

Association between allergic diseases and body composition in toddlers: A Nationwide birth cohort study in Japan

Yasutaka Kuniyoshi

Department of Social Services and Healthcare Management, International University of Health and Welfare, Otawara, Tochigi, Japan

Correspondence

Yasutaka Kuniyoshi, Department of Social Services and Healthcare Management, International University of Health and Welfare, 2600-1 Kitakanemaru, Otawara, Tochigi 324-8501, Japan.
Email: yasutakakuniyoshi@gmail.com

Funding information

Japan Society for the Promotion of Science

Editor: Motohiro Ebisawa

Abstract

Background: This study aimed to investigate the relationship between allergic diseases and body composition, specifically obesity and thinness, in toddlers.

Methods: We performed a secondary analysis of data from the *Longitudinal Survey of Newborns in the 21st Century in Japan*. Multinomial logistic regression analyses were used to examine the association between asthma, eczema, and food allergies occurring between 6 and 18 months of age and body composition, measured by body mass index (BMI) at 18 months. To assess potential reverse causality, we also analyzed whether BMI changes from birth to 18 months were associated with subsequent treatment history for allergic diseases within the same period.

Results: A total of 77,281 children were included in the study. The incidence of asthma, eczema, and food allergy between 6 and 18 months was 3.4%, 16.5%, and 5.2%, respectively. Asthma was significantly associated with obesity (odds ratio [OR], 1.40; 95% confidence interval [95% CI], 1.21–1.62). However, no significant associations were observed between eczema or food allergy and obesity or thinness. Additionally, BMI change from birth to 18 months was positively associated with a history of asthma treatment (OR, 1.12; 95% CI, 1.09–1.15) but was negligible or minimally related to eczema or food allergy.

Conclusions: Our findings suggest that asthma in infancy is positively associated with obesity, while no significant associations exist between eczema or food allergy and body composition. These results underscore the importance of considering age-related differences when exploring the relationship between allergic diseases and body composition.

KEYWORDS

asthma, atopic dermatitis, eczema, food allergy, obesity

1 | INTRODUCTION

Allergic diseases, including asthma, eczema (atopic dermatitis), and food allergies, are significant global health concerns, particularly among infants and young children. The prevalence of food allergies and eczema is notably high during the first 2 years of life,^{1,2} often

impacting early childhood development and quality of life. While previous studies have examined the relationship between body composition—specifically obesity—and allergic diseases, findings remain inconsistent, particularly in early childhood.

Obesity has been linked to asthma and eczema in older children and adults³; however, research in infants and toddlers has yielded

mixed results. Some studies have reported a positive association between eczema and increased body mass index (BMI),^{4,5} whereas others suggest a negative correlation.⁶ Similarly, while some studies indicate that children with food allergies are more likely to be underweight,⁷ others have found no such relationship.⁸ These discrepancies suggest that the relationship between allergic diseases and body composition may vary by developmental stage, necessitating further investigation.⁴

Several mechanisms have been proposed to explain the association between body composition and allergic diseases.⁹ Chronic low-grade inflammation, mediated by cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α), may contribute to both obesity and allergic diseases.¹⁰ Additionally, gut microbiota dysbiosis has been implicated in immune system modulation and allergic responses.¹¹ Early-life nutritional factors, including breastfeeding versus formula feeding, may also influence the development of allergic diseases in infants.¹²

To address these knowledge gaps, this study aimed to examine the association between allergic diseases (asthma, eczema, and food allergy) and body composition (obesity and thinness) in infants and early toddlers, using data from a nationally representative Japanese birth cohort. Additionally, we explored whether BMI changes from birth to 18 months influence allergic disease onset, shedding light on potential causality. Our findings may contribute to the development of early-life interventions for preventing allergic diseases and managing body composition in infancy and early childhood.

2 | METHODS

2.1 | Data source and participants

This study is a secondary analysis of data from the *Longitudinal Survey of Newborns in the 21st Century*, a nationwide cohort study conducted by the Japanese Ministry of Health, Labor, and Welfare. The survey was designed to address Japan's low fertility rates and improve child health policies.¹³

The study includes two cohorts: the 2001 cohort (infants born between January 10–17 and July 10–17, 2001) and the 2010 cohort (infants born between May 10 and 24, 2010). Participants were identified through national vital statistics birth records.

The initial survey was conducted when the infants were 6 months old (2001 cohort: $N=53,575$; 2010 cohort: $N=43,767$). Returning a completed questionnaire was considered implicit consent to participate. The response rate for the first survey was 88% in both cohorts (2001 cohort: $N=47,015$; 2010 cohort: $N=38,554$). Follow-up surveys were conducted annually for children who remained in the study, with the second survey administered at 18 months of age. This study included only participants who responded to both the first and second surveys.

The study protocol was approved by the Ethical Committee of the International University of Health and Welfare (No. 23-10-30) and adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.¹⁴

Key message

This study revealed a significant association between asthma and obesity in infancy. However, unlike asthma, eczema and food allergies showed no association with body composition in this infant cohort. These findings emphasize the importance of considering age when investigating the complex interplay between allergic diseases and body composition.

2.2 | Allergic diseases

The second survey collected data on medical treatment for allergic diseases, including asthma, eczema, and food allergies. Conditions were defined as follows: Defined by a "yes" response to the question, "Have you visited a hospital or clinic for any illness or injury in the past year (referring to the period from 6 to 18 months)?" along with the selection of "asthma," "atopic dermatitis," or "eczema" or "food allergy" from a symptom checklist.

The checklists for the 2001 and the 2010 cohort surveys included the following options, respectively:

- 2001 cohort survey: 1. Varicella, 2. Pertussis, 3. Rubella, 4. Measles, 5. Exanthema subitum, 6. Conjunctivitis, 7. Otitis media or otitis externa, 8. Common cold, bronchitis, or pneumonia, 9. Asthma, 10. Diarrhea, abdominal pain, or constipation, 11. Impetigo contagiosa, 12. Atopic dermatitis or eczema, 13. Other types of dermatitis, 14. Congenital diseases, 15. Seizures or convulsions, 16. Food allergies, 17. Other diseases, 18. Contusions or lacerations, 19. Bone fractures, 20. Burns, 21. Other injuries, 22. None.
- 2010 cohort survey: 1. None, 2. Pertussis, 3. Varicella, 4. Measles, 5. Rubella, 6. Exanthema subitum, 7. Intussusception, 8. Kawasaki disease, 9. Allergic rhinitis or allergic conjunctivitis, 10. Asthma, 11. Atopic dermatitis, 12. Food allergy, 13. Conjunctivitis (excluding allergic), 14. Otitis media or otitis externa, 15. Common cold, pharyngitis, tonsillitis, bronchitis, or pneumonia, 16. Influenza, 17. Gastrointestinal diseases such as gastroenteritis, diarrhea, abdominal pain, or constipation, 18. Impetigo contagiosa, 19. Eczema, 20. Other types of dermatitis, 21. Congenital diseases, 22. Seizures or convulsions, 23. Consultations regarding development and behavior, 24. Dental caries, 25. Other illnesses, 26. Contusions or lacerations, 27. Fractures, 28. Burns, 29. Other injuries.

