

Original Article



Analysis of Quality of Life and Mental Health in Patients With Atopic Dermatitis, Asthma and Allergic Rhinitis Using a Nation-wide Database, KNHANES VII

OPEN ACCESS

Received: Oct 5, 2021
Revised: Jan 19, 2022
Accepted: Jan 24, 2022
Published online: Feb 15, 2022

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Disclosure

There are no financial or other issues that might lead to conflict of interest.

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ABSTRACT

Purpose: This study investigated mental health status and quality of life in allergic disease patients compared with non-allergic controls.

Methods: This study used nationwide, population-based, cross-sectional data from the Korean National Health and Nutrition Examination Survey from 2016 to 2018. The propensity matching score was used to balance age and sex distributions between the allergic disease groups and corresponding controls. Atopic dermatitis (n = 446) and asthma (n = 483) groups were compared with controls in a 1:10 ratio, and the allergic rhinitis (n = 2,357) group was compared with controls in a 1:2 ratio. Multiple logistic regression analyses were used to evaluate the odds ratios (ORs) for mental health status and health-related quality of life (HRQoL) based on the presence of allergic diseases.

Results: The ORs for severe psychological stress, psychological consultation and diagnosis of depression were more significantly increased in the asthma (OR, 1.41, 1.83, and 2.1, respectively) and allergic rhinitis groups (OR, 1.35, 1.48, and 1.83, respectively) compared with non-allergic controls after adjustment for confounding factors. The rate of severe problems in mobility was more significantly increased in the asthma group compared to controls.

Conclusions: The results show that efforts should be made to manage psychological problems and improve HRQoL in patients with atopic dermatitis, asthma and allergic rhinitis.

Keywords: Quality of life; mental health; atopic dermatitis; asthma; allergic rhinitis; database; propensity matching score; HRQoL

INTRODUCTION

The prevalence of allergic diseases, such as atopic dermatitis, asthma and allergic rhinitis, has increased worldwide including in South Korea.^{1,2} Atopic dermatitis, asthma and allergic rhinitis are representative atopic diseases caused by the same pathogenic mechanisms of

hypersensitivity to allergens facilitated by immunoglobulin E antibodies resulting in allergic inflammation. The allergic march is a series of progression that appears food allergy or atopic dermatitis in infant and toddler ages persist as allergic rhinitis and asthma with age.³ In general, atopic dermatitis predates the development of asthma and allergic rhinitis, suggesting that atopic dermatitis is an “entry point” for subsequent allergic disease.⁴ These allergic diseases account for significant morbidity and socioeconomic burden. They significantly interfere with daily life because of physical discomfort and impairment with associated emotional stress. This interference suggests the need for interest in health-related quality of life (HRQoL). Several studies have shown a decline in the quality of life in allergic diseases, requiring clinical interest and intervention.

HRQoL is a multi-dimensional concept that incorporates the subjective perception of health status over time. It is defined as the functional effect of an illness and its consequent therapy as perceived by the patient. It highlights the subjective aspects of a disease, like cognitive, emotional and social factors; expectations; and coping styles which can affect the personal burden. Therefore, HRQoL is considered a key indicator in guiding health policies and used to evaluate the effects of chronic diseases and various treatments.

Quality of life and mental health status in patients with atopic dermatitis have been evaluated in the Korean population using a nationwide database.⁵ However, the relationship between HRQoL and mental health status in collective atopic dermatitis, asthma and allergic rhinitis has not been evaluated in a large-scale study. Therefore, this study aimed to examine the association between quality of life and mental health status among patients with allergic diseases in South Korea, using data obtained from the Seventh Korean National Health and Nutrition Examination Survey (KNHANES-VII, 2016–2018).

