Socioeconomic Disparities in the Economic Impact of Childhood Food Allergy

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abstract

OBJECTIVES: We compared direct medical costs borne by the health care system and out-of-pocket costs borne by families for children with food allergy by socioeconomic characteristics.

METHODS: We analyzed cross-sectional survey data collected between November 2011 and January 2012 from 1643 US caregivers with a food-allergic child. We used a 2-part regression model to estimate mean costs and identified differences by levels of household income and race or ethnicity.

RESULTS: Children in the lowest income stratum incurred 2.5 times the amount of emergency department and hospitalization costs as a result of their food allergy than higher-income children ($1021, SE ±$209, vs $416, SE ±$94; $P < .05$). Costs incurred for specialist visits were lower in the lowest income group ($228, SE ±$21) compared with the highest income group ($311, SE ±$18; $P < .01$) as was spending on out-of-pocket medication costs ($117, SE ± $26, lowest income; $366, SE ±$44, highest income; $P < .001$). African American caregivers incurred the lowest amount of direct medical costs and spent the least on out-of-pocket costs, with average adjusted costs of $493 (SE ±$109) and $395 (SE ±$452), respectively.

CONCLUSIONS: Disparities exist in the economic impact of food allergy based on socioeconomic status. Affordable access to specialty care, medications, and allergen-free foods are critical to keep all food-allergic children safe, regardless of income and race.

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WHAT'S KNOWN ON THIS SUBJECT: The cost of prevention and treatment of childhood food allergy is nearly $25 billion annually. The enormous costs include direct medical costs borne by health care systems and medical and nonmedical costs borne by families.

WHAT THIS STUDY ADDS: Socioeconomic disparities in the economic impact of food allergy were identified. Low-income children spent more on emergency department and hospitalization costs and less on out-of-pocket medication costs relative to higher-income children. Disparities by race and ethnicity were also identified.

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The impact of childhood food allergies is extensive and growing. An estimated 5.9 million children have ≥1 food allergy, making up 8% of the US pediatric population.[1] Almost 40% of these children have experienced a severe life-threatening reaction.[1,2] Limited research on racial and ethnic disparities in food sensitization and food allergy prevalence suggest that children of self-reported black race are more likely to be sensitized to multiple foods and have a greater prevalence of peanut, shellfish, and tree nut allergies when compared with other minority groups (Hispanic, multiracial).[3,4] Additionally, black children have been shown through parent-reported data with expert panel verification to have a higher overall prevalence of food allergy but lower odds of being diagnosed by a physician.[1]

The accompanying costs to the US population for prevention and treatment of allergic reactions are enormous at an estimated $24.8 billion annually ($4184 per year per child).[5] These costs include substantial direct medical costs ($4.3 billion annually) borne by the health care system and medical, as well as nonmedical, costs borne by families ($20.5 billion annually). Limited previous research has identified racial and socioeconomic disparities in the economic impact of food allergy.[6] For example, the cost of epinephrine autoinjectors presents an economic burden to low-income families.[7–9] Between 1986 and 2011, the wholesale costs of a single-dose unit of epinephrine rose 147%.[10] Depending on the prescription plan, insurance copays can range from $30 to 100% of costs per epinephrine autoinjector pack, which lasts only 12 months.[10] Without insurance, the national average retail price per autoinjector was ~$120 in January 2013, with advertised retail prices for cash payers several hundred dollars more.[11] In addition to autoinjectors, families with lower socioeconomic status often lack the financial means and access to allergen-free foods to prevent allergic reactions in the first place.[12–14]

To stay safe, food-allergic children must have access to allergen-free foods and access to medications in case of an allergic reaction. Determining the racial and financial barriers to appropriate management of food allergy for children is critical for clinicians and policymakers. To quantify the degree of disparities in direct medical and out-of-pocket costs associated with food allergy, we analyzed data from a national survey of caregivers of food-allergic children. We hypothesized that children from low-income households and racial or ethnic minorities would spend less on out-of-pocket prevention and incur more direct medical costs.

