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Original Article

Severity of eczema and mental health problems in Japanese schoolchildren: The ToMMo Child Health Study

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ISAAC International Study of Asthma and Allergies in Childhood
ADHD attention deficit/hyperactivity disorder
SDQ Strengths and Difficulties Questionnaire

ABSTRACT

Background: The association between eczema and mental health problems in schoolchildren has been underexplored. We aimed to investigate this association with the validated questionnaires.

Methods: Of 46,648 invited children, we analyzed 9954 (21.3%) in the 2nd to the 8th grades from the ToMMo Child Health Study conducted in 2014 and 2015, a cross-sectional survey in Miyagi Prefecture, Japan. We defined eczema status as “normal,” “mild/moderate,” or “severe,” based on the presence of persistent flexural eczema and sleep disturbance, according to the International Study of Asthma and Allergies in Childhood (ISAAC) Eczema Symptom Questionnaire. Clinical ranges of Strengths and Difficulties Questionnaire (SDQ) total difficulties scores and four SDQ subcategories of emotional symptoms, conduct problems, hyperactivity/inattention, and peer problems were defined as scores ≥ 16 , ≥ 5 , ≥ 5 , ≥ 7 , and ≥ 5 , respectively.

Results: The mean SDQ total difficulties score significantly increased as eczema status worsened (all $P \leq 0.004$ for trend). The OR of scores in the clinical range for SDQ total difficulties were 1.51 (95% CI, 1.31–1.74) for mild/moderate eczema and 2.63 (95% CI, 1.91–3.63) for severe eczema ($P < 0.001$ for trend), adjusted for sex, school grade, current wheeze, and disaster-related factors, using normal eczema as a reference. The association between severity of eczema and four SDQ subcategories showed a similar trend (all $P \leq 0.017$ for trend).

Conclusions: We found a significant association between severity of eczema and mental health problems. The presence of eczema was associated with four SDQ subcategories.

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Introduction

Eczema, otherwise known as atopic dermatitis or atopic eczema, is one of the most common chronic and recurrent inflammatory skin diseases among children. A global survey by the International Study of Asthma and Allergies in Childhood (ISAAC) showed that the prevalence of eczema was 7.9% in the 6- to 7-year age group and

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7.3% in the 13- to 14-year age group.¹ The prevalence of schoolchild eczema in Japan was estimated as 10.9%–19.6% according to the ISAAC questionnaire.²

Eczema affects the quality of life of children and their families in various ways.³ The appearance of the skin and pruritus associated with eczema impose a mental and physical burden. Emotional and behavioral symptoms, including irritability, fussiness, and increased crying, are commonly reported by parents.⁴ The relationships between eczema and neurodevelopmental disorders, such as attention deficit/hyperactivity disorder (ADHD) and autism spectrum disorder have been underexplored.⁵ Several systematic reviews^{6–9} and large, population-based surveys from Germany,¹⁰ Taiwan,¹¹ and the United States^{12,13} have shown positive associations between eczema and mental health problems, including neurodevelopmental disorders. However, the detailed mechanisms and causal relationships of these associations remain unclear. Considering the profound racial and ethnic differences in the profile of eczema,¹⁴ characterization of eczema among Japanese children is needed to deal with this issue in Japan, as well as for comprehensive understanding of the nature of the disease.

The objective of the present study was to investigate the association between eczema status and mental health problems with the use of two validated questionnaires, the ISAAC Eczema Symptom Questionnaire^{15,16} and the Strengths and Difficulties Questionnaire (SDQ),^{17,18} in a large, cross-sectional survey of Japanese schoolchildren.

Methods

Study design and participants

This study was based on the ToMMo Child Health Study conducted in 2014 and 2015, a cross-sectional survey of public schoolchildren in Miyagi Prefecture, Japan.^{19,20} The Great East Japan Earthquake and the subsequent huge tsunami caused massive damage in the survey areas on 11 March 2011. The ToMMo Child Health Study was conducted to elucidate health conditions regarding the risks of increased illness or worsening of symptoms following the earthquake. Ethical approval was obtained from the Institute Review Board of Tohoku University Graduate School of Medicine (No. 2012–1–278). The parents or guardians of the children provided informed consent to their participation in the study by completing and returning the questionnaire.

