Allergy Asthma Immunol Res. 2024 Jul;16(4):387-398
https://doi.org/10.4168/aair.2024.16.4.387
pISSN 2092-7355·eISSN 2092-7363

Allergy, Asthma & Immunology Research AAIR

Original Article

Check for updates

Behavior and Parenting Stress Characteristics in Young Children With Severe Food Allergies According to the Severity Score System

Changhoon Lee,[1] **Kyunguk Jeong**,[2] **Jinhee Lee**,[3,4] **Yeonjae Park**,[5] **Sanghwa Youm**,[2] **Eunyeong Jang**,[4] **Sooyoung Lee**,[2] **Jeongmin Lee**[1*]

[1]Department of Pediatrics, Yonsei University Wonju College of Medicine, Wonju, Korea
[2]Department of Pediatrics, Ajou University School of Medicine, Suwon, Korea
[3]Department of Psychiatry, Yonsei University Wonju College of Medicine, Wonju, Korea
[4]Department of Psychiatry, Wonju Severance Christian Hospital, Wonju, Korea
[5]Department of Biostatistics, Yonsei University Wonju College of Medicine, Wonju, Korea

OPEN ACCESS

Received: Jan 28, 2024
Revised: Mar 28, 2024
Accepted: Apr 26, 2024
Published online: Jul 30, 2024

Correspondence to
Jeongmin Lee, MD, PhD
Department of Pediatrics, Yonsei University Wonju College of Medicine, 20 Ilsan-ro, Wonju 26426, Korea.
Tel: +82-33-733-0567
Fax: +82-33-732-6229
Email: ejeongmin@yonsei.ac.kr

ORCID iDs
Changhoon Lee
https://orcid.org/0000-0002-1061-6824
Kyunguk Jeong
https://orcid.org/0000-0002-1261-4507
Jinhee Lee
https://orcid.org/0000-0003-4255-1831
Sanghwa Youm
https://orcid.org/0000-0002-3555-7787
Sooyoung Lee
https://orcid.org/0000-0003-1734-4101
Jeongmin Lee
https://orcid.org/0000-0002-1672-7445

ABSTRACT

Purpose: Limited knowledge exists regarding the psychosocial characteristics of young Asian children affected by food allergies (FAs) and their caregivers. This study aims to assess the usefulness of the Food Allergy Severity Score (FASS) system in evaluating the risk of emotional impacts on young children and caregivers who are dealing with severe FA.
Methods: Children between 2 and 10 years of age who were diagnosed with FA and following an elimination diet were enrolled in the study. The FASS, Korean Parenting Stress Index, and Korean Behavior Assessment System for Children-2 were used for evaluating the above mentioned risk.
Results: Among the 75 participants, 64.0% had a history of anaphylaxis, and 56.0% reported multiple FAs. A total of 160 cases of FASS was documented across 21 types of food and classified as mild (n = 5, 1.07), moderate (n = 100, 2.01–4.01), or severe (n = 55, 4.24–6.84). The concordance of calculated- and stakeholder interpreted-FASS was moderate (kappa 0.587). Children with severe FASS (sFASS) showed increased risk for functional communication (relative risk [RR], 1.57; 95% confidence interval [CI], 0.99–2.48) and increased parental reinforcement (RR, 1.40; 95% CI, 0.91–2.14). Their caregivers exhibited reduced levels of demandingness (RR, 0.59; 95% CI, 0.37–0.94) and role restriction (RR, 0.62; 95% CI, 0.39–0.98). Receiver operating characteristic curves suggested that functional communication (numeric FASS cutoff, 3.47; area under the curve [AUC], 0.695), withdrawal (cutoff, 3.40; AUC, 0.657), developmental social disorders (cutoff, 3.96; AUC, 0.648), and reinforces parent (cutoff, 3.15; AUC, 0.646) were possibly be affected.
Conclusions: The FASS provides an objective tool to assess pediatric FA severity. Early psychosocial intervention for young children with severe FASS and their caregivers may improve prognosis by identifying possible adaptive skill deficiencies and excessive parenting stresses.

Keywords: Food allergy; children; elimination diet; emotions; food allergy severity score; behavior

Disclosure

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

INTRODUCTION

The prevalence of immunoglobulin E (IgE)-mediated food allergy (FA) is 4.06% in Korea.[1] Considering the potential for life-threatening anaphylaxis in children with food allergies, following an elimination diet is essential for treatment.[2] However, this necessity often increases parental anxiety.[3] Previous studies on the association between FA and emotional stress have focused on adolescents and showed that they were at increased risk of developing depression, anxiety, and attention/deficit hyperactivity disorder. Also, their caregivers were at increased risk of developing anxiety.[4,5] Meanwhile, there are only a few studies on the emotional impact of young children with FAs and their caregivers; the wide age range of these children limits the generalizability of the results.[6] According to a single-center study, 40% of caregivers of young children (median age of 6) with FAs, exhibit posttraumatic stress symptoms and severe anxiety levels.[7] The anxiety may be due to the uncertainty of controlling exposure to food allergens, but it has conflicting results, especially as evaluated by disease severity. Certain levels of anxiety can be an adaptive strategy and self-efficacy, which may have an impact on the ability to cope and, in turn, be expected to reduce anxiety.[8-10] As caregivers of children with severe allergies receive more medical support or family cooperation plans, it may lead to increased confidence in managing the disease, thereby reducing anxiety.[11] Therefore, additional studies are required to investigate the characteristics of emotionally vulnerable young children with FA and their caregivers.