METHODS

Study Design

This study is a secondary analysis of primary data collected by Gupta et al[5] in a cross-sectional study between November 28, 2011 and January 26, 2012. After informed consent was obtained, we asked 1643 caregivers of food-allergic children to complete a computer-based survey to assess the direct medical costs, out-of-pocket costs, and lost opportunity costs that result from their children's food allergies. Details of the survey instrument and study participants have been described elsewhere.[5] A dual-sample approach was used for recruitment. The final study sample included 629 families resampled from an earlier study of the prevalence of food allergy[1] and 1014 families recruited from a food allergy support and advocacy organization. Knowledge Networks, a survey research firm in Menlo Park, California, completed the caregiver recruitment and survey administration electronically. The institutional review board of Lurie Children's Hospital of Chicago approved the study protocol.

Direct Medical Costs

The total direct medical costs are the costs incurred by the health care system as a result of diagnosis, prevention, and treatment of the child's food allergy. Because true costs vary widely based on hospital charges and insurance status, we asked caregivers questions about health care utilization, from which costs were then calculated. Caregivers reported the number of times the child had outpatient pediatrician visits, outpatient specialist visits, and emergency department (ED) visits or inpatient hospitalizations as a result of a food allergy in the past year.

The costs associated with utilization were then estimated from 2 sources. All outpatient visit costs were calculated based on 2010 Medicare cost data[15] as described in Gupta et al.[5] The mean cost used for an outpatient pediatrician visit was $112. Specialist costs varied according to the type of specialist. The cost of an allergist or pulmonologist visit was $175. The mean cost of a nutritionist or alternative provider was $100. The mean costs used for ED visits or inpatient hospitalizations were $711 and $6269, respectively, and were based on calculations from Patel et al.[16] The ED and hospitalization costs were combined as a single variable in the analysis.

Out-of-Pocket Costs

The total out-of-pocket costs are costs directly reported by the caregivers and encompass costs for health care–related items (ie, copayments, travel expenses); medication; counseling and mental health services; legal guidance; school, camp, and child care; and special food. In each case, we asked the caregiver for the amount spent on each item in the last year because of the child's food allergy.

Covariates

The primary independent variables in this analysis are household income and race or ethnicity. We created 3 annual income groups (<$50 000, $50 000–$100 000, and >$100 000) and 5 race and ethnicity groups (white, African American, Hispanic, Asian, and multiracial, other, or unknown). Income groups were chosen to balance cell sizes while representing children above and below the US median household income of $50 052 in 2011.[17] Other control variables included gender, age of child (0–5, 6–10, and ≥11 years), geographic region (Midwest, Northeast, South, and West), a dichotomous indicator of having multiple food allergies, a dichotomous indicator of having a severe allergic reaction in the past year, and 2 continuous variables describing the total number of reported needs and problems associated with the child's food allergy. Age groups were also chosen to balance cell sizes while reflecting standard periods of child development. Finally, we included measures of allergy-related needs and problems to control for parental perceptions of the impact of food allergy that may be related to out-of-pocket spending. It is known from previous studies that food allergies significantly impair a child's and family's quality of life.[12,18,19] To quantify which aspects are most affected, caregivers were instructed to select specific needs and problems affecting their families.

Statistical Analysis

Because a dual-sample approach was used, base and poststratification weights were used to create a sample representative of the 5.9 million US children with food allergy established by Gupta et al.[1] Specifically, weights were used to account for observed selection deviations in the distributions of age, race, gender, income, type of food allergy, and reaction severity. We used the person-level sample weight for all proportions and means to achieve estimates representative of the population of US children with food allergy. We used F-tests to test the equality of unadjusted mean costs across race or ethnicity and household income groups.

To obtain estimates of costs adjusted for covariates, we used 2-part regression models. The 2-part model is appropriate for heteroskedastic and highly skewed data where many respondents report zero expenditures.[20,21] The first part of our model used a logistic regression to estimate the log-odds of having any cost, and the second part estimated the adjusted mean cost by using a generalized linear model.[22] The generalized linear model is flexible in terms of the ability to select a distribution that best fits the outcome variable. For each of our models, we used a modified Park test to determine the distributional family and ultimately used Poisson or γ distributions depending on the results of the test.