Among a total of 481 public schools, including elementary, junior high, and special needs schools (289 from Survey 2014 and 192 from Survey 2015) in a total of 39 municipalities (25 from Survey 2014 and 14 from Survey 2015), we surveyed children in the second grade (grade 2, aged 7 and 8 years), fourth grade (grade 4, aged 9 and 10 years), and sixth grade (grade 6, aged 11 and 12 years) of elementary school and children in the second grade of junior high school (grade 8, aged 13 and 14 years). The questionnaire was distributed to a total of 46,648 children (28,159 from Survey 2014 and 18,489 from Survey 2015). The questionnaire was completed by the parents or guardians at home. Though grade 8 children were adolescence, parents or guardians answered the questionnaire in the present study unlike an original ISAAC design. They returned 11,571 questionnaires (7197 from Survey 2014 and 4374 from Survey 2015) to our laboratory by mail. We excluded the questionnaires from 1617 children because they were outside the target grades (164 from Survey 2014 and 121 from Survey 2015) or because of missing responses for wheeze symptoms (455 from Survey 2014 and 216 from Survey 2015), eczema symptoms (210 from Survey 2014 and 36 from Survey 2015), or for the SDQ (362 from Survey 2014 and 210 from Survey 2015). Finally, of 46,648 distributed questionnaires, 9954 (valid response rate 21.3%),

consisting of 6153 from Survey 2014 and 3801 from Survey 2015, were included in the present analysis.

Assessment of eczema status

To assess eczema status, the ISAAC Eczema Symptom Questionnaire^{15,16} was adopted. This questionnaire included following questions; 1) Has your child ever had an itchy rash which was coming and going for at least six months? 2) Has your child had this itchy rash at any time during the past 12 months? 3) Has this itchy rash at any time affected any of the following places: the folds of the elbows, behind the knees, in front of the ankles, under the buttocks, or around the neck, ears, or eyes? 4) Has your child's sleep been disturbed by this itchy rash for one or more nights per week during the past 12 months? Based on the study by Odhiambo *et al.*²¹ and our previous studies,^{19,20} we evaluated the following questions to determine the severity of eczema; If 2), 3) and 4) of the questions below were answered “yes,” eczema status was classified as “severe.” If only questions 2) and 3) were answered “yes,” eczema status was classified as “mild/moderate.” For all others, eczema status was classified as “normal”.²¹

Assessment of mental health problems

Mental health problems were assessed by the Japanese language version of SDQ.^{17,18} SDQ is a screening questionnaire to detect difficulties and strengths in the daily and social lives of children. SDQ consists of 25 items with three response options (“not true,” “somewhat true,” “certainly true”) categorized into five domains. SDQ total difficulties are composed of four subcategories: emotional symptoms, conduct problems, hyperactivity/inattention, and peer problems. Clinical ranges for total difficulties, emotional symptoms, conduct problems, hyperactivity/inattention, and peer problems were defined as scores of ≥ 16 out of 40, ≥ 5 out of 10, ≥ 5 out of 10, ≥ 7 out of 10, and ≥ 5 out of 10, respectively.¹⁸

Assessment of other covariates

Current wheeze status was defined as a positive response to the ISAAC question “Has your child had wheeze or whistling in the chest in the last 12 months?”.^{15,16}

The questionnaire included questions on tsunami experience and changing house experience. Disaster experience was classified as “earthquake,” “tsunami,” “both,” or “none.” Tsunami experience was defined as a positive response to either “tsunami” or “both.” In the questionnaire, the children's houses were classified as a 1) prefabricated temporary house; 2) private rental house under a designated leasing system for people affected by the disaster; 3) rental house not under a designated leasing system for people affected by the disaster; 4) house of family, friends, or relatives; 5) house rebuilt at the same location as before the disaster; 6) house rebuilt at a new location; 7) same house as that before the disaster; and 8) others. Changing house experience was defined as a positive response to any question except 7. Because our previous studies showed significant relationships between mental health problems and tsunami experience or changing house experience,^{19,20} we used these variables as confounding factors.

