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# Course of growth and nutritional status in Swiss children with food allergies

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**Summary**

*Purpose* Studies suggest that children with immunoglobulin E (IgE)-mediated food allergies (FA) are at risk of impaired growth, especially those with cow's milk or multiple FA. However, there is limited long-term data available on this topic. This analysis presents the growth of Swiss children for the first year after FA diagnosis.

*Methods* This is a secondary analysis of data from a multicentered study following food allergic children (0–10 years) over 1 year post diagnosis, comparing those who received dietary counselling with those who did not. Growth z-scores were calculated based on World Health Organization (WHO) standards, using data reported by caregivers. To analyze data, linear mixed models with between-subject factors related to dietary counselling, number of FA, and cow's milk allergy were fitted to the data.

*Results* In the 48 children (median age 16 months) studied, we observed an increasing prevalence of wasting (weight-for-length/height z-score $<2$; 2–10%) and a lower prevalence of stunting (length/height-for-age $<2$; 0–2%) over the 1-year period. Twelve months after diagnosis, all median z-scores showed an increase. Linear mixed model analysis did not find any significant within-subject and between-subject effects on growth.

*Conclusion* Children with IgE-mediated FA can have normal growth if children with cow's milk allergy or multiple food allergies receive dietary counselling. Routine length/height and weight measurements should be taken to identify individual malnutrition and to initiate tailored nutritional interventions. Larger studies with longer duration are needed to assess further growth development in children with IgE-mediated food allergies.

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**Keywords** Malnutrition · Stunting · Wasting · Underweight · Food hypersensitivity

## Abbreviations

| | |
|---|---|
| BMI | Body mass index |
| FA | Food allergy |
| IgE | Immunoglobulin E |
| WHO | World Health Organization |

## Introduction

FA is an increasing public health burden, affecting up to 10% of the population in western countries, with the highest prevalence among younger children [1]. Childhood is characterized by rapid growth and development [2]. The elimination of the allergenic food from the diet remains the standard treatment of IgE-mediated FA [3]. Among children, staple foods such as cow's milk, hen's egg and wheat, as well as foods difficult to avoid, such as peanut and hazelnut, often cause FA [4]. Consequently, affected children may experience a reduced macro- and micronutrient intake, leading to impaired nutritional status and growth [5]. It is also hypothesized that other factors, such as chronic inflammation or the development of feeding difficulties may occur due to the restricted diet [6].

Several studies have examined the association of FA with nutritional status and growth of children, but the results have been inconsistent, and long-term data is rare. While many studies suggest that children with FA, particularly those with cow's milk allergy or multiple FA, experienced impaired growth [7–11], there is limited research on the long-term effects of FA on growth [5, 9, 12, 13]. For example, in 2018, Dong et al. [5] found no significant differences in growth after the age of two years in a Chinese children cohort with IgE-mediated cow's milk allergy. In contrast, Beck et al. (2016) observed significantly lower z-scores in children with persistent IgE-mediated FA and eczema at age four [12]. This finding was further supported by Robbins et al. (2020), who found significantly lower growth from age two to age twelve in children with IgE-mediated cow's milk allergy [9]. A recent longitudinal assessment of a birth cohort in the US revealed that children with IgE-mediated food allergies, especially those with multiple allergies, experience more pronounced growth impairment after the first year of age [13]. These discrepancies between studies may be attributed to various factors, including differences in the study populations (such as types of FA, age, and country of origin), the use of different control groups, duration of disease, the medical care for children, the availability of alternative foods and the involvement of dietitians. However, in most of these studies, it remains unclear how long after diagnosis the data collection took place. Therefore, it is difficult to draw conclusions about the specific timepoint at which nutritional impairment develops or can be expected.

Therefore, a data analysis of growth parameters of the ERnährungsberatung von Kindern mit NAhrungsmittelallergien (ERNA; dietary counselling of children with food allergy) study was undertaken to focus on the prevalence of malnutrition over one year following diagnosis of FA and to detect whether cow's milk allergy, number of FA and dietary counselling are associated with effects on growth. This study utilized WHO indicators to define malnutrition for international comparison. The indicators included calculations for weight-for-age, height/length-for-age, weight-for-length/height, and body-mass-index (BMI)-for-age. The aim of this study is to provide insights into the growth and nutritional status of children with IgE-mediated FA during the critical first year following diagnosis, thus, contributing to the management and understanding of this medical condition.