The Behavior Assessment System for Children (BASC) is a self-report scale for the evaluation of not only negative but also positive dimensions. The Korean version of BASC-2 (K-BASC-2) is a tool to assess psychopathology in Korean children.[12] Korean-Parenting Stress Index 4th Edition; 2019 (K-PSI-4) is developed by translating the PSI 4th Edition and psychometrically validating the tool for Korean parenting stress.[13] The Food Allergy Severity Score (FASS) system has recently been developed and distributed to more objectively assess the severity of FA.[14]

This study aims to analyze the usefulness of FASS for evaluating the severity of FAs in young children. Additionally, we assessed the emotional impacts of FA in young children and their caregivers according to FA severity to find emotionally vulnerable factors and improve intervention strategies.

MATERIALS AND METHODS

Participants

This study prospectively included patients who met the following criteria: (1) diagnosed with FA by pediatric allergists at the outpatient clinics in Wonju Severance Christian Hospital (Wonju, Korea) and Ajou University Hospital (Suwon, Korea); (2) following an elimination diet of at least one causal food as a treatment policy; (3) followed up every 6 to 12 months; and (4) aged between 2 and 10 years. We excluded patients who (1) were diagnosed development disorders; or (2) were undergoing treatment for other psychiatric disorders. Electronic medical records were thoroughly reviewed by the trained study coordinators at each center. This study protocol was approved by the Institutional Review Board of Ajou University Medical Center (AJOUIRB-SUR-2022-120) and Yonsei Wonju University Hospital (CR321027). The informed consent was obtained from the parents of all participants.

https://doi.org/10.4168/aair.2024.16.4.387

FA severity assessment

The stakeholders were asked to fill out the patient's clinical manifestation sheet and categorize it into interpreted FASS (iFASS). Then, the ordinal FASS (oFASS)-3 format was used to grade FA by food type based on clinical history and categorize each reaction into mild, moderate, or severe. The oFASS-3 is a simplified version, where mild corresponds to grade 1, moderate to grades 2 and 3, and severe to grades 4 and 5. Grade 1 includes reactions restricted to the oral cavity. Grades 2 to 5 may consist of oral symptoms, but other target organs are affected. Grades 2 and 3 involved the following areas: the skin, eye/nose, digestive organ, and uterus, with Grade 2 affecting one area and Grade 3 affecting two or more areas. Larynx and/or bronchi involvement (even isolated) is classified as a grade 4 reaction, and cardiovascular and/or nervous involvement (even isolated) is Grade 5. In Grades 4 and 5, other target organs/systems of lower grades may be affected. The numeric FASS (nFASS), as well as oFASS format, used a software tool to implement the FASS according to the manual presented by using Zenodo (https://doi.org/10.5281/zenodo.5645164).[14]

Behavior characteristics of patients/caregivers and assessment of their stresses

K-BASC-2

The K-BASC-2[12] is a parenting rating scale and consists of 2 versions: a toddler version (aged 2–5 years) and a children version (aged 6–12 years). The K-BASC-2 consists of clinical scales that assess externalizing problems (EXT: HYPER, hyperactivity; AGG, aggression; COND, conduct problem), internalizing problems (INT: ANX, anxiety; DEP, depression; SOM, somatization), behavioral symptoms index (BSI: ATY, atypicality; WITH, withdrawal; ATT, attention problems), and adaptive skills (ADAP SKILLS: ADAP, adaptability; SS, social skills; LEAD, leadership; ADL, activities of daily living; COM, functional communication). Content scales (ANG; anger control; BULL, bullying; DSD, developmental social disorders; SC, emotional self-control; EF, executive function; NEG, negative emotionality; RESIL, resiliency) complement the 2 scales (clinical: ANG, BULL, DSD, SC, EF, and NEG; adapt: RESIL). The raw scores of each domain are converted to age-adjusted T-scores, indicating the differences in raw scores from the norm-group means.

K-PSI-4

The K-PSI-4[13] is a parenting questionnaire, and T-scores were calculated for 6 child domains' subscales (DI, distractibility/hyperactivity; AD, adaptability; RE, reinforces parent; DE, demandingness; MO, mood; AC, acceptability), 7 parent domains' subclasses (CO, competence; IS, isolation; AT, attachment; HE, health; RO, role restriction; DP, depression; SP, spouse/parenting partner relationship), and total stress (TS) plus life stress (LS). T-scores for each scale were calculated to analyze the results by reinterpreting the norm and median values of T-scores as reference values.

