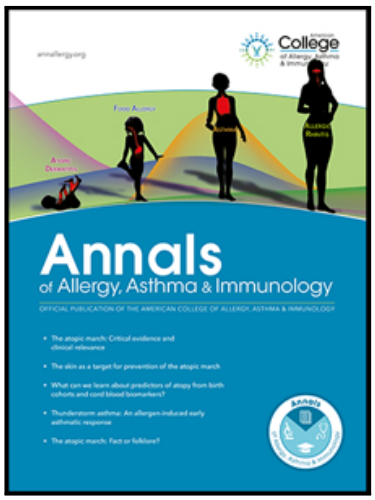


Epinephrine auto-injector carriage and use practices among US children, adolescents, and adults

Christopher M. Warren PhD(c) , Justin M Zaslavsky , Kristin Kan MD, MPH, MSc , Jonathan M Spergel MD PhD , Ruchi S. Gupta MD MPH

PII: S1081-1206(18)30482-4
DOI: 10.1016/j.anai.2018.06.010
Reference: ANAI 2587

To appear in: *Annals of Allergy, Asthma Immunology*

Received date: 30 March 2018
Revised date: 24 May 2018
Accepted date: 7 June 2018

Please cite this article as: Christopher M. Warren PhD(c) , Justin M Zaslavsky , Kristin Kan MD, MPH, MSc , Jonathan M Spergel MD PhD , Ruchi S. Gupta MD MPH , Epinephrine auto-injector carriage and use practices among US children, adolescents, and adults, *Annals of Allergy, Asthma Immunology* (2018), doi: 10.1016/j.anai.2018.06.010

Epinephrine auto-injector carriage and use practices among US children, adolescents, and adults

Christopher M. Warren PhD(c)[1]
Justin M Zaslavsky[2] (B.A. in progress)
Kristin Kan, MD, MPH, MSc[3]
Jonathan M Spergel, MD PhD[4]
Ruchi S. Gupta MD MPH[3]

Institutional Affiliations:

[1] University of Southern California Keck School of Medicine,
Department of Preventive Medicine, Division of Health Behavior Research
[2] Tufts University School of Arts and Sciences
[3] Northwestern University Feinberg School of Medicine,
Institute for Public Health and Medicine
[4] Children's Hospital of Pennsylvania, Allergy Section

Corresponding Author:

Ruchi S. Gupta MD MPH
750 N Lake Shore Drive, 6th Floor
Chicago, IL 60611
Phone: 312-503-3383
Fax: N/A
Email: r-gupta@northwestern.edu

Key Words:

food allergy; epinephrine carriage; anaphylaxis self-management;
food allergy management; chronic disease management

Abbreviations:

FA: Food Allergy
EAI: Epinephrine Auto-Injector
SEM: Structural Equation Modeling
QoL: Quality of Life
IRB: Institutional Review Board
ER: Emergency Room

Number of Tables: 5
Number of Figures: 1

Funding Source:

Mylan (Canonsburg, Pa) provided funding for the study.

Conflicts of Interest:

Ruchi S. Gupta receives grant support from the Allergy and Asthma Network, NIH/NIAID, Melchiorre Family Foundation and Sean N. Parker Center for Allergy & Asthma Research, UnitedHealth Group, Thermo Fisher Scientific, Rho Inc., and Aimmune Therapeutics. She serves as a consultant for DBV Technologies, Kaleo Inc., and BEFOREBrands.
J. M. Spergel serves as a consultant for DBV Technology and GlaxoSmithKline; receives grant support from DBV Technology, Aimmune Therapeutics, and Food Allergy Research & Education; receives payments for lectures from Meeting Events International and Rockpointe; receives payment for development of educational presentations from Rockpointe; holds stock options with DBV Technology; and serves on the advisory boards for the National Eczema Association, Food Allergy Research & Education, and the International Association for Food Protein Induced Enterocolitis
Christopher M Warren, Justin M Zaslavsky, and Kristin Kan have no conflicts to disclose.

Introduction

Daily management of allergies to food, medication, latex, and/or insect stings can adversely impact quality of life (QoL) [1,2] and impose considerable economic burden[3] onto affected patients and their caregivers. Studies suggest that such allergies are remarkably common in the US,[4,5] with food allergies (FA) in particular having substantially risen in prevalence over recent decades[6] to affect an estimated 8% of children[7] and 5% of adults.[8] Clinically, there is substantial variation in how allergic reactions can present and reactions to the same food can vary in severity. With no current widely available curative treatment, allergen avoidance and proper anticipatory management of anaphylaxis are essential. [9]

Epinephrine auto-injectors (EAIs) are first-line treatment for anaphylaxis, and administration is recommended at the first sign of a severe allergic reaction.[10] Unfortunately, research suggests that currently, daily carriage, and emergency use of EAIs for treatment of anaphylaxis is inadequate,[11] which can lead to adverse outcomes, including hospitalization and death.[12-14] Consequently, it is imperative that we better our understanding of current epinephrine carriage and usage practices in the US, including the barriers that may impair patients' ability to routinely carry and--if necessary--self-administer emergency epinephrine in a timely, efficacious manner.