## Materials and methods

### *Study population*

This study represents a secondary data analysis of anthropometric data obtained from the ERNA study. A comprehensive description of the methodology can be found in a previously published PhD thesis [14]. Briefly, the ERNA study is a nonrandomized controlled investigation examining the influence of dietary counselling on children (0–10 years) with IgE-mediated FA in terms of quality of life, allergic reactions, nutritional status, and diet diversity in the first year after diagnosis. Recruitment for the study was conducted between 2019 and 2021 at four hospitals located in the German-speaking part of Switzerland. The study population consisted of children who had recently received a diagnosis of IgE-mediated FA and did not present any other chronic diseases that could potentially influence their nutritional status. Children with non-IgE-mediated food allergy were excluded due to the less reliable nature of diagnosis. Additionally, caregivers who lacked sufficient proficiency in the German language to adequately respond to questionnaires and those who had already undergone dietary counselling before enrollment were further excluded from the study. Anthropometric data, including weight and length measurements, were collected at different timepoints: baseline (at the time of FA diagnosis), as well as at 6- and 12-months post diagnosis. Caregivers of the children answered the questionnaires. The 6-month data for all study outcomes have already been reported in the PhD thesis [14], while the findings for the 12-month data relating to the other outcomes will be presented separately in future publications.

### Growth indicators

To detect malnutrition in the study population we employed WHO z-scores [6, 15, 16]. According to their guidelines, z-scores below minus two indicate malnutrition [6, 15]. Low weight-for-length/height z-scores are used to evaluate wasting (acute undernutrition) in children younger than 5 years, while weight-for-age z-scores are used as an indicator for undernutrition and length/height-for-age as an indicator for stunting [17]. Z-scores above two for weight-for-height in children below 2 years and BMI-for-age in children above 2 years indicate overweight, as recommended by the American Academy of Pediatrics and the Centers for Disease Control and Prevention [18, 19].

### Statistical analysis

Study participant's anthropometric data were analyzed using R statistical software (version 4.2.1; R Foundation for Statistical Computing, Vienna, Austria). Z-score weight-for-age, height-for-age, weight-for-height, and BMI-for-age were calculated using the WHO Anthro® work package (version 1.0.0; WHO, Geneva, Switzerland) for children under the age of five and the WHO Anthro-plus® (version 0.9.0; WHO, Geneva, Switzerland) for children over the age of five in April 2023. Extreme z-scores according to WHO's cut-off values led to exclusion [16]. Prevalence of malnutrition indicators in the study population are shown as absolute and relative frequencies. We fitted individual linear mixed models to the data with each z-score as dependent variables, timepoint and each of the between-subject factors (dietary counselling, number of FA and cow's milk FA) and the corresponding interaction with timepoint as fixed effects and subject as random intercept. We performed tests of global effect of timepoint, group and group–timepoint interaction. If the group–timepoint interaction was not significant, main effect models were fitted to the data, thus, assuming additive effects of timepoint and group. We computed group-specific time contrasts with Tukey adjustment for multiple estimation. Residual analysis was performed to assess model assumptions. Significance level was set at 5%.

### Ethics

The Ethics Committee Bern (ID 2018-01216) and the Research Ethics Committee for the Faculty of Health & Human Sciences and Peninsula Schools of Medicine & Dentistry, Plymouth University approved the ERNA study [14]. Caregivers signed an informed consent prior to entering the ERNA study and they had the option to terminate their participation in the study any time without giving a reason.

## Results

Baseline characteristics are described in Table 1. The study population involved 48 children: 65% ($n=31$) male and 35% ($n=17$) female. Among these individuals, 60% ($n=29$) received dietary counselling, while 40% ($n=19$) did not. Furthermore, 73% ($n=35$) exhibited one or two food allergies, while 27% ($n=13$) presented with three or more food allergies. The most prevalent food triggers were tree nuts, affecting 56% ($n=27$) of the participants, followed by hen's eggs with 48% ($n=23$), and cow's milk with 27% ($n=13$). Most children ($n=44$) were below 5 years of age at baseline, and median age of participants at baseline was 16 months (interquartile range [IQR] = 12). Two parents did not answer the 6-month and one the 12-month questionnaire.

