

Patterns of Carriage of Prescribed Adrenaline Autoinjectors in 10- to 14-Year-Old Food-Allergic Students: A Population-Based Study



Marnie Robinson, MD^{a,b,c}, Jennifer J. Koplin, PhD^{a,d}, Michael J. Field, MD^a, Mari Sasaki, MD^a, Rachel L. Peters, PhD^a, Vicki McWilliam, MND^{a,b}, Susan M. Sawyer, MD^{a,b,e}, George C. Patton, MD, PhD^a, Peter J. Vuillermin, MD, PhD^{a,f,g}, Jo Douglass, MD^{c,e}, Lyle C. Gurrin, PhD^{a,d}, Mimi L.K. Tang, MD, PhD^{a,b,e}, Shyamali C. Dharmage, MD, PhD^{a,d}, and Katrina J. Allen, MD, PhD^{a,b,e}; on behalf of the SchoolNuts Investigators *Parkville and Geelong, Victoria, Australia*

What is already known about this topic? Adolescence is well recognized as a risk factor for severe and fatal food-induced anaphylaxis. Current Australian guidelines therefore suggest that specific consideration be given to adrenaline autoinjector (AAI) prescription in all adolescents with a food allergy.

What does this article add to our knowledge? We describe factors associated with adherence to AAI carriage among adolescent students prescribed an AAI. Although adherence was good at school and while attending school-related activities, adherence was poor in other domains of social and family life.

How does this study impact current management guidelines? Carriage of prescribed AAI devices among food-allergic young adolescents is suboptimal, particularly when away from parental supervision. Strategies need to be developed to help improve carriage of AAI devices by young adolescents with food allergy.

BACKGROUND: Adolescence is well recognized as a period of increased risk for severe and fatal food-induced anaphylaxis. Current Australian adrenaline autoinjector (AAI) prescription guidelines therefore suggest that consideration be given to AAI prescription in all adolescents with a food allergy. To date, however, few studies have assessed the AAI carriage behavior of adolescents prescribed AAI devices.

OBJECTIVE: To determine the carriage behavior of prescribed AAI devices in a population-based sample of young Australian adolescents.

METHODS: Students aged 10 to 14 years (and their parents) from randomly selected schools in metropolitan Melbourne

completed self-administered questionnaires regarding the history and management of food allergy, including prescription and carriage of AAI device in different domains of school and social life.

RESULTS: A total of 9816 students completed the questionnaire (46% response): 620 students were assessed to have likely IgE-mediated food allergy and 234 (38%) of these had been prescribed an AAI. Most students (93%; 95% CI, 89%-96%) who were prescribed AAI reported that they provided their AAI and anaphylaxis action plan to their school. Adherence to AAI carriage in other domains of social life was poor, with 49% (95% CI, 42%-56%) never carrying their AAI in 1 or more locations.

^aMurdoch Children's Research Institute, Parkville, Victoria, Australia

^bRoyal Children's Hospital, Parkville, Victoria, Australia

^cDepartment of Clinical Immunology and Allergy, The Royal Melbourne Hospital, Parkville, Victoria, Australia

^dSchool of Population and Global Health, University of Melbourne, Parkville, Victoria, Australia

^eDepartment of Pediatrics, University of Melbourne, Parkville, Victoria, Australia

^fChild Health Research Unit, Barwon Health, Geelong, Victoria, Australia

^gSchool of Medicine, Deakin University, Geelong, Victoria, Australia

The SchoolNuts Study was supported by funding from the National Health and Medical Research Council of Australia (grant no. 1047396) and the Victorian Government's Operational Infrastructure Support Program.

Conflicts of interest: M. Robinson has given presentations for Mylan (unpaid) and has been on advisory boards for Nestle Health and GlaxoSmithKline (GSK) (did not receive financial incentives). V. McWilliam personally received payments for lectures from Nestle and Nutricia for other works. J. Douglass personally received consultancy fees from GSK, AstraZeneca, and Seqirus and payments for lectures from AstraZeneca, GSK, Stallergenes, Novartis, Alphapharm, Shire, Mundipharma, Stallergenes-Greer, and Seqirus. Her institution received grants from Novartis Pharmaceuticals and payment for the development of educational presentations from Alogaogarm for other works. M.L.K. Tang is on the Nestle

Medical Advisory Board Oceania and the Danone Nutricia Global Scientific Advisory Board; received consultancy fees from Deerfield Consulting, GLG consulting, and Bayer; is employed by ProTATherapeutics; received payment for lectures from Danone Nutricia; receives royalties from Wilkinson Publishing; has a patent through Murdoch Children's Research Institute; and received payment for the development of educational presentations from MD Linx. K.J. Allen personally received consultancy fees from Nestle, ThermoFisher, and AspenCare, and is on the Before Brands Scientific Advisory Board. The rest of the authors declare that they have no relevant conflicts of interest.