Statistical analysis

We compared the mean values of SDQ scores for total difficulties and the four SDQ subcategories among children with normal, mild/moderate, and severe eczema, stratifying by sex and school grade. Tests of trend were performed by univariate regression analysis.

To calculate the ORs and 95% CIs of scores in the clinical range of SDQ total difficulties according to eczema status category, we performed multivariable logistic regression analyses, adjusting for sex, school grade (2nd, 4th, 6th, or 8th), current wheeze status (yes or no), tsunami experience (yes or no), and changing house experience (yes or no), using normal eczema status as a reference. The *P* values for analysis of linear trends were calculated by a contrast test using contrast coefficients of -1 , 0 , and 1 for eczema status categories of normal, mild/moderate, and severe, respectively. For subgroup analyses, these analyses were repeated stratifying by sex and school grade, adjusting for current wheeze, tsunami experience, and changing house experience. We created an interaction term that we added to the model to assess statistical interactions, by the above stratifying variables (boys = 1 and girls = 0 for sex; 2nd = 1, 4th = 2, 6th = 3, and 8th = 4 for school grade). The ORs (95% CIs) of scores in the clinical range for the four SDQ subcategories according to eczema status category were calculated in a similar manner. All statistical analyses were performed with SAS software, version 9.4 (SAS Institute, Cary, NC, USA), and $P < 0.05$ was considered to indicate statistical significance in two-tailed tests.

Table 1
Characteristics of participants by school grade.

Characteristic	2nd grade	4th grade	6th grade	8th grade	<i>P</i>
Total <i>N</i>	2,734	2,544	2,626	2,050	
Boy sex— <i>N</i> (%)	1,412 (52)	1,253 (49)	1,301 (50)	1,001 (49)	0.18
Eczema status— <i>N</i> (%)					<0.001
Normal	2,180 (80)	2,105 (83)	2,232 (85)	1,796 (88)	
Mild/Moderate	489 (18)	388 (15)	358 (14)	228 (11)	
Severe	65 (2.4)	51 (2.0)	36 (1.4)	26 (1.3)	
Current wheeze— <i>N</i> (%)	336 (12)	269 (11)	230 (8.8)	91 (4.4)	<0.001
Tsunami experience— <i>N</i> (%)	387 (14)	386 (15)	389 (15)	352 (17)	0.032
Changing house experience— <i>N</i> (%)	821 (30)	671 (26)	601 (23)	463 (23)	<0.001

Eczema status and current wheeze were assessed by the International Study of Asthma and Allergies in Childhood (ISAAC) Eczema Symptom Questionnaire. *P* values were computed by chi-squared tests. The total percentage for some categories does not sum up to 100% because of rounding errors.

Table 2
Mean Strengths and Difficulties Questionnaire (SDQ) scores according to eczema status by school grade and sex.

