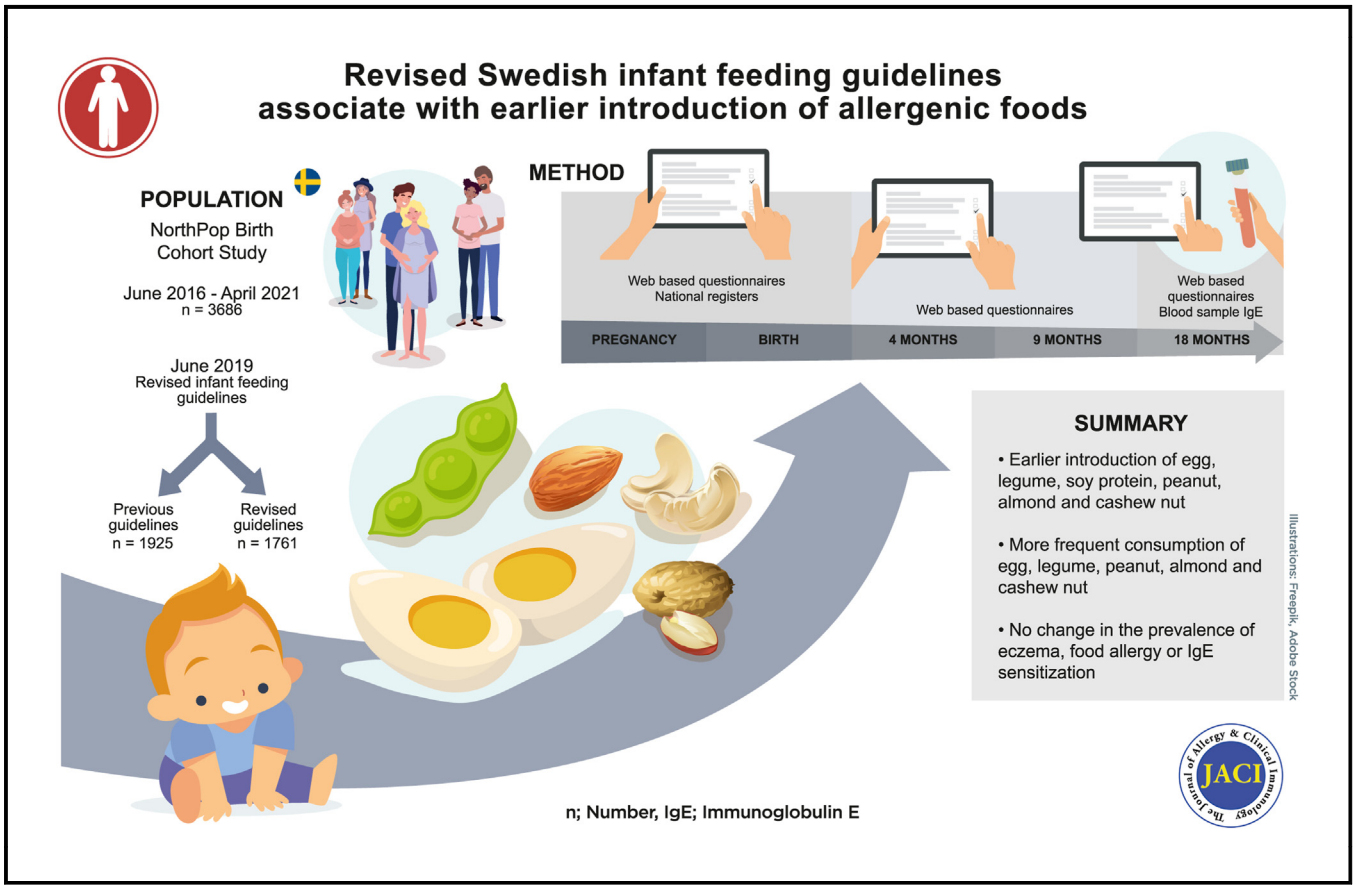
Revised Swedish infant feeding guidelines are associated with earlier introduction of allergenic foods

Jonas Österlund, MD, Gabriel Granåsen, PhD, Stina Bodén, RD, PhD, Sven Arne Silfverdal, MD, PhD, Magnus Domellöf, MD, PhD, Anna Winberg, MD, PhD, et al

GRAPHICAL ABSTRACT



Capsule summary: Revised infant feeding guidelines were associated with earlier introduction of egg, legume, soy, peanut, almond, and cashew nut. There was no change in the prevalence of eczema or FA up to age 18 months.

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Revised Swedish infant feeding guidelines are associated with earlier introduction of allergenic foods

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Background: Randomized controlled trials have demonstrated that early introduction of allergenic foods, such as peanut and egg, can reduce food allergy in high-risk children. Many international guidelines recommend introduction of allergenic foods in the first year of life, and accordingly, the Swedish National Food agency released updated guidelines in June 2019.
Objective: Our aim was to examine whether the age at introduction and consumption frequency of allergenic foods have changed since release of the revised national guidelines on the introduction of solid foods in Sweden.
Methods: Children born between June 2016 and December 2018 (n = 1925) were compared with children born between June 2019 and April 2021 (n = 1761) by using data from the NorthPop Birth Cohort study. Data on food introduction, eczema, and food allergy were prospectively collected until age 18 months by using web-based questionnaires. IgE sensitization was assessed at 18 age months.
Results: The proportion of participants who had been introduced to egg, legume, soy products, peanut, almond, and cashew nut during the first year of life increased after implementation of the revised national guidelines. The most significant changes were seen for legume (from 55.2% to 69.8% [adjusted odds ratio = 1.90 (95% CI = 1.62-2.24)] and peanut (from 29.2% to 43.2% adjusted odds ratio = 1.87 (95% CI = 1.55-2.24)]); consumption frequency had also increased. No differences in the prevalence of eczema, food allergy, or sensitization to the foods of interest were found.
Conclusion: Since release of the revised guidelines, infants in the general population are introduced to and consume a variety of allergenic foods earlier and more frequently; however, early manifestations of allergic disease have remained unchanged. (J Allergy Clin Immunol 2023;■■■:■■■-■■■.)