Table 2 displays the prevalence of malnutrition in this study population, presented as numbers and percentages. Both at baseline and after 12 months, the number of children exhibiting malnutrition was very

**Table 1** Sociodemographic and clinical baseline characteristics of participating children

| Baseline characteristic | | *n* | % |
|---|---|---|---|
| Center | Zurich | 26 | 54 |
| | Basel | 14 | 29 |
| | St Gallen | 7 | 15 |
| | Aarau | 1 | 2 |
| Dietary counselling | Yes | 29 | 60 |
| | No | 19 | 40 |
| Sex | Female | 17 | 35 |
| | Male | 31 | 65 |
| Emergency kit | Yes | 40 | 83 |
| Symptoms | Skin | 45 | 94 |
| | Gastrointestinal | 21 | 44 |
| | Respiratory | 15 | 31 |
| | Cardiovascular | 3 | 6 |
| Number of food allergies | 1–2 | 35 | 73 |
| | ≥ 3 | 13 | 27 |
| Allergens | Tree nuts | 27 | 56 |
| | Hen's egg | 23 | 48 |
| | Cow's milk | 13 | 27 |
| | Peanut | 12 | 25 |
| | Soy | 5 | 10 |
| | Others | 10 | 21 |
| Highest educational attainment (responding parent) | Primary | 0 | 0 |
| | Secondary | 16 | 33 |
| | Tertiary | 31 | 65 |
| | No answer | 1 | 2 |
| Household income (CHF per year) | < 50,000 | 0 | 0 |
| | 50,000–100,000 | 11 | 23 |
| | 100,000–200,000 | 28 | 58 |
| | > 200,000 | 5 | 10 |
| | No answer | 4 | 8 |

*N* = 48. Participants median age 16 months (interquartile range [IQR] = 12)

**Table 2** Nutritional status of children with immunoglobulin E (IgE)-mediated food allergies

| | Baseline | | | 6-months | | | 12-months | | |
|---|---|---|---|---|---|---|---|---|---|
| | *N* | *n* | % | *N* | *n* | % | *N* | *n* | % |
| Stunting | 46 | 0 | 0.0 | 44 | 1 | 2.3 | 43 | 0 | 0.0 |
| Underweight | 48 | 1 | 2.1 | 44 | 0 | 0.0 | 44 | 1 | 2.3 |
| Wasting | 43 | 2 | 4.7 | 40 | 2 | 5.0 | 41 | 4 | 9.8 |
| Overweight | 46 | 2 | 4.3 | 44 | 2 | 4.5 | 47 | 1 | 2.1 |

*N*= 48 The number and frequencies of participants being underweight (weight-for-age z-score < –2), stunted (height/length-for-age z-score < –2), wasted (weight-for-height/length; calculated only in children < 60 months), and overweight (weight-for-length/height z-score in children < 2 years, body mass index [BMI]-for-age in children > 2 years)

low. No stunted children were observed at any point during the study, except for a single case at 6 months. Underweight remained at a very low level, with only one case affected. However, wasting was more prevalent and showed an increase over time: At baseline and 6 months, there were two cases which rose to four cases at 12 months. Overweight, decreased from two cases at baseline to one at 12 months.

The z-scores of individual participants over the course of the study are presented in Fig. 1, illustrating the longitudinal growth and changes in z-score, including the median values. The weight-for-age measurements (**b**) showed a stable and consistent pattern in z-scores among the children, whereas length/height- and BMI-for-age (**a**, **d**), as well as weight-for-length/height (**c**), exhibited a few outliers and individual children show a decrease over time.

In Table 3, we summarize the median z-scores for each timepoint. On average, there was an increase of 0.19 in median z-scores from diagnosis to the 1-year follow-up. The median values ranged from –0.14 (BMI-for-age at baseline) to 0.30 (weight-for-age at 6 months) when considering all children. Generally, median values remained relatively stable over this 12-month period. However, children with three or more food allergies and those with cow's milk allergy tended to demonstrate lower z-scores. These findings suggest that the study population exhibited overall favorable growth, as evidenced by the lack of changes in median z-scores over the duration of the study.