The current study leverages self- and parent-proxy report survey data on a large, diverse sample of children, adolescents, and adults who had been prescribed an EAI for allergy treatment. This study characterizes current EAI prescription fill rates, EAI carriage and use behaviors, as well as common barriers, desired facilitators and key factors hypothesized to impact EAI carriage and use based on previous work. Such factors include: **1)** Knowledge of how/when to use an EAI;[15] **2)** Perceived social and environmental support;[16] **3)** Positive patient attitudes toward EAI carriage;[17] **4)** Allergic reaction history/severity;[18] and **5)** Allergy-related quality of life.[1] We employed a structural equation modeling (SEM) approach to examine whether and to what extent these factors are associated with the following behaviors: **1)** EAI prescription filling; **2)** routine carriage of a single EAI; **3)** routine carriage of multiple EAIs; and **4)** using an EAI to treat a severe allergic reaction. By comprehensively modeling and characterizing these relationships, we hope to aid clinicians, FA advocates, and policy-makers alike in their efforts to improve allergy management among patients at-risk of anaphylaxis.

Methods

Survey Development and Design

The survey instrument was developed by a multi-disciplinary team comprised of pediatricians, allergists, health services researchers, parents of food-allergic children, children, adolescent and adult food allergy patients, survey methodologists, a clinical psychologist, an epidemiologist and a biostatistician, in addition to research coordinators. The final instrument assessed demographics, allergic reaction history, QoL, social support, well as practices and attitudes relating to epinephrine carriage and other FA management behaviors. Items were drawn from previous, validated population-level surveys where possible.[7,19] Expert panel review and cognitive interviews of adults (N=5) and parents of children (N=10) with FA were conducted in batches of 2-3 individuals at a time. Consequently, 13 rounds of iterative survey modifications were made. Upon saturation, the survey was programmed for online and telephone-based administration. Additional quality control/user experience testing was conducted prior to final survey administration.

Study Participants

Eligible participants included English-speaking adults aged 18 and older who indicated they had been prescribed an EAI and/or were the parent of a child whom had been prescribed an EAI for an allergy (including but not limited to certain foods, latex, insect bites or medications). Participants were recruited first from the probability-based *AmeriSpeak® Panel*, which utilizes a sampling frame covering ² 97% of the U.S. population. This panel is hosted by NORC at the University of Chicago, a leading US survey research organization. Surveys were completed by 172/180 eligible *AmeriSpeak* panelists (96% completion rate). To ensure adequate sample size,

these data were augmented by additional surveys administered to a different, non-probability-based sample of adults recruited by *Survey Sampling International*. These surveys were completed by 425 of 470 eligible panelists (90% completion rate). Adult respondents answered questions pertaining to their own allergy management practices, as well as on behalf of any eligible children. Active written informed consent was obtained from each participant. All study activities were IRB approved.

Statistical Analysis

Frequencies of categorical responses were calculated and compared via chi-square tests. Hypothesis testing was conducted in Mplus 7.4 via SEM. This approach allowed us to specify an overall model simultaneously examining the four outcomes of interest, which was then fit among children (0-12 years), adolescents (13-17 years), and adults (18+ years) using a multiple-group SEM approach. The four dichotomous outcomes were responses to the following questions: **1)** *Did you fill your [EAI] prescription?* [Yes vs. No]; **2)** *How many epinephrine auto-injectors do you typically carry with you?* [responses dichotomized into: at least one vs. None]; **3)** *How many epinephrine auto-injectors do you typically carry with you?* [responses dichotomized into multiple EAI vs. one or fewer]; **4)** *Has an EAI ever been used to treat an allergic reaction you were having? (Excluding epinephrine administered in the ER)* [Yes vs. No].

SEM methods combine factor analysis and regression into a more flexible, generalized analytic framework that allows **1)** simultaneous examination of adjusted associations among the five latent constructs hypothesized to predict EAI carriage and use; **2)** simultaneous examination of

cluster- and covariate-adjusted associations between each of the five latent predictors and the four key allergy management outcomes; **3)** accounting for the fact that our constructs of interest were measured with error; and **4)** confirmatory testing of measurement invariance of each latent factor across ages to ensure that meaningful comparisons of estimates are possible across age groups.[20]

First, measurement models were independently created and evaluated via confirmatory factor analysis for each of the five factors hypothesized *a priori* to be associated with the four EAI carriage and use outcomes described above. Relevant manifest variables were tested for each latent factor until each factor was found to demonstrate excellent fit (RMSEA<0.05; CFI>0.95; factor loadings >0.5).[21]

The following indicators were used in the final model:

Latent Factor 1: EAI Knowledge

- *I would be able to effectively use an EAI if I had a severe allergic reaction.*
  [5-item Likert scale ranging from 1—Strongly disagree to 5—Strongly agree]
- *I know how to recognize the signs and symptoms of a severe allergic reaction.*
  [5-item Likert scale ranging from 1—Strongly disagree to 5—Strongly agree]
- *I know the steps to use an EAI.*
  [5-item Likert scale ranging from 1—Strongly disagree to 5—Strongly agree]

Latent Factor 2: Perceived social and environmental support

- *My friends and extended family support me in the management of my allergy.*
  [5-item Likert scale ranging from 1—Strongly disagree to 5—Strongly agree]
- *If I experienced a severe allergic reaction at work or school I am confident that these stock epinephrine auto-injectors be available for my immediate use.*
  [5-item Likert scale ranging from 1—Strongly disagree to 5—Strongly agree]

Latent Factor 3: Positive attitudes toward EAI carriage

- *Carrying epinephrine makes me feel safer in social situations involving my allergen* [5-item Likert scale ranging from 1—Strongly disagree to 5—Strongly agree]
- *Carrying epinephrine improves my quality of life.* [5-item Likert scale ranging from 1—Strongly disagree to 5—Strongly agree]

Latent Factor 4: Allergic reaction history

- *In the past 12 months, how many allergic reactions have you experienced?* [Integer response options, categorized to 0, 1, 2, 3+]
- *In your lifetime how many times have you visited a hospital emergency room for an allergic reaction?* [Integer response options, categorized to 0, 1, 2, 3, 4, 5+]
- *In the past 12 months, how many times have you visited a hospital emergency room for an allergic reaction?* [Integer response options, dichotomized to Yes/No]

Latent Factor 5: Allergy-related quality of life

- *My allergy affects the things I do with others* [5-item Likert scale ranging from 1—Strongly disagree to 5—Strongly agree]
- *My allergy affects the things I do with my family* [5-item Likert scale ranging from 1—Strongly disagree to 5—Strongly agree];
- *Food Allergy Independent Measure* [Mean of 7 item scale]

A structural model was then fit specifying residual covariances between the five latent factors and four outcomes of interest. This structural model allows formal testing of the hypothesized relationships between these five latent factors and four EAI outcomes of interest. When standardized, these parameters reflect the relative magnitude of correlations between study constructs after accounting for effects of other covariates. See Figure 1 for a visualization of the final covariate-adjusted model, which demonstrated good fit [RMSEA=.047 (90%CI (.44-.50); CFI=.927].[21] Once this final overall model was specified, a multiple-group approach confirmed latent factor invariance and examined associations within and across children, adolescents, and adults in two-, and three- group models, which demonstrated comparable fit. The comparable fit of the 2 (children/adolescents vs. adults) and 3 (children vs. adolescents vs. adults) group models

indicates that there is minimal additional explanatory value in analyzing children and adolescents as separate subpopulations. Consequently, the more parsimonious two-group model comparing children/adolescents vs adults is reported in the results. Nevertheless, child- and adolescent-specific parameters from the three-group model are provided in Supplemental Table 1. Estimated beta coefficients were comparable between the probability-based (N=211) and non-probability-based (N=706) samples. Consequently, further analyses were pooled. Parameter estimates account for within-household non-independence via cluster-robust standard errors.

Results

Demographic Characteristics

The final analytic sample consisted of responses for 917 individuals, which were collected from 597 surveys as some allergic adults provided both self- and parent-proxy responses. Data were collected on 255 children ages 0-12 years old, 212 adolescents ages 13-17 years old, and 450 adults ages 18-65 years old. As described above, children and adolescents were collapsed into a single group for the reported SEM analyses. Table 1 shows that while the majority of the sample identified as White (73%), the sample was well distributed with respect to household income. Table 3 reports that peanut (30%), shellfish (22%) and milk (21%) were the most commonly reported food allergies among our sample, with peanut allergy significantly ($p<.05$) more prevalent among children/adolescents (35%) relative to adults (24%), and shellfish allergy significantly ($p<.05$) more prevalent among adults (25%) than children (19%).

EAI Prescription Filling and Carriage Behavior

Most respondents (89%) reported filling EAI prescriptions as reported in Table 2. Among adults, the most commonly cited barriers to filling their prescription were cost (47%), perception that their allergy was not severe (23%), and no history of previous allergic reactions (20%). However, for children/adolescents, the most commonly cited barriers were no history of previous reactions (28%), followed by perceptions that an EAI wasn't needed (25%). Cost was only a barrier to obtaining an EAI for 15% of children/adolescents, while perception that their allergy was not severe was only reported as a barrier to obtaining an EAI for 8% of children/adolescents.

Half of participants (51%) reported having an EAI accessible (within 5 minutes) "all of the time," and slightly fewer (44%) claimed that they carried at least one EAI on their person "all the time." Less than a quarter (24%) of the entire sample reported carrying two or more EAIs. Adults reporting habitual EAI carriage most often carried on their person (84%). However, only 34% of carrying children/adolescents were reported to carry an EAI on their person. Another 34% reported that a parent was most likely to carry an EAI for them. Most participants reported that carrying epinephrine improves QoL (66%) and increased perceived safety in social situations (71%).