Score	Eczema status	2nd grade boy (<i>n</i> = 1,412)	2nd grade girl (<i>n</i> = 1,322)	4th grade boy (<i>n</i> = 1,253)	4th grade girl (<i>n</i> = 1,291)	6th grade boy (<i>n</i> = 1,301)	6th grade girl (<i>n</i> = 1,325)	8th grade boy (<i>n</i> = 1,001)	8th grade girl (<i>n</i> = 1,049)
Total difficulties (0–40)	Normal	10.8 ± 5.7	9.9 ± 5.5	10.3 ± 5.9	9.4 ± 5.4	9.1 ± 5.6	8.2 ± 5.2	8.7 ± 5.4	8.7 ± 5.3
	Mild/Moderate	12.0 ± 6.1	10.4 ± 5.7	12.9 ± 6.6	10.4 ± 6.0	10.4 ± 5.8	8.8 ± 5.3	10.3 ± 6.1	10.1 ± 5.6
	Severe	14.8 ± 5.9	14.1 ± 6.5	14.7 ± 5.9	11.8 ± 6.0	15.1 ± 6.8	12.9 ± 8.2	12.3 ± 6.4	12.2 ± 7.1
	<i>P</i>	<0.001	0.004	<0.001	0.003	<0.001	0.002	<0.001	<0.001
Emotional symptoms (0–10)	Normal	2.1 ± 2.0	2.3 ± 2.1	2.0 ± 2.0	2.2 ± 2.2	1.7 ± 1.9	1.9 ± 2.0	1.7 ± 1.9	2.1 ± 2.1
	Mild/Moderate	2.5 ± 2.3	2.7 ± 2.3	2.8 ± 2.4	2.7 ± 2.2	2.2 ± 2.2	2.1 ± 2.0	2.1 ± 2.1	2.7 ± 2.4
	Severe	3.7 ± 2.5	4.0 ± 2.1	3.6 ± 2.8	3.2 ± 2.0	4.1 ± 3.0	3.4 ± 3.0	3.1 ± 2.5	3.2 ± 2.1
	<i>P</i>	<0.001	<0.001	<0.001	0.002	<0.001	0.013	<0.001	0.003
Conduct problems (0–10)	Normal	2.5 ± 1.7	2.3 ± 1.7	2.5 ± 1.9	2.2 ± 1.6	2.2 ± 1.7	1.9 ± 1.5	1.9 ± 1.6	1.9 ± 1.5
	Mild/Moderate	2.9 ± 2.0	2.4 ± 1.6	3.0 ± 2.1	2.4 ± 1.9	2.4 ± 1.7	2.2 ± 1.6	2.1 ± 1.6	2.3 ± 1.7
	Severe	3.1 ± 2.0	2.9 ± 2.2	3.0 ± 2.0	2.6 ± 2.0	2.9 ± 1.7	2.6 ± 2.3	2.4 ± 2.0	2.8 ± 2.0
	<i>P</i>	<0.001	0.12	<0.001	0.021	0.013	0.003	0.14	<0.001
Hyperactivity/inattention (0–10)	Normal	4.3 ± 2.4	3.5 ± 2.3	4.0 ± 2.5	3.2 ± 2.2	3.3 ± 2.3	2.5 ± 2.0	3.1 ± 2.2	2.5 ± 1.9
	Mild/Moderate	4.6 ± 2.5	3.5 ± 2.4	4.7 ± 2.6	3.3 ± 2.3	3.7 ± 2.3	2.6 ± 2.0	3.5 ± 2.4	2.7 ± 1.9
	Severe	5.4 ± 2.3	4.9 ± 2.3	5.4 ± 2.1	3.3 ± 2.3	5.3 ± 2.1	3.9 ± 2.8	3.3 ± 1.9	4.2 ± 2.6
	<i>P</i>	<0.001	0.20	<0.001	0.40	<0.001	0.15	0.15	0.018
Peer problems (0–10)	Normal	1.9 ± 1.7	1.8 ± 1.6	1.9 ± 1.9	1.8 ± 1.6	1.9 ± 1.8	1.9 ± 1.7	2.0 ± 1.8	2.1 ± 1.8
	Mild/Moderate	2.0 ± 1.9	1.8 ± 1.6	2.4 ± 2.1	2.0 ± 1.9	2.1 ± 1.8	2.0 ± 1.7	2.6 ± 2.3	2.4 ± 1.8
	Severe	2.6 ± 1.8	2.4 ± 2.0	2.7 ± 2.1	2.7 ± 1.8	2.8 ± 2.2	2.9 ± 2.6	3.5 ± 2.7	2.1 ± 2.4
	<i>P</i>	0.038	0.37	<0.001	0.020	0.025	0.045	<0.001	0.25

Eczema status was assessed by the International Study of Asthma and Allergies in Childhood (ISAAC) Eczema Symptom Questionnaire. *P* values for trend were calculated by univariate regression analysis.