2.3 | Body composition

Body composition data included birth weight and height (from the first survey) and weight and height at 18 months (from the second survey). BMI (kg/m^2) was calculated as weight (kg) divided by height squared (m^2). Obesity and thinness at 18 months were defined using

sex-specific BMI cutoffs based on the 97th and third percentiles of Japanese national growth reference data¹⁵:

- Obesity: BMI $\geq 18.7 \text{ kg/m}^2$ (male) and $\geq 18.2 \text{ kg/m}^2$ (female)
- Thinness: BMI $< 13.9 \text{ kg/m}^2$ (male) and $< 13.5 \text{ kg/m}^2$ (female)
- Normal: BMI within these thresholds

Body mass index change was calculated as the difference between BMI at 18 months and at birth. Because height and weight at 6 months were not collected, BMI at that time point could not be determined.

2.4 | Covariates

The following variables were included as covariates: survey (2001 cohort or 2010 cohort), sex (male or female), birth type (singleton or multiple), gestational age (≥ 37 or < 37 weeks), birth weight ($< 2500 \text{ g}$ or $\geq 2500 \text{ g}$), number of elder siblings at 6 months (0 or ≥ 1), feeding practice (exclusive breastfeeding, partial breastfeeding, or exclusive formula feeding), daycare attendance (none, at 6 months of age only, at 18 months of age only, or at both time points), household income (< 2.50 , $2.50\text{--}4.99$, $5.00\text{--}7.49$, $7.50\text{--}9.99$, or ≥ 10.00 million JPY), maternal and paternal educational attainment (junior high school, high school, university/junior college/vocational school, or others) and maternal and paternal smoking status at 6 months (smoking or non-smoking).

Feeding practices were categorized into three groups¹⁶: exclusive breastfeeding, partial breastfeeding, and exclusive formula feeding. Exclusive breastfeeding was defined as infants who

were exclusively breastfed for the first 6 months. Partial breastfeeding included infants who were breastfed and received formula. Exclusive formula feeding included infants who were never breastfed or received colostrum only. These categorizations were based on responses to survey questions: "Did you breastfeed your child?" (response options: "breastfed," "never breastfed," or "colostrum only"); "If 'breastfed,' for how many months?"; "Did you feed your child formula milk?" (response options: "formula milk" or "never formula milk"); and "If 'formula fed,' for how many months?" Consistent with previous studies, "never breastfed" and "colostrum only" were combined into the "exclusive formula feeding" category.

2.5 | Statistical analysis

Baseline characteristics were compared between participants with and without allergic diseases (asthma, eczema, and food allergy). To mitigate potential bias due to missing data and enhance statistical power, multiple imputations using chained equations were performed. We generated 100 imputed datasets with 20 iterations for each, using predictive mean matching for continuous variables, logistic regression for binary variables, and polytomous logistic regression for categorical variables. Final estimates and standard errors were computed following Rubin's rules.

A multinomial logistic regression analysis was conducted to assess associations between allergic disease history (6–18 months) and body composition at 18 months, using "normal" status as the reference category. Two models were developed:

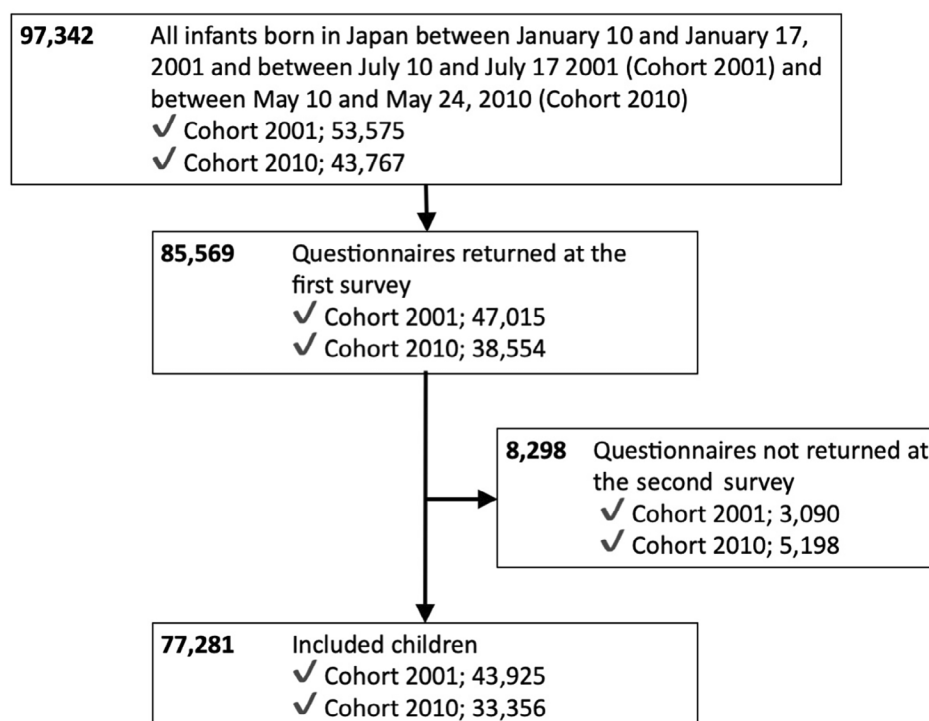


FIGURE 1 Flowchart of study participant selection.

TABLE 1 Characteristics of study participants according to each allergic disease status.