Allergic Reaction History, EAI Utilization and Barriers

Most participants (69%) experienced at least one allergic reaction in the past 12 months, and 39% of participants experienced multiple reactions. Adults were more likely to report an allergic reaction in the past year (77% of adults vs. 62% of children/adolescents; $p<0.001$) and were almost twice as likely to have had three or more reactions in the past year compared to children/adolescents (27% of adults vs. 14% of children/adolescents; $p<0.001$). Eighty-eight

percent of adults and 69% of children/adolescents reported at least one lifetime visit to a hospital for an allergic reaction, but adults were more likely to have visited an emergency room in the past 12 months due to an allergic reaction than children (54% of adults vs. 43% of children/adolescents; p<0.01).

Sixty-five percent of respondents reported that an EAI had been used to treat an allergic reaction they were having (69% of adults vs. 57% of children; p<.001). Regarding respondents' most severe reported allergic reaction, slightly higher EAI usage rates were also reported amongst adults compared to children (59% vs. 52%; p=.084). The EAI used to treat their most severe allergic reaction was carried by the reacting individual 50% of the time. In 33% of cases the EAI used was provided by medical personnel. In 7% of cases, the first EAI used was prescribed to another individual, whereas 6% of cases involved use of stock EAI provided by an institution (e.g. school or workplace). Rates of routine carriage of at least one (93% vs. 62%; p<0.001) and multiple EAIs (29% vs. 16%; p<.001) were higher among respondents previously treated with an EAI. A majority of adults (52%) reported that an EAI was not used, even though it would have been beneficial during their most severe reaction. The most frequently given reasons for not using an EAI among respondents owning one were that an EAI was not available (45%), followed by that their allergy was undiagnosed at the time (35%), that an EAI was not necessary (26%), and that they lacked knowledge of how/when to use an EAI (21%). When surveyed, 58-59% of participants reported strong agreement with the statements: *ñI know the steps to use an EAIò*; *ñI can recognize the signs and symptoms of a severe allergic reactionò*; and *ñI would be able to effectively use an EAI if I had a severe allergic reactionò* [Table 4].

Regarding participant's suggestions for improving management, 68% of respondents reported that lowering EAI cost would improve epinephrine access, with 50% of respondents reporting that their insurance co-pay or deductible presented a barrier to access. Other desired changes included increasing availability of stock epinephrine and public awareness about allergens (50% and 47% of respondents, respectively). Many reported that more effective patient education (61%) and more time educating patients (47%) during physician visits on how/when to use an EAI, would be beneficial.

Structural Equation Model of EAI Prescription Filling, Carriage and Use Behaviors

In the multiple-group structural equation model, significant latent predictors of filling an EAI prescription across all ages included more positive attitudes toward EAI carriage ($p<0.01$), more serious allergic reaction history ($p<0.05$), and greater environmental support ($p<0.05$). Standardized parameters for children/adolescents and adults are reported in Table 5. Greater EAI knowledge was only a significant predictor among children/adolescents ($p<0.001$), while greater allergy-related QoL impact was only a significant predictor among adults ($p<0.05$). Children with allergies to peanut ($p<0.001$), tree nut ($p<0.01$), and insect sting/venom ($p<0.001$) were more likely to report filling their prescription, as were older children, relative to younger children ($p<.01$). These relationships are expressed visually in Figure 1.

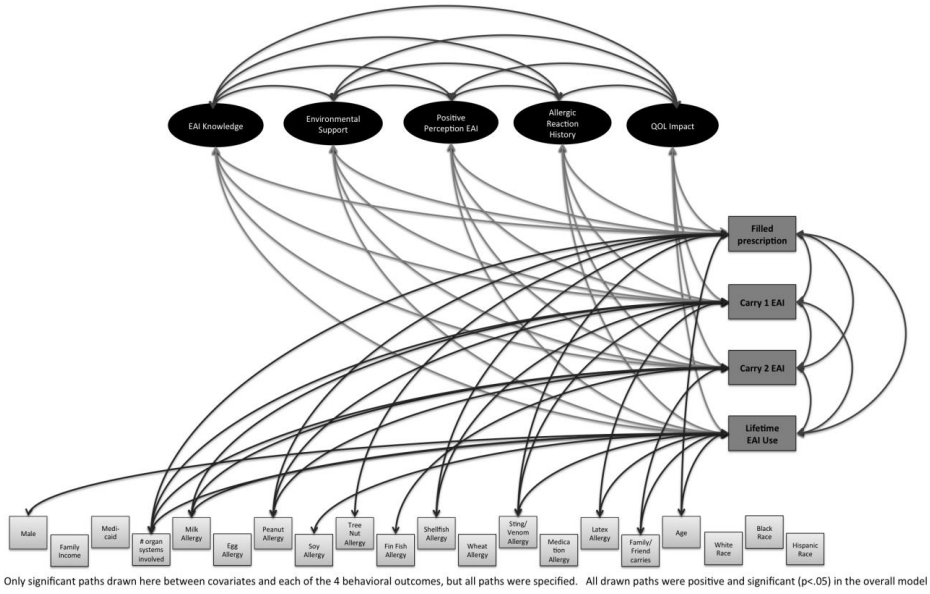
Each of the five aforementioned latent factors was also positively associated ($p<0.01$) with routine carriage of at least one EAI among all participants, as well as routine carriage of multiple EAIs among children. However, only more positive attitudes toward EAI carriage ($p<0.001$),

