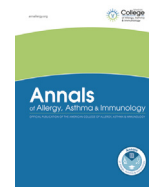




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Parental timing of allergenic food introduction in urban and suburban populations

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ABSTRACT

Background: Recommendations on timing for introduction of allergenic foods in an infant diet have changed twice during the past decade. How families with different demographic characteristics implement the change has not been studied in the United States.

Objective: To compare the age of introduction of allergenic foods between an urban Medicaid-based population and a suburban private insurance–based population in Cincinnati, Ohio.

Methods: Two hundred parent surveys were distributed at well-child checkups between 4 and 36 months of age. Data were analyzed using distribution mapping to determine the difference in the age of introduction of infant formula, infant solids, whole cow's milk, eggs, peanut, and fish. Random forest analysis was used to determine the most important factors affecting the age of introduction for both populations.

Results: There was no statistically significant difference in the age of infant solid introduction, but urban populations introduced allergenic foods earlier than suburban populations, with a statistically significant difference in the age of introduction of infant formula, whole cow's milk, eggs, peanut, and fish. The most important factor for the timing of all food introductions was the recommended age of introduction from health care professionals.

Conclusions: There is a difference between urban and suburban populations in the timing of introduction of allergenic foods but not in other infant solid foods. The reliance on physician recommendation for both populations supports the need for education and guidance to health care professionals on up-to-date guidance and recommendations.

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Introduction

The introduction of solid foods to an infant is an important pediatric milestone. Although there are recommendations for the introduction of an infant's first solid food, there are no concrete recommendations for the introduction of allergenic foods, namely, egg, cow's milk, peanut, and fish. In 2000, citing concerns about the increasing rate of food allergies in the United States, the American Academy of Pediatrics (AAP) recommended that the introduction of allergenic foods be delayed as follows: introduction of cow's milk until 1 year of age, eggs until 2 years of age, and peanuts and fish until 3 years of age.¹ In 2008, the AAP altered its recommendations

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stating that solids should be introduced at 4 to 6 months of age but provided no specific schedule for introduction of common allergenic foods, citing a paucity of data to suggest that delayed introduction reduced the rates of food allergy.² In 2010, the National Institute of Allergy and Infectious Diseases–sponsored Expert Panel report agreed with these findings and recommended the introduction of solid foods between 4 and 6 months of age and the introduction of allergenic foods at any time afterward.³ At that time, health care professionals and the US population did not have clear direction on the timing of allergenic food introduction. Although subsequent recommendations have been published since then, the issue of how the families responded to the 2010 recommendations was not studied.^{4–6}

McKean et al⁷ reported on the timing of introduction of solid foods and allergenic foods in a population of infants with a family history of atopy, who were thus at higher risk for atopic disease.

However, there are no available reported data regarding the timing of introduction of allergenic foods in a general pediatric population. In addition, prior studies have found socioeconomic differences in food introduction. Although these studies discuss the socioeconomic implications, such as enrollment in the government Women, Infants, and Children (WIC) program, the effect on allergenic food introduction has not been specifically addressed.^{8,9}

In this study, we collected data regarding food introduction by caregiver report in 2 separate populations: an urban Medicaid-based population affiliated with Cincinnati Children's Hospital Medical Center (CCHMC) and a suburban private insurance–based population in Montgomery, Ohio, a suburb located 14 miles outside Cincinnati, Ohio. The goal was to determine the timing of introduction of allergenic foods and whether there was a difference between urban and suburban populations. The primary aim was to analyze general pediatric allergenic food introduction with evaluation of timing differences between the populations, hypothesizing that urban caregivers would introduce foods at an earlier age as has been previously reported with nonallergenic foods.^{8,9} The secondary aim was to determine which factors, including maternal age, number of children, patient and family histories of atopic diseases, and recommendations by health care professionals, were considered most important in determining the age of allergenic food introduction.