In all conducted statistical models, the group–timepoint interaction effects were assessed, and it was observed that these effects did not reach statistical significance. Consequently, only the main effect models were retained for further analysis. Residual analysis showed no evidence against model assump-

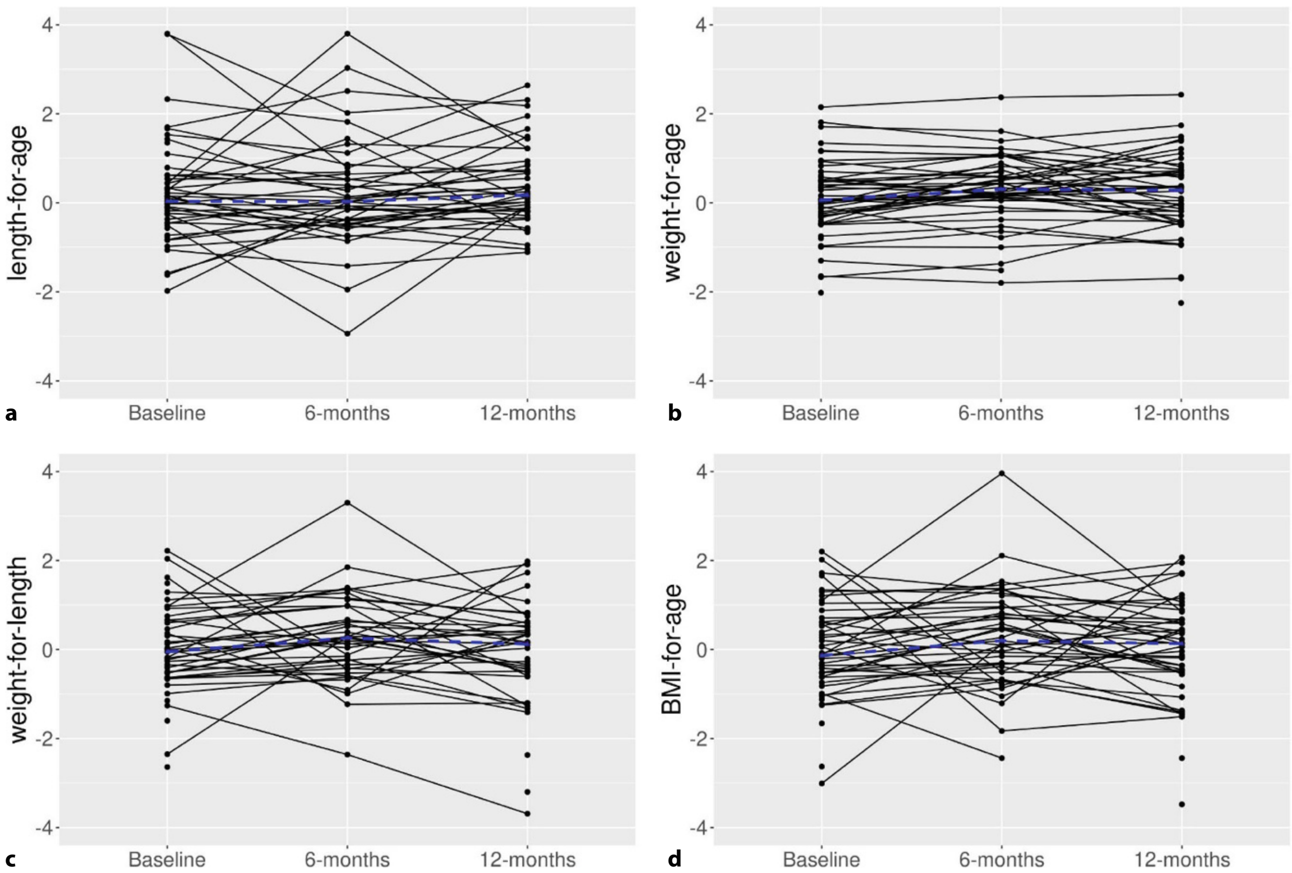


**Fig. 1** The course of the z-scores for each individual over the first year after diagnosis (**a**) for length/height-for-age, (**b**) weight-for-age, (**c**) weight-for-length/height and (**d**) BMI-for-age. *Note*: Each line represents the z-score of an individual participant following one year after food allergy diagnosis with median (*blue line*). Two individuals are not shown because their values were outside the visualized range of –4 to +4