Results

Characteristics of participants

Table 1 shows the characteristics of the participants according to school grade. Among the 9954 children, the number of children with eczema symptoms, including those with mild/moderate or severe symptoms, was 554 of 2734 in grade 2 (20%), 439 of 2544 in grade 4 (17%), 394 of 2626 in grade 6 (15%), and 254 of 2050 in grade 8 (12%). The prevalence of eczema symptoms decreased as the school grade increased. The prevalence of current wheeze symptoms showed a similar trend. There were no significant differences between survey 2014 and survey 2015 in the proportion of eczema status ($P = 0.88$) and the clinical range for SDQ total difficulties ($P = 0.13$).

Association between eczema status and SDQ scores

The mean values of the SDQ total difficulties score and the four SDQ subcategories scores are shown in Table 2 stratified according to school grade and sex. We found that the severity of eczema was associated with SDQ total difficulties scores in the clinical range. As the severity of eczema worsened, the mean SDQ total difficulties score increased from the 2nd to the 8th grade in both boys and girls. The results were similar for the four SDQ subcategories scores. Figure 1 shows the adjusted ORs for SDQ total difficulties scores in the clinical range and the four SDQ subcategories scores in the clinical range according to eczema status. Using normal eczema status as a reference category, the adjusted ORs (95% CIs) of scores in the clinical range for total difficulties were 1.51 (1.31–1.74) for mild/moderate eczema and 2.63 (1.91–3.63) for severe eczema ($P < 0.001$ for trend). The severity of eczema was significantly associated with scores in the clinical range for all four SDQ subcategories. As the severity of eczema worsened, the adjusted ORs of scores in the clinical range for each SDQ subcategory increased (all $P \leq 0.017$ for trend).

Table 3 shows the adjusted ORs of scores in the clinical range for SDQ total difficulties by subgroup stratified according to school grade and sex. Overall, as the severity of eczema worsened, the adjusted ORs tended to increase across all grades in both boys and