Received for publication February 13, 2018; revised May 11, 2018; accepted for publication June 7, 2018.

Available online July 19, 2018.

Corresponding author: Katrina J. Allen, MD, PhD, Centre for Food and Allergy Research, Murdoch Children's Research Institute, Royal Children's Hospital, Flemington Rd, Parkville, Victoria 3052, Australia. E-mail: katie.allen@rch.org.au.

2213-2198

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<https://doi.org/10.1016/j.jaip.2018.06.025>

Abbreviations used
AAI-Adrenaline autoinjector

Carriage of the AAI device was particularly poor when students were independent of parental supervision: 32% (95% CI, 25%-39%) never carried it when they were by themselves, 28% (95% CI, 22%-36%) never carried it while out with friends, and 36% (95% CI, 30%-43%) never carried their AAI to sporting activities.

CONCLUSIONS: Carriage of AAI devices is suboptimal in young adolescents prescribed AAIs, particularly when young adolescents are independent of parental supervision. © 2018 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2019;7:437-43)

Key words: Adrenaline autoinjector; Adrenaline autoinjector carriage; Adolescence; Food allergy; Anaphylaxis

INTRODUCTION

In recent decades there has been a significant increase in the prevalence of documented food allergy¹ and food-related anaphylaxis in industrialized²⁻⁵ and developing countries.⁶ The adolescent age group has been identified as being at particularly high risk of severe and fatal food-related anaphylaxis.^{3,7,8} A recent Australian study has also provided preliminary evidence for an acceleration in the frequency of anaphylaxis in children aged 4 to 15 years,⁹ which may be expected to result in increased morbidity and mortality in adolescents and young adults. Consistent with this, anaphylaxis fatality rates had risen in parallel with hospital anaphylaxis admission rates in Australia between 1997 and 2013,¹⁰ and most food-related anaphylaxis fatalities have continued to occur in adolescents and young adults.¹⁰

An important part of adolescence is that children gradually become more autonomous in making decisions as they become more independent of their parents. Adolescence is particularly challenging for young people with food allergy^{11,12} who must learn to balance the risk of food reactions with their emerging social identity.¹¹ As children with food allergy progress into adolescence, they become increasingly responsible for food choices, especially outside the home, and at the same time engage in behaviors that may place them at risk.¹³ Adolescents have high rates of poor adherence to medical treatment and are more likely to have poorly controlled asthma,^{14,15} which is a well-recognized risk factor for fatal anaphylaxis.^{3,7} They are also less likely to carry their adrenaline autoinjectors (AAIs),¹⁶ which in the event of an anaphylactic reaction would delay treatment, another risk factor for fatal anaphylaxis.³ It is also possible that there may be age-related hormonal changes that contribute to the vulnerability of the adolescent age group.¹⁷

Although adolescents are at particular risk for fatal food-related anaphylaxis, few studies have explored the potential risk factors in this group. Indeed, adolescents currently represent the most understudied patient group in allergy research. In this study, we sought to describe AAI carriage behavior and document the factors associated with poor adherence to AAI carriage among young adolescent students prescribed an AAI using a large

population-based study investigating food allergy in the general community—the SchoolNuts Study.

METHODS

Study population

Students in the 2 final years of primary school and the first 2 years of secondary school (aged 10-14 years) were recruited from randomly selected government and independent (private and Catholic) schools in metropolitan Melbourne, Australia, as described previously.¹⁸ This age group was selected to allow assessment of children across the transition from primary to secondary school when greater autonomy and independence occur. A total of 9816 students (46% response rate) participated in the study between 2011 and 2014.

Data collection

Students completed a self-administered questionnaire during a researcher-led session at their school. The questionnaire addressed demographic details (age, sex, year level, and country of birth), knowledge and perception of food allergy, general health, quality of life, and personal history and management of food allergy, including AAI prescription and carriage. Parents were also asked to complete a questionnaire that collected additional information about the child's allergy history (53% response rate, n = 5226). In this study, only the student questionnaire was used because the data required were collected in the student questionnaire (not the parent questionnaire) and low response rate from parents meant that validation was not possible for many factors.