Statistical analysis

The characteristics of the study subjects are presented as nominal data, which were calculated as the percentage of the frequency of occurrence. If more than one FASS was obtained in multiple FAs, patients are classified based on the highest severity. For example, if a patient has clinical cases of mild FASS and moderate FASS, it is classified as patient-moderate FASS. The demographic and clinical characteristics of the patients, according to the FASS, were compared using the Chi-square or Fisher's exact test, as appropriate. The immunological characteristics of patients were compared according to their FASS. The Shapiro-Wilk test was used to assess the data normality. If normality was satisfied, the two groups were compared using an independent t-test. If normality was not satisfied, the two

groups were compared using the Mann-Whitney U test. Spearman's coefficient was used to analyze the correlations among the concentrations of total IgE and FASS for each food type. We utilized quadratic weighted kappa to assess the agreement between software-calculated FASS and iFASS. The relative risk (RR) was analyzed using the emotional factor score as a dichotomy as the median standard. For dichotomizing the severity into severe and non-severe, we employed Cohen's kappa. The cutoff points for FASS concerning each emotional factor were estimated using receiver operating characteristic (ROC) curves and the Youden index. All statistical analyses were performed using SAS statistical software version 9.4 (SAS Institute, Cary, NC, USA), R version 3.6.3 (R core Team, Vienna, Austria). Statistical significance was set at $P < 0.05$.

RESULTS

Subject

A total of 75 participants was included. The median age of the participants was 54 months (range: 24–119), and the participants were mostly male, accounting for 70.7% (n = 53). The most common comorbidity was allergic rhinitis as reported in 51 participants (68.0%), followed by atopic dermatitis in 45 (60.0%), chronic spontaneous urticaria in 17 (22.7%), and asthma in 15 (20.0%). More than half of the participants (48; 64.0%) had a history of receiving treatment due to food-induced anaphylaxis. Of them, 9 (18.8%) used an epinephrine auto-injector. More than half (n = 42, 56.0%) were diagnosed with multiple FAs, and 57.1% (24 out of 42) had allergies to at least 3 foods (**Table 1**).

FASS

A total of 160 cases of FASS by food types in participants was evaluated, and 21 types of foods were included in a list of elimination diet; the most common elimination food was hen's egg (n = 51, 89.47%), followed by grains (wheat, n = 26; barley, n = 3; buckwheat, n = 2; 19.4%), tree nuts (walnuts, n = 12; almond, n = 3; cashew, n = 3; macadamia, n = 2; hazel, n = 2, pine nut, n = 1; 14.4%), cow's milk (n = 20, 12.5%), legumes (peanut, n = 10; soybean, n = 5; 9.4%) n = 12, 7.5%), seafood (shrimp, n = 6; fish, n = 5; 6.9%), fruits and vegetables (peach, n = 2;

Table 1. Clinical characteristics of the patients (n = 75)

Characteristics	No. (%) or median (range)
Age (mon)	54 (24–119)
Sex	
Male	53 (70.67)
Female	22 (29.33)
Comorbidity	
Atopic dermatitis	45 (60.00)
Allergic rhinitis	51 (68.00)
Chronic spontaneous urticaria	17 (22.67)
Asthma	15 (20.00)
Past history	
Food anaphylaxis	48 (64.00)
Auto-injectable epinephrine use	9 (out of 48; 18.80)
No. of food allergies diagnosed	
1	33 (44.00)
2	18 (24.00)
3	13 (17.33)
4	4 (5.33)
5	6 (8.00)
6	1 (1.33)

https://doi.org/10.4168/aair.2024.16.4.387

apple, n = 2; tomato, n = 2; carrot, n = 1; strawberry, n = 1; kiwifruit n = 1; n = 5, 5.6%). FASS were calculated and classified into mild (1.07; n = 5), moderate (2.01–4.01; n = 100, grade 2 = 77, grade 3 = 23), and severe (4.24–6.84; n = 55, grade 4 = 43, grade 5 = 12). Interestingly, the concordance of software-calculated FASS with the iFASS was moderate (kappa 0.587). Mismatches often occur in mild-iFASS and moderate FASS-dealing cases with hives ranging from 3–10. Stakeholders interpreted a total of 86 cases as a mild group (53.75%; **Fig. 1**). When we regrouped cases into severe FASS (n = 105) and non-severe FASS (n = 55), the overall concordance rate between FASS with iFASS was robust (kappa 0.879) and the agreement within the food categories met all the criteria for a strong level of concordance (**Supplementary Table S1**).

The severity analysis by food categories revealed that severe reactions were more frequently observed in grains, cow's milk, and seafood (**Fig. 2**). Demographic findings, as compared between patients with severe FASS (pt-severe FASS; n = 40) and those with non-severe-FASS (pt-non-severe FASS; n = 35), showed that the $\log^{\text{total IgE}}$ level was significantly higher in the pt-severe FASS group (**Table 2**). There was a strong positive relation between $\log^{\text{total IgE}}$ concentration and severe FASS in cow's milk (r = 0.47) and grains (r = 0.44); and a weak positive relation in egg white (r = 0.29) ($P < 0.05$, **Supplementary Fig. S1**).