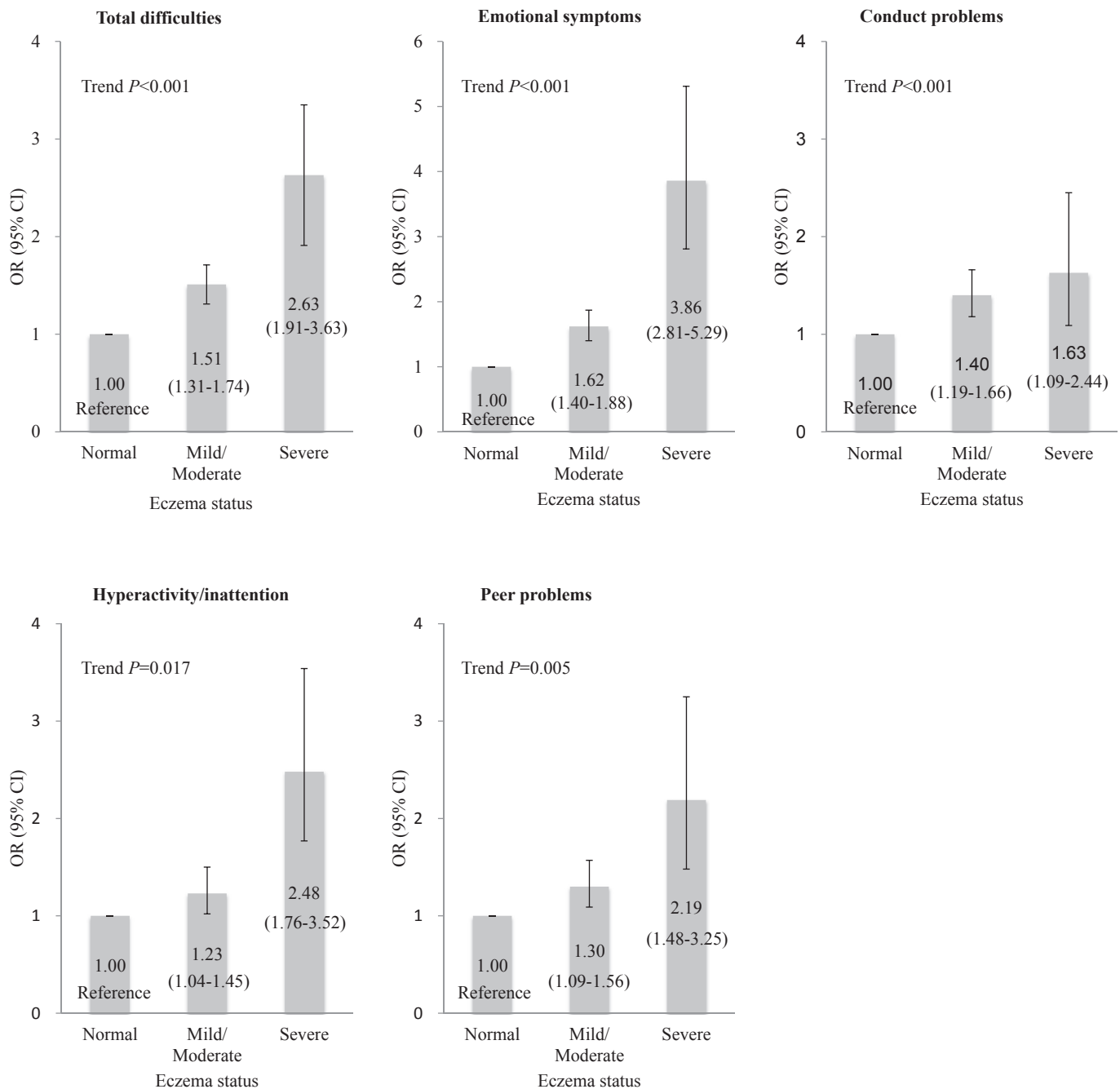


Fig. 1. Adjusted odds ratios (ORs) of scores in the clinical range for Strengths and Difficulties Questionnaire (SDQ) total difficulties and for SDQ subcategories according to eczema status. ORs were adjusted for school grade, sex, current wheeze, tsunami experience, and changing house experience. Eczema status was assessed by the International Study of Asthma and Allergies in Childhood (ISAAC) Eczema Symptom Questionnaire. Normal eczema status was used as a reference category. The respective cutoffs for normal, borderline, and clinical range were 0–12, 13–15, and 16–40 for total difficulties score; 0–3, 4, and 5–10 for emotional symptoms score; 0–3, 4, and 5–10 for conduct problems score; 0–5, 6, and 7–10 for hyperactivity/inattention score; and 0–3, 4, and 5–10 for peer problems score.

girls; there were no significant interactions among school grades ($P = 0.24$ for interaction term by sex) or between boys and girls ($P = 0.95$ for interaction term by grade).

Discussion

The present study showed that mental health problems measured by SDQ were associated with the severity of eczema according to the ISAAC Eczema Symptom Questionnaire in Japanese schoolchildren. The SDQ total difficulties scores and all four SDQ

subcategories scores significantly increased as the severity of eczema worsened.

Studies on the association between eczema and neurodevelopmental disorders, particularly ADHD, have been performed over the past decade.⁵ Most studies found a positive association between eczema and neurodevelopmental disorders. Three cohort studies from Germany²² and Taipei^{23,24} also found positive associations. On the contrary, another cohort study²⁵ yielded conflicting results regarding the association between the two conditions. We evaluated the participants with the use of the SDQ and the ISAAC

Table 3

Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) of scores in the clinical range for Strengths and Difficulties Questionnaire (SDQ) total difficulties according to eczema status by school grade and sex.