The Index of Community Socio-Educational Advantage score was determined for each school. This is a scale of socioeducational advantage generated from student-level parent occupation and education, location, and percent indigenous student enrollment, developed by the Australian Curriculum, Assessment and Reporting Authority.¹⁹

Definitions

Food allergy. Self-reported current food allergy was defined as an affirmative response to the question "Do you *currently* have a food allergy?" Students were further classified as having *possible IgE-mediated food allergy* if they reported an allergy to a food commonly associated with IgE-mediated food allergy (peanut, tree nuts, egg, milk, sesame, shellfish, fish, soy, wheat, kiwi fruit, banana, meats, and legumes). Students who reported only celiac disease, lactose intolerance, or reactions to food coloring/preservatives were excluded from this analysis.

Current AAI. This referred to an affirmative response to the question "Do you currently have an EpiPen/Anapen?" (EpiPen and Anapen were the only 2 AAI devices available in Australia at the time of the study) among students with a current possible IgE-mediated food allergy.

AAI carriage. Students who reported currently having an AAI answered the question "Do you carry your EpiPen/Anapen with you?" for a series of locations. Possible responses were "Always," "Sometimes," and "Never." Students were classified into 2 categories—"Always/Sometimes" or "Never"—for further analysis.

Reaction in the past year. This was defined as an affirmative response to the question "Have you had an allergic reaction to a food in the past 12 months?" among students reporting a current possible

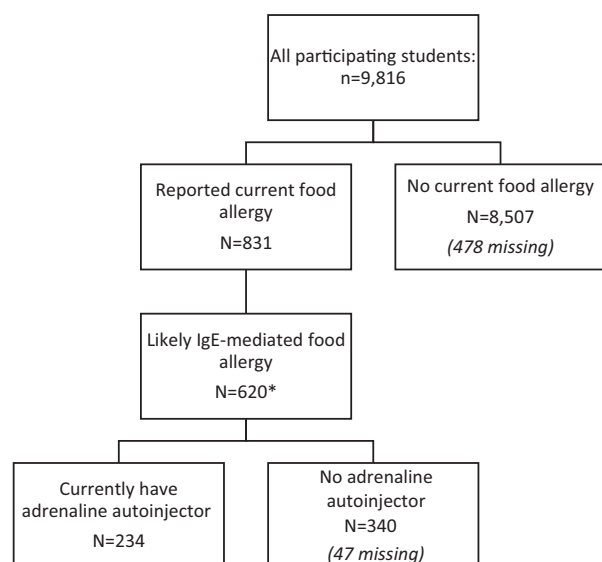


FIGURE 1. Food allergy and current AAI ownership among students participating in the SchoolNuts Study. *Excludes those with celiac disease, lactose intolerance, and reactions to colors/preservatives.

IgE-mediated food allergy. Information was also collected on the location of reaction.

History of anaphylaxis. This represented an affirmative response to the question “Have you ever had anaphylaxis to a food?”

Current asthma. Current asthma was defined as an affirmative response to both the questions “Have you ever had asthma?” and “Do you still have asthma?”

Statistical analysis

The population prevalence of AAI carriage was estimated as the observed proportion of students with both a food allergy and a current AAI who reported AAI carriage, with 95% CIs calculated by using the normal approximation to the binomial distribution. These analyses were stratified by the student’s sex, school stage, current asthma status, history of reaction in the past year, and history of anaphylaxis. *P* values addressing the null hypothesis of equal population prevalences between strata were generated using the Pearson chi-square statistics from the corresponding contingency table.

All statistical analyses were undertaken using Stata version 14.1 (StataCorp, College Station, Texas).

Ethics

Ethical approval was obtained from the Royal Children’s Hospital Human Research Ethics Committee (HREC no. 31079), the Department of Education and Early Childhood, and the Catholic Education Office.

RESULTS

Study population

A total of 9816 students completed the questionnaire. Of these, 831 reported a current food allergy, with 620 assessed to have a history consistent with a likely IgE-mediated food allergy. Of the students with a likely IgE-mediated food allergy, 234 (38%) reported having been prescribed an AAI and were

TABLE I. Demographic and clinical characteristics of students prescribed an AAI (*n* = 234)

Characteristic	n (%) [*]
Demographic characteristics	
Sex	
Male	129 (55)
Female	105 (45)
Country of birth	
Australia	220 (94)
Other	13 (6)
School stage	
Primary	135 (58)
Secondary	99 (42)
ICSEA quartile [†]	
1 (925-991)	22 (9)
2 (992-1038)	48 (21)
3 (1039-1151)	83 (35)
4 (1152-1207)	81 (35)
Clinical characteristics	
Current asthma	
No	110 (52)
Yes	101 (48)
Type of food allergy [‡]	
Peanut or tree nuts	211 (90)
Other foods	23 (10)
Reaction in the past year	
No	123 (62)
Yes	77 (38)
History of anaphylaxis	
No	65 (33)
Yes	133 (67)

ICSEA, Index of Community Socio-Educational Advantage.