Table 5. Estimates from structural equation model of EAI prescription filling, carriage and use determinants

CHILDREN/ADOLESCENTS				ADULTS			
Construct Assessed	**B**	**SE**	**P**	**Construct Assessed**	**B**	**SE**	**P**
Measurement Model				***Measurement Model***			
Indicators of EAI KNOWLEDGE				**Indicators of EAI KNOWLEDGE**			
I would be able to effectively use an EAI if I had a severe allergic reaction.	0.942	0.012	0.000	*I would be able to effectively use an EAI if I had a severe allergic reaction.*	0.854	0.021	0.000
I know how to recognize the signs and symptoms of a severe allergic reaction.	0.885	0.015	0.000	*I know how to recognize the signs and symptoms of a severe allergic reaction.*	0.834	0.020	0.000
I know the steps to use an EAI	0.946	0.010	0.000	*I know the steps to use an EAI*	0.880	0.020	0.000
Indicators of ENVIRONMENTAL SUPPORT				**Indicators of ENVIRONMENTAL SUPPORT**			
If I experienced a severe allergic reaction at work or school I am confident that stock epinephrine auto-injectors be available	0.672	0.053	0.000	*If I experienced a severe allergic reaction at work or school I am confident that stock epinephrine auto-injectors be available*	0.694	0.062	0.000
My friends and family support me in the management of my allergy.	0.876	0.048	0.000	*My friends and family support me in the management of my allergy.*	0.903	0.090	0.000
Indicators of POSITIVE ATTITUDES TOWARD EAI CARRIAGE				**Indicators of POSITIVE ATTITUDES TOWARD EAI CARRIAGE**			
Carrying epinephrine makes me feel safer in social situations involving my allergen	0.832	0.020	0.000	*Carrying epinephrine makes me feel safer in social situations involving my allergen*	0.858	0.020	0.000
Carrying epinephrine improves my quality of life	0.877	0.016	0.000	*Carrying epinephrine improves my quality of life*	0.856	0.020	0.000
Indicators of ALLERGIC REACTION HISTORY				**Indicators of ALLERGIC REACTION HISTORY**			
In the past 12 months, how many allergic reactions have you experienced?	0.701	0.032	0.000	*In the past 12 months, how many allergic reactions have you experienced?*	0.554	0.039	0.000
In your lifetime how many times have you visited a hospital emergency room for an allergic reaction?	0.864	0.029	0.000	*In your lifetime how many times have you visited a hospital emergency room for an allergic reaction?*	0.686	0.037	0.000
In the past 12 months, how many times have you visited a hospital emergency room for an allergic reaction?	0.854	0.031	0.000	*In the past 12 months, how many times have you visited a hospital emergency room for an allergic reaction?*	0.875	0.037	0.000
Indicators of FOOD ALLERGY-RELATED QUALITY OF LIFE				**Indicators of FOOD ALLERGY-RELATED QUALITY OF LIFE**			
My allergy affects the things I do with others	0.759	0.041	0.000	*My allergy affects the things I do with others*	0.704	0.035	0.000
My allergy affects the things I do with my family	0.636	0.042	0.000	*My allergy affects the things I do with my family*	0.655	0.038	0.000
Food Allergy Independent Measure	0.705	0.037	0.000	*Food Allergy Independent Measure*	0.690	0.038	0.000
Structural Model				***Structural Model***			
Filled EAI Prescription <-->				**Filled EAI Prescription <-->**			
EAI KNOWLEDGE	0.502	0.061	0.000	EAI KNOWLEDGE	0.032	0.111	0.775
POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.372	0.075	0.000	POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.263	0.099	0.008
ALLERGIC REACTION HISTORY	0.609	0.070	0.000	ALLERGIC REACTION HISTORY	0.205	0.100	0.041
FOOD ALLERGY-RELATED QUALITY OF LIFE	0.115	0.090	0.199	FOOD ALLERGY-RELATED QUALITY OF LIFE	0.235	0.112	0.037
ENVIRONMENTAL SUPPORT	0.411	0.087	0.000	ENVIRONMENTAL SUPPORT	0.235	0.118	0.047
Typically carry 2+ EAI <-->				**Typically carry 2+ EAI <-->**			
EAI KNOWLEDGE	0.213	0.077	0.006	EAI KNOWLEDGE	0.010	0.073	0.895
POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.324	0.071	0.000	POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.334	0.068	0.000
ALLERGIC REACTION HISTORY	0.406	0.073	0.000	ALLERGIC REACTION HISTORY	0.467	0.067	0.000
FOOD ALLERGY-RELATED QUALITY OF LIFE	0.396	0.084	0.000	FOOD ALLERGY-RELATED QUALITY OF LIFE	0.242	0.078	0.002
ENVIRONMENTAL SUPPORT	0.248	0.081	0.002	ENVIRONMENTAL SUPPORT	0.115	0.080	0.152
Lifetime History of EAI Use <-->				**Lifetime History of EAI Use <-->**			
EAI KNOWLEDGE	0.193	0.069	0.005	EAI KNOWLEDGE	0.142	0.072	0.048
POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.449	0.062	0.000	POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.465	0.061	0.000
ALLERGIC REACTION HISTORY	0.752	0.041	0.000	ALLERGIC REACTION HISTORY	0.805	0.043	0.000
FOOD ALLERGY-RELATED QUALITY OF LIFE	0.299	0.072	0.000	FOOD ALLERGY-RELATED QUALITY OF LIFE	0.455	0.071	0.000
ENVIRONMENTAL SUPPORT	0.357	0.073	0.000	ENVIRONMENTAL SUPPORT	0.278	0.080	0.001
Typically Carry 1+ EAI <-->				**Typically Carry 1+ EAI <-->**			
EAI KNOWLEDGE	0.428	0.064	0.000	EAI KNOWLEDGE	0.209	0.080	0.009
POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.577	0.060	0.000	POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.684	0.052	0.000
ALLERGIC REACTION HISTORY	0.667	0.047	0.000	ALLERGIC REACTION HISTORY	0.676	0.056	0.000
FOOD ALLERGY-RELATED QUALITY OF LIFE	0.356	0.083	0.000	FOOD ALLERGY-RELATED QUALITY OF LIFE	0.327	0.082	0.000
ENVIRONMENTAL SUPPORT	0.467	0.072	0.000	ENVIRONMENTAL SUPPORT	0.397	0.088	0.000
ENVIRONMENTAL SUPPORT <-->				**ENVIRONMENTAL SUPPORT <-->**			
EAI KNOWLEDGE	0.807	0.047	0.000	EAI KNOWLEDGE	0.621	0.070	0.000
POSITIVE ATTITUDES TOWARD EAI CARRIAGE <-->				**POSITIVE ATTITUDES TOWARD EAI CARRIAGE <-->**			
EAI KNOWLEDGE	0.668	0.038	0.000	EAI KNOWLEDGE	0.573	0.048	0.000
ENVIRONMENTAL SUPPORT	0.901	0.051	0.000	ENVIRONMENTAL SUPPORT	0.754	0.079	0.000
ALLERGIC REACTION HISTORY <-->				**ALLERGIC REACTION HISTORY <-->**			
EAI KNOWLEDGE	0.197	0.063	0.002	EAI KNOWLEDGE	0.013	0.066	0.843
ENVIRONMENTAL SUPPORT	0.356	0.069	0.000	ENVIRONMENTAL SUPPORT	0.231	0.073	0.001
POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.424	0.053	0.000	POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.424	0.058	0.000
FOOD ALLERGY-RELATED QUALITY OF LIFE <-->				**FOOD ALLERGY-RELATED QUALITY OF LIFE <-->**			
EAI KNOWLEDGE	0.195	0.063	0.002	EAI KNOWLEDGE	0.167	0.064	0.009
ENVIRONMENTAL SUPPORT	0.375	0.071	0.000	ENVIRONMENTAL SUPPORT	0.435	0.073	0.000
POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.642	0.050	0.000	POSITIVE ATTITUDES TOWARD EAI CARRIAGE	0.694	0.049	0.000
ALLERGIC REACTION HISTORY	0.393	0.063	0.000	ALLERGIC REACTION HISTORY	0.613	0.060	0.000

