

Association of maternal depression and allergic diseases in Korean children

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ABSTRACT

Purpose: An association between childhood allergic disease and parental psychological disorders has been reported. However, little is known about the relationship between childhood allergic disease and maternal depression. This study was performed to determine if there is an association between childhood allergic disease and maternal depression.

Methods: Data were acquired from 13,782 subjects (8091 mothers) ages < 18 years who participated in the Korea National Health and Nutrition Examination Surveys, which was conducted from 2007 to 2014. The presence of allergic disease (asthma or atopic dermatitis) and depression was based on self-reported physician diagnosis in the health interview surveys.

Results: Logistic regression analyses showed maternal depression was significantly associated with single marital status (separated or divorced, adjusted odds ratio [aOR] 2.204 [95% confidence interval {CI}, 1.256–3.867]), less than middle school graduated level (aOR 2.959 [95% CI, 1.514–5.781]), middle school graduated educational level (aOR 2.420 [95% CI, 1.355–4.319]), being a current smoker (aOR 2.257 [95% CI, 1.481–3.438]), being an ex-smoker (aOR 2.533 [95% CI, 1.506–4.260]), maternal asthma (aOR 2.786 [95% CI, 1.453–5.344]), and maternal hypertension (aOR 1.942 [95% CI, 1.106–3.408]). Maternal depression was significantly associated with children's asthma (aOR 2.028 [95% CI, 1.234–3.335]) and children's atopic dermatitis (aOR 1.755 [95% CI, 1.183–2.602]).

Conclusion: The present study showed maternal depression might be a risk factor for the clinical diagnosis of asthma and atopic dermatitis in Korean children.

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Allergic diseases are one of the most common chronic conditions and are recognized as a serious public health problem. The prevalence of allergic diseases has been increasing in recent decades.¹ Although the reason for the increasing prevalence of allergic diseases is unclear, it is widely believed that the westernized lifestyle that resulted from industrialization, which includes increased levels of air pollution,² living in primarily indoor environments,³ enhancements in hygiene,⁴ and a reduction in the incidence of infections early in life,⁵ has contributed to the risk of developing an allergic disease.

Recently, childhood allergic diseases were reported to have a negative emotional impact on families⁶ and to be associated with maternal depression.^{7,8} From an epidemiologic standpoint, children born of mothers who are depressed have an increased prevalence of asthma,⁹ and an increased prevalence of maternal depression was reported in children with asthma.¹⁰ In addition, the prevalence of maternal depression was

associated with increased rates of atopic dermatitis in children.^{7,8} Although maternal depression may be associated with the diagnosis and treatment of childhood allergic disease, little information is available about the relationship between childhood allergic disease and maternal depression in Korean families. Therefore, the aim of this study was to investigate the association between childhood allergic diseases and maternal depression in Korea by using Korean National Health and Nutrition Examination Survey (KNHANES) data.

METHODS

Study Subjects

This study was based on data obtained from the KNHANES (2007–2014) conducted by the Division of Chronic Disease Surveillance at the Korea Centers for Disease Control and Prevention. The KNHANES was a cross-sectional survey designed to examine the health and nutritional status of the noninstitutionalized Korean population. Data were collected in a variety of ways, including household interviews, physical examinations, laboratory tests, and nutritional status assessments. All survey protocols were approved by the Korea Centers for Disease Control and Prevention Institutional Review Board. Written informed consent was obtained from all participants before the survey began. This study included 15,879 people < 18 years old from the 65,973 who participated in the KNHANES

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Table 1 Baseline characteristics of the mothers (N = 8091)