^{*}Numbers may not add up to total because of missing data.

[†]ICSEA is a scale of socioeducational advantage generated from student-level parent occupation and education, remoteness, and percent indigenous student enrollment. Lower scores indicate more disadvantage.

[‡]The “peanut or tree nuts” category includes all students with a nut allergy (± other food allergies). The “other foods” category includes students who are allergic to other foods but do not have an allergy to peanut or tree nuts. Of these 23 students, allergies were to shellfish (*n* = 3), shellfish + other food (*n* = 3), egg (*n* = 6), milk (*n* = 4), egg + milk (*n* = 1), pine nut (*n* = 1), kiwi fruit, avocado, and banana (*n* = 1), legumes (*n* = 1), and other (*n* = 3).

therefore included in our analyses (Figure 1). Demographic and clinical characteristics of these students are presented in Table I.

Most students (93% [95% CI, 89%-96%]) who were prescribed an AAI reported that they provided their AAI device and anaphylaxis action plan to their school.

AAI carriage

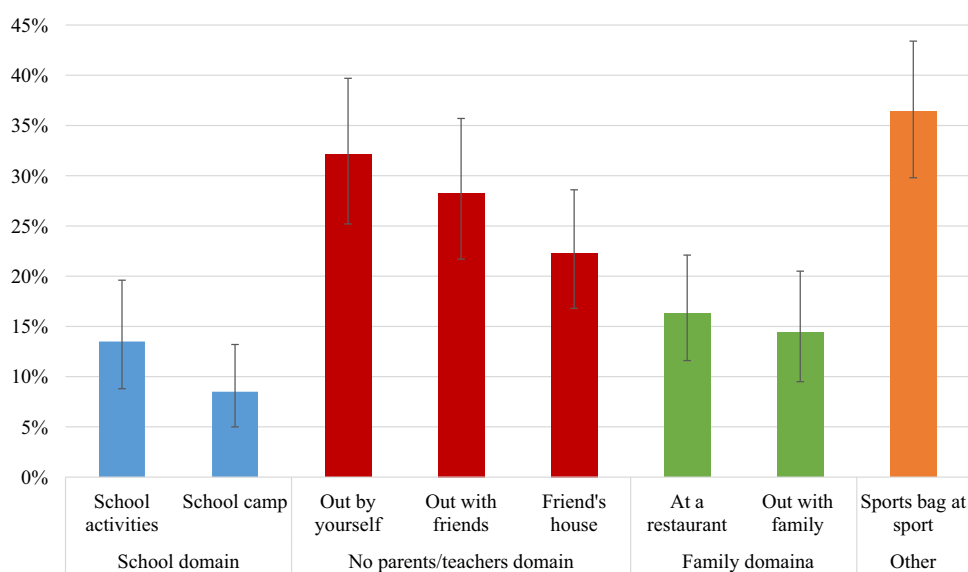
Carriage of an AAI was assessed across different domains of school and social life. The proportion of students who always carried their AAI ranged from 34% to 86% depending on the location, whereas the proportion who never carried their AAI ranged from 8% to 36% (Table II). Only 23% (95% CI, 16.3%-30.0%) of students always carried their AAI in all locations assessed.

Overall, 49% (95% CI, 42%-56%) of students reported never carrying their AAI in 1 or more of the listed locations. Of these, 29% answered “never” for only 1 location, 16% for 2 locations,

TABLE II. Reported AAI carriage among students with a prescribed AAI device (n = 234) in different locations

Domain	Location	n*	AAI carriage, % (95% CI)		
			Always	Sometimes	Never
School	School activities	169	67.5 (60.3-74.6)	18.9 (13.0-24.9)	13.6 (8.4-18.8)
	School camp	201	86.1 (81.2-90.9)	5.5 (2.3-8.6)	8.0 (4.1-11.7)
No parents/teachers	Out by yourself	170	48.8 (41.2-56.4)	19.4 (13.4-25.4)	31.8 (24.7-38.8)
	Out with friends	172	50.6 (43.0-58.1)	20.9 (14.8-27.1)	28.5 (21.7-35.3)
Family	Friend's house	205	56.1 (49.2-62.9)	22.0 (16.2-27.7)	22.0 (16.2-27.7)
	At a restaurant	207	65.7 (59.2-72.2)	17.9 (12.6-23.1)	16.4 (11.3-21.5)
Other	Out with family	173	67.1 (60.0-74.1)	19.1 (13.2-25.0)	13.9 (8.7-19.1)
	Sports bag at sport	205	33.7 (27.1-40.2)	30.2 (23.9-36.6)	36.1 (29.5-42.7)

*Numbers do not add up to total because of missing data for individual questions.