Filled EAI Prescription <-->				**Filled EAI Prescription <-->**			
Male Gender	0.058	0.089	0.513	Male Gender	0.096	0.119	0.420
White Race	-0.040	0.104	0.697	White Race	0.239	0.113	0.035
Black Race	0.100	0.130	0.442	Black Race	0.253	0.108	0.019
Hispanic Race	0.127	0.140	0.363	Hispanic Race	-0.252	0.130	0.053
Milk Allergy	0.155	0.112	0.164	Milk Allergy	0.082	0.171	0.632
Egg Allergy	0.211	0.136	0.123	Egg Allergy	0.052	0.216	0.809
Peanut Allergy	0.423	0.099	0.000	Peanut Allergy	0.332	0.146	0.827
Soy Allergy	-0.003	0.183	0.985	Soy Allergy	-0.141	0.191	0.458
Tree Nut Allergy	0.440	0.145	0.002	Tree Nut Allergy	0.051	0.156	0.742
Fin Fish Allergy	0.418	0.172	0.015	Fin Fish Allergy	-0.155	0.168	0.357
Shellfish Allergy	0.475	0.139	0.001	Shellfish Allergy	0.056	0.144	0.697
Wheat Allergy	-0.106	0.169	0.533	Wheat Allergy	-0.185	0.248	0.456
Insect Sting Allergy	0.445	0.099	0.000	Insect Sting Allergy	0.014	0.124	0.912
Medication Allergy	0.266	0.147	0.069	Medication Allergy	-0.104	0.129	0.417
Latex Allergy	0.018	0.182	0.923	Latex Allergy	0.294	0.333	0.377
Many friends/family carry an EAI for their allergies.	-0.006	0.078	0.939	Many friends/family carry an EAI for their allergies.	-0.087	0.110	0.428
Age	0.204	0.061	0.001	Age	-0.105	0.075	0.161
Household Income	0.089	0.080	0.265	Household Income	0.076	0.086	0.372
Medicaid Insurance	-0.129	0.109	0.238	Medicaid Insurance	-0.121	0.120	0.312
# of Organ Systems Involved in Most Severe Rxn	0.575	0.044	0.000	# of Organ Systems Involved in Most Severe Rxn	0.079	0.093	0.398
Typically carry 2+ EAI	0.489	0.103	0.000	Typically carry 2+ EAI	0.389	0.132	0.003
Lifetime History of EAI Use	0.615	0.078	0.000	Lifetime History of EAI Use	0.374	0.104	0.000
Typically carry 1+ EAI	0.791	0.051	0.000	Typically carry 1+ EAI	0.710	0.074	0.000
Typically carry 2+ EAI <-->				**Typically carry 2+ EAI <-->**			
Male Gender	0.086	0.080	0.284	Male Gender	0.161	0.079	0.042
White Race	0.078	0.096	0.416	White Race	-0.059	0.086	0.491
Black Race	0.010	0.124	0.938	Black Race	0.100	0.129	0.438
Hispanic Race	-0.258	0.133	0.053	Hispanic Race	0.110	0.102	0.281
Milk Allergy	0.313	0.100	0.002	Milk Allergy	0.418	0.095	0.000
Egg Allergy	0.184	0.111	0.095	Egg Allergy	0.081	0.141	0.566
Peanut Allergy	0.272	0.085	0.001	Peanut Allergy	0.137	0.098	0.160
Soy Allergy	0.206	0.158	0.191	Soy Allergy	-0.055	0.150	0.715
Tree Nut Allergy	0.188	0.108	0.083	Tree Nut Allergy	0.104	0.104	0.317
Fin Fish Allergy	0.219	0.125	0.079	Fin Fish Allergy	0.264	0.118	0.025
Shellfish Allergy	0.041	0.108	0.701	Shellfish Allergy	0.203	0.094	0.030
Wheat Allergy	0.115	0.162	0.475	Wheat Allergy	0.190	0.190	0.317
Insect Sting Allergy	0.000	0.099	0.998	Insect Sting Allergy	-0.030	0.087	0.730
Medication Allergy	-0.287	0.131	0.029	Medication Allergy	-0.039	0.093	0.675
Latex Allergy	0.011	0.166	0.947	Latex Allergy	0.165	0.120	0.168
Many friends/family carry an EAI for their allergies.	0.181	0.071	0.011	Many friends/family carry an EAI for their allergies.	0.245	0.063	0.000
Age	-0.025	0.069	0.714	Age	-0.130	0.068	0.056
Household Income	0.121	0.076	0.114	Household Income	0.099	0.065	0.131
Medicaid Insurance	-0.110	0.105	0.296	Medicaid Insurance	0.122	0.085	0.149
# of Organ Systems Involved in Most Severe Rxn	0.235	0.079	0.003	# of Organ Systems Involved in Most Severe Rxn	0.163	0.068	0.017
Lifetime History of EAI Use	0.262	0.087	0.002	Lifetime History of EAI Use	0.243	0.083	0.003
Typically carry 1+ EAI	0.745	0.192	0.000	Typically carry 1+ EAI	0.766	0.117	0.000
Lifetime History of EAI Use <-->				**Lifetime History of EAI Use <-->**			
Male Gender	-0.030	0.075	0.691	Male Gender	0.380	0.073	0.000
White Race	-0.041	0.084	0.628	White Race	-0.079	0.085	0.349
Black Race	0.198	0.113	0.079	Black Race	0.056	0.132	0.674
Hispanic Race	0.061	0.102	0.548	Hispanic Race	0.139	0.104	0.183
Milk Allergy	0.185	0.094	0.049	Milk Allergy	0.440	0.112	0.000