MATERIALS AND METHODS

Study population and data collection

This study employed a nationwide, population-based, cross-sectional study design and secondary data analysis using KNHANES-VII (2016–2018) data. The Korea Centers for Disease Control and Prevention (KCDC) conducts the KNHANES annually. This survey adopted a multi-staged, stratified, clustered-sampling method based on age, sex and geographical area of residence based on household registries.⁶ It consisted of a health interview, health behavior survey, health examination and nutrition survey. The first 3 were performed in a vehicle-based examination center, and the nutrition survey was conducted at scheduled household visits. Physicians or trained interviewers collected all questionnaires in person at the participants' homes. All participants who agreed to take part in the survey provided written informed consent before the study began and had the right to refuse to participate at any time. The KCDC complies with the Personal Information Protection Act and Statistics Act and only provides data that have been de-identified to maintain the anonymity of participants. The data can be downloaded from the KNHANES website (<https://knhanes.kdca.go.kr/>) and used for academic research purposes. The study design followed the tenets of the Declaration of Helsinki for biomedical research. The KNHANES-VII (2016–2018) was carried out following approval from the Institutional Review Board (IRB) of the KCDC (IRB No. 2018-01-03-P-A).

Definition of allergic diseases

The presence of medical histories of allergic diseases (atopic dermatitis, asthma, and allergic rhinitis) was based on participant responses to the questionnaires. The participants who answered “yes” to “Have you ever been diagnosed with atopic dermatitis by a physician” were placed in the atopic dermatitis group. The participants who answered “yes” to “Have you ever been diagnosed with asthma by a physician” were placed in the asthma group, and the individuals who answered “yes” to “Have you ever been diagnosed with allergic rhinitis by a physician” were placed in the allergic rhinitis group. Those who did not answer yes to any of these 3 questions were classified as a control group without allergic diseases.

Sociodemographic characteristics, health behavior, and chronic conditions

Data on age, sex, smoking and drinking status, sleep duration, physical activity, household income, education level, habitat, marital status, occupation, working time, and restriction of activities were collected from self-reported questionnaires. Participants were considered drinkers if they drank more than once per month during the past year. Smoking status was divided into current and non-smokers. Subjects were considered regular exercisers if they performed moderate exercise more than 5 times per week for over 30 minutes per session or if they performed vigorous exercise more than 3 times per week for over 20 minutes per session. The lowest income level was defined as the 25th percentile of that of all subjects. We classified participants' education level according to the graduation of school. We obtained information regarding the medical history of diabetes, hypertension, stroke, myocardial infarction or angina, osteoarthritis, rheumatoid arthritis, osteoporosis, thyroid diseases, and types of cancer that could influence the mental health status and HRQoL through questionnaires.

Measurements

Trained staff measured the height (cm) and weight (kg) of each subject to the nearest 0.1 cm and 0.1 kg, respectively, with subjects wearing light clothing and no shoes. Body mass index (BMI) was calculated by dividing weight (kg) by the square of height (m²). Waist circumference was measured at the midpoint between the lower border of the rib cage and the iliac crest with subjects in a standing position.

Psychological health status and HRQoL

Psychological stress was evaluated from the subjects' responses to the following question: “How much stress do you feel in your everyday life?” Subjects who answered “feel very strongly” or “feel strongly” were categorized as having psychological stress. The proportions of participants who experienced psychiatric consultations or had been diagnosed with depression disorder were analyzed for mental health status.

HRQoL was assessed by the questionnaire. We analyzed patients with severe problems in mobility, pain/discomfort and anxiety/depression. Subjects chose one of the 3 responses for each question: no problems, moderate problems, and severe problems. The subjects who selected severe problems for each question were classified as “participants with problems.”

Age and sex distributions

Considering the imbalance of age and sex between the allergic disease group and control, we used propensity score matching to homologize the age and sex distributions of the allergic disease and control groups. The propensity score for an individual is defined as the conditional probability of being in the allergic disease group, given the individual's covariates are reported to be able to balance covariates in the 2 groups and thus reduce bias.⁷ Controls

were composed in a 1:10 ratio in atopic dermatitis (n = 446) and asthma (n = 483) patients, and a 1:2 ratio in the allergic rhinitis patient group (n = 2,357).