**FIGURE 2.** Proportion of students with a current AAI device (n = 235) who report *never* carrying their device in different locations. Bars show proportions with 95% CIs.

and 55% for 3 or more locations. Particularly low carriage rates were seen in locations where adult supervision is lacking, including when out with friends (28% never carried), out by themselves (32% never carried), and while at a friend's house (22% never carried). In addition, more than a third of the participants (36%) never carried their AAI in their sports bag when playing sports (Figure 2).

We also examined the location of recent reactions and AAI carriage in these locations. The most frequently reported location for food reactions was at home (n = 116 students), with fewer reactions occurring at a restaurant (n = 31) and a friend's house (n = 19). Of those who reported a reaction at a restaurant, half (52%) had been prescribed an AAI, and most of these (69%) reported always carrying their AAI at a restaurant. Of the 19 students who reported a reaction at a friend's house, 6 (32%) had been prescribed an AAI and 80% of these reported always carrying their AAI while at a friend's house.

Demographic and clinical factors affecting AAI carriage

Male students were generally less likely to carry their AAI than female students (Figure 3, A), particularly when the student was

at a friend's house, while out by themselves, at a restaurant, or undertaking school activities.

There was no evidence of a difference in prevalence of AAI carriage between primary and secondary school students (Figure 3, B) or between children with and without asthma (Figure 3, E). There was a tendency for participants with a history of recent reaction (in the last 12 months) (Figure 3, C) to carry their AAI more frequently, particularly while participating in school activities, while at school camp, and while eating out at restaurants. Similarly, participants with a history of anaphylaxis carried their AAI more often (Figure 3, D), particularly during school activities, school camp, and when out with their family.

DISCUSSION

This study is the first to look at patterns of AAI carriage in young adolescents prescribed an AAI for food allergy using a large and representative population-based sampling frame. Our findings are therefore expected to be reflective of the full range of behaviors in this age group rather than limited to higher risk patients attending hospital clinics and outpatient services. We found that although adherence was good at school and while attending school-related activities, adherence was much poorer in