Egg Allergy	0.076	0.106	0.476	Egg Allergy	0.205	0.147	0.165
Peanut Allergy	0.190	0.081	0.019	Peanut Allergy	0.368	0.095	0.000
Soy Allergy	0.207	0.157	0.187	Soy Allergy	0.427	0.158	0.007
Tree Nut Allergy	0.174	0.105	0.096	Tree Nut Allergy	0.055	0.104	0.595
Fin Fish Allergy	0.187	0.124	0.130	Fin Fish Allergy	0.403	0.132	0.002
Shellfish Allergy	0.390	0.094	0.000	Shellfish Allergy	0.138	0.197	0.152
Wheat Allergy	-0.066	0.152	0.664	Wheat Allergy	0.005	0.201	0.982
Insect Sting Allergy	0.175	0.085	0.039	Insect Sting Allergy	0.119	0.084	0.156
Medication Allergy	-0.092	0.112	0.414	Medication Allergy	-0.162	0.087	0.064
Latex Allergy	0.139	0.154	0.366	Latex Allergy	0.219	0.124	0.078
Many friends/family carry an EAI for their allergies.	0.325	0.060	0.000	Many friends/family carry an EAI for their allergies.	0.301	0.065	0.000
Age	0.140	0.058	0.017	Age	-0.075	0.062	0.229
Household Income	-0.087	0.065	0.184	Household Income	0.057	0.064	0.370
Medicaid Insurance	0.093	0.089	0.293	Medicaid Insurance	0.015	0.085	0.857
# of Organ Systems Involved in Most Severe Rxn	0.478	0.056	0.000	# of Organ Systems Involved in Most Severe Rxn	0.312	0.061	0.000
Typically carry 1+ EAI	0.642	0.067	0.000	Typically carry 1+ EAI	0.589	0.066	0.000
Typically Carry 1+ EAI <-->				**Typically Carry 1+ EAI <-->**			
Male Gender	0.034	0.085	0.690	Male Gender	0.235	0.087	0.007
White Race	0.021	0.104	0.840	White Race	0.030	0.094	0.749
Black Race	0.034	0.143	0.814	Black Race	0.351	0.167	0.036
Hispanic Race	0.098	0.118	0.456	Hispanic Race	-0.191	0.106	0.072
Milk Allergy	0.178	0.110	0.104	Milk Allergy	0.263	0.134	0.050
Egg Allergy	0.198	0.129	0.124	Egg Allergy	-0.071	0.154	0.645
Peanut Allergy	0.343	0.091	0.000	Peanut Allergy	0.415	0.114	0.000
Soy Allergy	0.058	0.177	0.741	Soy Allergy	0.124	0.171	0.469
Tree Nut Allergy	0.221	0.122	0.069	Tree Nut Allergy	0.010	0.117	0.932
Fin Fish Allergy	0.467	0.166	0.005	Fin Fish Allergy	-0.098	0.137	0.475
Shellfish Allergy	0.330	0.118	0.004	Shellfish Allergy	0.049	0.109	0.651
Wheat Allergy	0.059	0.179	0.741	Wheat Allergy	-0.159	0.205	0.440
Insect Sting Allergy	0.314	0.096	0.001	Insect Sting Allergy	0.165	0.095	0.083
Medication Allergy	0.085	0.133	0.519	Medication Allergy	-0.055	0.100	0.581
Latex Allergy	0.059	0.181	0.744	Latex Allergy	0.401	0.159	0.012
Many friends/family carry an EAI for their allergies.	0.076	0.078	0.332	Many friends/family carry an EAI for their allergies.	0.152	0.071	0.033
Age	0.050	0.069	0.463	Age	-0.062	0.061	0.308
Household Income	0.052	0.078	0.505	Household Income	0.097	0.068	0.155
Medicaid Insurance	-0.175	0.102	0.087	Medicaid Insurance	-0.023	0.094	0.809
# of Organ Systems Involved in Most Severe Rxn	0.532	0.054	0.000	# of Organ Systems Involved in Most Severe Rxn	0.137	0.069	0.047
White Race <-->				**White Race <-->**			
Black Race	-0.909	0.054	0.000	Black Race	-0.876	0.040	0.000
Hispanic Race	-0.938	0.043	0.000	Hispanic Race	-0.952	0.024	0.000
Household Income	0.297	0.068	0.000	Household Income	0.210	0.065	0.001
Black Race <-->				**Black Race <-->**			
Hispanic Race	-0.413	0.186	0.026	Hispanic Race	-0.368	0.113	0.001
Household Income	-0.380	0.093	0.000	Household Income	-0.195	0.101	0.055
Household Income <-->				**Household Income <-->**			
Medicaid Insurance	-0.499	0.055	0.000	Medicaid Insurance	-0.559	0.043	0.000
My allergy affects the things I do with others <-->				**My allergy affects the things I do with others <-->**			
My allergy affects the things I do with my family	0.784	0.030	0.000	My allergy affects the things I do with my family	0.835	0.020	0.000

Figure 1. Graphical Repr esentation of Overall Structural Equation Model



Only significant paths drawn here between covariates and each of the 4 behavioral outcomes, but all paths were specified. All drawn paths were positive and significant (p<.05) in the overall model