Grade and sex	Normal eczema status		Mild/Moderate eczema status		Severe eczema status		P for trend
	N (%)	OR	N (%)	OR (95% CI)	N (%)	OR (95% CI)	
2nd grade boy	1,125 (80)	1	245 (17)	1.33 (0.96–1.84)	42 (3)	2.05 (1.06–3.94)*	0.091
2nd grade girl	1,055 (80)	1	244 (18)	1.30 (0.90–1.87)	23 (2)	2.50 (1.01–6.23)*	0.17
4th grade boy	1,023 (82)	1	196 (16)	1.98 (1.41–2.79)***	34 (3)	2.56 (1.25–5.23)*	<0.001
4th grade girl	1,082 (84)	1	192 (15)	1.52 (1.02–2.26)*	17 (1)	1.14 (0.32–4.13)	0.039
6th grade boy	1,089 (84)	1	192 (15)	1.42 (0.94–2.15)	20 (2)	4.08 (1.63–10.20)**	0.092
6th grade girl	1,143 (86)	1	166 (13)	1.44 (0.88–2.35)	16 (1)	4.14 (1.40–12.26)*	0.14
8th grade boy	890 (89)	1	97 (10)	1.55 (0.88–2.74)	14 (1)	2.91 (0.88–9.59)	0.13
8th grade girl	906 (86)	1	131 (12)	1.80 (1.11–2.92)*	12 (1)	4.06 (1.20–13.72)*	0.017

ORs were adjusted for current wheeze, tsunami experience, and changing house experience. Eczema status was assessed by the International Study of Asthma and Allergies in Childhood (ISAAC) Eczema Symptom Questionnaire. Normal eczema status was used as a reference category. Cutoffs for normal, borderline, and clinical range were 0–12, 13–15, and 16–40 for total difficulties score. N (%) is the number and percentage of scores in the clinical range for SDQ total difficulties. The total percentage for some categories does not sum to 100% because of rounding errors.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Eczema Symptom Questionnaire. In line with previous studies,^{5,22} we found a significant association between eczema status and mental health problems in Japanese children. Because SDQ scores were known to correlate with age and sex,²⁶ we performed subgroup analyses according to sex and school grade. With the subgroup analyses according to sex and school grade, we obtained the similar tendency with respect to the relation between the eczema status and SDQ total difficulties.

In our study, mental health problems were assessed not by physician diagnosis but by the parent- or guardian-reported SDQ questionnaire. The reliability and validity of the SDQ questionnaire for behavioral screening has been established.²⁷ A previous cohort study²² using SDQ to evaluate mental health problems showed that the presence of eczema was significantly related to an increased risk of mental health problems. However, SDQ scores in the clinical range can reflect not only the existence of psychiatric disorders but also mental state at the time of the survey.

Several underlying mechanisms have been hypothesized to explain the relations between eczema and mental health problems. First, eczema in early childhood or infancy could cause later neurodevelopmental disorders by producing chronic sleep disturbance due to itching. Sleeping problems are common in children with eczema. According to one cohort study,²⁴ children diagnosed with eczema at younger than 2 years may be at increased risk of developing neurodevelopmental disorders. In our study, eczema status was categorized as mild/moderate or severe based on the presence of sleep disturbance due to pruritus. Therefore, severe eczema status could strongly reflect the influence of sleep disturbance. Two previous cross-sectional studies^{10,13} showed that eczema and sleep disturbance had strong and independent associations with ADHD. Neurotransmitter and neuroendocrine systems that are related to brain development and psychological development may be influenced by sleep disturbance during infancy, because sleep is vital for brain development.²⁸ Moreover, it is hypothesized that young children with atopic disease are influenced by oversecretion of proinflammatory cytokines that can pass through the blood–brain barrier²⁹ and affect brain development related to behavioral and emotional modulation.²³ Second, the appearance of the skin affects self-identity and self-esteem. Adolescents suffering from eczema may experience emotional effects, including anxiety, embarrassment, interpersonal difficulty, social isolation, shame, and self-consciousness.³ Third, pruritus may lead to irritability or fussiness in children with eczema, with effects on mental health. Therefore, the SDQ score may strongly reflect eczema-associated mental health problems at the time of the survey. Providing active treatment of eczema could improve not only current sleep disturbances but also current mental health problems