Characteristics	Sample Size, no.	Estimate Percentage (95% CI)
Marital status (n = 8084)		
Both	7727	94.3 (93.6–95.0)
One (separated or divorced)	357	5.7 (5.0–6.4)
Employment status (n = 7969)		
Employed	3782	50.8 (49.4–52.3)
Unemployed	4187	49.2 (47.7–50.6)
Education (n = 7752)		
Less than middle school	213	3.6 (3.1–4.2)
Middle school	392	6.5 (5.8–7.4)
High school	3741	50.9 (49.4–52.4)
Post-high school	3406	38.9 (37.4–40.5)
Smoking (n = 8012)		
None	7081	88.4 (87.5–89.3)
Current	605	7.6 (6.9–8.4)
Ex-smoker	326	3.9 (3.5–4.4)
Asthma (n = 8091)		
Yes	160	1.9 (1.6–2.3)
No	7931	98.1 (97.7–98.4)
Atopic dermatitis (n = 8091)		
Yes	197	2.5 (2.2–3.0)
No	7894	97.5 (97.0–97.8)
Depression (n = 8091)		
Yes	272	3.5 (3.0–4.0)
No	7819	96.5 (96.0–97.0)
Hypertension (n = 8091)		
Yes	295	4.3 (3.7–4.9)
No	7796	95.7 (95.1–96.3)
Diabetes mellitus (n = 8091)		
Yes	140	1.8 (1.5–2.2)
No	7951	98.2 (97.8–98.5)

CI = Confidence interval.

study (2007–2014). We excluded 2097 participants with unweighted data due to nonresponsiveness and no mothers. The remaining 13,782 participants (8091 mothers) were included in the final analyses.

General Characteristics, Anthropometrics, and Definition of Asthma

The health interview and health behavior surveys included well-established questions to determine participants' demographic and socioeconomic characteristics. These surveys included questions regarding sex; age; marital status; employment status; educational level; monthly family income; number of household members; residence area; maternal smoking habits; and maternal diagnoses of hypertension, diabetes mellitus, depression, atopic dermatitis, and asthma. Respondents' residential areas were categorized as urban (an administrative division of a city) or rural (not classified as an administrative division of a city). In Korea,

the definition of a city is a place in which >50,000 people live and is larger than a town.

Monthly family income indicates monthly equalized family income and was calculated by dividing total family income by the square root of the number of household members. In the KNHANES, monthly family income was classified into quartiles to determine monthly household income level (1, low; 2, middle low; 3, middle high; and 4, high). Educational level was defined as less than middle school, middle school, high school, or college or more. Cigarette use was divided into three categories: current smoker, ex-smoker, and nonsmoker. Hypertension, diabetes mellitus, depression, atopic dermatitis, and asthma were defined by self-report from a physician's diagnosis. In this study, the presence or absence of each disease was investigated in the following format, "Have you ever been diagnosed with asthma by a physician?"

Table 2 Baseline characteristics of the children ($N = 13,782$)

Characteristics	Sample Size, no.	Estimate Percentage (95% CI)
Sex ($N = 13,782$)		
Male	7236	52.6 (51.7–53.6)
Female	6546	47.4 (46.4–48.3)
Age ($N = 13,782$)		
≤1 y	803	4.7 (4.3–5.1)
2–6 y	3927	23.5 (22.5–24.5)
7–12 y	5040	33.4 (32.4–34.3)
13–18 y	4012	38.5 (37.2–39.8)
Asthma, ($N = 13,782$)		
Yes	702	4.9 (4.5–5.4)
No	13,080	95.1 (94.6–95.5)
Atopic dermatitis ($N = 13,782$)		
Yes	1567	10.7 (10.1–11.5)
No	12,215	89.3 (88.5–89.9)
Monthly family income by quartile ($n = 8016$)		
1	554	8.0 (7.2–8.9)
2	2124	27.7 (26.4–29.2)
3	2831	34.2 (32.8–35.6)
4	2507	30.1 (28.4–31.8)
No. household members ($n = 8091$)		
2	177	2.5 (2.1–3.0)
3	1923	23.2 (22.1–24.4)
4	4108	50.2 (48.8–51.6)
≥5	1883	24.1 (22.9–25.3)
Residence area ($n = 8091$)		
Urban	6836	83.7 (81.1–86.0)
Rural	1255	16.3 (14.0–18.9)

CI = Confidence interval.

Statistical Analyses

We conducted all statistical analyses by using a complex sample procedure because the KNHANES data were collected through a representative, stratified, and clustered sampling method. For more accurate statistical comparisons, univariate analyses were conducted to select significant covariates. After selection of significant covariates, we carried out binary logistic regression analyses to identify the relationships between risk factors and the prevalence of maternal depression. Statistical analyses were conducted by using the Statistical Package for the Social Sciences version 21.0 (SPSS, Inc., Chicago, IL). For all analyses, the p values were two-tailed and p values of <0.05 were considered statistically significant.

Ethics Statement

The study protocol was approved by the institutional review board of Samsung Changwon Hospital (2016–10–02). Informed consent was exempted by the board.