Key words: *Food introduction, food allergy, weaning, infants, solid foods, complementary feeding, guidelines, NorthPop*

Abbreviations used
aOR: Adjusted odds ratio
FA: Food allergy
FFQ: Food frequency questionnaire
OR: Odds ratio
RCT: Randomized controlled trial

The prevalence of food allergy (FA) among children is high and imposes a growing societal burden.[1,2] Early introduction of potentially allergenic foods has been one of the most promising FA prevention strategies in randomized controlled trials (RCTs). Egg and peanut are the foods with the strongest association between early introduction and lower FA risk for the respective food.[3-6] On the basis of evidence from observational studies and RCTs, infant feeding guidelines have been revised in some regions and now state that postponing the introduction of allergenic foods beyond age 4 to 6 months is not necessary; however, the majority do not recommend active introduction of specific foods as a prevention strategy for FA.[7-9] This stands in contrast to the earliest guidelines, which recommended complete avoidance of allergenic foods until at least age 1 year.[10]

Studies of infant feeding practices over time in relation to the revised guidelines are still sparse.[11] In 2016, the Australian infant feeding guidelines were updated, stating that all infants independent of allergy risk should be given allergenic solid foods during the first year of life.[8] In a cross-sectional study from 2018 that used the same sampling frame as used in the HealthNuts cohort, a significant change was observed with earlier introduction of peanut and egg.[12]

The Swedish National Food Agency released revised infant feeding guidelines in June 2019; the revised guidelines stated that the underlying evidence for early introduction of allergenic foods as a prevention strategy for allergy in the general population in Sweden was still insufficient. The nutritional benefits of a diet rich in legumes, fish, and nuts are well described, however, and the expert group assessed that, independent of allergic risk factors, milk, egg, nuts, legume, and fish are adequate constituents in the infant diet and should be introduced during the first year of life.[13] The previous guidelines from 2011 stated that all types of food could be introduced during the first year of life regardless of allergic heredity and without increased risk of development of FA.[14] The revised guidelines from 2019, however, emphasized that legume, peanut, and tree nuts also should be a part of the infant diet.[13] The infant feeding guidelines were communicated by staff at Child Health Services, which cover more than 99% of Swedish infants.[15]

In this study, we examined whether the age at introduction and consumption frequency of a large variety of allergenic foods changed after the revision of the Swedish infant feeding guidelines. We also studied the prevalence of eczema, FA, and food sensitization in relation to the revised guidelines.

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METHODS

Design and outcome

We used data from the NorthPop Birth Cohort Study[16] with the natural intervention of the implementation of revised national guidelines on the introduction of foods in infancy during the data collection process. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

The primary outcomes were introduction of egg, fish, legume, soy products, peanut, almond, cashew nut, hazelnut, walnut, and Brazil nut by age 9 to 11 months. Data on introduction by 4 and 6 months are also presented. The secondary outcomes were the consumption frequency of egg, fish, legume, peanut, almond, cashew nut, hazelnut, walnut, and Brazil nut during the month preceding completion of the 9-month questionnaire. There was no change in the guidelines regarding introduction of dairy products, and in a sensitivity analysis we analyzed age at introduction and consumption frequency of dairy products according to the revised guidelines on peanuts, nuts, and legumes.

We also present data on food sensitization and the self-reported prevalence of eczema and physician-diagnosed FA at ages 4, 9, and 18 months with 2-sample comparisons.

Sample size

The 2 groups were based on date of birth. Infants born between June 2016 and December 2018 constituted the previous guidelines group (n = 1925), and infants born between June 2019 and April 2021 comprised the revised guidelines group (n = 1761). The size of the previous guidelines group was fixed on account of the start of the NorthPop Birth Cohort Study in May 2016 and national implementation of the revised guidelines in June 2019. Calculations for the estimated sample size for the revised guidelines group was performed before data withdrawal. The size of the revised guidelines group provides an 80% power to detect a 7.5% change in the primary outcome for all foods of interest and a 5% change in the primary outcome for all nuts at a significance level of .05.

Infants born during a transition period of 5 months (January 2019-May 2019) were excluded because we hypothesized that the revised guidelines were not implemented instantly and that the parents of infants born during this time were likely to have received both guidelines.

Study population

The NorthPop Birth Cohort Study is a large longitudinal population-based birth cohort in Västerbotten county, Sweden. Eligible families are recruited at the time of the routine ultrasound examination at gestational week 17 to 20. The inclusion criteria were a viable pregnancy at gestational weeks 14 to 24 and pregnant woman aged 18 years or older who comprehended the Swedish language, and the family living in Västerbotten county, and was planning to do so in the forthcoming years.[16] For this study, only data from families living in the larger Umeå area were used because recruitment from other parts of Västerbotten started in 2019. Fig 1 depicts the enrollment of the 2 groups.