**Table 3** Median z-scores and interquartile range (IQR) for children with food allergy (FA), stratified by dietary counselling (counselling), multiple food allergies (≥3 FA), and cow's milk allergy (CMA)

| z-score | Baseline | | 6-months | | 12-months | |
|---|---|---|---|---|---|---|
| | *n* | Median (IQR) | *n* | Median (IQR) | *n* | Median (IQR) |
| Length-for-age | | | | | | |
| All children | 46 | 0.04 (1.06) | 44 | 0.06 (1.22) | 46 | 0.18 (1.05) |
| Counselling | 29 | 0.05 (1.15) | 26 | 0.03 (1.45) | 27 | 0.22 (1.15) |
| ≥3 FA | 12 | 0.49 (0.91) | 13 | 0.28 (1.14) | 12 | 0.07 (1.14) |
| CMA | 13 | −0.09 (1.06) | 11 | −0.39 (0.79) | 12 | 0.07 (0.38) |
| Weight-for-age | | | | | | |
| All children | 48 | 0.06 (0.95) | 44 | 0.30 (0.67) | 44 | 0.29 (1.14) |
| Counselling | 19 | 0.08 (1.05) | 27 | 0.26 (0.82) | 28 | 0.31 (0.94) |
| ≥3 FA | 13 | 0.08 (0.71) | 12 | 0.22 (0.38) | 12 | 0.18 (0.68) |
| CMA | 13 | −0.24 (0.83) | 12 | 0.17 (0.37) | 13 | −0.19 (0.83) |
| Weight-for-length/height [a] | | | | | | |
| All children | 43 | −0.05 (1.24) | 40 | 0.23 (1.41) | 41 | 0.10 (1.12) |
| Counselling | 27 | 0.00 (1.10) | 25 | 0.14 (1.15) | 26 | 0.24 (1.10) |
| ≥3 FA | 11 | −0.05 (0.62) | 11 | 0.14 (0.76) | 11 | −0.27 (1.37) |
| CMA | 13 | −0.19 (0.70) | 11 | 0.26 (0.56) | 13 | −0.27 (1.03) |
| BMI-for-age | | | | | | |
| All children | 46 | −0.14 (1.23) | 43 | 0.20 (1.39) | 46 | 0.10 (1.17) |
| Counselling | 27 | −0.15 (1.35) | 25 | 0.20 (1.56) | 27 | 0.13 (1.17) |
| ≥3 FA | 12 | −0.26 (0.82) | 13 | 0.20 (1.03) | 12 | −0.03 (1.26) |
| CMA | 13 | −0.31 (0.81) | 11 | 0.27 (0.69) | 12 | −0.16 (0.99) |

*N*= 48. [a] weight-for-length/height; calculated only in children <60 months

**Table 4** Comparison of time and dietary counselling effects in the main effects model

| | | | 95% CI | |
|---|---|---|---|---|
| z-score | Time contrast | Estimate | *LL* | *UL* |
| Length/height-for-age [a] | 6-months to baseline | 0.135 | −0.283 | 0.552 |
| | 12-months to baseline | 0.181 | −0.229 | 0.590 |
| | 12-months to 6-months | 0.046 | −0.372 | 0.464 |
| | Counselling yes vs no | −0.006 | −0.618 | 0.607 |
| Weight-for-age [a] | 6-months to baseline | 0.153 | −0.047 | 0.352 |
| | 12-months to baseline | 0.083 | −0.116 | 0.282 |
| | 12-months to 6-months | −0.070 | −0.274 | 0.135 |
| | Counselling yes vs no | −0.004 | −0.505 | 0.496 |
| Weight-for-length/height [b] | 6-months to baseline | 0.111 | −0.360 | 0.581 |
| | 12-months to baseline | −0.201 | −0.665 | 0.263 |
| | 12-months to 6-months | −0.311 | −0.784 | 0.162 |
| | Counselling yes vs no | −0.056 | −0.727 | 0.615 |
| BMI-for-age [c] | 6-months to baseline | 0.206 | −0.238 | 0.649 |
| | 12-months to baseline | −0.069 | −0.502 | 0.365 |
| | 12-months to 6-months | −0.275 | −0.718 | 0.169 |
| | Counselling yes vs no | 0.147 | −0.419 | 0.713 |

[a] *N*= 48 with 136 observations, [b] *N*= 45 with 124 observations, [c] *N*= 47 with 135 observations, *n*= 29 with dietary counselling
*CI* confidence interval, *LL* lower limit, *UL* upper limit, *BMI* body mass index