Statistical analysis

All variables are presented as the mean \pm SE or as percentages (SE). After propensity score matching, differences according to the presence of allergic diseases (χ^2 tests for categorical variables, or independent t-tests for continuous variables) were performed between the allergic disease group and the control. Multivariable logistic regression analysis was used to evaluate the risk of atopic dermatitis, asthma or allergic rhinitis according to mental health status and HRQoL, and odds ratios (ORs) and 95% confidence intervals (CIs) were calculated after adjusting for potential confounders. Analyses were adjusted for BMI, current smoking, current drinking, physical activity, income, education, habitat, sleep duration, marital status, occupation, working time, and restricted activities, and medical history of diabetes mellitus, hypertension, stroke, myocardial infarction, osteoarthritis, rheumatoid arthritis, osteoporosis, thyroid diseases and any type of cancers. All statistical analyses were performed using the SURVEY procedures of Statistical Analysis System software (SAS version 9.4; SAS Institute Inc., Cary, NC, USA) to account for the complex sampling design. All statistical tests were 2-tailed, and statistical significance was set at $P < 0.05$.

RESULTS

Demographics

Among 24,269 potential participants in KNHANES VII from 2016 to 2018, those younger than 19 years (n = 4,880) were excluded. Additionally, 3,085 individuals were eliminated due to missing data. Thus, the final study population contained 16,304 participants with complete data sets (**Figure**). Among a total of 16,304 patients, 446 had been diagnosed with atopic dermatitis, 483 with asthma and 2,353 with allergic rhinitis. There were significant differences between the allergic disease groups and the control group in terms of age and sex. Using propensity score matching, the controls were included in a 1:10 ratio for atopic dermatitis and asthma and a 1:2 ratio for the allergic rhinitis group. Baseline characteristics are presented in **Table 1**.

Compared to the control group, the atopic dermatitis group had an increased percentage of physical activity and the lowest household income. In addition, the atopic dermatitis group showed a higher rate of living without a spouse and an unemployment rate compared to the control group. The presence of atopic dermatitis increased the rate of restricted activity compared to the control group (**Table 1**).

The asthma group (mean 47.29 ± 1.18 years of age) was older than the other allergic disease groups. The proportion of individuals with restricted activities was higher in the asthma group ($13.51\% \pm 1.55\%$) than in the control group. The comorbidities of medical diseases, such as myocardial infarction, osteoarthritis, rheumatoid arthritis and osteoporosis, were more significantly increased in the asthma group compared to the control group (**Table 1**).

The allergic rhinitis group had a lower percentage of current smoking status and a higher percentage of regular exercise than the control group. However, the rate of restrictive activities was higher in the allergic rhinitis group ($6.04\% \pm 0.56\%$) compared to the control group (4.38 ± 0.48). The proportions with myocardial infarction, osteoarthritis, and