	Asthma (-)	Asthma (+)	Missing	Eczema (-)	Eczema (+)	Missing	Food allergy (-)	Food allergy (+)	Missing
Survey, n (%)									
2001 cohort	42,450 (97%)	1475 (3%)	0	36,600 (83%)	7325 (17%)	0	41,863 (95%)	2062 (5%)	0
2010 cohort	30,895 (96%)	1140 (4%)	1321	26,843 (84%)	5192 (16%)	1321	30,155 (94%)	1880 (6%)	1321
Sex, n (%)									
Male	37,660 (96%)	1705 (4%)	648	32,439 (82%)	6926 (18%)	648	37,102 (94%)	2263 (6%)	648
Female	35,685 (98%)	910 (2%)	673	31,004 (85%)	5591 (15%)	673	34,916 (95%)	1679 (5%)	673
Birth type, n (%)									
Singleton	71,953 (97%)	2533 (3%)	1308	62,212 (84%)	12,274 (16%)	1308	70,613 (95%)	3873 (5%)	1308
Multiple	1392 (94%)	82 (6%)	13	1231 (84%)	243 (16%)	13	1405 (95%)	69 (5%)	13
Gestational age, n (%)									
≥37 weeks	69,627 (97%)	2430 (3%)	1253	60,114 (83%)	11,943 (17%)	1253	68,291 (95%)	3766 (5%)	1253
<37 weeks	3681 (95%)	185 (5%)	67	3295 (85%)	571 (15%)	67	3690 (95%)	176 (5%)	67
Missing	37	0	1	34	3	1	37	0	1
Birth weight, n (%)									
≥2500 g	66,924 (97%)	2336 (3%)	1209	57,725 (83%)	11,535 (17%)	1209	65,608 (95%)	3652 (5%)	1209
<2500 g	6401 (96%)	279 (4%)	111	5699 (85%)	981 (15%)	111	6390 (96%)	290 (4%)	111
Missing	20	0	1	19	1	1	20	0	1
Number of elder siblings at 6 months, n (%)									
0	36,433 (98%)	836 (2%)	672	30,655 (82%)	6614 (18%)	672	35,024 (94%)	2245 (6%)	672
≥1	36,910 (95%)	1779 (5%)	648	32,786 (85%)	5903 (15%)	648	36,992 (96%)	1697 (4%)	648
Missing	2	0	1	2	0	1	2	0	1
Feeding practice, n (%)									
Exclusive breastfeeding	19,701 (97%)	637 (3%)	420	16,858 (83%)	3480 (17%)	420	18,994 (93%)	1344 (7%)	420
Exclusive formula feeding	3531 (97%)	125 (3%)	68	3127 (86%)	529 (15%)	68	3533 (97%)	123 (3%)	68
Partial breastfeeding	49,557 (96%)	1832 (4%)	812	42,966 (84%)	8423 (16%)	812	48,946 (95%)	2443 (5%)	812
Missing	556	21	21	492	85	21	545	32	21
Daycare attendance, n (%)									
None	57,916 (97%)	1528 (3%)	1130	49,642 (84%)	9802 (16%)	1130	56,529 (95%)	2915 (5%)	1130
At 6 months only	273 (91%)	27 (9%)	2	263 (88%)	37 (12%)	2	282 (94%)	18 (6%)	2
At 18 months only	12,923 (94%)	825 (6%)	168	11,447 (83%)	2301 (17%)	168	12,876 (94%)	872 (6%)	168
At both time points	2088 (90%)	227 (10%)	20	1956 (84%)	359 (16%)	20	2183 (94%)	132 (6%)	20
Missing	145	8	1	135	18	1	148	5	1
Household income, n (%)									

TABLE 1 (Continued)

	Asthma (-)	Asthma (+)	Missing	Eczema (-)	Eczema (+)	Missing	Food allergy (-)	Food allergy (+)	Missing
<2.50 million JPY	4318 (95%)	222 (5%)	84	3887 (86%)	653 (14%)	84	4336 (96%)	204 (4%)	84
2.50–4.99 million JPY	24,850 (96%)	905 (4%)	501	21,697 (84%)	4058 (16%)	501	24,483 (95%)	1272 (5%)	501
5.00–7.49 million JPY	24,409 (97%)	782 (3%)	372	20,913 (83%)	4278 (17%)	372	23,873 (95%)	1318 (5%)	372
7.50–9.99 million JPY	9309 (97%)	290 (3%)	119	7844 (82%)	1755 (18%)	119	9048 (94%)	551 (6%)	119
≥10.00 million JPY	5389 (96%)	201 (4%)	69	4578 (82%)	1012 (18%)	69	5253 (94%)	337 (6%)	69
Missing	5070	215	176	4524	761	176	5025 (95%)	260 (5%)	176
Maternal educational attainment, n (%)									
Junior high school	3654 (94%)	213 (6%)	128	3333 (86%)	534 (14%)	128	3703 (95%)	164 (5%)	128
High school	38,222 (96%)	1479 (4%)	689	33,578 (85%)	6123 (15%)	689	37,813 (96%)	1888 (4%)	689
University/junior college/vocational school	31,029 (97%)	911 (3%)	485	26,143 (82%)	5797 (18%)	485	30,078 (94%)	1862 (6%)	485
Others	134 (98%)	3 (2%)	5	118 (86%)	19 (14%)	5	122 (89%)	15 (11%)	5
Missing	306	9	14	271	44	14	302	13	14
Paternal educational attainment, n (%)									
Junior high school	5353 (95%)	254 (5%)	132	4818 (86%)	789 (14%)	132	5375 (96%)	232 (4%)	132
High school	35,525 (96%)	1339 (4%)	640	31,027 (84%)	5837 (16%)	640	35,055 (95%)	1809 (5%)	640
University/junior college/vocational school	31,060 (97%)	936 (2%)	491	26,322 (82%)	5674 (18%)	491	30,169 (94%)	1827 (6%)	491
Others	150 (99%)	2 (1%)	4	129 (85%)	23 (15%)	4	145 (95%)	7 (5%)	4
Missing	1257	84	54	1147	194	54	1274	67	54
Maternal smoking status, n (%)									
Smoking	8475 (95%)	433 (5%)	143	7597 (85%)	1311 (15%)	143	8567 (96%)	341 (4%)	143
Non-smoking	64,574 (97%)	2170 (3%)	1170	55,576 (83%)	11,168 (17%)	1170	63,156 (95%)	3588 (5%)	1170
Missing	296	12	8	270	38	8	295	13	8
Paternal smoking status, n (%)									
Smoking	38,106 (96%)	1440 (4%)	557	33,243 (84%)	6303 (16%)	557	37,604 (95%)	1942 (5%)	557
Non-smoking	33,868 (97%)	1073 (3%)	720	28,960 (83%)	5981 (17%)	720	33,007 (96%)	1934 (4%)	720
Missing	1371	102	44	1240	233	44	1407	66	44
Asthma, n (%)									
No	–	–	–	61,489 (84%)	11,856 (16%)	0	69,705 (95%)	3640 (5%)	0
Present	–	–	–	1954 (75%)	661 (25%)	0	2313 (88%)	302 (12%)	0
Missing	–	–	–	0	0	1321	0	0	1321
Eczema, n (%)									
No	61,489 (97%)	1954 (3%)	0	–	–	–	61,304 (97%)	2139 (3%)	0

