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HOSPITAL-TREATED AND FATAL ADVERSE FOOD REACTIONS IN VICTORIA, 2011/12 TO 2020/21

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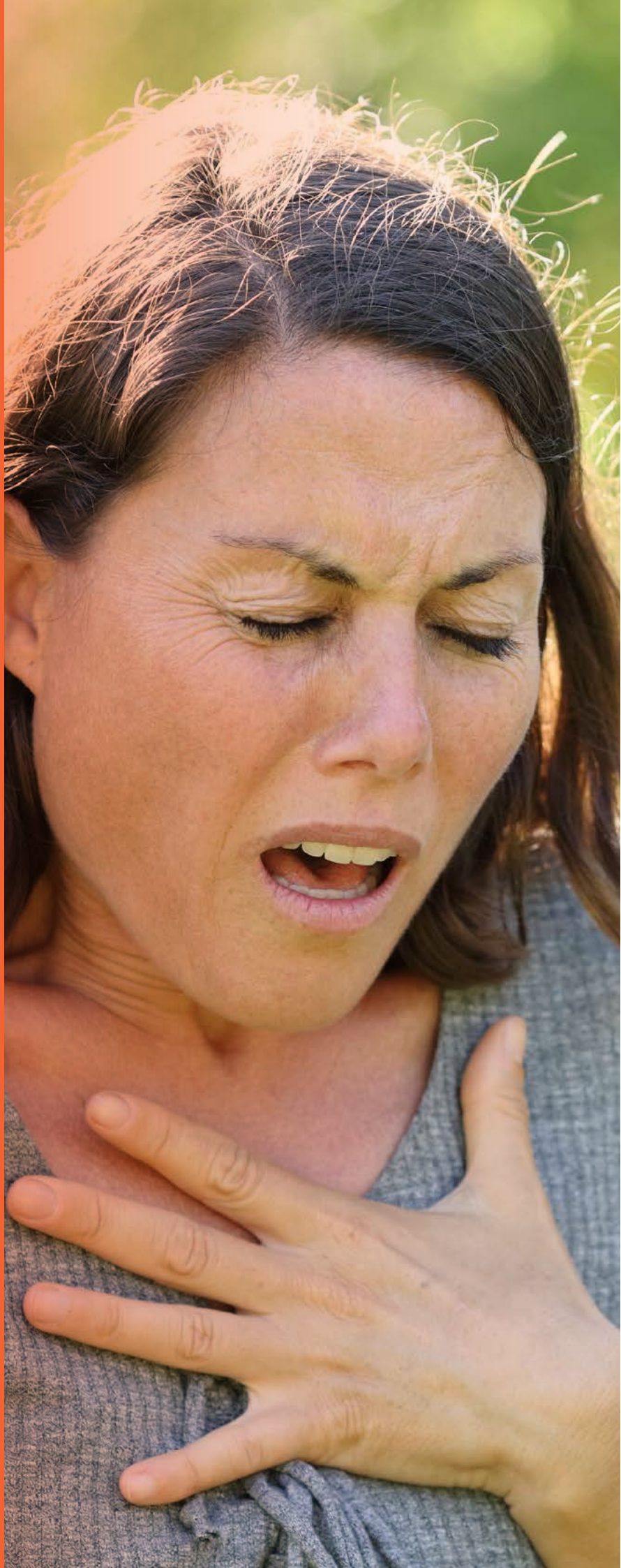

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OVERVIEW

This edition of *Hazard* focused on adverse food reactions in Victoria. Adverse food reactions are common in Australia. A 2015 study reported a 9% prevalence of egg allergy in one year-olds and a 5% prevalence of multiple food allergy, based upon a population-based cohort study of infants in Melbourne, Australia (Peters et al., 2015). Between 1997 and 2013, food anaphylaxis deaths as well as food anaphylaxis hospital admission rates increased by 10% per year in Australia (Mullins et al., 2016). Due to the high prevalence as well as rapid increase in allergies in the population, a comprehensive, current overview of food allergy in Victoria was considered timely. Research at the Victorian Injury Surveillance Unit is focused on injury. Food reactions and anaphylaxis are in the ICD-10-AM Chapter 19 on *Injury, poisoning and certain other consequences of external causes*[1]. Adverse food reactions therefore contribute to overall estimates of burden of injury, and given the scale of this issue, a more in-depth evaluation was warranted.

The aim of this edition of *Hazard* is to provide an in-depth epidemiological overview of food allergies resulting in hospital treatment or death in Victoria, including frequencies, rates and trends. Time trends in the ten-year period from 2011/12 to 2020/21 are presented, as well as an in-depth analysis of hospital-treated food allergies in the three-year period from 2018/19 to 2020/21.