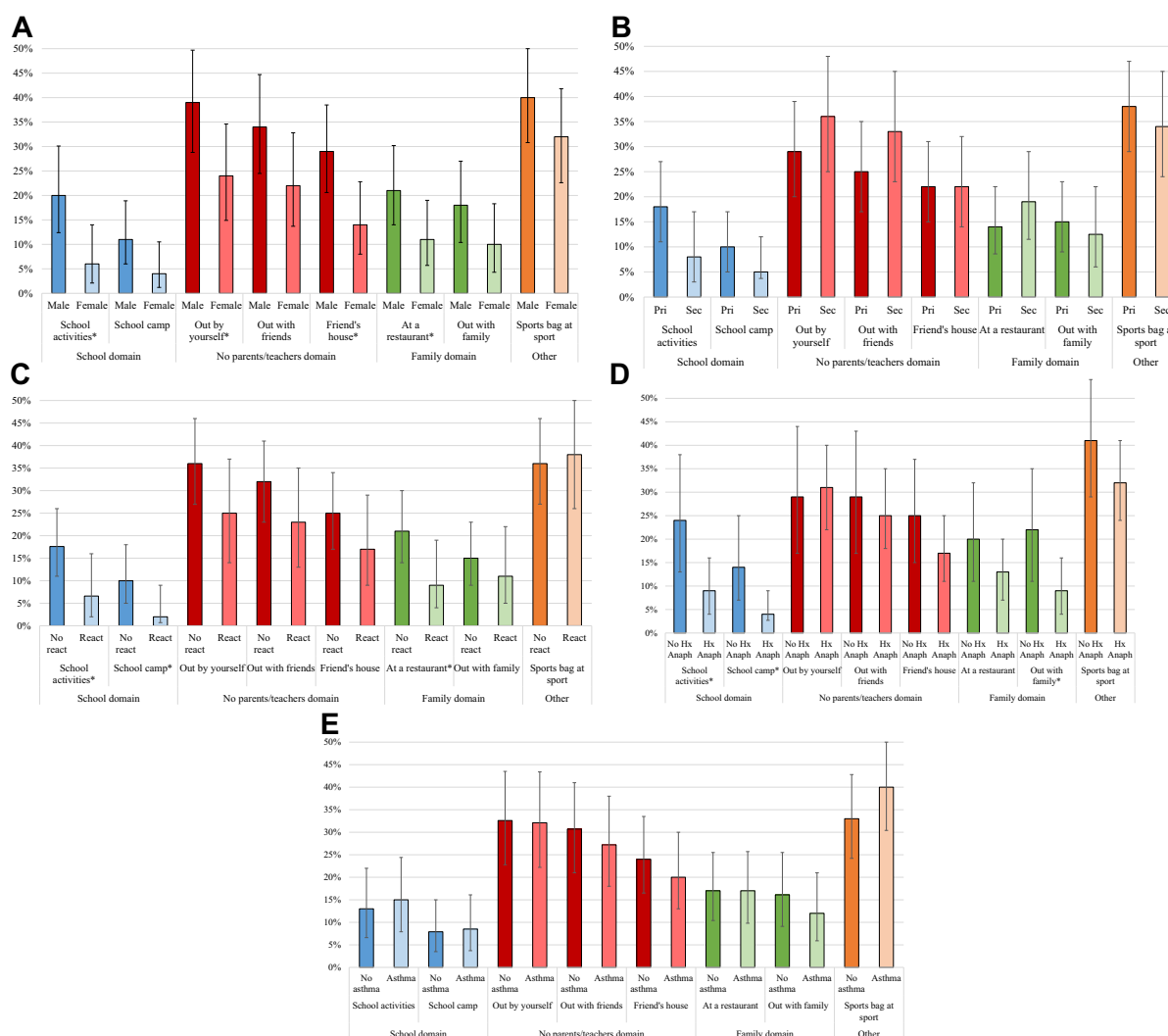


FIGURE 3. Proportion of students with a current AAI device who report *never* carrying their device, stratified by demographic and clinical factors. Bars show proportions with 95% CIs. (A) Student's sex; (B) school stage (primary [Pri] vs secondary [Sec]); (C) reaction to food in the past year; (D) history of anaphylaxis (ever); and (E) current asthma. * $P < .05$.

other domains of social and family life. Carriage of AAI devices was found to be particularly poor when adolescents were independent of their parents, specifically when by themselves, at a friend's house, or out with friends. The poorest rates of carriage were reported while attending sporting activities. These low rates of AAI carriage while students are independent of their parents are particularly concerning, given the increased potential for inadvertent food allergen exposure.

Rates of AAI carriage were generally the highest while at school (93%) and while on structured school activities and attending school camps. This likely reflects the compliance of Melbourne schools with the Department of Education's allergy and anaphylaxis guidelines that mandate Victorian (Melbourne-based) schools having individualized allergy action/anaphylaxis management plans for all children with documented food allergies.²⁰

Poor carriage of AAI devices while participating in sporting activities is particularly concerning given that strenuous activity at the time of an allergic reaction is a recognized augmenting factor

for more severe reaction.²¹ In addition, physical exertion is an established precipitant for asthma, which could further augment any allergic reaction occurring during sporting activities. Concerningly, AAI carriage was equally poor among students with coexistent asthma, including while participating in sporting activities. Sporting activities involving young adolescents are likely to involve some level of adult supervision. This is an area in which anaphylaxis management guidelines similar to those currently in existence for Victorian schools could potentially be developed to mandate that students are required to have their AAI available while participating in organized sporting activities.

The currently available AAI devices in Australia are large and cumbersome and cannot be easily carried in a pocket, and we speculate that the size of these currently available AAI devices may possibly affect young people's preparedness to carry their AAI device. Females were more likely than males to carry their AAI device, which may reflect that females are more likely to carry a bag or purse, facilitating easier AAI device carriage. The size of the AAI device does seem to be a factor in carriage for

adolescents,^{11,22,23} and smaller devices may more likely be carried. Smaller AAI devices are now available in other countries, and provision of smaller devices to the Australian market may represent another opportunity to potentially improve AAI carriage in young adolescents.

Poor adherence to AAI carriage when with friends may reflect concerns by adolescents about their peers perceiving them as being different and/or vulnerable. Rates of bullying in food-allergic children have been reported to be in the range of 25% to 50%.²⁴ Bullying results in high levels of anxiety and poorer quality of life, sadness, depression, and embarrassment.^{22,24,25} Conversely, a positive reaction by peers has been associated with improved carriage of AAI devices.²³ The development of school and community education programs on food allergy and AAI use may therefore be useful in fostering improved understanding by peers and support carriage of AAI devices.