Data collection

Web-based questionnaires (available in the Online Repository at www.jacionline.org) with questions on country of birth, family situation, education, work, diet, and medical history were sent to the pregnant woman and her partner at the time of enrollment and at gestational week 26. Data on parental age at gestation, infant sex, gestational age, delivery mode, and neonatal care were obtained from the Swedish Pregnancy Register[17] and the Swedish Neonatal Quality Register.[18]

Questionnaires with questions on age at introduction of specific foods, breast-feeding, formula feeding, adverse reactions to foods, presence of eczema, and physician-diagnosed FA were administered when the infant was aged 4, 9, and 18 months (see the questionnaires in the Online Repository). A Patient-Oriented Eczema Measure score[19,20] was obtained from infants with parent-reported eczema. Family history of eczema, FA, and asthma were defined as parent-reported disease in the mother, her partner, and/or the child's siblings.

A food was considered introduced to the infant's diet if the parents responded yes to the question "Has your child tasted …?" in the 4-month questionnaire and/or if the parents had responded with age at introduction to the question "At what age did your child first taste …?" in the 9-month questionnaire. The reported age intervals were 0 to 3 months, 4 to 6 months, and 7 months or older. The amount or form (raw, baked, or cooked) were not reported. Questions on introduction of soy milk, soy yogurt, and soy-based products such as tofu and soy mince were grouped as soy products. Full-fat milk, semi-skimmed milk, skimmed milk, sour milk, and yogurt were grouped as dairy products. Food frequency questionnaire (FFQ) data for beans, chickpeas, lentils, and hummus were grouped into the category legume. No FFQ data were available for soy products.

When the infant was 9 months old, an FFQ was filled in by the parents; they were able to complete the FFQ until the infant was 11 months old. The total FFQ consisted of 55 food items, and the frequency of consumption was reported as never, 1 to 3 times per month, 1 to 3 times per week, 4 to 6 times per week, 1 to 3 times per day, and 4 to 6 times per day. For the statistical analysis, the frequencies were merged as daily, weekly, monthly, or never.

At age 18 months, all infants in the cohort were invited to a blood sampling for analysis of levels of IgE to common food allergens (Food Mix fx5 [cow's milk, egg white, wheat, cod, and peanut and soybean]) by using ImmunoCAP (Thermo Fisher Scientific/Phadia, Uppsala, Sweden) according to the manufacturer's instructions. An IgE level of 0.35 kU/L or higher was considered positive, and analyses for the specific IgE levels of the included allergens were conducted. The same cutoff level was used for the food-specific analyses.

Statistical analysis

Binary measures were reported as observed proportions. Two-sample comparisons of categoric data between the groups were assessed with the Pearson chi-square test or Fisher exact test, as applicable. Continuous data were reported as medians with interquartile ranges, and differences between the groups were assessed with an independent-sample *t* test.

The primary outcomes were analyzed by using simple and multivariable logistic regression with results expressed as odds ratios (ORs) and adjusted ORs (aORs). Relevant confounders were identified from previous studies,[21-25] hypothesized *a priori*, and visualized in a directed acyclic graph.[26] For the total effect, the following factors and covariates were included in the adjusted model: heredity for FA (yes/no), maternal country of birth