RESULTS

Clinical Characteristics for the Study Subjects

A total of 13,782 children (8091 mothers) from the 2007–2014 KNHANES years were included in this study. Among the mothers in the study, most were married (94.3%) and nonsmokers (88.4%), with at least a high school education (89.8%). The prevalence of maternal asthma was 1.9%, and atopic dermatitis was 2.5%. The rate of maternal depression was 3.5% and of hypertension was 4.3% (Table 1). Among enrolled children, the prevalence of asthma was 4.9% and atopic dermatitis was 10.7%. A majority of the families lived in urban areas (83.7%) (Table 2).

Clinical Characteristics of Subjects with Maternal Depression

The mothers who reported having been diagnosed with depression were more likely to be single (separated or divorced), to be undereducated, to have a lower monthly income, and to have a smoking history

Table 3 Demographic characteristics of maternal depression according to maternal factors

Characteristics	Maternal Depression, no. (estimate %)		<i>p</i> Value
	Yes	No	
Marital status (<i>n</i> = 8084)			<0.01
One (separated or divorced)	34 (15.5)	323 (5.3)	
Both	237 (84.5)	7490 (94.7)	
Employment status (<i>n</i> = 7969)			0.30
Employed	119 (47.1)	3663 (51.0)	
Unemployed	153 (52.9)	4034 (49.0)	
Education (<i>n</i> = 7752)			<0.01
Less than middle school	17 (9.7)	196 (3.4)	
Middle school	27 (14.6)	365 (6.2)	
High school	141 (49.0)	3600 (51.0)	
Post-high school	87 (26.7)	3319 (39.4)	
Smoking (<i>n</i> = 8012)			<0.01
None	199 (72.3)	6882 (89.0)	
Current	51 (19.0)	554 (7.2)	
Ex-smoker	21 (8.7)	305 (3.8)	
Asthma (<i>n</i> = 8091)			<0.01
Yes	17 (6.1)	143 (1.8)	
No	255 (93.9)	7676 (98.2)	
Atopic dermatitis (<i>n</i> = 8091)			<0.01
Yes	13 (5.7)	184 (2.4)	
No	259 (94.3)	7635 (97.6)	
Hypertension (<i>n</i> = 8091)			<0.01
Yes	20 (9.4)	275 (4.1)	
No	252 (90.6)	7544 (95.9)	
Diabetes mellitus (<i>n</i> = 8091)			0.22
Yes	8 (2.9)	132 (1.8)	
No	264 (97.1)	7687 (98.2)	

(current and ex-smoker) compared with the mothers who were not depressed ($p < 0.01$) (Tables 3 and 4). The mothers who were depressed had more asthma, atopic dermatitis, and hypertension ($p < 0.01$) (Table 3). Compared with the children of the mothers who were not depressed, the children of the mothers who were depressed were more likely to have asthma and atopic dermatitis ($p < 0.01$) (Table 4).

After adjusting for significant covariates, presented in Tables 3 and 4, logistic regression analyses showed that being single (separated or divorced) (adjusted odds ratio [aOR] 2.204 [95% confidence interval {CI}, 1.256–3.867]), having less than a middle school education graduated level (aOR 2.959 [95% CI, 1.514–5.781]), middle school education graduated level (aOR 2.420 [95% CI, 1.355–4.319]), being a current smoker (aOR 2.257 [95% CI, 1.481–3.438]), being an ex-smoker (aOR 2.533 [95% CI, 1.506–4.260]), being diagnosed with asthma (aOR 2.786 [95% CI, 1.453–5.344]), and being diagnosed with hypertension (aOR 1.942 [95% CI, 1.106–3.408]) were significantly associated with mater-

nal depression. Maternal depression was significantly associated with the children's asthma (aOR 2.028 [95% CI, 1.234–3.335]) and the children's atopic dermatitis (aOR 1.755 [95% CI, 1.183–2.602]) (Table 5).