Parents and caregivers have an important role in reducing risk-taking behavior,²⁶ and adolescents are strongly influenced by the behaviors modeled by their parents.²⁷ It is therefore concerning that a relatively high proportion of students with food allergy reported failure to carry their AAI device when out for dinner with their family. This finding is particularly concerning given that most fatal food-related anaphylaxis has been reported to occur while eating out at restaurants and fast food outlets^{3,7} and that both adolescents and their parents recognize eating out as a challenge.^{11,22,28}

A major strength of this study is that it is population-based, because other studies have been limited to clinical and hospital settings and have been small in scale.^{11,16,22} We have been able to report carriage of AAI in a wider food-allergic population than in hospital settings, in which there is the risk of bias toward those with more severe food allergy phenotypes, higher socioeconomic status, and greater access to specialized medical management and education. The study is however limited by the relatively small number of students with AAI devices. Furthermore, the study involved a self-administered questionnaire that introduces a risk of recall bias. It is also possible that students answering the questionnaire may not be fully aware of the symptoms of previous reactions, which may have potentially led to an underreporting of anaphylaxis history or alternatively there may also be a risk of overreporting. In only recruiting students from metropolitan Melbourne, it is possible that findings may be different in students living in more rural or remote locations. The study group was also limited to young adolescents between 10 and 14 years old and may not be generalizable to older adolescents. The study of this age group does however allow a unique perspective into early adolescence when the transition from primary to secondary school occurs and greater autonomy and independence are developed.

CONCLUSIONS

The study highlights that AAI carriage in this high-risk young adolescent group is suboptimal. Ensuring regular review of adolescent patients to review their need for AAI devices and reinforce management plans may help address this issue. Further research is needed to develop strategies to improve AAI carriage among adolescents with food allergy. Food-allergic young adolescents need to be informed about the specific risks of eating out and about reaction risks outside of the family home. It also remains crucial that the adolescent patient be familiar with risk

avoidance measures and is confident in recognition of symptoms and signs of an allergic reaction, particularly the recognition of anaphylaxis. Adolescents need to be aware of the indications for using their AAI and be comfortable using the device correctly. Above all, they need to be aware of the importance of carrying their AAI at all times.

Acknowledgments

We thank the children, parents, and schools that participated in the SchoolNuts Study. We also thank the SchoolNuts Safety Committee that comprised Associate Professor Noel Cranswick (Australian Paediatric Pharmacology Research Unit, Murdoch Children's Research Institute, Parkville, Victoria, Australia), Dr Jo Smart (Department of Allergy and Immunology, Royal Children's Hospital, Melbourne, Victoria, Australia), and Professor Jo Douglass (Department of Clinical Immunology and Allergy, Royal Melbourne Hospital, Melbourne, Victoria, Australia). Finally, we acknowledge the SchoolNuts research staff: Helen Czech, Deborah Anderson, Leone Thiele, Nicola Palmer, Sigrid Pitkin, Holly Shaw, Olivia Hamilton, John Molloy, Dean Tey, Jana Eckert, Noor Suaini, Rebecca Bereny, Penny Blunden, Jeeva Sanjeevan, Nadine Bertalli, and Giovanni Zurzolo.