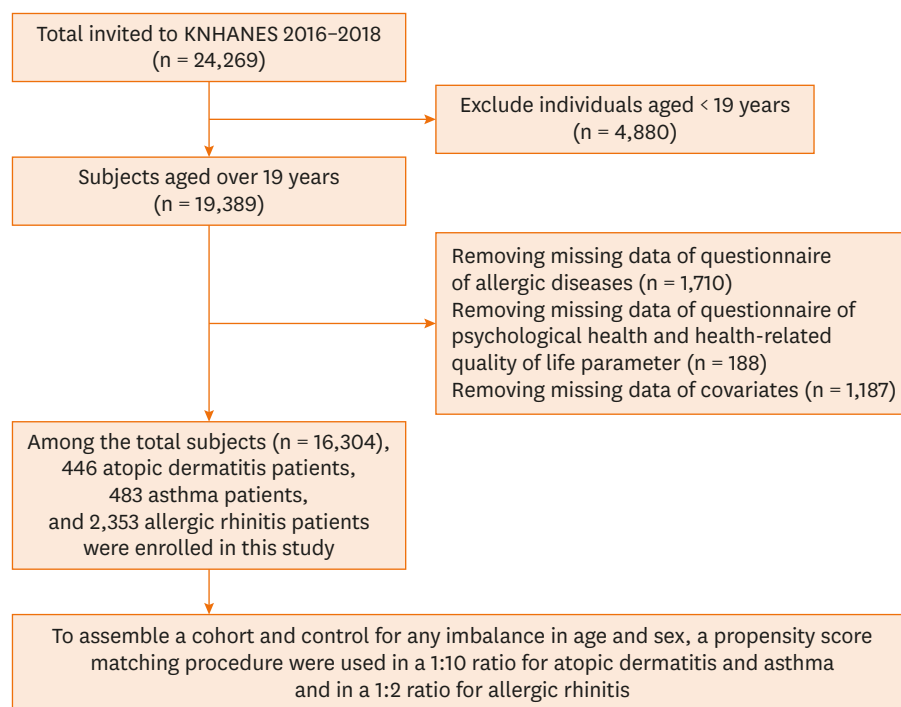


Figure. Flow chart of the study design.
KNHANES, Korean National Health and Nutrition Examination Survey.

Table 1. Differences in clinical characteristics between atopic dermatitis, asthma and allergic rhinitis

	Atopic dermatitis			Asthma			Allergic rhinitis		
	No (n = 4,460)	Yes (n = 446)	P value	No (n = 4,830)	Yes (n = 483)	P value	No (n = 4,706)	Yes (n = 2,353)	P value
Age	36.11 ± 0.24	34.42 ± 0.84	0.05	46.99 ± 0.43	47.29 ± 1.18	0.80	39.98 ± 0.26	40.52 ± 0.34	0.17
Sex (male)	52.42 (0.76)	53.84 (2.78)	0.63	47.74 (0.87)	48.66 (2.8)	0.75	43.53 (0.83)	43.16 (1.2)	0.80
Sleep duration (hr)	7.31 ± 0.02	7.42 ± 0.07	0.15	7.23 ± 0.02	7.28 ± 0.08	0.55	7.23 ± 0.02	7.23 ± 0.03	0.85
Sleep duration group (hr)	0.28			0.39			0.76		
≤ 5	3.88 (0.34)	3.93 (1.05)		5.63 (0.39)	7.1 (1.13)		4.76 (0.37)	4.33 (0.46)	
> 5 to ≤ 6	11.5 (0.55)	7.96 (1.41)		12.85 (0.61)	11.61 (1.75)		11.89 (0.55)	11.97 (0.7)	
> 6 to ≤ 7	27.76 (0.79)	26.45 (2.41)		28.65 (0.8)	28.11 (2.41)		29.63 (0.8)	29.4 (1.05)	
> 7 to ≤ 8	34.11 (0.79)	36.6 (2.42)		31.31 (0.79)	28.35 (2.45)		32.42 (0.79)	33.92 (1.1)	
> 8	22.74 (0.76)	25.05 (2.5)		21.55 (0.77)	24.82 (2.49)		21.3 (0.71)	20.39 (1.02)	
Current smoker	23.61 (0.8)	23.16 (2.49)	0.86	20 (0.76)	22.38 (2.64)	0.35	20.79 (0.73)	17.98 (0.96)	0.02
Current alcohol drinker	65.19 (0.85)	65.71 (2.47)	0.84	53.9 (0.89)	56.37 (2.66)	0.37	61.49 (0.85)	60.94 (1.15)	0.68
Regular exercise	51.76 (0.97)	58.85 (2.81)	0.01	46.34 (0.99)	49.21 (2.91)	0.35	50.31 (0.88)	53.22 (1.19)	< 0.05
Household income, first quartile	10.07 (0.64)	16.67 (2.18)	< 0.001	19.92 (0.83)	21.9 (2.12)	0.34	10.44 (0.63)	11.1 (0.92)	0.50
Education level	0.52			0.06			0.08		
≤ Elementary school graduate	5.22 (0.35)	5.93 (1.07)		19.94 (0.83)	22.82 (2.29)		6.89 (0.4)	5.73 (0.5)	
Middle school graduate	3.71 (0.31)	4.76 (1.12)		7.64 (0.41)	9.21 (1.44)		5.5 (0.36)	5.88 (0.55)	
High school graduate	37.78 (1.05)	39.17 (2.73)		36.04 (0.98)	29.08 (2.48)		39.38 (0.98)	37.32 (1.25)	
≥ University graduate	53.29 (1.08)	50.14 (2.65)		36.38 (1.05)	38.89 (2.84)		48.23 (1.06)	51.08 (1.35)	
Urban habitat (yes)	88.32 (1.35)	89.61 (2)	0.48	84.84 (1.49)	80.98 (2.8)	0.06	88.31 (1.28)	88.33 (1.54)	0.98
Body mass index (kg/m ²)	23.77 ± 0.08	23.53 ± 0.22	0.31	24.02 ± 0.07	23.98 ± 0.2	0.88	23.71 ± 0.07	23.54 ± 0.09	0.11
Total cholesterol	189.83 ± 0.63	184.71 ± 1.78	< 0.01	190.66 ± 0.66	191.19 ± 2.03	0.80	191.86 ± 0.63	191.82 ± 0.84	0.97
Marital status	< 0.001			0.62			0.31		
Never married	44.09 (1.15)	61.17 (2.72)		31.11 (1.06)	32.87 (2.86)		33.95 (0.97)	32.51 (1.25)	
Living with partner	51.93 (1.14)	34.11 (2.63)		55.36 (1)	52.7 (2.73)		60.09 (0.99)	60.73 (1.28)	
Divorced, separated, widowed	3.99 (0.3)	4.72 (0.95)		13.53 (0.59)	14.43 (1.72)		5.96 (0.39)	6.76 (0.53)	
Occupation (yes)	66.16 (0.9)	58.37 (2.58)	< 0.01	57.25 (0.91)	54.07 (2.73)	0.26	66.2 (0.89)	67.46 (1.18)	0.38
Working hours per week	31.93 ± 0.38	29.3 ± 1.15	0.03	26.66 ± 0.42	24.89 ± 1.22	0.17	31.07 ± 0.39	30.24 ± 0.53	0.18
Restricted activities (yes)	4 (0.34)	5.92 (1.12)	0.05	7.32 (0.43)	13.51 (1.55)	< 0.001	4.38 (0.33)	6.04 (0.56)	< 0.01