Each of the 2-part models includes all the covariates described earlier. In addition, we examined the interaction between race or ethnicity and household income in models of direct medical and out-of-pocket costs. The interaction was highly significant in the model of direct medical costs ($P < .05$) and marginally significant in the logit of out-of-pocket costs ($P < .1$). The interaction term was included in both of these models. We estimated adjusted means from predictions stemming from the 2-part models and SEs using bootstrapping with 1000 iterations. To reduce the influence of outliers, we truncated all costs at the 99th percentile for each type of cost. Small amounts of missing data were encountered and observations with missing data were dropped, resulting in an estimation sample of 1623 individuals. Two-part models were implemented in Stata 13 (Stata Corp, College Station, TX) with the command *tpm* written by Belotti, Deb, Manning, and Norton.[23]

RESULTS

Demographic data describing the sample are found in Table 1. After we weighted the analytic sample, 41.8% (95% confidence interval, 37.4%–46.2%) of families had household income <$50 000 annually. The majority of children, 74.3% (95% confidence interval, 70.1%–78.1%) were white, 10.7% were African American, and 7.6% were Hispanic. More than 40% of the sample consisted of children >11 years old; gender was evenly distributed. There were slightly more respondents from the southern United States than other regions (33.6%).

Caregivers reported an average of 1 need and 1 problem associated with their child's food allergy. The percentages of caregivers reporting specific needs and problems related to their child's food allergy are depicted in Fig 1. The most commonly reported need was more time for shopping and preparing food, which affected 42.8% of families in our sample. Approximately one-third of the caregivers (32.3%) reported needing special foods. Furthermore, ~1 in 5 caregivers needed more time to prepare for school (22.9%), reported their child's social life being inhibited (19.3%), and that the family's vacation choices were restricted (18.7%) because of the child's food allergy.

Unadjusted and adjusted per capita direct and out-of-pocket food allergy costs by race or ethnicity and household income are presented in Table 2. For nearly every type of cost, adjusted costs exceeded unadjusted costs, indicating the influence of control variables. After adjustment, African American families were the only racial or ethnic group with lower out-of-pocket costs than direct medical costs ($493 direct, SE ±$109; $395 out-of-pocket, SE ±$452). Interestingly, African American families incurred significantly lower ED and hospital costs while spending significantly less than white children on each type of out-of-pocket cost.

In terms of adjusted costs by household income, there were significant differences in costs incurred for pediatrician, specialist, and ED and hospitalization but not overall direct medical costs. We found that families in the lowest income stratum incurred adjusted mean costs for ED and hospitalization due to food allergy ($1021, SE ±$209, $P < .001$) that were nearly 2.5 times the mean costs of either of the other 2 income strata ($434, SE ±$106, and $416, SE ±$94). We also found statistically significant but small differences in how much each income group incurred for general pediatrician and specialist costs, with the lowest income group incurring more for pediatrician ($123, SE ±$14) and less for specialist visits ($228, SE ±$21) than children in the highest income group ($103 pediatrician, SE ±$11; $311 specialists, SE ±$18; $P < .01$). In terms of adjusted out-of-pocket costs, we found that increasing family income was significantly associated with increased out-of-pocket spending for medications ($171 lowest income group, SE ±$26; $366 highest income group, SE ±$44; $P < .001$).

After analysis of the adjusted mean food allergy–related costs by race or ethnicity and income, we found inconsistent relationships with income (Table 3). White, Hispanic, and other race or ethnicity children tended to incur lower direct medical costs with increasing household income, although none of the trends were significant. In terms of out-of-pocket costs, white, Asian, and other race or ethnicity children tended to spend more with increasing income. The only association that bordered on statistical significance by household income was direct medical costs for

TABLE 1 Demographic Characteristics of Children With Food Allergy

	Weighted % or Mean (95% Confidence Interval)	Unweighted *N* (*n* = 1623)
Race or ethnicity		
White	74.3 (70.1–78.1)	1353
African American	10.7 (7.9–14.2)	69
Hispanic	7.6 (5.4–10.6)	61
Asian	3.7 (2.4–5.7)	45
Multiracial, other, or unknown	1.6 (0.8–3.2)	18
Household income		
<$50 000	41.8 (37.4–46.2)	381
$50 000–$99 999	39.1 (35.1–43.2)	633
>$100 000	19.2 (16.7–21.9)	609
Age, y		
0–5	30.7 (27.1–34.6)	603
6–10	27.2 (23.7–31.1)	554
≥11	42.0 (37.8–46.4)	466
Gender		
Male	50.7 (46.4–54.9)	922
Female	49.3 (45.1–53.6)	701
Geographic region		
Midwest	20.7 (17.6–24.2)	400
Northeast	23.9 (20.6–27.6)	444
South	33.6 (29.6–37.8)	466
West	21.6 (18.2–25.4)	306
Allergy type		
Multiple allergies	30.0 (26.8–33.4)	1078
Single allergy	70.0 (66.6–73.2)	545
Severity		
Severe reaction in last year	15.1 (12.6–18.0)	367
No severe reaction in last year	84.9 (82.0–87.4)	1256
Reported needs		
Mean number of reported needs	1.00 (0.91–1.09)	1623
Reported problems		
Mean number of reported problems	0.81 (0.70–0.92)	1623