REFERENCES

- Gupta RS, Springston EE, Warrier MR, Smith B, Kumar R, Pongracic J, et al. The prevalence, severity and distribution of childhood food allergy in the United States. *Paediatrics* 2011;128:e9-17.
- Poluos LM, Waters AM, Correll PK, Loblay R, Marks G. Trends in hospitalizations for anaphylaxis, angioedema and urticaria in Australia, 1993-1994 to 2004-2005. *J Allergy Clin Immunol* 2007;120:878-84.
- Liew WK, Williamson E, Tang ML. Anaphylaxis fatalities and admission in Australia. *J Allergy Clin Immunol* 2009;123:434-42.
- Rudders SA, Arias SA, Camargo CA. Trends in hospitalizations for food induced anaphylaxis in US children 2000-2009. *J Allergy Clin Immunol* 2014;134:960-2.
- Turner PJ, Gowland MH, Sharma V, Ierodiakonou D, Harper N, Garcez T, et al. Increase in anaphylaxis related hospitalisations but no increase in fatalities: an analysis of United Kingdom national anaphylaxis data 1992-2012. *J Allergy Clin Immunol* 2015;135:956-63.
- Prescott SL, Pawankar R, Allen KJ, Campbell DE, Sinn JKH, Ebizawa M, et al. A global survey of changing patterns of food allergy burden in children. *World Allergy Organ J* 2013;6:21.
- Pumphrey RS. Lessons for management of anaphylaxis from a study of fatal reactions. *Clin Exp Allergy* 2000;30:1144-50.
- Bock SA, Munoz-Furlong A, Sampson HA. Further fatalities caused by anaphylactic reactions to food 2001-2006. *J Allergy Clin Immunol* 2007;119:1016-8.
- Mullins RJ, Dear KB, Tang ML. Time trends in Australian hospital anaphylaxis admissions in 1998-1999 to 2011-2012. *J Allergy Clin Immunol* 2015;136:367-75.
- Mullins RJ, Wainstein BK, Barnes EH, Liew WK, Campbell DE. Increases in anaphylaxis fatalities in Australia from 1997-2013. *Clin Exp Allergy* 2016;46:1099-110.
- Gallagher M, Worth A, Cunningham-Burley S. Epinephrine auto-injector use in adolescents at risk of anaphylaxis: a qualitative study in Scotland, UK. *Clin Exp Allergy* 2011;41:869-77.
- Akeson N, Worth A, Sheikh A. The psychosocial impact of anaphylaxis on young people and their parents. *Clin Exp Allergy* 2007;37:1213-20.
- Sampson M, Munoz-Furlong A, Sicherer SH. Risk-taking and coping strategies of adolescents and young adults with food allergy. *J Allergy Clin Immunol* 2006;117:1440-5.
- Shah S, Peat JK, Mazurski E, Wang H, Sindhusake D, Bruce C, et al. Effect of peer led programme for asthma education in adolescents: a cluster randomized controlled trial. *BMJ* 2001;322:583-5.
- Cohen R, Franco K, Motlow F, Reznik M, Ozuah PO. Perceptions and attitudes of adolescents with asthma. *J Asthma* 2003;40:207-11.

16. Niemark L, Wales J, Du Toit G, Pastacaldi C, Haddad D, Gardner J, et al. The use of adrenaline autoinjectors by children and teenagers. *Clin Exp Allergy* 2011;42:284-92.
17. Bonds RS, Midoro-Horiuti T. Estrogen effects in allergy and asthma. *Curr Opin Allergy Clin Immunol* 2013;13:92-9.
18. Sasaki M, Koplin J, Dharmage S, Field MJ, Sawyer SM, McWilliam V, et al. Prevalence of clinic-defined food allergy in early adolescence: the SchoolNuts Study. *J Allergy Clin Immunol* 2018;141:391-8.
19. Australian Curriculum, Assessment and Reporting Authority. Guide to understanding ICSEA (Index of Community Socio-Educational Advantage) values; 2015. Available from: http://docs.acara.edu.au/resources/Guide_to_understanding_icsea_values.pdf. Accessed January 22, 2018.
20. Department of Education and Training, State of Victoria. Anaphylaxis guidelines: a resource for managing severe allergies in Victorian schools; 2017. Available from: http://www.education.vic.gov.au/Documents/school/principals/health/Anaphylaxis_Guidelines_FINAL.pdf. Accessed January 22, 2018.
21. Nigggerman B, Beyer K. Factors augmenting allergic reactions. *Allergy* 2014;69:1582-7.
22. Monks H, Gowland H, Mackenzie M, Erlewyn-Lajeunesse M, King R, Lucas JS, et al. How do teenagers manage their food allergies? *Clin Exp Allergy* 2010;40:1533-40.
23. Macadam C, Barnett J, Roberts G, Stiefel G, King R, Erlewyn-Lajeunesse M, et al. What factors affect the carriage of epinephrine auto injectors by teenagers? *Clin Transl Allergy* 2012;2:3.
24. Lieberman JA, Weiss C, Furlong TJ, Sicherer M, Sicherer SH. Bullying among pediatric patients with food allergy. *Ann Allergy Asthma* 2010;105:282-6.
25. Shemesh E, Annunziato R, Ambrose M, Ravid NL, Mullarkey C, Rubes M, et al. Child and parental reports of bullying in a consecutive sample of children with food allergy. *Pediatrics* 2013;131:e10-7.
26. Hurd NM, Zimmerman MA, Xue Y. Negative adult influences and the protective effects of role models: a study with urban adolescents. *J Youth Adolesc* 2009;38:777-89.
27. Hazen E, Scholzman S, Beresin E. Adolescent psychological development: a review. *Pediatr Rev* 2008;29:161-8.
28. Avery N, King R, Knight S, Hourihane J. Assessment of quality of life of children with peanut allergy. *Pediatr Allergy Immunol* 2003;14:378-82.