The data sources for this report were: Emergency Department presentations recorded in the Victorian Emergency Minimum Dataset (VEMD), hospital admissions recorded in the Victorian Admitted Episodes Dataset (VAED), and deaths recorded in the Cause of Death Unit Record Dataset (COD). Population data were sourced from the Australian Bureau of Statistics (ABS).

1. ICD-10-AM codes 78.0: Anaphylaxis and anaphylactic shock due to adverse food reaction; T78.1: Other adverse food reactions, not elsewhere classified.

CONTENTS

EXECUTIVE SUMMARY

Adverse food reactions in Australia have increased over the past two decades: this has been described in terms of food-related anaphylaxis deaths as well as food reaction-related hospital admissions.

The Victorian Injury Surveillance Unit is mostly focused on traditional injury causes such as transport incidents, falls, self-harm and assault; however, the ICD-10-AM codes T78.0 & T78.1 (*anaphylaxis and anaphylactic shock due to adverse food reaction; other adverse food reactions, not elsewhere classified*) are within the ICD-10-AM Injury & Poisoning chapter and therefore contribute to overall injury statistics in terms of incidence and burden.

The aim of this edition of *Hazard* is to provide an overview of food allergies in Victoria over the ten-year period from 2011/12 to 2020/21, as well as an in-depth analysis of food allergies in the recent three-year period from 2018/19 to 2020/21. The focus of *Hazard* is on immunologic reactions: primarily, IgE- mediated allergic reactions to food. However, hospital admissions due to allergic and dietetic gastroenteritis and colitis are also included; coeliac disease is not included.

FATALITIES (FOOD ALLERGY RELATED)

- In Victoria, 2010–2019, there were nine deaths recorded in the Australian Coordinating Registry – Unit Record File with *Anaphylaxis and anaphylactic shock due to adverse food reaction* or *Other adverse food reactions* recorded in the conditions associated with the death (record axis data).

HOSPITAL TREATED – PATTERNS – 3 YEARS

EMERGENCY DEPARTMENT PRESENTATIONS (FOOD ALLERGY RELATED)

- Emergency Department presentations for adverse food reactions were selected from the Victorian Emergency Minimum Dataset (VEMD) for the 3-year period from 1 July 2018 to 30 June 2021: 12,568 in total.
- Over one-third of ED presentations (38%) were children below five years of age; children aged up to 15 years accounted for more than half (55%) of cases and more than half (53%) were female.
- The majority of cases resided in metropolitan Melbourne (78.2%).
- Country of birth of people presenting to the ED for adverse food reactions was most commonly Australia (90%); those born in China or India made up 0.7% and 0.8% of cases, respectively.
- Almost one-third of cases were diagnosed and coded as anaphylaxis (32%) while two-thirds (66%) were attributed to other adverse food reactions; dermatitis due to ingested food constituted 1.7% of adverse food reaction presentations.
- The most common day of presentation was Saturday (17%) followed by Sunday (16%); the most common season of presentation was Summer (28%) and the least common was Autumn (23%).
- More than one in three cases (34%) were triaged as *resuscitation* or *emergency* and a further 50% were considered *urgent*; the remaining 16% were triaged as *semi-* or *non-urgent*.
- Of those individuals presenting to the ED for adverse food reactions, 42% were admitted or transferred; 2% left before treatment was completed and 56% returned to their usual residence after the ED visit.
- The most commonly encountered (stemmed) words in the injury narrative free text were: ‘reaction’, ‘allergic/allergies’, ‘rash’, ‘vomit’, ‘anaphylaxis’, ‘swelling’, ‘nuts’, ‘ate’, ‘develop’, ‘eggs’, ‘given’ and ‘peanuts’; words such as ‘unknown’ and ‘nil’ were excluded.

HOSPITAL ADMISSIONS (FOOD ALLERGY RELATED)

- Hospital admission records for adverse food reactions were selected from the Victorian Admitted Episodes Dataset (VAED) for the 3-year period from 1 July 2018 to 30 June 2021: 3956 in total.
- More than one in four admissions (26%) were for children below five years of age; children aged up to 15 years accounted for 42% of admissions and more than half (53%) were female.
- The majority of cases resided in metropolitan Melbourne (81.3%).
- Country of birth of people admitted to hospital for adverse food reactions was most commonly Australia (88%); people born in China or India made up 0.6% and 0.9% of admissions, respectively.

- The principal diagnosis was most commonly anaphylaxis (65%) followed by other adverse food reactions (32%), allergic and dietetic gastroenteritis and colitis (2%), dermatitis due to ingested food (1%) and allergic contact dermatitis due to food in contact with skin (0.2%).
- In 2019/20–2020/21, the most commonly indicated allergen group was fruit, grains, nuts, seeds and vegetables; in this group, the most common specific allergens were tree nuts, nuts not elsewhere classified, and legumes (groundnuts – i.e. peanut): this ordering was observed in anaphylaxis cases as well as in other adverse food reactions, not elsewhere classified.
- Place of occurrence of onset of reaction was unspecified in 56% of cases; in 24% the place of occurrence was recorded as home.
- The most common day of admission was Sunday (17%) followed by Saturday (16%); the most common season of admission was Summer (28%) and the least common was Autumn (24%).