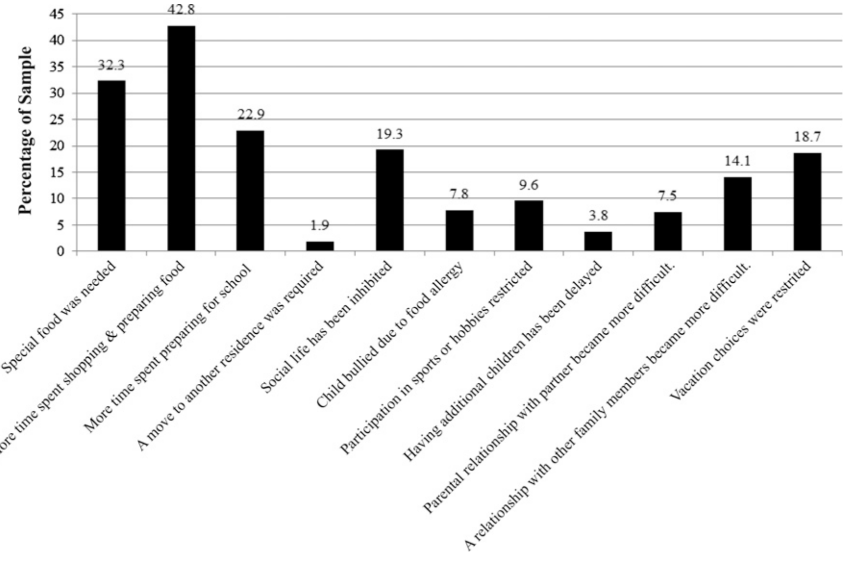

FIGURE 1
Percentage of children with caregiver report of specific allergy-related needs and problems.

TABLE 2 Unadjusted and Adjusted Mean per Capita Food Allergy Expenditures

	Race or Ethnicity						Income Level			
	White	African American	Hispanic	Asian	Multiracial, Other, or Unknown		Household Income <$50 000	Household Income $50 000–99 000	Household Income >$100 000	
	Weighted Mean $ (SE)					*P*	Weighted Mean $ (SE)			*P*
Total direct costs										
Unadjusted	657 (106)	300 (69)	527 (206)	583 (300)	1796 (1000)	*	728 (181)	580 (109)	613 (132)	
Adjusted	999 (104)	493 (109)	643 (224)	885 (514)	2961 (880)	**	1374 (274)	1024 (125)	940 (128)	
Total pediatrician costs										
Unadjusted	82 (06)	80 (19)	103 (23)	43 (16)	178 (60)		80 (09)	100 (10)	69 (08)	
Adjusted	119 (09)	99 (22)	116 (24)	72 (24)	231 (52)		123 (14)	143 (12)	103 (11)	*
Total specialist costs										
Unadjusted	192 (14)	103 (28)	102 (29)	52 (20)	321 (148)	**	121 (15)	211 (25)	219 (18)	**
Adjusted	310 (13)	157 (40)	127 (37)	101 (36)	440 (104)	**	228 (21)	330 (27)	311 (18)	***
Total ED and hospitalization costs										
Unadjusted	380 (99)	115 (48)	319 (188)	478 (275)	1410 (918)		522 (169)	280 (97)	321 (120)	
Adjusted	504 (79)	108 (60)	395 (220)	1271 (630)	1536 (599)	**	1021 (209)	434 (106)	416 (94)	*
Total out-of-pocket costs										
Unadjusted	1362 (125)	110 (29)	417 (164)	192 (102)	2450 (888)	**	791 (125)	1156 (157)	1933 (298)	***
Adjusted	4203 (750)	395 (452)	1093 (856)	1327 (1948)	6577 (2560)	**	3174 (858)	3434 (658)	5062 (1168)	
Total health care costs										
Unadjusted	223 (37)	43 (11)	182 (88)	88 (59)	642 (364)	**	211 (64)	207 (42)	218 (27)	
Adjusted	498 (90)	117 (65)	196 (89)	157 (131)	1458 (884)	**	572 (159)	456 (101)	547 (110)	
Total medication costs										
Unadjusted	138 (09)	26 (07)	96 (46)	42 (14)	195 (72)	**	84 (13)	131 (13)	186 (16)	**
Adjusted	312 (28)	52 (18)	148 (78)	87 (37)	251 (50)	**	171 (26)	275 (30)	366 (44)	**
Total mental health and legal costs										
Unadjusted	32 (05)	08 (08)	06 (06)	01 (01)	240 (168)	**	14 (05)	40 (17)	63 (14)	***
Adjusted	78 (13)	11 (16)	02 (04)	03 (09)	447 (125)	**	59 (18)	85 (19)	119 (28)	
Total school, camp, and child care costs										
Unadjusted	401 (62)	15 (10)	57 (49)	47 (36)	703 (232)	**	150 (39)	302 (66)	787 (185)	***
Adjusted	1107 (321)	46 (165)	31 (86)	149 (1911)	1199 (642)	*	529 (285)	716 (192)	1592 (646)	
Total food costs										
Unadjusted	392 (35)	16 (07)	39 (23)	13 (07)	454 (104)	**	214 (32)	330 (46)	493 (63)	***
Adjusted	1213 (200)	177 (501)	219 (281)	148 (290)	1548 (762)	**	744 (216)	941 (230)	1545 (347)	