DISCUSSION

We found that maternal depression was significantly associated with asthma and atopic dermatitis among Korean children, which was consistent with previous studies.^{7–10} Compared with the general population, previous studies reported that the prevalence of maternal depression was higher among children with allergic disease.^{7–10} Although the causal relationship between maternal depression and children's allergic diseases was not clear, several mechanisms were indicated. First, maternal depression might disturb adherence to disease medications and illness management among children with allergic disease, and poorly controlled childhood allergic diseases increased the prevalence of allergic symptoms. Therefore, maternal de-

Table 4 Demographic characteristics of maternal depression according to the children factors

Characteristics	Maternal Depression, no. (estimate %)		P Value
	Yes	No	
Children factors			
Sex (<i>n</i> = 13,782)			0.45
Boys	248 (54.7)	6988 (52.5)	
Girls	217 (45.3)	6329 (47.5)	
Age (<i>n</i> = 13,782)			0.32
≤1 y	19 (2.9)	784 (4.7)	
2–6 y	126 (23.6)	3801 (23.5)	
7–12 y	163 (31.6)	4877 (33.4)	
13–18 y	157 (41.9)	3855 (38.3)	
Asthma (<i>n</i> = 13,782)			<0.01
Yes	41 (9.7)	661 (4.7)	
No	424 (90.3)	12,656 (95.3)	
Atopic dermatitis (<i>n</i> = 13,782)			<0.01
Yes	71 (16.6)	1496 (10.5)	
No	394 (83.4)	11,821 (89.5)	
Family factors			
Monthly family income by quartile (<i>n</i> = 8016)			<0.01
1	37 (14.9)	517 (7.8)	
2	86 (39.0)	2038 (27.3)	
3	79 (25.2)	2752 (34.5)	
4	66 (20.9)	2441 (30.4)	
No. household members (<i>n</i> = 8091)			0.06
2	14 (5.5)	163 (2.4)	
3	65 (23.3)	1858 (23.2)	
4	125 (48.2)	3983 (50.2)	
≥5	68 (23.1)	1815 (24.1)	
Residence area (<i>n</i> = 8091)			0.23
Urban	240 (86.9)	6596 (83.6)	
Rural	32 (13.1)	1223 (16.4)	

pression was shown to be associated with childhood allergic diseases.^{11,12} Second, maternal disrupted sleep, a product of allergic disease among children, might influence the quality of maternal sleep. Decreased quality of maternal sleep can aggravate the symptoms of maternal depression.^{13,14} Third, maternal stress, *e.g.*, depression during pregnancy, might influence the hypothalamic-pituitary-adrenal axis development in the fetus. Upregulated stress hormones in early life can influence type 2 T-helper cell immune response, which leads to allergic inflammation in later life.^{15–18}

Our study found that single marital status (separated or divorced) was significantly associated with maternal depression. Previous studies reported that this relationship was bidirectional and that depression might cause individuals to avoid marriage, and that marital disruption might cause depression.^{19–21} In our study, smoking was significantly associated with maternal depression. Smoking has been shown to be a risk factor

for depression²² and that depression may disturb smoking cessation efforts.²³ We found that maternal asthma and maternal atopic dermatitis were associated with maternal depression, consistent with previous studies.^{24–29} Compared with the general population, previous studies reported that depression prevalence was higher among individuals with allergic disease. Several mechanisms about the association between allergic disease and depression are indicated. First, emotional disturbance in allergic disease causes the development of depression. Fearful events, *e.g.*, asthma attack, can cause psychological stress that leads to depression,^{30,31} and lower self-esteem due to atopic dermatitis might increase the propensity for depression.³²

Second, depression leads to the development of asthma and atopic dermatitis. Long periods in a state of tension that is caused by depression may be able to dysregulate the hypothalamic-pituitary-adrenal axis. The subsequent downregulation of cortisol and adren-

Table 5 Adjusted ORs and their 95% CIs for the prevalence of maternal depression

Characteristics	Adjusted OR*	95% CI
Maternal factor		
Marital status		
One (separated or divorced)	2.204	1.256–3.867
Both		
Education		
Less than middle school	2.959	1.514–5.781
Middle school	2.420	1.355–4.319
High school	1.252	0.900–1.741
Post-high school	Reference	
Smoking habits		
Current	2.257	1.481–3.438
Ex-smoker	2.533	1.506–4.260
None	Reference	
Asthma		
Yes	2.786	1.453–5.344
No	Reference	
Atopic dermatitis		
Yes	1.650	0.853–3.190
No	Reference	
Hypertension		
Yes	1.942	1.106–3.408
No	Reference	
Children factor		
Asthma		
Yes	2.028	1.234–3.335
No	Reference	
Atopic dermatitis		
Yes	1.755	1.183–2.602
No	Reference	
Family factor		
Monthly family income by quartile		
1	1.276	0.727–2.238
2	1.481	0.989–2.218
3	0.907	0.608–1.352
4	Reference	
No. household members		
2	0.995	0.452–2.188
3	0.908	0.595–1.384
4	1.095	0.768–1.562
≥5	Reference	

OR = Odds ratio; CI = confidence interval.