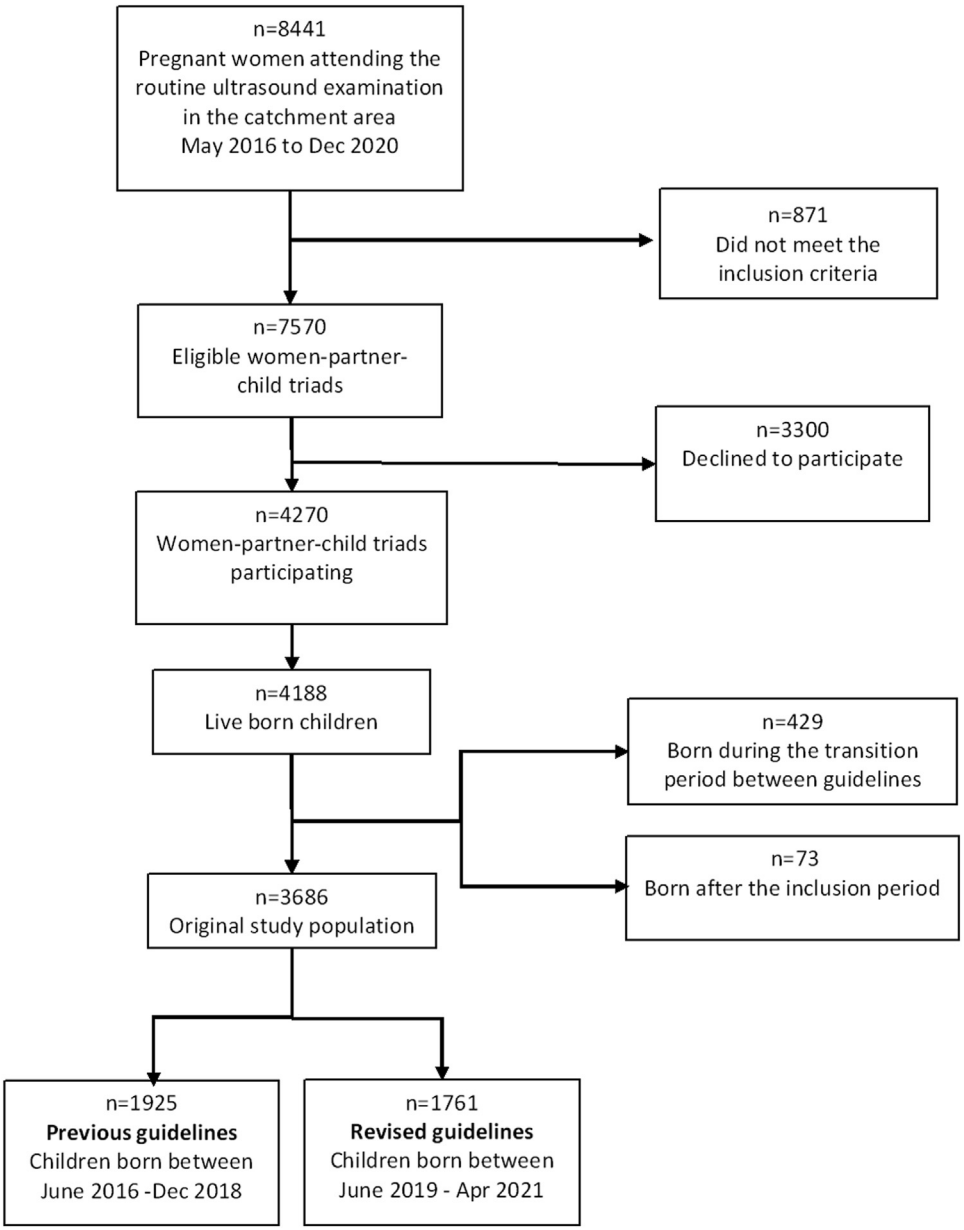

FIG 1. Flowchart of the inclusion of the study population from the NorthPop Birth Cohort Study and division of the 2 study groups according to previous and revised guidelines.

(Sweden/other country), maternal education level (elementary school/high school/university), siblings/children in the household (yes/no), history of adverse reactions to food at age 9 months (yes/no), eczema at age 9 months (yes/no), history of wheeze at age 9 months (yes/no), and gestational age in weeks (see Fig E1 in the Online Repository at www.jacionline.org). No adjusted analyses of the introduction of Brazil nut and walnut by age 6 months were conducted owing to the low number of events per variable. The secondary outcomes were analyzed by using ordinal logistic regression and expressed as ORs adjusted with the same confounders as for the primary outcomes (see Fig E2 in the Online Repository at www.jacionline.org).

To handle missing values, we applied multiple imputation using multivariate imputation by chained equations (MICE) using the mice package version 3.15.0[27] with 15 imputations and 10 iterations. Both the crude and adjusted regression models were estimated on the basis of the imputed data. The imputation model included the outcome variables as well as the set of independent variables.

Statistical analysis was conducted using IBM SPSS Statistics, version 28.0 (IBM Corp, Armonk, NY) and R 4.2.2 (R Core Team, Vienna, Austria). A P value less than .05 was considered statistically significant.

Ethics

Ethical permission was granted by the regional Ethical Committee in Umeå, Sweden (2016/349-31 and 2018/504-32). All parents were informed both verbally and in writing, and informed consent was collected from both parents.

TABLE I. Characteristics of the study population and missing values by variable and group

Characteristic	Previous guidelines	Revised guidelines	Missing previous guidelines, no. (%)	Missing revised guidelines, no. (%)
Participants, no. (%)	1925 (100)	1761 (100)	0 (0)	0 (0)
Boys, no. (%)	1001 (52.0)	913 (51.8)	0 (0)	0 (0)
Gestational wk, median (IQR)	39 (2)	39 (2)	2 (0.1)	4 (0.2)
Prematurity (<37 wk), no. (%)	114 (5.9)	92 (5.2)	2 (0.1)	4 (0.2)
Caesarean section, no. (%)	326 (17.0)	345 (19.6)	2 (0.1)	4 (0.2
Birthweight (g), median (IQR)	3535 (658)	3540 (660)	0 (0)	2 (0.1)
Neonatal care, no. (%)	217 (11.3)	189 (10.7)	0 (0)	0 (0)
Maternal age (y), median (IQR)	31 (6)	31 (6)	0 (0)	328 (18.6)
Partner age (y), median (IQR)	33 (8)	33 (7)	27 (1.4)	30 (1.7)
Presence of other children in the household, no. (%)	604 (39.3)	534 (39.1)	388 (20.2)	396 (22.5)
Parent born in Sweden, no. (%)				
Mother	1655 (90.6)	1497 (89.3)	98 (5.1)	84 (4.8)
Mother's partner	1509 (91.9)	1311 (90.2)	283 (14.7)	307 (17.4)
Highest educational level of mother, no. (%)			100 (5.2)	85 (4.8)
University	1260 (69.0)	1177 (70.2)		
High school	504 (27.6)	445 (26.6)		
≤Elementary school	61 (3.3)	54 (3.2)		
Highest educational level of mother's partner, no. (%)			289 (15.0)	312 (17.7)
University	867 (53.0)	783 (54.0)		
High school	731 (44.7)	624 (43.1)		
≤Elementary school	38 (2.3)	42 (2.9)		
Heredity, no. (%)			358 (18.6)	384 (21.8)
Family history of eczema	428 (27.3)	345 (25.1)		
Family history of food allergy	441 (28.1)	372 (27.0)		
Family history of asthma	520 (33.2)	467 (33.9)		
Family history of pollen allergy	769 (49.1)	671 (48.7)		
Breast-feeding, no. (%)				
Exclusively at age 4 mo	1051 (69.1)	959 (67.0)	405 (21.0)	330 (18.7)
In some form at age 4 mo	1297 (85.3)	1182 (82.6)	405 (21.0)	330 (18.7)
In some form at age 9 mo	570 (38.4)	580 (43.6)	441 (22.9)	431 (24.5)

IQR, Interquartile range.