(continued to the next page)

Table 1. (Continued) Differences in clinical characteristics between atopic dermatitis, asthma and allergic rhinitis

	Atopic dermatitis			Asthma			Allergic rhinitis		
	No (n = 4,460)	Yes (n = 446)	P value	No (n = 4,830)	Yes (n = 483)	P value	No (n = 4,706)	Yes (n = 2,353)	P value
History of medical diseases									
Diabetes (yes)	5.4 (0.35)	4.91 (1.01)	0.66	11.5 (0.56)	11.06 (1.48)	0.77	6.96 (0.42)	4.78 (0.48)	< 0.001
Hypertension (yes)	15.79 (0.65)	16.68 (1.84)	0.64	28.85 (0.83)	29.87 (2.51)	0.68	18.1 (0.63)	16.8 (0.84)	0.21
Stroke (yes)	0.54 (0.09)	0.68 (0.48)	0.75	1.91 (0.2)	2.81 (0.79)	0.17	0.72 (0.12)	0.84 (0.19)	0.56
Myocardial infarction or angina (yes)	0.68 (0.11)	1.26 (0.46)	0.12	2.1 (0.19)	4.26 (0.97)	< 0.01	0.68 (0.12)	1.61 (0.27)	< 0.001
Osteoarthritis (yes)	3.1 (0.25)	4.78 (1.03)	0.06	11.47 (0.49)	16.87 (1.73)	< 0.001	4.46 (0.29)	7.43 (0.58)	< 0.001
Rheumatoid arthritis (yes)	0.87 (0.14)	0.78 (0.36)	0.82	2.01 (0.21)	4.63 (0.98)	< 0.001	1.14 (0.16)	1.65 (0.31)	0.13
Osteoporosis (yes)	2.03 (0.2)	2.63 (0.68)	0.35	8.66 (0.46)	13.21 (1.51)	< 0.001	2.94 (0.24)	3.91 (0.37)	0.02
Thyroid diseases (yes)	2.58 (0.26)	1.18 (0.43)	0.03	3.22 (0.31)	3.7 (0.86)	0.59	3.62 (0.31)	3.39 (0.37)	0.64
Cancers (yes)	2.13 (0.24)	1.55 (0.47)	0.32	4.45 (0.33)	3.94 (0.83)	0.58	3.11 (0.29)	3.04 (0.38)	0.88