(Continues)

TABLE 1 (Continued)

	Asthma (-)	Asthma (+)	Missing	Eczema (-)	Eczema (+)	Missing	Food allergy (-)	Food allergy (+)	Missing
Present	11,856 (95%)	661 (5%)	0	—	—	—	10,714 (86%)	1803 (14%)	0
Missing	0	0	1321	—	—	—	0	0	1321
Food allergy, n (%)									
No	69,705 (97%)	2313 (3%)	0	61,304 (85%)	10,714 (15%)	0	—	—	—
Present	3640 (92%)	302 (8%)	0	2139 (54%)	1803 (46%)	0	—	—	—
Missing	0	0	1321	0	0	1321	—	—	—
BMI at 18 months, mean (SD)	16.3 (1.4)	16.7 (1.6)		16.3 (1.4)	16.3 (1.4)		16.3 (1.4)	16.3 (1.4)	
BMI categories at 18 months, n (%)									
Obesity	4008 (95%)	219 (5%)	55	3556 (84%)	671 (16%)	55	4030 (95%)	197 (5%)	55
Normal	58,747 (97%)	1990 (3%)	909	50,531 (83%)	10,206 (17%)	909	57,569 (95%)	3168 (5%)	909
Thinness	1490 (97%)	46 (3%)	27	1299 (85%)	237 (15%)	27	1455 (95%)	81 (5%)	27
Missing	9100	360	330	8057	1403	330	8964	496	330
BMI change, mean (SD)	3.7 (1.7)	4.2 (1.9)		3.7 (1.7)	3.7 (1.7)		3.7 (1.7)	3.7 (1.7)	

Note: BMI change, the difference between BMI at 18 months and at birth.

Abbreviations: BMI, body mass index; SD, standard deviation.

- Model 1: Adjusted for all covariates.
- Model 2: Adjusted for Model 1 variables plus a history of the other two allergic diseases.

To assess potential reverse causality, multiple logistic regression analyses were performed, using BMI change from birth to 18 months as a continuous explanatory variable and allergic disease history between 6 and 18 months as the outcome variable. The same covariates were used for adjustment.

Subgroup analyses were conducted by stratifying the data by sex. Furthermore, as sensitivity analyses, we performed a complete case analysis.

All statistical analyses were performed using R version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria). Data manipulation and visualization were conducted using the “tidyverse” package, multiple imputation was performed using the “mice” package, and regression models were fitted using the “nnet” package and the “glm” function.

3 | RESULTS

A total of 77,281 participants were included in the final analysis (Figure 1). Baseline characteristics stratified by allergic disease status are presented in Table 1. The incidence of allergic diseases between 6 and 18 months of age was as follows: asthma, 3.4% (2615 cases); eczema, 16.5% (12,517 cases); and food allergy, 5.2% (3942 cases).

Figure 2 presents the odds ratios (ORs) and 95% confidence intervals (95% CIs) for the association between allergic diseases and body composition (obesity and thinness) at 18 months of age. Model 1 represents associations adjusted for basic covariates, while Model 2 accounts for the treatment history of other allergic diseases. Asthma showed a significant positive association with obesity in both models (Model 1: OR, 1.38; 95% CI, 1.20–1.60; Model 2: 1.40; 95% CI, 1.21–1.62). Conversely, eczema was not significantly associated with either obesity (Model 1: OR, 0.95; 95% CI, 0.87–1.03; Model 2: OR, 0.95; 95% CI, 0.87–1.03) or thinness (Model 1: OR, 0.93; 95% CI, 0.81–1.07; Model 2: OR, 0.92; 95% CI, 0.80–1.06). Similarly, food allergy was not significantly associated with obesity (Model 1: OR, 0.90; 95% CI, 0.78–1.05; Model 2: OR, 0.90; 95% CI, 0.77–1.05) or thinness (Model 1: OR, 1.08; 95% CI, 0.86–1.35; Model 2: OR, 1.11; 95% CI, 0.88–1.40). These findings were consistent in the complete case analysis (Figure S1). The sex-stratified subgroup analyses also showed similar trends (Figures 3 and 4); however, the point estimate for the association between asthma and obesity was lower for girls compared to boys.

To further investigate reverse causality, we examined the association between BMI change from birth to 18 months and subsequent treatment for allergic diseases between 6 and 18 months of age (Table 2). An increase in BMI during this period was positively associated with a history of asthma treatment (OR, 1.12; 95% CI, 1.09–1.15). However, any association between BMI change and treatment for eczema (OR, 0.99; 95% CI, 0.98–1.01) or food allergy (OR, 0.96;