and quality of life. The positive association between eczema and mental health problems could also be because children with mental health problems may have difficulty in resisting scratching an itch, resulting in worsening of their eczema.

Our study showed significant associations between eczema and all four SDQ subcategories. There have been two studies of the association between eczema and SDQ subcategories. One cohort study found significant associations between eczema and emotional and conduct problems.²² A cross-sectional study found significant associations between eczema and emotional symptoms, conduct problems, and hyperactivity/inattention.⁵ Studies of the association between eczema and ADHD have been conducted in both the laboratory and the clinic.³⁰ In our study, not only hyperactivity/inattention, but also all other SDQ subcategories, were associated with eczema.²⁷

The reasons that the results of our study are different from those of other studies are unclear. One hypothesis is that the associations between eczema status and SDQ subcategories became stronger in the post-disaster environment, although at the time of the survey, 3 years or more had passed since the Great East Japan Earthquake and the subsequent huge tsunami on 11 March 2011. One case–control study of Finnish university students found a significant association between stressful life events and eczema.³¹ Another hypothesis is that the differences between our results and those of other studies were due to racial, ethnic, or cultural differences. Phenotypic racial differences in eczema may be due to genetic predisposition.¹⁴ Further studies are needed to clarify the associations between eczema and mental health problems after taking racial, ethnic, and cultural differences into consideration, as well as for comprehensive understanding of the nature of the disease.

A strength of our study was the large sample size of 9954 schoolchildren. Because the study was based on a survey of children in public schools rather than in hospitals, the data included children who had not been diagnosed with eczema or psychiatric disorders by physicians. Both the ISAAC and the SDQ questionnaires are widely used, validated questionnaires. With the use of these questionnaires, the associations between eczema status and mental health problems were properly examined. The associations with SDQ subcategories, including emotional symptoms, conduct problems, hyperactivity/inattention, and peer problems, could also be investigated. To our knowledge, only two studies have been conducted on the associations between eczema and SDQ subcategories.^{5,22}

On the contrary, this study has some limitations. First, the study could not explain the temporal and causal relationships between eczema and mental health problems because of its cross-sectional

design. Second, a nonrespondent bias may have occurred, because the response rate was low (valid response rate 24.8%). The response rate may be higher among parents or guardians who are more anxious about the mental condition of their children. Thus, there is a possibility that the prevalence of eczema and mental health disorders was different between children who responded to our survey and those who did not. Further research will be needed to generalize the results of the present study. Third, current treatment for eczema was not assessed in the survey. Among children with similar skin conditions, treatment could influence both mental health problems and eczema status, including sleep disturbance. Fourth, we could not consider information about medication which could affect itchiness or mental condition, such as antihistamines.

In conclusion, the present study showed a significant association between the severity of eczema and mental health problems in schoolchildren. We found that the risk of mental health problems increased significantly with increasing severity of eczema. In addition, the presence of eczema was associated with multiple psychiatric symptoms. Physicians treating children with eczema should pay attention to potential mental health problems.

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Conflicts of interest

AH is doing collaborative study with Omron Health Care and Yakult Honsha and also belongs to endowed course of East Japan Railway Company.

Authors' contributions

YK and MK designed the study and wrote the manuscript. MK, MM, CY, MI, TO, HM, NN, FN, HT, AH, IT, SKure, NY, MY, and SKuri contributed to data collection. YK and MK performed the statistical analysis and interpretation of the results. All authors have read and approved the final manuscript.

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