**Table 5** Comparison of time and number of food allergy (*FA*) effects in the main effects model

| | | | 95% CI | |
|---|---|---|---|---|
| z-score | Time contrast | Estimate | *LL* | *UL* |
| Length/height-for-age [a] | 6-months to baseline | 0.135 | −0.283 | 0.553 |
| | 12-months to baseline | 0.181 | −0.229 | 0.590 |
| | 12-months to 6-months | 0.046 | −0.372 | 0.464 |
| | 1–2 vs ≥3 FA | −0.081 | −0.755 | 0.594 |
| Weight-for-age [a] | 6-months to baseline | 0.153 | −0.047 | 0.352 |
| | 12-months to baseline | 0.083 | −0.116 | 0.282 |
| | 12-months to 6-months | −0.070 | −0.274 | 0.135 |
| | 1–2 vs ≥3 FA | 0.133 | −0.416 | 0.682 |
| Weight-for-length/height [b] | 6-months to baseline | 0.110 | −0.360 | 0.580 |
| | 12-months to baseline | −0.201 | −0.664 | 0.262 |
| | 12-months to 6-months | −0.311 | −0.784 | 0.161 |
| | 1–2 vs ≥3 FA | 0.171 | −0.558 | 0.901 |
| BMI-for-age [c] | 6-months to baseline | 0.204 | −0.240 | 0.647 |
| | 12-months to baseline | −0.069 | −0.502 | 0.365 |
| | 12-months to 6-months | −0.272 | −0.716 | 0.171 |
| | 1–2 vs ≥3 FA | 0.098 | −0.526 | 0.723 |

[a] *N*= 48 with 136 observations, [b] *N*= 45 with 124 observations, [c] *N*= 47 with 135 observations, *n*= 13 with three and more food allergies
*CI* confidence interval, *LL* lower limit, *UL* upper limit, *BMI* body mass index

**Table 6** Comparison of time and cow's milk allergy (*CMA*) effects in the main effects model

| | | | 95% CI | |
|---|---|---|---|---|
| z-score | Time contrast | Estimate | *LL* | *UL* |
| Length/height-for-age [a] | 6-months to baseline | 0.130 | −0.288 | 0.548 |
| | 12-months to baseline | 0.176 | −0.233 | 0.586 |
| | 12-months to 6-months | 0.046 | −0.372 | 0.464 |
| | CMA yes vs no | −0.591 | −1.24 | 0.062 |
| Weight-for-age [a] | 6-months to baseline | 0.153 | −0.046 | 0.352 |
| | 12-months to baseline | 0.085 | −0.115 | 0.284 |
| | 12-months to 6-months | −0.069 | −0.273 | 0.136 |
| | CMA yes vs no | −0.388 | −0.926 | 0.149 |
| Weight-for-length/height [b] | 6-months to baseline | 0.110 | −0.361 | 0.580 |
| | 12-months to baseline | −0.200 | −0.664 | 0.264 |
| | 12-months to 6-months | −0.309 | −0.783 | 0.164 |
| | CMA yes vs no | −0.137 | −0.843 | −0.843 |
| BMI-for-age [c] | 6-months to baseline | 0.204 | −0.239 | 0.647 |
| | 12-months to baseline | −0.070 | −0.503 | 0.364 |
| | 12-months to 6-months | −0.274 | −0.717 | 0.170 |
| | CMA yes vs no | −0.135 | −0.761 | 0.490 |

[a] *N*= 48 with 136 observations, [b] *N*= 45 with 124 observations, [c] *N*= 47 with 135 observations, *n*= 13 with cow's milk allergy
*CI* confidence interval, *CMA* cow's milk allergy, *LL* lower limit, *UL* upper limit, *BMI* body mass index

tions. Tables 4, 5, and 6 illustrate the time contrasts for the corresponding main effect models. None of the global tests for time effect and of the between-subject factors (dietary counselling, number of FA, and cow's milk allergy) showed a statistical significance. Thus, it can be inferred that these factors did not exert discernible impact on z-scores during the study.