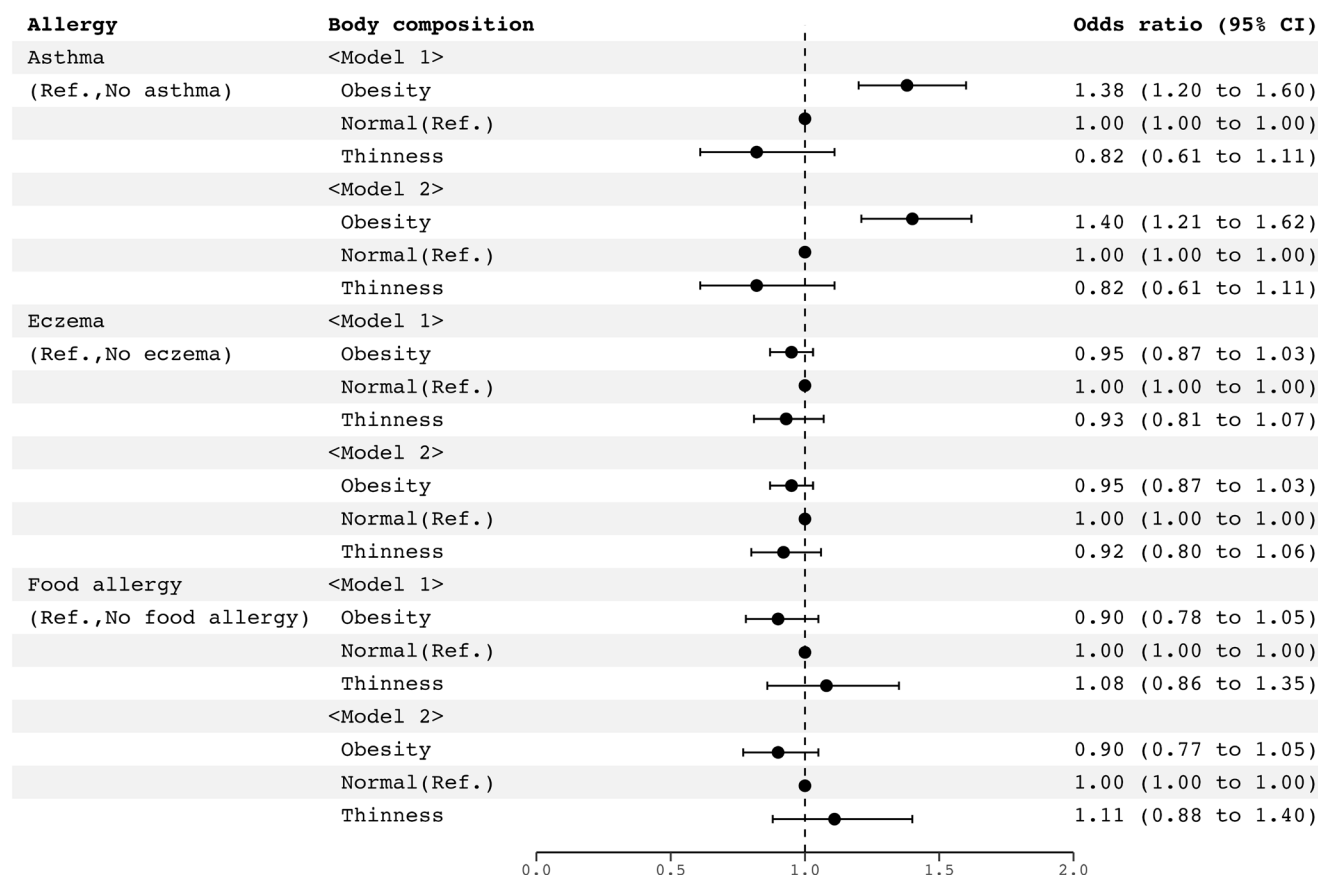


FIGURE 2 Association between allergic diseases and body composition. Multinomial logistic regression analyses were conducted to examine the relationship between a history of treatment for each allergic disease from 6 to 18 months of age and body composition at 18 months, using “normal” status as the reference category. Model 1: Adjusted for survey (2001 cohort or 2010 cohort), sex (male or female), birth type (singleton or multiple birth), gestational age (≥ 37 or < 37 weeks), birth weight (< 2500 g or ≥ 2500 g), number of elder siblings at 6 months (0 or ≥ 1), feeding practice (exclusive breastfeeding, partial breastfeeding, or exclusive formula feeding), daycare attendance (none, at 6 months of age only, at 18 months of age only, or at both time points), household income (< 2.50 , 2.50 – 4.99 , 5.00 – 7.49 , 7.50 – 9.99 , or ≥ 10.00 million JPY), and parental educational attainment (junior high school, high school, university/junior college/vocational school, or others), and parental (maternal/paternal) smoking status at 6 months (smoking or non-smoking). Model 2: Adjusted for all covariates in Model 1, plus the treatment history of the other two allergic diseases. 95% CI, 95% confidence interval.

95% CI, 0.94–0.98) was negligible or minimal. These findings were consistent in the complete case analysis (Table S1).

4 | DISCUSSION

This study investigated the relationship between allergic diseases and body composition in a large, nationally representative cohort of Japanese infants. Our findings revealed a significant positive association between asthma and obesity; however, no significant association was identified between eczema or food allergies and body composition.

Asthma and obesity are linked in infancy, aligning with findings in older children and adults. This suggests that the relationship between these conditions may develop early in life. Although the complex, bidirectional nature of the obesity–asthma relationship is well recognized,¹¹ our findings indicate that this association is already present in infancy and early toddlerhood. Several mechanisms may

underlie this relationship. Chronic low-grade inflammation, a key factor in both obesity and asthma pathophysiology, could contribute to the association.¹⁰ Additionally, metabolic dysregulation related to airway inflammation may promote weight gain. Given that most prior studies have focused on older children and adults, our findings emphasize the importance of identifying early-life risk factors for both conditions. Recognizing this association in infancy suggests that obesity prevention strategies may also help manage asthma risk in later childhood.

Longitudinal analyses examining the relationship between BMI changes and subsequent development further supported this positive association. Previous studies in infants and toddlers have similarly reported a link between obesity and asthma.¹⁷ A systematic review suggested that a rapid increase in BMI during the first 2 years of life may be associated with an increased risk of subsequent asthma.¹⁸ Our findings indicate that this association is evident as early as between birth and 18 months of age. However, our study design did not allow us to establish causality, and we were unable to determine whether