TABLE II. Introduction of solid foods by age 9 to 11 months and comparison between the 2 time periods in relation to the revised guidelines

Food introduced by age 9-11 mo, no. (%)	Previous guidelines*	Revised guidelines†	*P* value	OR (95% CI)	aOR (95% CI)
Egg	1173 (82.3)	1149 (88.7)	**<.001**	**1.65 (1.33-2.04)**	**1.66 (1.34-2.06)**
Fish	1369 (96.1)	1247 (96.3)	.762	1.05 (0.73-1.52)	1.06 (0.73-1.54)
Legume	545 (55.2)	904 (69.8)	**<.001**	**1.92 (1.64-2.24)**	**1.90 (1.62-2.24)**
Soy products	192 (19.5)	311 (24.0)	**.009**	**1.33 (1.05-1.69)**	**1.31 (1.03-1.67)**
Peanut	416 (29.2)	560 (43.2)	**<.001**	**1.86 (1.55-2.23)**	**1.87 (1.55-2.24)**
Almond	167 (11.7)	203 (15.7)	**.003**	**1.42 (1.13-1.79)**	**1.40 (1.11-1.76)**
Cashew nut	133 (9.3)	151 (11.7)	**.047**	**1.32 (1.03-1.69)**	**1.32 (1.03-1.70)**
Hazelnut	89 (6.2)	91 (7.0)	.413	1.19 (0.86-1.65)	1.15 (0.82-1.60)
Walnut	79 (5.5)	97 (7.5)	**.039**	**1.44 (1.03-1.99)**	1.39 (0.99-1.95)
Brazil nut	18 (1.3)	13 (1.0)	.525	0.88 (0.42-1.87)	N/A
Dairy products	1022 (71.7)	927 (71.6)	.937	0.99 (0.84-1.17)	0.99 (0.83-1.18)

Statistically significant differences set in bold. *P* value for the Pearson chi-square test. ORs for comparison using logistic regression between the revised guidelines and the previous guidelines. Multiple imputation of missing values. Adjustment for heredity of FA; maternal country of birth; maternal education level; presence of other children in the household; gestational age in weeks; and at a 9-month history of adverse reactions to food, eczema, and wheeze.

N/A, Not applicable.

*Missing data for age of introduction for dairy products, egg, fish, peanut, almond, cashew nut, hazelnut, walnut and Brazil nut (n = 500 [26.0%]) and for soy products and legume (n = 938 [48.7%]) based on the question first added to the questionnaire in March 2018.

†Missing data for all foods (n = 466 [26.5%]).

RESULTS

Study population characteristics

We included 3686 infants, who were divided into 2 groups according to the current infant feeding guideline at their birth. Demographic characteristics are presented in Table I. There were no statistically significant differences between the groups from the standpoints of sex, gestational age, prematurity, birthweight, neonatal care, parental age, parental country of birth, parental education level, or parental smoking. The proportion of infants delivered by caesarean section was higher in the revised

TABLE III. Introduction of solid food by age 4 months and 2-sample comparison between the 2 time periods in relation to the revised guidelines

Food introduced	No.*	Percentage (95% CI)	No.†	Percentage (95% CI)	*P* value
Egg	20	1.3 (0.8-2.0)	17	1.2 (0.7-1.9)	.751
Fish	16	1.1 (0.6-1.7)	15	1.0 (0.6-1.7)	.986
Vegetable	33	2.2 (2.5-3.0)	48	3.4 (2.5-4.4)	.050
Peanut	11	0.7 (0.4-1.3)	9	0.6 (0.3-1.2)	.751
Almond	1	0.1 (0.0-0.4)	2	0.1 (0.0-0.5)	.614
Nuts	1	0.1 (0.0-0.4)	1	0.1 (0-0.4)	1.000
Potato	92	6.1 (4.9-7.4)	91	6.4 (5.2-7.8)	.740
Root vegetable	58	3.8 (2.9-4.9)	59	4.1 (3.2-4.3)	.677
Fruit/berry	151	10 (8.5-11.6)	164	11.5 (9.9-13.2)	.186
Yogurt, sour milk, cream	92	6.1 (4.9-7.4)	80	5.6 (4.5-6.9)	.583
Ice cream	23	1.5 (1.0-2.3)	18	1.3 (0.7-2.0)	.550
Meat/meat product	12	0.8 (0.4-1.4)	17	1.2 (0.7-1.9)	.275
Bread/biscuit	30	2.0 (1.3-2.8)	18	1.3 (0.7-2.0)	.123
Porridge	60	4.0 (2.0-5.1)	46	3.2 (2.4-4.3)	.280
Any of the aforementioned	247	16.3 (14.5-18.2)	229	16.0 (14.1-18.0)	.837

No adjustment for confounders.
*Missing data for the previous guidelines group (n = 408 [21.2%]).
†Missing data for the revised guidelines group (n = 300 [18.7%]).

guidelines group (19.6 vs 17.6% [$P = .035$]), which is consistent with the national and local trend.[17] The proportion of infants partially breast-fed at age 4 months was significantly lower (82.6% vs 85.3% [$P = .043$]) in the revised guidelines group; however, it was higher (43.6% vs 38.4% [$P = .005$]) for those in the revised guidelines group who were breast-fed 9 months. We found no differences between the 2 groups in terms of proportion of exclusively breast-fed infants at age 4 months.