## Discussion

This study presents the first comprehensive assessment of growth patterns in children with IgE-mediated FA in Switzerland, spanning from the time of diagnosis to the 12-month follow-up. Our investigation revealed that the study population comprised well-nourished children with normal growth, as evidenced by stable median z-scores and a low prevalence of malnutrition (and overweight). Nevertheless, it is important to note an increase in the number of children with wasting during the 1-year observation period. Employing linear mixed models, we conducted throughout analysis for each z-score, considering the timepoint of measurement and between-subject factors, namely dietary counselling, number of FA and cow's milk allergy. Despite the rigorous examination, no significant differences were detected in these factors with regard to z-scores.

Our analyses revealed a relatively high and increasing prevalence of wasting, ranging from 4.7% at diagnosis to 9.8%. Our documented prevalence rate is similar to other studies, which found wasting prevalence in FA children between 3.7% and 10.5% [3, 8, 20]. It cannot be inferred from these studies that the risk of wasting increases after diagnosis, since most of them are cross-sectional studies and they did not report the timepoint of taking anthropometric measurements. But considering the global and regional low prevalence estimation of United Nations Children's Fund (UNICEF)—the prevalence of wasting in children under five in east Europe is 1.9% and in high income countries 0.4% [21]—we recommend focusing on growth parameters to prevent wasting in this young and vulnerable population.

Compared to the high prevalence of wasting we found a very low prevalence of stunting, with zero children stunted at baseline and 12 months, but one at 6 month, while UNICEF estimates for Europe a higher prevalence of 4.5% in the general population, and lower prevalence of 2.3% in western Europe [21]. Other studies report in contrast to our results a higher prevalence of stunting, ranging from 5.3% to 11.5% [3, 8, 20, 22]. Stunting indicates a child received inadequate nutrients to support normal growth over a long period, maybe this is observed in a later stage of disease duration [17].

The present study identified only a small number of children with overweight, which decreased from 4.3% to 2.1% over the 1-year study period. Other studies investigating children with FA have reported similar rates of overweight, ranging from 1.4% to 8% [8, 20, 23, 24]. However, the overweight rate in our cohort was at the lower end of the range, which might be explained by the young age of the children in our study, with a median age of 16 months. The prevalence of overweight in children under 5 years is estimated to be around 3.1% in the neighboring country of Germany, which is similar to our cohort [25]. A recent study from New Zealand found that overweight rates rise from 1% at 6 weeks to over 9% at 27 months, showing that overweight rates increase with the age of the child [26]. Although the prevalence rates of overweight in children with FA are relatively low in our cohort, this might increase with age and should be considered and included in treatment if appropriate.

No statistically significant differences in growth z-scores were observed between children with cow's milk allergy and those without. However, a trend towards lower median z-scores was noted. It is important to acknowledge the limited sample of cow's milk allergic children ($n = 13$), which may have impacted the ability to detect between-group differences. This finding contrasts with existing research indicating a heightened risk of growth issues in children with cow's milk allergy [9, 10, 23, 27]. Notably, almost all children with cow's milk allergy, except one, received dietary counselling, potentially contributing to their favorable nutritional status. Furthermore, it can be assumed that all children with cow's milk allergy in Switzerland have access to appropriate milk substitutes, which was not the case in the Brazilian study [10]. Moreover, the age of the children might be a contributing factor, given that other studies suggest that growth issues in children with persistent cow's milk allergy tend to emerge later in their development [9, 27]. For instance, Mehta et al. (2014) observed no significant differences in growth impairment under the age of 2 years, while disparities were detected in children aged 2–5 years. The authors hypothesized that milk is effectively replaced with milk substitutes or breast milk during the initial 2 years, but older children might lack suitable alternative nutrient sources. However, a longer follow-up period is necessary to comprehensively explore this potential effect, ideally considering the impact of extended dietary counselling as milk substitutes or breast milk are phased out. Although our study did not confirm a significant association of impaired growth in children with cow's milk allergy, they should receive dietary counselling and frequent monitoring of anthropometric data.

In this study, no significant association was observed between having three or more FA and impaired growth over the 1-year period following diagnosis, despite of observing lower median z-scores compared to the rest of the cohort. Regarding the influence of the number of FA on growth, the results of other studies are diverse. A systematic review conducted by Sova et al. [7] revealed that, in five out of six studies examining growth in children with multiple IgE-mediated FA, growth remained within normal limits as defined by WHO. Nevertheless, three of the studies indicated that children with multiple FA were shorter compared those with only a single FA [7]. Whereas Meyer et al. [20] (2014) found an impact of multiple FA on weight-for-age in a UK survey, no association was found in the international survey by Meyer et al. (2018) [23]. They suggest that receiving additional support explains the good nutritional status in children with multiple FA [20]. Also, in the ERNA cohort a relatively high percentage (85%) of children with multiple FA (≥3) received dietary counselling compared to 49% in the group with one or two FA. This might have influenced the results.