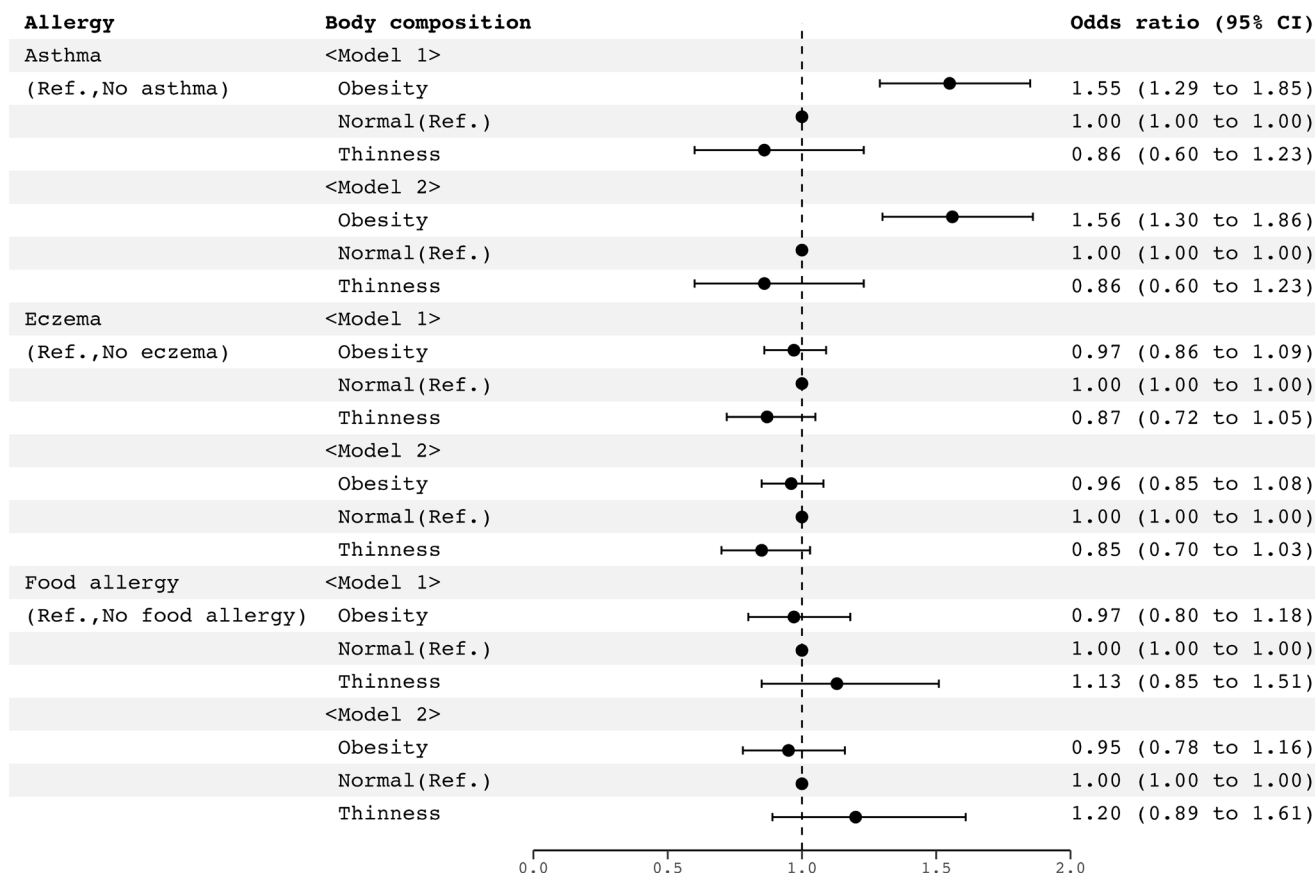


FIGURE 3 Association between allergic diseases and body composition in male toddlers. Multinomial logistic regression analyses were conducted to examine the relationship between a history of treatment for each allergic disease from 6 to 18 months of age and body composition at 18 months, using “normal” status as the reference category. Model 1: Adjusted for survey (2001 cohort or 2010 cohort), birth type (singleton or multiple birth), gestational age (≥ 37 or < 37 weeks), birth weight (< 2500 g or ≥ 2500 g), number of older siblings at 6 months (0 or ≥ 1), feeding practice (exclusive breastfeeding, partial breastfeeding, or exclusive formula feeding), daycare attendance (none, at 6 months of age only, at 18 months of age only, or at both time points), household income (< 2.50 , 2.50 – 4.99 , 5.00 – 7.49 , 7.50 – 9.99 , or ≥ 10.00 million JPY), maternal and paternal educational attainment (junior high school, high school, university/junior college/vocational school, or others), and parental (maternal/paternal) smoking status at 6 months (smoking or non-smoking). Model 2: Adjusted for all covariates in Model 1, plus the treatment history of the other two allergic diseases. 95% CI, 95% confidence interval.

obesity in infancy predisposes children to asthma or whether asthma contributes to increased BMI. Further research is needed to clarify the temporal relationship and directionality of these associations.¹¹

Several studies on older children and adults have reported a positive association between eczema and obesity.³ However, our study did not find a significant relationship between eczema and body composition—whether obesity or underweight status—in early toddlerhood. This discrepancy suggests that the association between eczema and body composition may be age-dependent. Previous studies investigating this relationship in infancy have yielded conflicting results, with some studies reporting positive associations^{4,5} and others reporting negative ones.⁶ These inconsistencies could arise from variations in study design, differences in population characteristics, or discrepancies in the assessment methods for eczema and body composition. For example, one cohort study found that children with atopic dermatitis had a higher BMI than those without the condition up to 5.5 years of age, after which this relationship reversed.⁴ Further research is needed to clarify the physiological and

immunological factors unique to infancy that may explain these inconsistencies. Additionally, longitudinal studies should aim to identify potential modifying or mediating factors across the lifespan, such as eczema severity, comorbidities (e.g., sleep disturbances), and specific therapeutic interventions.

Interpreting the absence of a significant association between food allergy and body composition in our study requires careful consideration, given the complex nature of food allergy-related growth patterns. Several factors may have influenced this null finding. First, our dataset lacked detailed information on critical aspects such as specific food allergens, diagnostic methods, and the extent of food elimination diets, all of which can impact growth outcomes. These limitations may have reduced our ability to detect a significant association. Indeed, previous studies have suggested that the type and number of food allergens can differentially affect BMI.⁸ Second, the relatively short follow-up period may not have been sufficient to detect subtle or long-term effects. While some studies have suggested a potential link between food allergies and thinness,⁷ others have