Primary outcome

Introduction by age 9 to 11 months. A higher proportion of infants had been introduced to egg, legume, soy products, peanut, almond, cashew nut, and walnut in their diet in the revised guidelines group (Table II). The largest increase was seen for legume, with 69.8% of infants in the revised guidelines group introduced to legume by age 9 to 11 months compared with 55.2% in the previous guidelines group (aOR = 1.90 [95% CI = 1.62-2.24]), followed by peanut (43.2% vs 29.2% [aOR = 1.87 (95% CI: 1.55-2.24)]). In the simple logistic regression model, the introduction of walnut was also statistically significantly associated with the revised guidelines. The proportion of infants who had been introduced to dairy products was similar across these 2 time periods.

Introduction by 4 months. There were no differences regarding the introduction of foods by 4 age months according to data from the 4-month questionnaire (Table III). Solid foods had been introduced to 16% of the infants in both groups. Fruit/berry, potato, and dairy products were the most common foods to be introduced, with no statistical differences between the 2 groups.

Introduction in the first 6 months. Infants introduced to the foods of interest in the first 6 months of life followed a pattern similar to that for introduction by 9 to 11 months (see Table E1 in the Online Repository at www.jacionline.org) according to data from the 9-month questionnaire. The proportion of infants introduced to egg, legume, soy protein, peanut, almond, and cashew nut was higher in the revised guidelines group. In the adjusted model, the results were significant for egg, legume, soy protein, peanut, almond, and cashew nut, with the largest effect estimate between the revised guidelines and early peanut introduction (aOR = 1.84 [95% CI = 1.55-2.17]).

Secondary outcomes

Consumption frequency of allergenic foods. At age 9 months, the consumption frequency of egg, legume, peanut, cashew nut, and almond (Fig 2) had increased in the revised guidelines group, with the largest effect estimate for peanut (aOR = 1.73 [95% CI = 1.47-2.04]). Without adjustment for confounders, the associations between consumption frequency and revised guidelines were similar for the aforementioned foods (see Table E2 in the Online Repository at www.jacionline.org). In the revised guidelines group, 48.4% and 9.1% of the infants, respectively, were eating egg and peanut on a daily or weekly basis compared with 40.3% and 4.1%, respectively, in the previous guidelines group (see Table E2).

Eczema, FA, and food sensitization. The prevalence of physician-diagnosed FA and symptoms elicited by food at ages 9 and 18 months were similar between the groups. IgE levels were available for 991 children in the previous guidelines group (51.5%) and 930 in the revised guidelines group (52.8%). The prevalence of sensitization to Food Mix fx5 (Table IV) was significantly higher among the children in the revised guidelines group. No differences in the prevalence of IgE sensitization to the foods of interest (egg, cod, soybean, and peanut) in this study were found; however, a trend toward higher prevalence of sensitization to soybean and peanut was seen. *Post hoc* testing indicated that the group size was insufficient to reach statistical significance (data not shown). There were no statistically significant differences in 2-sample comparisons between the 2 groups regarding the prevalence of eczema at ages 4, 9, and 18 months (Table IV). Eczema severity based on Patient-Oriented Eczema Measure score was also similar between the groups at these ages (data not shown).

DISCUSSION

To our knowledge, this is the first study in a European setting describing the population response to revised national guidelines