We also found no significant impact of dietary counselling on growth parameters during the first year following the diagnosis of IgE-mediated FA. This finding stands in contrast to the outcomes of an Italian study conducted by Berni Canani et al., in which they documented significant improvement in the nutritional status of children with FA compared to a healthy control group with a similar age range (mean age of 18.9 months compared to this study's median age of 16 months) [28]. These observed disparities could partially be attributed to the higher baseline prevalence of malnutrition within the participants in the Italian study, with around 20% of children experiencing wasting at the start of the research compared to 4.4% in our cohort. This variance may be explained by the elevated occurrence (88%) of children with cow's milk allergy in the Italian cohort, as opposed to 27% in the ERNA cohort. As previously indicated, children with cow's milk allergy appear to be at a particularly high risk of malnutrition [23]. Moreover, unlike the ERNA study, the Italian study likely included children with non-IgE-mediated FA as well, a subgroup recognized by Meyer et al. to be also more predisposed to malnutrition [23]. Furthermore, the children in the Italian study adhered to an elimination diet for a minimum of 60 days without any dietary counselling prior to their participation, conceivably contributing to their relatively inferior nutritional statuses at baseline. Conversely, in our investigation, all but one child with cow's milk allergy received dietary counselling, which was initiated shortly after diagnosis. This might have further contributed to the different baseline situation. Consequently, this study underscores the complexity of dietary counselling's influence on nutritional outcomes in children FA, warranting further exploration and consideration of diverse contributing factors.

We employed WHO z-scores as indicators of nutritional status, a practice that facilitates international cross-comparison. Moreover, the Swiss Society of Pediatrics presently endorses the utilization of WHO growth charts [29]. Nonetheless, an ongoing discourse questions whether these growth charts accurately capture the growth patterns of Swiss children. A 2019 study by Eiholzer et al. involving 30,149 girls and boys aged 0–20 found that while Swiss children are taller from the second year to adulthood compared to the WHO sample, their weight and BMI median percentiles remain similar [30]. While this divergence may not notably impact the outcomes of this relatively young cohort, it is prudent to contemplate the use of nationally derived z-scores for comparison in the future, as these might more faithfully reflect the Swiss context.

It is essential to recognize that accurate measurement of length/height of children below the age of two can be particularly challenging and this might explain some of the implausible z-scores seen in Fig. 1 [16]. This is especially relevant in a young cohort, such as that of the present study. It underscores the significance of additional clinical appointments for standardized measurement. This was not done in the ERNA study to minimize the burden on patients and it was outside the financial scope of the study; furthermore, the anthropometric data were not the primary endpoint of the study [23]. In addition, the small sample size, especially in the subgroup with cow's milk FA, emerges as a further constraint. This limitation is rooted in the context of recruitment challenges encountered during the course recruitment for the ERNA, a circumstance compounded by the disruptive influence of the coronavirus disease 2019 (COVID-19) pandemic on research endeavors.

The strengths inherent in this presented analysis are primarily rooted in the use of long-term data initially collected at the time of diagnosis of FA. Furthermore, the drop-out rate of 6.1% over 1 year was relatively low [14]. This approach directly addresses the need for accurate information about the effect of FAs on growth over the initial year following diagnosis.

## Conclusion

Our findings suggest that children with IgE-mediated FA can have normal growth when those with cow's milk or multiple allergies receive dietary counselling. Timing counselling for particular stages, like transitioning from infant formula, could be advantageous for mitigating the elevated risk of wasting. In general, it is essential that routine length and weight measurements are taken to identify individual malnutrition in this vulnerable group of patients and to initiate tailored nutritional interventions.

Furthermore, there exists a need for prospective investigations that longitudinally track growth patterns beyond the initial year following the diagnosis of FAs. These extended studies should encompass larger participant groups, enabling the discernment of growth-influencing factors in a more nuanced manner. This comprehensive approach will consequently facilitate the development of targeted interventions tailored to specific growth challenges.

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