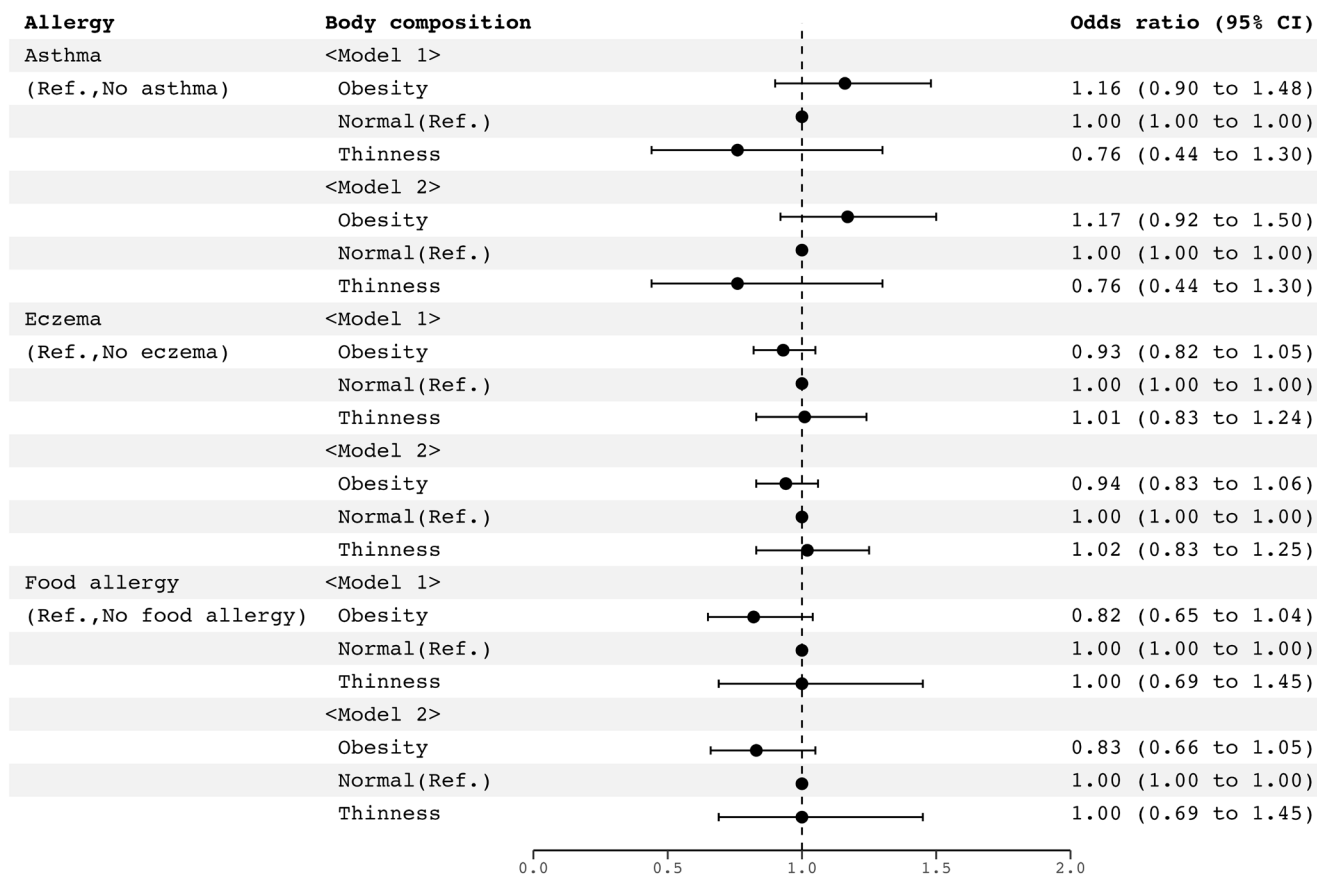


FIGURE 4 Association between allergic diseases and body composition in female toddlers. Multinomial logistic regression analyses were conducted to examine the relationship between a history of treatment for each allergic disease from 6 to 18 months of age and body composition at 18 months, using “normal” status as the reference category. Model 1: Adjusted for survey (2001 cohort or 2010 cohort), birth type (singleton or multiple birth), gestational age (≥ 37 or < 37 weeks), birth weight (< 2500 g or ≥ 2500 g), number of older siblings at 6 months (0 or ≥ 1), feeding practice (exclusive breastfeeding, partial breastfeeding, or exclusive formula feeding), daycare attendance (none, at 6 months of age only, at 18 months of age only, or at both time points), household income (< 2.50 , 2.50 – 4.99 , 5.00 – 7.49 , 7.50 – 9.99 , or ≥ 10.00 million JPY), maternal and paternal educational attainment (junior high school, high school, university/junior college/vocational school, or others), parental (maternal/paternal) smoking status at 6 months (smoking or non-smoking). Model 2: Adjusted for all covariates in Model 1, plus the treatment history of the other two allergic diseases. 95% CI, 95% confidence interval.

reported inconsistent findings, including no association.^{8,19} Notably, Japanese guidelines for food allergy 2020 emphasize minimal elimination of causative foods,²⁰ which may explain why studies on young Japanese children have found no significant differences in BMI between those with and without food allergies.^{8,19} These findings suggest that dietary management strategies, particularly those focused on maintaining nutritional adequacy, may play a crucial role in mitigating the potential impact of food allergies on body composition.

This study has several strengths, including a large sample size and a nationally representative birth cohort design.¹³ However, several limitations must be acknowledged. First, reliance on parental reports for treatment histories of allergic diseases introduces the possibility of outcome misclassification. This arises from the lack of information on the specific diagnostic criteria used by physicians and the potential inaccuracy of parental recall. This limitation is particularly relevant for conditions such as asthma, which are inherently difficult to diagnose in infants and toddlers. Nevertheless, the prevalence of allergic diseases in our study was comparable to that reported in other

large-scale surveys conducted in Japan,⁶ suggesting that the impact of such bias may have been minimal. Therefore, it is important to interpret with the understanding that non-differential misclassification generally biases associations toward the null.²¹

However, the potential for differential misclassification remains a concern. For example, parents with higher health awareness might be more likely to seek medical consultation for their children—thereby increasing the likelihood of an allergy diagnosis—while also being more proactive in preventing obesity. To partially address this potential bias, we adjusted for proxies of socioeconomic status, including household income and parental educational attainment. Nevertheless, other forms of bias, such as reporting bias related to disease severity (e.g., more severe cases being more likely to be reported while milder cases are overlooked), could introduce additional complexity to the interpretation of our findings. Second, data on treatment history before 6 months of age were unavailable. Although this limitation may have had a minimal effect on asthma analyses, it could have led to an underestimation

BMI change	Asthma (+) (ref. Asthma [-])		Eczema (+) (ref. Eczema [-])		FA (+) (ref. FA [-])	
	OR	95% CI	OR	95% CI	OR	95% CI
Total	1.12	1.09–1.15	0.99	0.98–1.01	0.96	0.94–0.98
Male	1.13	1.10–1.16	1.00	0.99–1.01	0.97	0.95–0.99
Female	1.09	1.04–1.13	1.00	0.98–1.02	0.96	0.93–0.99

TABLE 2 Association between body mass index change and each allergic disease.

Note: Multiple logistic regression analyses were conducted with BMI change from birth to 18 months as the explanatory variable and treatment history for each allergic disease between 6 and 18 months as the outcome variable. The following covariates were included as adjustment factors: Survey (2001 cohort or 2010 cohort), sex (male or female), birth type (singleton or multiple birth), gestational age (≥ 37 weeks or < 37 weeks), birth weight (< 2500 g or ≥ 2500 g), number of elder siblings at 6 months of age (0 or ≥ 1), feeding practice (exclusive breastfeeding, partial breastfeeding, or exclusive formula feeding), daycare attendance (none, at 6 months of age only, at 18 months of age only, or at both time points), household income (< 2.50 , 2.50 – 4.99 , 5.00 – 7.49 , 7.50 – 9.99 , or ≥ 10.00 million JPY), maternal and paternal educational attainment (junior high school, high school, university/junior college/vocational school, or others), maternal smoking status at 6 months of age (smoking or non-smoking), and paternal smoking status at 6 months of age (smoking or non-smoking).