Emotional characteristics of children with severe FA and their caregivers

Behavioral characteristics of the patients and parenting stress questionnaire were obtained from all subjects. The mean score of externalizing problem was 53.7 (standard deviation [SD] = 10.7; over subclinical cutoff[15] of 60; ≥ 60, 29.3%), internalizing problem was 52.5 (SD = 10.7; ≥ 60, 36.0%), behavioral symptom index was 52.2 (SD = 9.3; ≥ 60, 20.0%), and adaptive skills was 46.4 (SD = 10.2; under the subclinical cutoff of 40; < 40, 16.0%). Among clinical content scale, the mean score of anger was 51.0 (SD = 10.1; ≥ 60, 16.0%), bullying was 52.2 (SD = 10.3; ≥ 60, 24.0%), developmental social disorder was 51.2 (SD = 11.5; ≥ 60, 20.00%), emotional self-control was 51.3 (SD = 10.4; ≥ 60, 17.3%), executive function was 53.3 (SD = 12.1; ≥ 60,

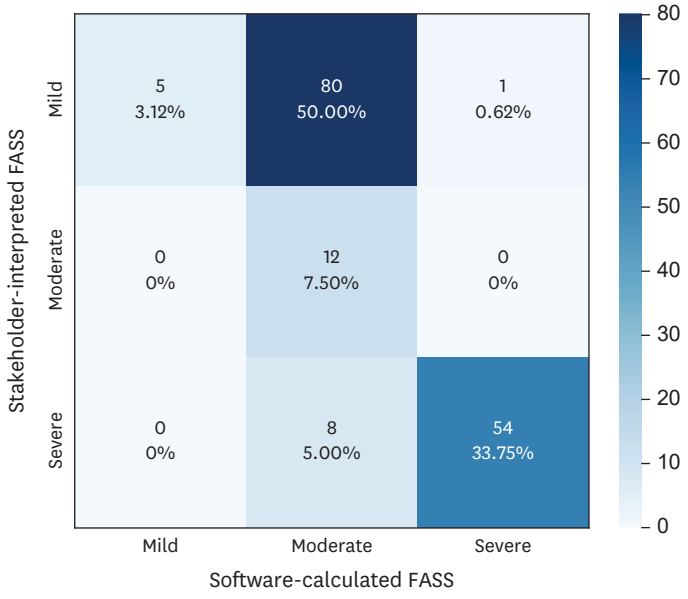


Fig. 1. Comparative heatmap analysis of agreement levels between software-calculated FASS and stakeholder-interpreted FASS.
FASS, Food Allergy Severity Score.

https://doi.org/10.4168/aair.2024.16.4.387

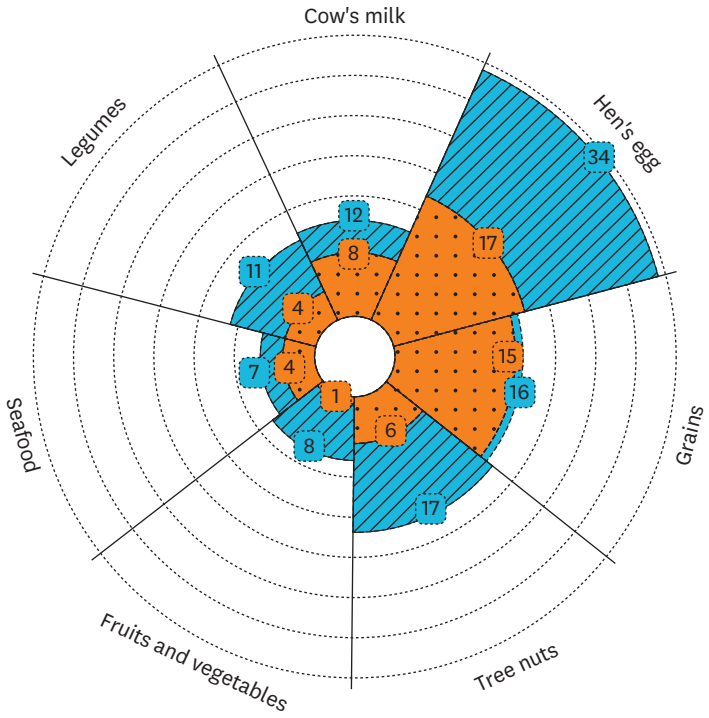


Fig. 2. Comparative nightingale rose chart analysis for types of food allergy between non-severe (blue line) and severe (orange dot) by the Food Allergy Severity Score system (n = 160).

Table 2. Comparison of demographic, clinical, and immunological characteristics of the patients* according to the FASS system

Characteristics	Pt-non-sFASS (n = 40)	Pt-sFASS (n = 35)	*P* value
Age (mon)	46 (35–71.5)	60 (41–86)	0.15
Sex			0.70
Male	29 (72.5)	24 (68.6)	
Female	11 (27.5)	11 (31.4)	
Comorbidity			
Atopic dermatitis	26 (65.0)	19 (54.3)	0.34
Allergic rhinitis	26 (65.0)	25 (71.4)	0.55
Chronic idiopathic urticaria	7 (17.5)	10 (28.6)	0.25
Asthma	10 (25.0)	5 (14.3)	0.24
No. of food allergies diagnosed			0.69
Single	19 (47.5)	15 (42.9)	
Multiple	21 (52.5)	20 (57.1)	
Log [Total Immunoglobulin E (kU/L)]†	2.37 ± 0.51	2.72 ± 0.57	< 0.05
Eosinophil count (10^3/uL)	311 (233.8–538)	441.6 (287–560)	0.36

Values are presented as number (%) or median (range).
FASS, Food Allergy Severity Score; sFASS, severe grade by Food Allergy Severity Score; pt, patients.
*More than one FASS was obtained in multiple food allergy children, and patients are classified based on high severity. For example, if a patient has clinical cases of mild FASS and moderate FASS, it is classified as pt-moderate FASS. None of the subjects in this study was classified with the pt-mild-FASS. †ImmunoCAP (ThermoFisher Scientific, Waltham, MA, USA).