BURDEN OF INJURY (FOOD ALLERGY RELATED)

- Hospital beds were occupied for 7854 days as a result of adverse food reactions.
- Among those aged below 15 years, males accounted for 60% of bed days, whereas among those aged 15 years and above, females accounted for 63% of bed days.
- More than two-thirds of admissions (68%) were same-day stays; less than one-third (30%) were overnight admissions and 2% of admissions were multi-day stays.
- Multi-day stays were more common at ages 75+ years (21.1%), but overall, adverse food reaction hospital admissions were rare in this older age group (only 1.3% of all admissions).

HOSPITAL TREATED – TRENDS – 10 YEARS

EMERGENCY DEPARTMENT PRESENTATIONS (FOOD ALLERGY)

- In the ten-year period from 2011/12 to 2020/21, there were 34,986 Emergency Department presentations (an average of 3,499 per year) in relation to adverse food reactions in Victoria.
- Among males, ED presentations were most common at 0–4 years, and frequency decreased with increasing age. Among females, presentations were also most common at 0–4 years, with a second, smaller peak around the ages of 20–24 years.
- The age-standardised annual rate was 58.2 ED presentations per 100,000 population, on average over the ten-year period.
- The adverse food reaction ED presentation rate increased statistically significantly by 4.2% per year over the ten years.
- An increase in ED presentation rate was observed among both males (+3.4%) and females (+4.2%); for both males and females, the steepest *rate of increase* was observed at 15–24 years: +6.0% and +6.8% per year, respectively.
- Over the 10-year period, there was an increase in the proportion of ED presentations that were subsequently admitted/transferred, from 25% in 2011/12 to a maximum of 45% in 2018/19; this was followed by a slight decrease to 39% in 2020/21.
- There was also an increase in the proportion of ED presentations that were triaged as resuscitation/emergency, from 26% in 2011/12 to a maximum of 33% in both 2019/20 and 2020/21.

HOSPITAL ADMISSIONS (FOOD ALLERGY)

- In the ten-year period from 2011/12 to 2020/21, there were 17,010 hospital admissions (an average of 1,701 per year) in relation to adverse food reactions in Victoria.
- Among males, hospital admissions were most common at 0–4 years, and admissions decreased with increasing age; among females, hospital admissions were also most common at 0–4 years, with a second, smaller peak at 20–24 years.
- The age-standardised annual rate was 27.7 hospital admissions per 100,000 population, on average over the ten-year period.
- An increase in hospital admissions rate was observed among both males (+12.8%) and females (+15.7%); for both males and females, the steepest rate of increase was observed at 15–24 years: +17.6% and +19.1% per year, respectively.
- Of the hospital admissions over the 10-year period, 78% were Short Stay Unit admissions: this proportion increased from 41% of admissions in 2011/12 to a maximum of 86% of admissions in 2017/18, followed by a gradual decrease to 79% in 2020/21.

INTRODUCTION

Adverse food reactions are common and on the increase in Australia. Adverse food reactions include toxic reactions such as food poisoning, as well as non-toxic reactions. Non-toxic reactions consist of immunologic reactions such as allergies, and non-immunologic reactions such as lactose intolerance (Tedner et al., 2022). The focus of this edition of *Hazard* is on immunologic reactions: predominantly IgE-mediated, immediate allergic reactions. However, allergic and dietetic gastroenteritis and colitis are also included. Coeliac disease, which is a non-IgE immunologic food reaction, is not included in this analysis.

Adverse food reactions can range from mild skin itching, hives, or stomach pain to anaphylaxis and can be fatal. Anaphylaxis is a severe allergic reaction that may include a range of systemic symptoms and signs including difficult breathing, tongue swelling, throat tightness, hoarse voice, wheezing or cough, or dizziness/collapse (any one or more of these symptoms can occur). In this edition of *Hazard*, anaphylactic as well as less severe allergic reactions to food are included.

Common adverse food reactions are allergies to tree nuts, peanuts (which are groundnuts), shellfish, and sesame. In children, allergies to milk, soy or egg are relatively common, but these are often (although not always) outgrown with time; a similar pattern is observed for wheat allergies in children (Sicherer et al., 2018). Overall in Australia, peanuts and tree nuts are the most common cause of severe allergic reactions to food; the onset is often in early childhood and these allergies are usually not outgrown. Meat allergies, historically considered to be relatively rare, have become more common over time, possibly due to better recognition of the diagnosis. Seafood allergy and anaphylaxis are similarly more common, and represent a common trigger for fatal food related anaphylaxis in adults in Australia (Mullins et al., 2016). Furthermore, recent advances in understanding have demonstrated an interplay between tick exposure and meat allergies. This type of allergy, alpha-gal syndrome, has a delayed onset of several hours after ingestion of meat; the symptoms can range from urticaria (hives) or gastrointestinal symptoms, to anaphylactic reaction (Wilson et al., 2019).