Abbreviations: 95% CI, 95% confidence interval; BMI, body mass index; FA, food allergy; OR, odds ratio.

of the associations between eczema and food allergy with body composition, as these conditions often emerge earlier in infancy. Third, the study lacked detailed information on disease severity and specific treatments. Consequently, the observed associations may reflect not only the direct effects of allergic diseases but also the indirect effects of therapeutic interventions, such as corticosteroid use, which has been linked to weight gain and metabolic alterations. Future studies should incorporate detailed treatment data to differentiate the effects of disease pathology from those of medical interventions.

5 | CONCLUSION

This study found a positive association between asthma and obesity in early toddlers, aligning with findings in older children and adults. However, unlike some studies on older age groups, we found no significant associations between eczema or food allergies and body composition in our infant cohort. These results suggest that the relationship between allergic diseases and body composition may vary by age. Further research is needed to determine whether early interventions for allergic diseases can influence long-term body composition, particularly in the context of obesity prevention.

AUTHOR CONTRIBUTIONS

Yasutaka Kuniyoshi: Conceptualization; methodology; data curation; investigation; formal analysis; visualization; writing – original draft; writing – review and editing.

ACKNOWLEDGMENTS

The author thanks Enago (www.enago.jp) for the English language review.

FUNDING INFORMATION

This study was supported by the Japan Society for the Promotion of Science (JSPS) KAKENHI (grant number, 25K20605). The funders had no role in the study design, data collection, data analysis, data interpretation, or writing of the paper.

CONFLICT OF INTEREST STATEMENT

None.

PEER REVIEW

The peer review history for this article is available at <https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/pai.70163>.

ETHICS STATEMENT

All procedures were conducted in accordance with the ethical standards of the Helsinki Declaration of 1975, as revised in 2013. The study protocol was reviewed and approved by the Ethical Committee of the International University of Health and Welfare (No. 23-10-30).

REFERENCES

- Garmhausen D, Hagemann T, Bieber T, et al. Characterization of different courses of atopic dermatitis in adolescent and adult patients. *Allergy*. 2013;68:498–506.
- Sicherer SH, Warren CM, Dant C, Gupta RS, Nadeau KC. Food allergy from infancy through adulthood. *J Allergy Clin Immunol Pract*. 2020;8:1854–1864.
- Kuniyoshi Y, Tsujimoto Y, Banno M, Taito S, Ariie T, Kimoto T. Association of obesity or metabolic syndrome with various allergic diseases: an overview of reviews. *Obes Rev*. 2025;26:e13862.
- Nicholas MN, Keown-Stoneman CD, Maguire JL, Drucker AM. Association between atopic dermatitis and height, body mass index, and weight in children. *JAMA Dermatol*. 2022;158:26–32.

5. O'Donovan SM, Hourihane JO, Murray DM, et al. Neonatal adiposity increases the risk of atopic dermatitis during the first year of life. *J Allergy Clin Immunol*. 2016;137:108-117.
6. Yamamoto-Hanada K, Suzuki Y, Yang L, et al. Persistent eczema leads to both impaired growth and food allergy: JECS birth cohort. *PLoS One*. 2021;16:e0260447.
7. Papachristou E, Voutsina M, Vagianou K, Papadopoulos N, Xepapadaki P, Yannakoulia M. Dietary intake, diet diversity, and weight status of children with food Allergy. *J Acad Nutr Diet*. 2024;124:1606-1613.
8. Saito M, Hasunuma H, Okuda M, et al. Relationship between growth and food avoidance with food allergy at age 3 years: the Japan environment and Children's study (JECS). *World Allergy Organ J*. 2023;16:100826.
9. Calcaterra V, Verduci E, Ghezzi M, et al. Pediatric obesity-related asthma: the role of nutrition and nutrients in prevention and treatment. *Nutrients*. 2021;13:3708.
10. Umamo GR, Pistone C, Tondina E, et al. Pediatric obesity and the immune system. *Front Pediatr*. 2019;7:487.
11. Reyes-Angel J, Kaviany P, Rastogi D, Forno E. Obesity-related asthma in children and adolescents. *Lancet Child Adolesc Health*. 2022;6:713-724.
12. Greer FR, Sicherer SH, Burks A, Committee on Nutrition and Section on Allergy and Immunology. Effects of early nutritional interventions on the development of atopic disease in infants and children: the role of maternal dietary restriction, breastfeeding, timing of introduction of complementary foods, and hydrolyzed formulas. *Pediatrics*. 2008;121:183-191.
13. Fuse K, Nishi N, Ikeda N. Cohort profile: 2001 cohort of the longitudinal survey of newborns in the 21st century. *Int J Epidemiol*. 2017;46:1398.
14. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol*. 2008;61:344-349.
15. Kato N, Takimoto H, Sudo N. The cubic functions for spline smoothed L, S and M values for BMI reference data of Japanese children. *Clin Pediatr Endocrinol*. 2011;20:47-49.
16. Kuniyoshi Y. The lack of an Association of Breastfeeding with the development of childhood intussusception: a Nationwide birth cohort survey in Japan. *Breastfeed Med*. 2024;19:924-931.
17. Taveras EM, Rifas-Shiman SL, Camargo CA Jr, et al. Higher adiposity in infancy associated with recurrent wheeze in a prospective cohort of children. *J Allergy Clin Immunol*. 2008;121:1161-1166.
18. Chang CL, Ali GB, Pham J, et al. Childhood body mass index trajectories and asthma and allergies: a systematic review. *Clin Exp Allergy*. 2023;53:911-929.
19. Fukuda Y, Kameda M. Assessment of the correlation between mother and child body mass index and mother and child diet in children with food allergies. *J Clin Med Res*. 2019;11:703-710.
20. Ebisawa M, Ito K, Fujisawa T, Committee for Japanese Pediatric Guideline for Food Allergy, The Japanese Society of Pediatric Allergy and Clinical Immunology, Japanese Society of Allergology. Japanese guidelines for food allergy 2020. *Allergol Int*. 2020;69:370-386.
21. Haine D, Dohoo I, Dufour S. Selection and misclassification biases in longitudinal studies. *Front Vet Sci*. 2018;5:99.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Kuniyoshi Y. Association between allergic diseases and body composition in toddlers: A Nationwide birth cohort study in Japan. *Pediatr Allergy Immunol*. 2025;36:e70163. doi:[10.1111/pai.70163](https://doi.org/10.1111/pai.70163)