30.7%), negative emotionality was 52.4 (SD = 10.1; ≥ 60, 20.00%), and resiliency was (SD = 47.1; < 40, 25.3%, **Supplementary Tables S2** and **S3**).

For the children domain scale, compared to the pt-non-severe-FASS group, the RR of adaptive skill (ADAP SKILLS 1.27, 95% confidence interval [CI], 0.81–1.99), which is composed of adaptability (ADAP 1.14, 95% CI, 0.75–1.74), leadership (LEAD 1.59, 95% CI,

https://doi.org/10.4168/aair.2024.16.4.387

0.66–3.84), functional communication (COM 1.57, 95% CI, 0.99–2.48), and social skills (SS 1.33, 95% CI, 0.86–2.06), were increased among pt-severe FASS group, along with significantly decreased values in demandingness (DE 0.59, 95% CI, 0.37–0.94). The RR of behavioral symptom index (BSI 0.64, 95% CI, 0.40–1.03), as well as externalizing problems (EXT 0.81, 95% CI, 0.53–1.24) decreased; part of the content-clinical-index, such as anger control (ANG 0.83, 95% CI, 0.53–1.31), bullying (BULL 0.90, 95% CI, 0.61–1.34), and developmental social disorders (DSD 0.69, 95% CI, 0.44–1.08) also showed decreased values in the pt-severe FASS group. For the parental domain scale, the RR of reinforces parent (RE 1.40, 95% CI, 0.91–2.14) increased, and role restriction (RO 0.62, 95% CI, 0.39–0.98) decreased as observed in the pt-severe FASS group (**Fig. 3**). The ROC curves showed that the functional communication (nFASS-cutoff 3.47, area under the curve [AUC] 0.695), withdrawal (nFASS-cutoff 3.40, AUC 0.657), developmental social disorders (nFASS-cutoff 3.96, AUC 0.648) and reinforces parent (nFASS-cutoff 3.15, AUC 0.646) were significantly affected by a moderate grade in young children ($P < 0.05$, **Fig. 4**).

DISCUSSION

The perception of the severity of FA is often very different among stakeholders. Many score systems have been developed to assess the severity of FA, but there was considerable heterogeneity in these systems.[16] The numeric range values assigned by FASS in this study (moderate: 2.01–4.01, severe: 4.24–6.84) closely align with prior research,[14] where moderate ranged from 2.01 to 3.98, and severe reactions spanned from 4.07 to 7.75. This finding supports FASS as a valuable tool to objectively assess the FA severity of pediatric patients.

FASS demonstrates particular reliability in assessing severe FAs. Allergic reactions involving 'the skin only' are often considered mild, but this perception may differ among clinicians. Anaphylaxis, typically deemed a severe reaction, is frequently diagnosed when there is skin involvement along with other organ manifestations. This may lead to regarding severe 'skin-only' reactions being regarded as mild forms of FA. Therefore, a different methodology is essential to more accurately assess the severity of FA through numeric data. The oFASS, as utilized in this study, divides skin symptoms into five steps (oFASS-5) according to the number of rashes, severity, presence of angioedema, and simplifies it into three steps (FASS; mild, moderate, severe). Consequently, in many cases in our research, a significant degree of FA, categorized as mild by estimation, was calculated as moderate by the FASS software. This discordance in severity interpretation highlights the importance of using objective tools to assess FA.

We focused on the RRs of the emotional status of young patients with severe FA using the numeric FASS, as this method provides reliable discrimination. Though statistical significance was weak, the pt-severe FASS group tended to show vulnerabilities in adaptive skills, especially in the area of functional communication, and caregivers emphasized the role of parenting. When the sample size is small, a wide CI is inevitable, so CI needs to be interpreted as the direction of the effect.[17] Therefore, the increased risk of adaptation issues in young patients and the high demandingness in their caregivers, as indicated in this study, would be interpreted as clinically relevant. Hypervigilance by parents may increase the protectiveness of children with FA.[11] Adaptive skills encompass a child's social and practical competence which are crucial for independent living and reflect their ability to adapt to various environments. Given previous studies on the associations of suicidal risk in children