Data are shown as mean \pm SE or number (%). Bold-faced values mean statistical significance.

osteoporosis were more significantly higher in the allergic rhinitis group than in the control group (**Table 1**).

Analyses of psychological health status and HRQoL according to the presence of allergic diseases

The percentages of participants who felt stress strongly, who had experienced psychiatric consultations, and who had been diagnosed with depression were higher in the allergic disease groups compared to the non-allergic control group (**Table 2**). In addition, these differences were significant between the asthma group/allergic rhinitis group and the control group ($P < 0.01$). The risks of strong psychological stress, psychiatric consultations, and diagnosis of depression were significantly higher in asthma patients (OR [95% CI], 1.42 [1.09–1.85], 1.83 [1.11–3.03], and 2.1 [1.35–3.26], respectively) and allergic rhinitis patients (OR [95% CI], 1.35 [1.18–1.54], 1.48 [1.08–2.05], and 1.83 [1.39–2.43], respectively) compared to the control group without allergic diseases after adjustment for BMI, current smoking, current drinking, physical activity, income, education, habitat, sleep duration, marital status, occupation, working time, and restricted activities, and medical history of diabetes mellitus, hypertension, stroke, myocardial infarction, osteoarthritis, rheumatoid arthritis, osteoporosis, thyroid diseases, and any type of cancers. The atopic dermatitis group showed higher ORs for mental health problems, though the difference was not significant ($P > 0.05$) (**Table 2**).

The percentages of patients who had severe problems in mobility, pain/discomfort, and anxiety/depression also were higher in the allergic disease groups compared to the control group (**Table 2**). After adjustment for BMI, current smoking, current drinking, physical activity, income, education, habitat, sleep duration, marital status, occupation, working time, and restricted activities, and medical history of diabetes mellitus, hypertension, stroke, myocardial infarction, osteoarthritis, rheumatoid arthritis, osteoporosis, thyroid diseases, cancers, the risk for severe problems in mobility was higher in the asthma group (OR, 3.03; 95% CI, 1.29–7.09) compared to the control group (**Table 2**).

DISCUSSION

This study revealed the presence of significant mental health problems, such as strong psychological stress, experiences of psychiatric consultations, and diagnosis of depression, in asthma and allergic rhinitis patients compared with non-allergic controls after

Table 2. Analysis of mental health status and health-related quality of life according to allergic disease