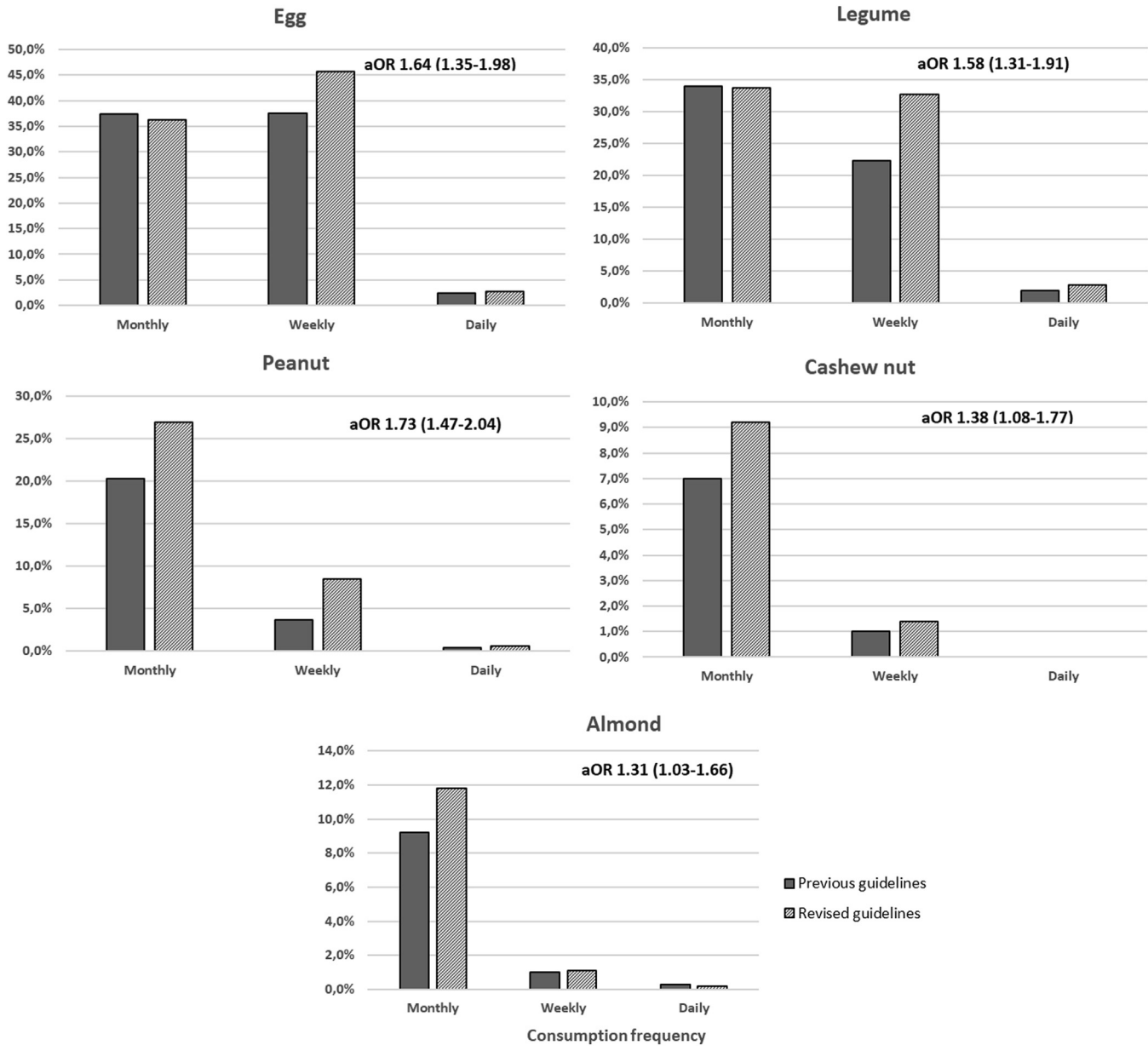

FIG 2. Consumption frequency at age 9 months according to the previous and revised infant feeding guidelines. aOR for an ordinal logistic regression model with multiple imputation of missing values is shown. The option never is included in the model but not shown. Adjustment for heredity of FA; maternal country of birth; maternal education level; presence of other children in the household; gestational age in weeks; and history of adverse reactions to food, eczema, and wheeze at 9 months, respectively.

on the introduction of complementary foods. We found a significant and robust association between the time periods for the revised guidelines and an earlier and more frequent consumption of egg, legume, soy products, peanut, almond, and cashew nut during the first year of life. The revised guidelines, however, were not associated with any change in the prevalence of FA, food-induced symptoms, or eczema in the general population.

The proportion of infants who had been introduced to peanut by age 9 to 11 months increased from 29.2% in the previous guidelines group to 43.2% in the revised guidelines group. Compared with the shift found in the Australian HealthNuts and EarlyNuts studies, this shift was smaller. In the HealthNuts study, 28.4% of those studied had been introduced to peanut before age 12 months, and in the EarlyNuts study with data collection after the update of infant feeding guidelines, the corresponding number was 88.6% at age 12 months.[12] A plausible explanation is the more moderate changes in the Swedish guidelines than in the Australian guidelines, which actively recommend introduction of egg and peanut before 12 months to all infants as a FA prevention measure,[28] whereas the Swedish guidelines do not include any such recommendation. The difference might also be explained by the very high prevalence of FA among Australian infants,[29] which could increase compliance with revised guidelines. Peanut is not considered a

TABLE IV. Prevalence of physician-diagnosed FA, any food induced symptoms, self-reported eczema, and Immunoglobulin E (IgE) sensitization at ages 4, 9, and 18 months

Allergic diseases of child	Previous guidelines	Missing	Revised guidelines	Missing	*P* value
Physician-diagnosed FA, no. (%)					
Any FA at age 9 mo	42 (2.9)	487 (25.3)	42 (3.1))	415 (23.6)	.758
Milk allergy at age 9 mo	42 (2.9)		37 (2.7)		.274
Egg allergy at age 9 mo	4 (0.3)		8 (0.6)		.203
Peanut allergy at age 9 mo	0 (0)		0 (0)		N/A
Soy protein allergy at age 9 mo	3 (0.2)		1 (0.1)		.617
Tree nut allergy at age 9 mo	0 (0)		0 (0)		N/A
Any FA at age 18 mo	55 (4.3)	644 (33.5)	52 (5.0)	720 (40.9)	.423
Milk allergy at age 18 mo	40 (3.1)		31 (3.0)		.309
Egg allergy at age 18 mo	22 (2.4)		23 (2.1)		.525
Peanut allergy at age 18 mo	8 (0.6)		5 (0.5)		.493
Soy protein allergy at age 18 mo	3 (0.2)		3 (0.3)		1.000
Tree nut allergy at age 18 mo	2 (0.2)		2 (0.2)		1.000
Self-reported food-induced symptoms, no. (%)					
At age 9 mo	171 (11.9)	487 (25.3)	183 (13.6)	415 (23.6)	.177
At age 18 mo	299 (23.3)	644 (33.5)	243 (23.3)	720 (40.9)	.991
Serology at age 18 mo, no. (%)	991 (51.5)	934 (48.5)	930 (52.8)	831 (47.2)	
Food Mix fx5 ≥ 0.35 kU/L	161 (16.2)		186 (20.0)		**.033**
Egg ≥ 0.35 kU/L*	81 (50.3)		92 (49.5)		.875
Cod ≥ 0.35 kU/L*	3 (1.9)		5 (2.7)		.729
Soybean ≥ 0.35 kU/L*	12 (7.5)		26 (14.0)		.052
Peanut ≥ 0.35 kU/L*	25 (15.5)		44 (23.7)		.059
Self-reported eczema, no. (%)					
At age 4 mo	192 (12.2)	349 (18.1)	191 (13.5)	345 (19.6)	.286
At age 9 mo	322 (22.3)	482 (25.0)	340 (25.2)	414 (23.5)	.069
At age 18 mo	458 (31.2)	459 (23.8)	381 (30.5)	511 (29.0)	.669