Methods

Study design

Three clinical sites were used for patient recruitment: Montgomery Pediatrics in Cincinnati, Ohio, representing the suburban population, and Hopple Street Health Center and the Pediatric Primary Care Center, both urban academic pediatric clinics affiliated with CCHMC. Hopple Street Health Center and the Pediatric Primary Care Center were considered together as the urban population. Caregivers of children at their 4-month to 3-year well-child checkups (WCCs) were enrolled. Data were deidentified and collected at one WCC with no longitudinal data collection or follow-up. The study was approved by the CCHMC Institutional Review Board. The institutional review board waived the requirement to obtain documentation of informed consent for all adult participants and waived the requirement to obtain documentation of assent for all child participants (parents who are minors). The institutional review board approved the study questionnaire and a cover letter that introduced the questionnaire to the parents.

Study Participants

Two hundred caregiver questionnaires were distributed between January and March 2010. A 2-month window was used to decrease the likelihood of resurveying the same family at a subsequent WCC. Of the 200 questionnaires, 100 were given to Montgomery Pediatrics, whereas 100 were split equally between Hopple Street Health Center and the Pediatric Primary Care Center. No questionnaire was excluded for incomplete data, and any given information was analyzed.

Survey Instrument

Clinic staff distributed to caregivers, coming for a WCC visit, the multiple-choice and fill-in-the-blank response questionnaire (eFig 1). The letter gave parents the option to say no to filling the questionnaire and the option to not complete it if they did not want to after starting. Clinic staff collected the questionnaires from the parents and turned them in to the study investigators.

For allergenic food introduction, caregivers were asked to fill in the age in months when the child first had the food in question. Tree nuts and shellfish outside the fish or seafood category were not addressed specifically. Baby foods were used as a surrogate for

the pureed foods we defined as infant solids. Caregivers were also asked, in the same fashion, to report at what age their pediatrician or nurse practitioner told them that their child could start eating the aforementioned foods. No parallel data were collected directly from the physicians or advanced care professionals regarding their specific instructions to families regarding allergenic food introduction practices.

History of child atopy was asked via yes or no responses for each studied atopic disease: eczema, asthma, food allergies, and environmental allergies. Caregivers were then asked if they waited longer to start foods because of their child's atopic disease. Family history of atopic diseases in primary relatives (brother, sister, mother, and father) and waiting longer to introduce foods because of the family history of atopy were also assessed.

Demographic data were obtained regarding maternal age and number of children in the family. Maternal educational level, race/ethnicity, and type of insurance were also assessed.

Statistical Analysis

Study data were collected and managed using REDCap (research electronic data capture) tools hosted at the CCHMC by the principal investigator.¹⁰ If ranges were given for fill-in-the-blank age responses (ie, stating a child had solids between 4 and 6 months of age), the mean value of 5 was used. If caregivers responded in years of age, the number of months corresponding to that age were used (ie, for 2 years, 24 months was used for data entry). Insurance was entered into the database and changed to public, private, or self-pay to group for analysis. Family history of atopy, also used along with child-reported atopy as allergy risk for the forest modeling, was defined as caregiver report of 1 or more primary family members with atopic disease.

Only the patients responding yes to specific allergenic food introduction were used for analysis of timing. For example, if a 15-month-old patient was not reported to have had egg introduced into his/her diet, s/he was not used for the calculation of mean egg introduction. Thus, the sample size for each food is reported and was used for data analysis. No analysis was performed to determine how many children at a specific age had not ingested a specific food because there is no specific time of recommended introduction by guidelines. Similarly, only those patients responding with a recommended age of introduction by a health care professional were used for analysis.

Data were read into R version 2.15.0 for statistical analysis. Ages at introduction of formula, milk, peanut butter, fish, baby food, and eggs were summarized within urban and suburban individuals using the mean and median. Empirical densities of the age at introduction of each food were plotted. The summary measures and plots revealed that the ages were not normally distributed, and comparisons across urban and suburban residence were conducted using a Wilcoxon rank sum test. It was not possible to create multiple linear regression models for the age outcome variables because the explanatory variables of interest (maternal age, maternal race, insurance type, urban residence, and educational level) were found to be highly correlated.

Random forest modeling was chosen as an alternative to multiple regression to determine those factors that are most important in determining the age at introduction of the foods under study. In the random forest method, a subset of the data is selected at random, and, in this case, a regression tree is created from the selected data set. This is done in an iterative fashion, leaving out approximately one-third of the data for each iteration. The importance of variables is measured using the Gini impurity criterion, which is calculated by leaving one variable out of the iteration and determining how many observations are misclassified by the resulting tree. Those variables whose exclusion led to the most

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