Adjusted means reflected predicted values from 2-part models controlling for gender, race, age, family income, region, having multiple food allergies, and a report of a severe reaction in the past year. Generalized linear models (2nd part) use γ or Poisson distributions and log links depending the results of modified Park tests.

* $P < .05$ for F-test of equality of means across groups.

** $P < .001$ for F-test of equality of means across groups.

*** $P < .01$ for F-test of equality of means across groups.

African American children ($P < .06$), but the relationship was not linear.

DISCUSSION

Children in the lowest income stratum incurred 2.5 times as much on ED and hospitalization costs due to food allergy than higher-income children. They also incurred significantly less for specialist visits and spent less on out-of-pocket costs for key preventive measures. These results suggest that children in lower-income families may be at a higher risk for accidental ingestions and anaphylaxis because they have less access to specialty care, allergen-free foods, and emergency medications such as epinephrine autoinjectors. In terms of race and

TABLE 3 Adjusted Mean per Capita Food Allergy Expenditures by Race and Income

	Direct Costs				Out-of-Pocket Costs			
	Household Income <$50 000	Household Income $50 000–$99 000	Household Income >$100 000		Household Income <$50 000	Household Income $50 000–$99 000	Household Income >$100 000	
Race or Ethnicity	Weighted Mean $ (SE)			*P*	Weighted Mean $ (SE)			*P*
White	1268 (239)	963 (115)	890 (120)	.29	3528 (984)	3611 (712)	5142 (1221)	.36
African American	501 (186)	650 (188)	196 (96)	.06	692 (957)	196 (70)	111 (72)	.58
Hispanic	780 (441)	580 (171)	359 (445)	.86	1946 (1687)	323 (208)	514 (215)	.57
Asian	149 (120)	505 (340)	1752 (1380)	.34	50 (47)	287 (123)	3331 (5710)	.18
Other	4234 (2249)	2941 (1165)	1829 (666)	.47	4294 (4917)	7291 (2764)	7886 (4338)	.83

Adjusted means reflected predicted values from 2-part models controlling for gender, race, age, family income, region, having multiple food allergies, and a report of a severe reaction in the past year. Generalized linear models (2nd part) use γ or Poisson distributions and log links depending on the results of modified Park tests. *P* values reflect the probability from *F*-test of equality of means across income groups for each racial and ethnic group.

ethnicity, African American children had the lowest levels of direct medical and out-of-pocket costs.

The lower costs reported by African American and low-income families may involve awareness, access, and possibly the severity of the child's food allergy. Previous research has examined the relationship between sociodemographic factors including race or ethnicity, mother's education, and household poverty status and severity of reaction.[1,4,24] Using data from the 2007 National Survey of Children's Health, Branum et al[24] found no relationship between socioeconomic factors and reported food allergy severity among food-allergic children. A more recent study by Gupta et al[1] also found no relationship between race or ethnicity and reported severity among US children. After controlling for severity in our models, we still found significant differences in costs by household income and race.