*Adjusted for maternal marital status, maternal education, maternal smoking history, maternal asthma, maternal atopic dermatitis, maternal hypertension, children's asthma, children's atopic dermatitis, monthly family income, number of household members.

ergic hormone receptors leads to altered regulation of inflammatory responses, which trigger the development of asthma^{33,34} and atopic dermatitis.³⁵ Third, allergic disease and depression have the same underlying immunologic mechanism. Because interleukin (IL) 1, IL-4, and IL-6 are elevated in allergic disease³⁶ and

depression,³⁷ the presence of the same immunologic mechanism in allergic disease and depression was indicated. IL-4 is an essential cytokine in allergic diseases and was shown to have an effect on the serotonin metabolism. The polymorphism in the serotonin transporter gene promoter was found to be associated with

depression.³⁸ However, more conclusive data are needed to clarify a underlying immunologic mechanism. Fourth, adverse effects of common allergic medications, such as pseudoephedrine, antihistamine, and corticosteroid, may be associated with depression.³⁹

Lower socioeconomic status, such as lower education and lower income, was known to be associated with depression.^{40–43} Two hypotheses have been proposed for this relationship. One is that stress due to conditions of poverty increase the risk of mental illness, and the other hypothesis is that people with mental illness are at increased risk of moving into or remaining in poverty due to loss of employment. Our study found that a lower educational level was significantly associated with an increasing prevalence of maternal depression, which was consistent with previous studies.^{44,45} Previous studies reported that depression was overrepresented among adults with lower education and that this inverse association between depression and education strengthened with increasing age. We found that lower monthly family income groups had an increasing trend of maternal depression but not significantly. Previous studies reported an increasing prevalence of depression as monthly family income decreased.^{46,47}

In our study, hypertension was significantly associated with maternal depression, which was consistent with previous studies.^{48,49} Compared with the general population, previous studies indicated that hypertension prevalence was higher in patients who were depressed. This relationship might be due to poor blood pressure control among patients who are depressed due to a loss of interest in adhering to hypertension treatments.⁵⁰ In addition, it might be due to a common biologic pathway that increases sympathetic tone.⁵¹ Also, in our study, diabetes mellitus was not associated with depression. The association between diabetes mellitus and depression is conflicting. Previously, a number of studies reported that depression was a risk factor for diabetes^{52–54}; these studies were based on a white population; however, one Korean population study did not show the association between diabetes mellitus and depression.⁵⁵ We assumed that these different results might be due to racial differences or biases, such as recall and misclassification. More studies are needed to clarify this association.

Our study found that maternal depression was not associated with employment status. A previous study reported that full-time working mothers were at high risk for depression but that part-time working mothers were not.⁵⁶ We could not differentiate employment status into full time or part time in this study. Also, there was no association between the number of household members and maternal depression. Previous studies reported families with large numbers of children were associated with maternal depression.^{57,58}

However, in our study, we used the number of household members, which differed from the number of children. We did not find urban-rural differences in maternal depression, which was consistent with a previous study, which found that the prevalence of mental disorders, including depression, did not vary between urban and rural areas.⁵⁹

This study had several limitations. First, because this study was cross-sectional in design, we could not establish causality. Second, the diagnoses of depression, asthma, and atopic dermatitis were based on participant self-report. This may have produced a misclassification bias. Third, although this study was based on a national survey, this study's results might be influenced by selection or recall bias. One notable strength of this study was that it used national, widely sampled data to examine the association between children's allergic disease and maternal depression among Korean families. The other strength was that previous reports about the association between maternal depression and pediatric allergic diseases were mainly based on a white subjects,^{7,9,10,60} but this study was conducted on Asian subjects.

CONCLUSION

When considering these results, we believe that maternal depression was an important risk factor for asthma and atopic dermatitis among Korean children.

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