	Atopic dermatitis			Asthma			Allergic rhinitis		
	No	Yes	P value	No	Yes	P value	No	Yes	P value
Mental health									
Strong psychological stress	32.04 (0.87)	34.78 (2.61)	0.31	26.28 (0.83)	34.21 (2.68)	< 0.01	29.86 (0.79)	36.18 (1.22)	< 0.001
Adjusted OR (95% CI)	1.15 (0.90–1.47)		0.26	1.42 (1.09–1.85)		< 0.01	1.35 (1.18–1.54)		< 0.001
Experience of psychological consultation	2.97 (0.3)	3.64 (0.94)	0.47	2.61 (0.27)	5.47 (1.1)	< 0.001	2.8 (0.29)	4.37 (0.45)	< 0.01
Adjusted OR (95% CI)	1.07 (0.59–1.95)		0.83	1.83 (1.11–3.03)		0.02	1.48 (1.08–2.05)		0.02
Diagnosis of depression	2.82 (0.29)	3.86 (0.97)	0.25	3.45 (0.29)	8.31 (1.38)	< 0.001	2.98 (0.28)	5.78 (0.53)	< 0.001
Adjusted OR (95% CI)	1.26 (0.71–2.26)		0.43	2.1 (1.35–3.26)		0.001	1.83 (1.39–2.43)		< 0.001
Health-related quality of life									
Severe problem in mobility	0.15 (0.05)	0.61 (0.38)	0.03	0.41 (0.08)	1.51 (0.52)	< 0.001	0.12 (0.04)	0.17 (0.07)	0.54
Adjusted OR (95% CI)	2.46 (0.81–7.45)		0.11	3.03 (1.29–7.09)		0.01	0.98 (0.36–2.68)		0.96
Severe problem in pain/discomfort	0.59 (0.13)	1.82 (0.56)	< 0.01	1.96 (0.22)	4.71 (0.94)	< 0.001	0.77 (0.14)	1.35 (0.25)	0.02
Adjusted OR (95% CI)	2.11 (0.73–6.08)		0.17	1.66 (0.98–2.83)		0.06	1.58 (0.86–2.93)		0.14
Severe problem in anxiety/depression	0.38 (0.09)	0.68 (0.37)	0.32	0.63 (0.11)	1.35 (0.53)	0.07	0.36 (0.08)	0.42 (0.15)	0.73
Adjusted OR (95% CI)	0.90 (0.25–3.23)		0.87	1.25 (0.51–3.08)		0.63	0.90 (0.37–2.18)		0.81

ORs were analyzed after adjustment for body mass index, current smoking, current drinking, physical activity, income, education, habitat, sleep duration, marital status, occupation, working time, and restricted activities, and medical history of diabetes mellitus, hypertension, stroke, myocardial infarction, osteoarthritis, rheumatoid arthritis, osteoporosis, thyroid diseases, and cancers. Bold-faced values mean statistical significance. CI, confidence interval; OR, odds ratio.

adjustment for multiple covariates. We also observed severe problems in mobility in asthma patients than controls.

Previous studies have reported the association of sleep disturbance with child atopic dermatitis^{8,9} and adult atopic dermatitis.^{10,11} Sleep-related impairment and sleep disturbance are known to be associated with the severity of atopic dermatitis. Sleep disturbance is a critical problem in allergic rhinitis^{12,14} and asthma patients.¹⁵ However, in this study, sleep duration in the allergic disease groups was not significantly different from that in the non-allergic controls. The importance of sleep duration is a controversial issue, and sleep quality does not solely depend on duration.⁹ Therefore, it is difficult to say that there was no association between allergic diseases and sleep disturbance, although there was no statistical significance in the difference in sleep duration in allergic disease groups in our study.

Mental health is paramount at every stage of life. Mental and physical health are equally important components of overall health. Several studies have reported that mental health problems increase the risk of atopic dermatitis, asthma, and allergic rhinitis. Similarly, the presence of allergic disease can increase the risk for mental illness. The results of this study are consistent with previous studies. Especially, South Korea's suicide rate is the highest among Organization for Economic Cooperation and Development (OECD) countries. In 2019, South Korea's suicide rate was 24.6 cases per 100,000 population.¹⁶ Attention needs to be paid to the increased risk for mental health problems associated with allergic diseases.

In this study, allergic disease patients had good health behaviors including non-smoking, exercising regularly and consuming less alcohol than non-allergic controls. These findings are consistent with previous studies and explained by the association between mental illness and health behavior. An interesting study about mental health found that people with a mental illness are interested in improving their health risk behaviors. The study reported that people with depression were more likely to be interested in quitting smoking and increasing physical activities.¹⁷ This study did not confirm the association between mental health problems and good health behaviors in patients with allergic diseases, but health behaviors were adjusted for analysis considering the association with mental health behavior and HRQoL.