Our findings on out-of-pocket spending among caregivers with the lowest household incomes suggest that these families may be unable to take needed preventive measures. There is limited research on disparities in access to epinephrine and utilization of acute care services, and findings have been mixed. A 2011 study by Coombs et al[8] found that children from higher-income homes were 8.35 times more likely than those from lower-income homes to be prescribed autoinjectors. A retrospective chart review of children seen in a predominantly minority clinic found no differences in rates of food-induced anaphylaxis by race.[4] However, a recent study by Dyer et al[25] found that Hispanic children had a significantly higher increase in the rate of ED visits for food-induced anaphylaxis than other children. Other studies have found disparities in the timing of epinephrine administration before arriving at the ED. In 1 study, Medicaid-enrolled children presenting at the ED with food-induced anaphylaxis were less likely to have received epinephrine before ED arrival,[26] and another found that white children compared with nonwhite children were significantly more likely to have early epinephrine treatment.[27] These disparities in the timing of epinephrine administration are important because both studies found that early administration is associated with a lower risk of hospitalization.[26,27]

The unique profile of costs for African American children was not fully explained by household income. Although we found a marginally significant association with household income and direct medical costs for African American children, the pattern of spending by household income was not linear. Even after controlling for income, we found that caregivers of African American children reported lower costs incurred as a result of health care utilization and lower out-of-pocket costs than children in other racial and ethnic groups. For African American children, the lower on average spending for potentially preventive out-of-pocket costs does not imply higher costs incurred for the ED or hospitalization. This finding may represent a protective effect in the environments of African American children that is not well understood. Although a survey of food allergy knowledge in the general population revealed less ability to identify food allergy triggers among racial and ethnic minorities, there was greater recognition of the necessity of avoiding allergic foods as a means to control food allergy.[28] More research is needed to test this hypothesis and assess awareness of preventive measures and differences in food allergy burden on families.

Several limitations of this study must be considered. First, our estimates of disparities in out-of-pocket spending for medication may have been affected by lack of information about the type of health insurance and the cost-sharing requirements for prescription medications. Caregivers in our survey were asked only whether their child was insured but not the type of health insurance (89% reported having insurance). Children covered through the Medicaid program may be less likely to have copays for an epinephrine autoinjector. Our data reflect only differences in reported out-of-pocket spending for such medication, not whether differences in utilization exist. If low-income children were subject to $0 copays, we may erroneously conclude that children from low-income households used less medicine. We conducted sensitivity testing by including an indicator of health insurance and found no differences in our results. Second, there was wide variation in the self-reported out-of-pocket costs that probably reflects some measurement error. Although this error may exist, we do not believe that it differentially affects groups by socioeconomic status, and therefore our findings of disparities in the economic impact remain valid. There may also be some measurement error in the estimates of direct medical costs borne by the health care system. It is possible that the standardized prices used to estimate direct medical costs either underestimated or overestimated the true direct medical costs incurred by the health care system. Finally, because our sample included some families recruited through support and advocacy organizations, our findings may not generalize to the broadest population of underserved families of children with food allergy.

Improving equity in food allergy management for all children is critically needed. Knowing that low-income children incur greater costs for ED visits and hospitalization and have lower spending on specialty care and out-of-pocket expenses warrants both clinical and public health interventions. Pediatricians need to be aware of these disparities and work with low-income families to ensure that they can access specialty care and needed medications such as epinephrine. They also need to provide families with an action plan detailing how to recognize a reaction and when and how to give epinephrine.

Pediatricians and policy and public health advocates need to help ensure that epinephrine is available in as many public places as possible. To date all but 1 state have mandated that schools have undesignated epinephrine autoinjectors accessible in case of emergency.[29] The results can be lifesaving; in Chicago alone, 38 epinephrine autoinjectors were used in 1 year, with >50% by children with no known history or documentation of allergic reactions.[30] Additionally, work must be done to ensure that families can access safe foods at low cost. All grocery stores should have designated aisles for affordable foods free of the most common allergens. Specialty stores often are not accessible to low-income families. Improving access to safe foods and medications will help decrease possible accidental exposures and allow timely treatment of allergic reactions and anaphylaxis.

ABBREVIATION

ED: emergency department

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