of stress, and the ORs of asthma symptoms rose with stress ratings in a dose-response manner. Among adolescents with asthma history, perceived stress was significantly associated with asthma symptoms.

Previous studies have suggested the increased risks of asthma incidence and medical care visits for asthma in relation to psychological stress. Psychological stress derived from bereavement may increase the risk for asthma attack in asthmatic children [9]. Stressful life events in children may be related to asthma hospitalization risk [10], and higher perceived stress may induce higher asthma incidence [11]. In the present study, 9.8% and 18.5% of subjects without asthma history reported wheezing and wheezing on exertion, respectively, in the last 12 months. These adolescents' symptoms might not have been due to asthma, and some may have had undiagnosed asthma. However, regardless of their true prevalence of asthma, it is possible that high perceived stress induces airway hyper responsiveness even in healthy adolescents. There is a need to conduct longitudinal studies of psychological stress levels and asthma symptom occurrence in healthy adolescents.

Numerous biomarker studies have supported the linkage between psychological stress due to various stress factors and asthma symptom occurrence via immune responses. Some studies found increased interleukin levels and immune cells after academic examinations in asthmatic adolescents [17,18]. Low socioeconomic status can cause chronic stress, and Chen and colleagues suggested that chronic stress may mediate the pathways between socioeconomic status and immune responses such as production of interleukin-5 and interleukin-13 in children with asthma [19]. In our study, the major reasons of perceived stress included academic grades (54.6%), conflicts with parents (15.3%), appearance (10.2%), and conflicts with peers (8.7%). Because these factors are intertwined and function with complexity, it would be difficult to indicate which reason caused our subjects' chronic stress. However, individuals' responses to stress factors and coping abilities may vary [20], so perceived stress ratings may be a reasonable basis for investigating the effect of psychological stress.

Our study is strengthened by using a nationally representative sample of adolescents in the Republic of Korea, and found that high perceived stress may increase asthma symptom occurrence both in asthmatic and non-asthmatic adolescents. However, there are several limitations to be considered. First, our study was cross-sectional, and thus may be lacking in temporal relationship. Asthma symptoms might increase perceived stress, but health problems were the least frequent reason for stress, at 1.7% ( $N=1280$ ), in our sample. Nonetheless, our results should be cautiously interpreted due to the possibility of reverse causation. It is still possible that adolescents suffering from asthma symptoms might have been susceptible to stressful events or factors. Second, all information was based on self-report. For example, self-reported weight and BMI may be underestimated [21], although obesity is regarded as an important factor for asthma [5]. Direct measurement of height and weight may be helpful in future studies.

**Table 2:** Subjective stress ratings of study population.

Subjective stress ratings, N (%)	Total (N=72,229)		Wheezing (N=8,224)		Wheezing on exertion (N=14,658)	
	N	(%)	N	(%)	N	(%)
Very low	1,812	(2.52)	102	(1.16)	224	(1.58)
Low	10,254	(14.18)	712	(8.74)	1,413	(9.79)
Moderate	29,724	(41.57)	2,735	(33.69)	5,182	(35.51)
High	22,013	(30.22)	2,973	(35.90)	5,229	(35.33)
Very high	8,426	(11.50)	1,702	(20.51)	2,610	(17.78)

All percentages were weighted.  
Differences between those with and those without the symptom were all significant ( $p < 0.001$ ).

**Table 3:** Odds ratios\* of asthma symptoms in relation to subjective stress ratings in adolescents.

Subjective stress ratings, N (%)	Wheezing		Wheezing on exertion	
	OR (95% CI)		OR (95% CI)	
Very low	Referent		Referent	
Low	1.208	(0.939–1.555)	1.003	(0.844–1.193)
Moderate	1.442	(1.130–1.840)	1.170	(0.988–1.386)
High	1.909	(1.493–2.440)	1.530	(1.289–1.816)
Very high	2.621	(2.040–3.367)	1.960	(1.638–2.344)
<i>P</i> for trend	$< 0.001$		$< 0.001$	

OR: Odds ratio, 95% CI: 95% confidence interval  
\* From multivariate logistic regression analyses adjusting for age, sex, asthma history, drinking experience, smoking experience, exposure to secondhand smoke, physical activity, fast food consumption, snack consumption, subjective health status, body mass index category, and household economic status.

**Table 4:** Odds ratios of asthma symptoms in relation to subjective stress ratings in adolescents by asthma history.

	Without asthma history				With asthma history			
	Wheezing		Wheezing on exertion		Wheezing		Wheezing on exertion	
Subjective stress ratings, N (%)								
<b>Very low</b>	<b>Referent</b>		<b>Referent</b>		<b>Referent</b>		<b>Referent</b>	
Low	1.197	(0.898–1.595)	0.977	(0.808–1.181)	1.247	(0.729–2.132)	1.174	(0.751–1.836)
Moderate	1.429	(1.084–1.883)	1.139	(0.945–1.371)	1.491	(0.898–2.477)	1.371	(0.887–2.118)
High	1.960	(1.483–2.592)	1.511	(1.251–1.826)	1.676	(1.002–2.804)	1.626	(1.055–2.506)
Very high	2.775	(2.092–3.681)	1.992	(1.638–2.424)	2.011	(1.171–3.452)	1.746	(1.110–2.748)
<i>P for trend</i>	<0.001		<0.001		<0.001		<0.001	

The values were expressed as odds ratios and 95% confidence intervals.  
 \*From multivariate logistic regression analyses adjusting for age, sex, asthma history, drinking experience, smoking experience, exposure to secondhand smoke, physical activity, fast food consumption, snack consumption, subjective health status, body mass index category, and household economic status.

In conclusion, we conducted a cross-sectional study using a nationally representative sample, and suggested the positive associations of perceived stress ratings with wheezing and wheezing on exertion in Korean adolescents. The associations were significant both in asthmatic and healthy adolescents.

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