There have been several reports that revealed depression and psychological distress to be common in atopic dermatitis.¹⁸⁻²⁴ Silverberg *et al.*²² reported several studies that revealed atopic dermatitis is associated with depressive symptoms and severe psychological distress in the US.^{18,21,24} Nicholas and Gooderham²⁰ reported increasing severity of AD and female sex are associated with an increased risk for both depression and suicidality in Canada. Choi *et al.*¹⁹ reported that atopic dermatitis patients had 2.3 times higher risk for depression in Korea using the Korea Community Health Survey during the period 2010–2013. The previous study used propensity score method using the survey data performed by Korea Centers for Disease Control and Prevention in the same way as our research. However, in this study, the comparison between the atopic dermatitis group and the non-allergic controls showed no significant difference. The discrepancy of the results might be related to the limitation of the data. Because KNHANES employs questionnaires-based data collection, we could not assess the severity of atopic dermatitis or medication history. Compared to previous studies, this study adjusted more covariables, such as marital status, occupation status, and history of medical diseases that might affect mental health status and HRQoL.

Previous studies have reported the association between depression and asthma.²⁵⁻²⁸ Anastasia *et al.*²⁵ reported that the asthma exacerbation was associated with the level of depression in Greece. Bardach *et al.*²⁶ analyzed the Massachusetts All-Payer Claims database for 2014 to 2015 and reported that the presence of anxiety and depression increased the rate of asthma-related Emergency Department visit in US pediatric asthma patients. Bedolla-Barajas *et al.*²⁷ revealed more than 50% of all asthmatic patients suffered from anxiety and depression in Mexico. González-Freire *et al.*²⁸ recently reported that anxiety and depression were associated with poor HRQoL in all dimensions.

Allergic rhinitis is associated with mental health problems, such as depression and anxiety.²⁹⁻³¹ Like other allergic diseases, allergic rhinitis can also lead to social and interpersonal difficulties and loss of productivity. Subjective worsening of mood with high allergen season has been reported in college students in the United States of America.^{29,32} A recent Korean study that analyzed data from the annual Korea Youth Risk Behavior Web-based Survey from 2007 to 2017 reported that adolescents with allergic rhinitis had a significantly greater prevalence of depression and suicidal ideation.³⁰ Comorbidity between allergic diseases and mental conditions is considered the norm rather than the exception. Especially in the coronavirus disease 2019 pandemic era, mental health problems have emerged as a substantial issue in allergic disease patients.^{33,34}

Atopy, allergic rhinitis, and asthma had slightly different risks of mental health problems and HRQoL. However, since the three diseases are related by atopic march, the study suggests that quality of life is poor, and mental health problems arise in allergic disease patients throughout their lives compared to non-allergic controls. Comparing HRQoL among patients with 3 allergic diseases, 2 allergic diseases, and one allergic disease can explain whether the burden of allergic comorbidities affects HRQoL. In addition, it can be presumed that the effect on the HRQoL was related to the duration of allergic diseases and whether there were allergic diseases in the past. Research on these contents should continue in the future.

This study has several limitations. First, this study used a cross-sectional design, which precludes causal inferences about the relationship. Secondly, most measures were based on self-reported data including the diagnostic history of atopic dermatitis, asthma, and allergic rhinitis, which might involve recall bias. HRQoL was measured not by the standardized

system but produced with data obtained from several mental health-related questionnaires. However, this study has a strength that the mental health status and HRQoL were analyzed in all 3 allergic diseases using a nationwide database. HRQoL research has led investigators and clinicians to adopt a comprehensive approach that integrates clinical and functional measurements with patient viewpoint. Although objective evaluation is important in defining health status, patient subjective perceptions translate their health into the actual quality of life. This study examined a nationwide, population-based survey and concluded that mental status and HRQoL were significantly associated with each of atopic dermatitis, asthma, and allergic rhinitis. Efforts should be made to manage psychological problems and improve HRQoL in allergic disease patients.

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