https://doi.org/10.4168/aair.2024.16.4.387

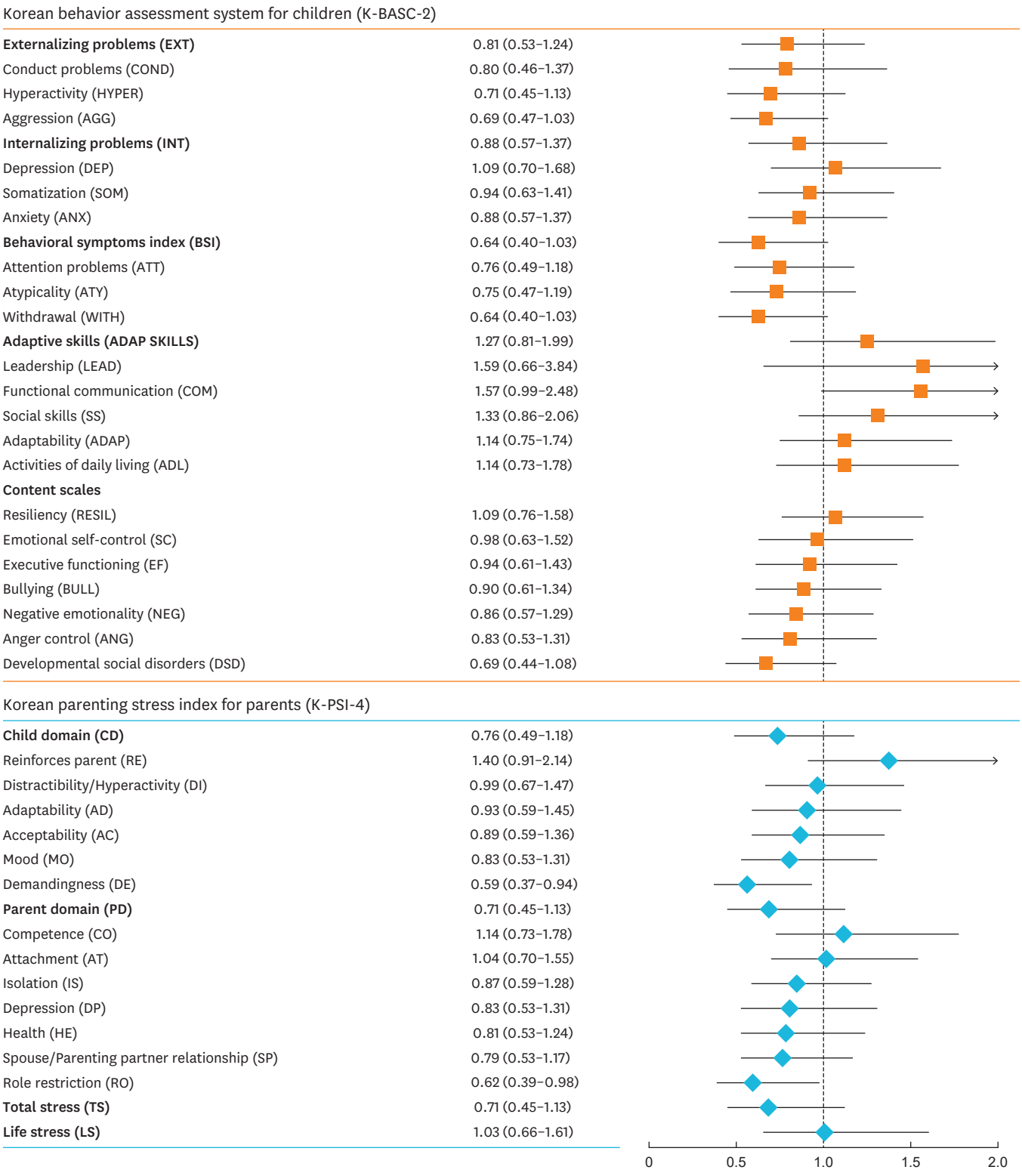
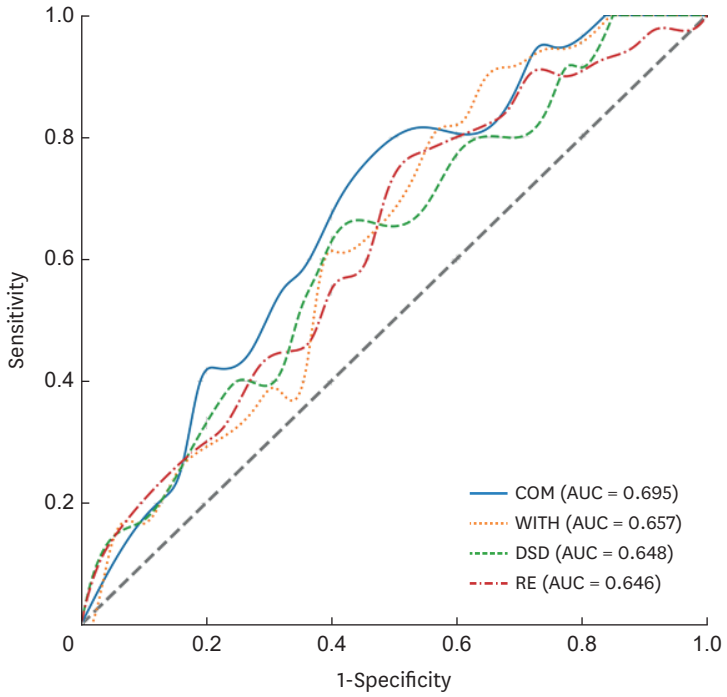


Fig. 3. The relative risk of psychosocial characteristics of children and caregivers with severe food allergy by using the Food Allergy Severity Score system.

https://doi.org/10.4168/aair.2024.16.4.387



Components	Best cutoff	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	AUCs	*P* value
COM	3.47	76.32	59.46	65.91	70.97	0.695	0.001
WITH	3.40	75.00	53.85	60.00	70.00	0.657	0.013
DSD	3.96	65.71	60.00	58.97	66.67	0.648	0.020
RE	3.15	77.50	51.43	64.58	66.67	0.646	0.023

Fig. 4. The receiver operating characteristic curves for the cutoff point of numeric Food Allergy Severity Score to vulnerable emotional characteristics.
COM, functional communication; WITH, withdrawal; DSD, developmental social disorders; RE, reinforces parent; AUC, area under the curve; PPV, positive predictive value; NPV, negative predictive value.

with atopic dermatitis with impaired responsiveness to stress,[18] it seems crucial to thoroughly assess the risk of compromised adaptive skills in severe FA, especially for young individuals who are vulnerable in communication.