Twp-sample comparisons without adjustment for confounders. Statistically significant differences between the 2 groups are set in bold.
*Specific IgE levels were analyzed only if Food Mix fx5 value was 0.35 kU/L or higher.

traditional Nordic food, and in comparison with another Nordic country, a recent survey in Norway reported that 77% of the 1-year-olds had not tried peanut or other nuts,[30] with the corresponding guidelines saying that there is no need for delaying introduction of or avoiding allergens during the first year of life.[31]

By age 6 months, the association between the revised guidelines and earlier introduction followed the same pattern. The proportion of infants who had been introduced to egg during the first 6 months of life increased from 48.8% to 59.0% in our study compared with a more dramatic increase between the HealthNuts study and EarlyNuts study (25.0% vs 57.9%), but the proportion was similar when our revised guidelines group was compared with the EarlyNuts study participants.[12]

For the first time, we also present data on introduction and consumption frequency for a variety of allergenic foods, including fish, soy products, legume, tree nuts, and almond, in relation to infant feeding guidelines. A shift toward earlier and more frequent intake of soy products, legume, almond, and cashew nut was seen. However, the overall results also show that the introduction and consumption of tree nuts and almond before age 1 year are infrequent. In the Irish CORAL birth cohort study, 52% of the infants consumed peanut at least once a week and 87% consumed peanut at least once a month at age 12 months.[32] This is considerably higher than the 9% consuming peanut weekly and 36% consuming peanut at least once a month in the revised guidelines group in our study. During data collection in the CORAL birth cohort study, the families interacted with an allergy-focused research team and were encouraged to continue consuming peanuts, which is likely to explain this marked difference.[32]

The optimal window for introducing allergenic foods has been widely discussed, with most guidelines stating that introduction should not start before age 4 months.[28,33] Recently, introduction of peanut, milk, wheat, and egg from age 3 months in the large Nordic PreventADALL RCT was shown to be safe and to reduce the risk of physician-diagnosed FA at age 3 years.[5] In our study, introduction of solid foods by age 4 months was uncommon, with no significant differences between the 2 groups for any type of food.

The proportion of infants who were exclusively breast-fed at 4 months was similar before and after the implementation of the revised guidelines. The frequencies of partially breast-fed infants differed at both age 4 months and age 9 months, but not in a unidirectional way. There was a lower frequency of partial breast-feeding at 4 months; in contrast, the proportion at 9 months was higher in the revised guidelines group. This is consistent with reports from Australia, where revised guidelines were not associated with a decline in breast-feeding rates.[34]

In our study, the overall prevalence of self-reported physician-diagnosed FA for the foods of interest was low, with no significant differences between the 2 time periods. This is in accordance with the prevalence of challenge-proven peanut allergy among infants in Australia, which has remained unchanged after the implementation of revised guidelines.[35] A possible explanation for this difference is that despite the earlier and more frequent consumption after implementation of revised guidelines, the absolute change was low and the introduction was not at a very early age. In the PreventADALL study, the authors calculated that introduction of allergenic foods from age 3 months in 63 children could prevent 1 case of FA at age 3 years.[5]

A trend toward a higher proportion of specific IgE levels of 0.35 kU/L or higher for peanut and soy protein was noted but did not reach statistical significance at the .05 level. This trend could be explained by the transient elevation of IgE level following introduction.[36]

A major strength of this study is its use of the same population-based birth cohort with the natural intervention of implementation of revised infant feeding guidelines, which minimizes selection bias. Another strength is the study's prospective design and short time interval between questionnaires, which minimizes recall bias. The sample size is sufficient to assess meaningful differences in the introduction and consumption frequency of a wide variety of allergenic foods. We also used a directed acyclic graph to identify potential confounders *a priori*.[26]

Potential limitations are the homogenous population, with a large proportion of university-graduated and Sweden-born parents, which may affect adherence to infant feeding guidelines.[21] Adjustment for educational level and maternal country of birth did not alter the results significantly. Another potential weakness is the fairly large proportion of missing values in both groups. We found it reasonable to assume that the data were missing at random, thus enabling the option of using multiple imputation of data instead of complete-case analysis to reduce the risk of bias.[37] The increased imputed data size also led to an increase in power. The use of physician-diagnosed FA may lead to an underestimation of the true prevalence, but it reduces the risk of detection bias. Food sensitization data were not available for all children, and a previous study in the NorthPop Birth Cohort Study found that a larger proportion attending the blood sampling had mothers with FA and higher educational level than did the nonattenders.[38] The time period for data collection for the revised guidelines group was mostly during the coronavirus disease 2019 (COVID-19) pandemic, and how this may have affected infant feeding practices is still unknown.

In conclusion, since the release of revised guidelines, infants in the general population in Sweden have been consuming a variety of allergenic foods earlier and more frequently than before, albeit more rarely than in other countries. Early manifestations of allergic disease have remained unchanged, and the ongoing follow-up of the NorthPop Birth Cohort study will allow future studies of the population effect on changed infant feeding guidelines. Further work is needed to translate the results from RCTs to practically feasible and effective guidelines at a population level.[6]

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Key messages

- **Revised infant feeding guidelines are associated with an earlier introduction of egg, legume, soy products, peanut, almond, and cashew nut.**
- **Revised infant feeding guidelines are also associated with more frequent consumption of egg, legume, peanut, almond, and cashew nut.**
- **There was no change in the prevalence of eczema, FA, or IgE sensitization to the allergenic foods of interest according to change in infant feeding guidelines.**

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