The emotional characteristics observed in this study were distinct from those in previous studies, highlighting a unique aspect of young children.[4,5,7,8,11,19-21] Young children with severe FA in this study showed reductions in RRs of bullying, attention problems, anxiety and hyperreactivity, while the patients from the previous studies showed increases in depression, anxiety, attention problems, and hyperactivity. The difference may have been attributed to the fact that this study analyzed patients with FA by severity rather than by the presence of disease or the predominant inclusion of preschool children.[20,22] Treatment environments may also have an impact. When patients with anaphylaxis are admitted to the emergency department, 63.8% are already treated with epinephrine, a rate higher than in other countries.[21,22] Most importantly, young children are significantly affected by their environment, and each country has different parenting styles and levels of care for children. All these affect patients' emotional status and caregivers' stress levels.[19,20]

https://doi.org/10.4168/aair.2024.16.4.387

This study has some limitations. First, the participants were recruited from the tertiary clinics only. Secondly, the sample size is small. Therefore, findings may not be generalizable to a nonclinic-based population suffering from FA with a wider range of severity. The most common cause of anaphylaxis in pediatric patients is FA,[23] but the proportion of patients with anaphylaxis among pediatric patients with FA has yet to be determined in Korea. The prevalence of FA among 20,000 Korean students was 4.06%, and the prevalence of anaphylaxis was 0.97%.[1] Based on these results, approximately 24% of patients with FA can be expected to experience anaphylaxis. However, the proportion of patients who experienced anaphylaxis was 64% (more than half of the patients) in this study, and the proportion of pt-severe FASS was 55%. Therefore, to analyze the emotional characteristics of patients with severe FA at more significant levels, the population with target disease should be well represented in the future. Thirdly, because both questionnaires are caregiver-reported, the psychological characteristics of children may have been overestimated or underestimated. Lastly, behavioral and parenting stress characteristics may also be influenced by numerous factors, such as the food type, amount and duration of elimination diets, and the degree of daily difficulty, but these potential factors were not fully evaluated together.

Nevertheless, exploring the Asian population in this study provides valuable insights. The FASS can be utilized to select psychosocially vulnerable patients with FA. Early detection of weakness in adaptive skills, especially functional communication, in young patients with objectively well-analyzed severe FA may lead to initiating appropriate interventions and reduce the risk of its persistence. This can prevent a vicious circle where the child's declining social skills increase parental stress, leading to diminished support for the child. Concerning the interplay between children's psychosocial development and parental influence, the findings in this study represent a significant step toward enhancing cultural inclusivity within this research field.

In summary, the FASS could be utilized to obtain numeric severity assessment scores in pediatric patients with FA. Moreover, it can help screen the patients and their caregivers who are vulnerable to adaptability and parenting stress. Early psychological intervention can be initiated by selecting high-risk pediatric patients and their caregivers with the FASS.

SUPPLEMENTARY MATERIALS

Supplementary Table S1

Concordance of software calculation with stakeholder estimation of FASS according to the types of food allergy

Supplementary Table S2

Mean and standard deviation of the K-BASC-2 with subclinical cutoff

Supplementary Table S3

Mean and standard deviation of the PSI-4 subscale (child domain and parent domain)

Supplementary Fig. S1

Spearman correlation scatter plots with confidence interval (grey area) for log [total immunoglobulin E (kU/L)] concentration and FASS. The figure shows the levels of log [total immunoglobulin E (kU/L)] (y-axis) at numeric FASS (x-axis) for each food type. (A) Cow's

https://doi.org/10.4168/aair.2024.16.4.387

milk; (B) Grains; (C) Hen's egg; (D) Fruits and vegetables; (E) Legumes; (F) Seafood; (G) Tree nuts.

REFERENCES

1. Kim M, Lee JY, Jeon HY, Yang HK, Lee KJ, Han Y, et al. Prevalence of immediate-type food allergy in Korean schoolchildren in 2015: a nationwide, population-based study. Allergy Asthma Immunol Res 2017;9:410-6. PUBMED | CROSSREF
2. NIAID-Sponsored Expert Panel, Boyce JA, Assa'ad A, Burks AW, Jones SM, Sampson HA, et al. Guidelines for the diagnosis and management of food allergy in the United States: report of the NIAID-sponsored expert panel. J Allergy Clin Immunol 2010;126:S1-58. PUBMED | CROSSREF
3. Berry MJ, Adams J, Voutilainen H, Feustel PJ, Celestin J, Järvinen KM. Impact of elimination diets on growth and nutritional status in children with multiple food allergies. Pediatr Allergy Immunol 2015;26:133-8. PUBMED | CROSSREF
4. Ferro MA, Van Lieshout RJ, Ohayon J, Scott JG. Emotional and behavioral problems in adolescents and young adults with food allergy. Allergy 2016;71:532-40. PUBMED | CROSSREF
5. Akeson N, Worth A, Sheikh A. The psychosocial impact of anaphylaxis on young people and their parents. Clin Exp Allergy 2007;37:1213-20. PUBMED | CROSSREF
6. Rouf K, White L, Evans K. A qualitative investigation into the maternal experience of having a young child with severe food allergy. Clin Child Psychol Psychiatry 2012;17:49-64. PUBMED | CROSSREF
7. Roberts K, Meiser-Stedman R, Brightwell A, Young J. Parental anxiety and posttraumatic stress symptoms in pediatric food allergy. J Pediatr Psychol 2021;46:688-97. PUBMED | CROSSREF
8. Boyle RJ, Umasunthar T, Smith JG, Hanna H, Procktor A, Phillips K, et al. A brief psychological intervention for mothers of children with food allergy can change risk perception and reduce anxiety: outcomes of a randomized controlled trial. Clin Exp Allergy 2017;47:1309-17. PUBMED | CROSSREF
9. Walter HJ, Bukstein OG, Abright AR, Keable H, Ramtekkar U, Ripperger-Suhler J, et al. Clinical practice guideline for the assessment and treatment of children and adolescents with anxiety disorders. J Am Acad Child Adolesc Psychiatry 2020;59:1107-24. PUBMED | CROSSREF
10. Knibb RC, Barnes C, Stalker C. Parental confidence in managing food allergy: development and validation of the Food Allergy Self-Efficacy Scale for Parents (FASE-P). Clin Exp Allergy 2015;45:1681-9. PUBMED | CROSSREF
11. Cummings AJ, Knibb RC, King RM, Lucas JS. The psychosocial impact of food allergy and food hypersensitivity in children, adolescents and their families: a review. Allergy 2010;65:933-45. PUBMED | CROSSREF
12. Song J, Leventhal BL, Koh YJ, Cheon KA, Hong HJ, Kim YK, et al. Cross-cultural aspect of behavior assessment system for children-2, parent rating scale-child: Standardization in Korean children. Yonsei Med J 2017;58:439-48. PUBMED | CROSSREF
13. Chung KM, Lee S, Lee C. Standardization study for the Korean version of Parenting Stress Index Fourth Edition (K-PSI-4). Korean J Psychol Gen 2019;38:247-73. CROSSREF
14. Fernández-Rivas M, Gómez García I, Gonzalo-Fernández A, Fuentes Ferrer M, Dölle-Bierke S, Marco-Martín G, et al. Development and validation of the food allergy severity score. Allergy 2022;77:1545-58. PUBMED | CROSSREF
15. Reynolds CR, Kamphaus RW. Behavior Assessment System for Children--Second Edition (BASC-2) [Database record]. APA PsycTests [Internet]. Washington, D.C.: American Psychological Association; 2006 [cited 2023 Nov 1]. Available from: https://doi.org/10.1037/t15079-000.
16. Muraro A, Fernandez-Rivas M, Beyer K, Cardona V, Clark A, Eller E, et al. The urgent need for a harmonized severity scoring system for acute allergic reactions. Allergy 2018;73:1792-800. PUBMED | CROSSREF
17. du Prel JB, Hommel G, Röhrig B, Blettner M. Confidence interval or p-value?: part 4 of a series on evaluation of scientific publications. Dtsch Arztebl Int 2009;106:335-9. PUBMED | CROSSREF
18. Kelly KA, Balogh EA, Kaplan SG, Feldman SR. Skin disease in children: Effects on quality of life, stigmatization, bullying, and suicide risk in pediatric acne, atopic dermatitis, and psoriasis patients. Children (Basel) 2021;8:1057. PUBMED | CROSSREF
19. Valentine AZ, Knibb RC. Exploring quality of life in families of children living with and without a severe food allergy. Appetite 2011;57:467-74. PUBMED | CROSSREF

20. Keith C, Crnic KA, Gaze C, Hoffman C. Cumulative parenting stress across the preschool period: relations to maternal parenting and child behaviour at age 5. Infant Child Dev 2005;14:117-32. CROSSREF

21. Saleh-Langenberg J, Goossens NJ, Flokstra-de Blok BM, Kollen BJ, van der Meulen GN, Le TM, et al. Predictors of health-related quality of life of European food-allergic patients. Allergy 2015;70:616-24. PUBMED | CROSSREF

22. van der Velde JL, Flokstra-de Blok BM, Dunngalvin A, Hourihane JO, Duiverman EJ, Dubois AE. Parents report better health-related quality of life for their food-allergic children than children themselves. Clin Exp Allergy 2011;41:1431-9. PUBMED | CROSSREF

23. Jeong K, Ye YM, Kim SH, Kim KW, Kim JH, Kwon JW, et al. A multicenter anaphylaxis registry in Korea: clinical characteristics and acute treatment details from infants to older adults. World Allergy Organ J 2020;13:100449. PUBMED | CROSSREF