Over the past two decades, research has shown that food allergies in Australia have increased. These increases have been described in hospital admissions for food-related anaphylaxis; between 2005/06 and 2011/12, rates increased 1.5-fold in Australia (Mullins et al., 2015). The greatest increases were observed in the age group 5 to 14 years, although the highest rates overall were in the age group 0 to 4 years. Between 1997 and 2013, food anaphylaxis deaths were reported to have increased by 10% per year in Australia; the same study also reported a similar rate of increase in food anaphylaxis hospital admission rates in that period (Mullins et al., 2016). Of the 22 food allergy deaths described in the study, the most common allergen was seafood (n=11), not nuts. Increased prevalence of allergies was also described in a survey-based study in Victorian government schools: the number of students at risk of anaphylaxis was reported to have increased from 0.98% in 2009 to 1.38% in 2014: a 40% increase over six years (Loke et al., 2016).

Management of food allergies consists of avoidance of allergens and treatment of reactions. Avoidance of allergens is not always simple, as this involves not only the person with the food allergy but also the immediate family, friends, workplace and/or school setting. Allergens may be unidentified or unintended ingredients in pre-packaged or freshly prepared meals/snacks. Furthermore, food labelling can be confusing, particularly the interpretation of non-regulated allergen precautions on packages. In children in particular, avoidance of multiple food groups can lead to undernourishment, if a well-rounded diet is not carefully managed. In the case of mild childhood allergies to eggs and potentially also milk, strict avoidance can sometimes be relaxed if small amounts of cooked foods are tolerated.

Severe allergic reactions can be treated with adrenaline, administered using adrenaline auto-injectors. Although generally considered effective and safe, adrenaline auto-injectors have been reported to be under-utilised for anaphylaxis (Gold et al., 2000). For small children (less than 20 kg), auto-injectors contain 150 micrograms per 0.3 ml injection; for older children and adults, the standard dosage is 300 micrograms (500 microgram dose is now available for larger adolescents and adults).

Trends in uptake of (publicly funded) adrenaline auto-injectors can provide an indication of trends in incidence of potentially severe allergies (Australian Government Department of Health, 2022). Pharmaceutical Benefit Scheme (PBS) subsidised supply of adrenaline injections in a pen device, for anticipated emergency treatment of acute allergic reaction with anaphylaxis, increased by over 70% in Victoria between 2011/12 (21,999 items) and 2020/21 (37,542 items). PBS items 8698T (300 micrograms per 0.3 ml injection) and 8697R (150 microgram per 0.3 ml injection) are both included: the latter, which contains a small child dosage, did not show an increasing trend, whereas the former showed an increase of 106% over the 10-year period, in Victoria. The combined PBS subsidised adrenaline auto-injector trends in other Australian jurisdictions also showed increased uptake over the period from 2011/12 to 2020/21. The use of these medications is, however, not limited to acute treatment of food-related reactions but expands to all allergic reactions with potential anaphylaxis (e.g., insect allergy).

To prevent allergies from developing, the current advice is to encourage early introduction of allergen foods prior to one year of age (i.e. not to delay the introduction of allergenic foods in infants): this guideline was first implemented in Australia in 2008 and updated in 2016 (Joshi et al., 2019). Prior to 2008 it was recommended to delay the introduction of allergenic food, because early introduction was thought to increase the risk of food sensitisation due to immaturity of the infant gut lining; this is no longer believed to be true (Mullins et al., 2022). Recent, preliminary evidence suggests that the altered feeding guidelines may have had an effect in slowing down the observed increase in anaphylaxis in children in Australia (Soriano et al., 2019; Mullins et al., 2022). In this rapidly changing landscape of food allergy incidence and prevalence, a comprehensive overview of current food allergy-related hospital admissions and ED presentations in Victoria is timely.

AIMS AND DATA SOURCES

AIM

The aim of Edition 91 of *Hazard* is to provide an overview of food allergies resulting in hospital treatment in Victoria. Time trends over the ten-year period from 2011/12 to 2020/21 are presented, as well as an in-depth analysis of hospital-treated food allergies in the three-year period from 2018/19 to 2020/21. Deaths due to adverse food reactions are also presented for the period 2010 to 2019.

DATA SOURCES

The data sources for this edition of *Hazard* are the Victorian Emergency Minimum Dataset (VEMD), the Victorian Admitted Episodes Dataset (VAED), and Cause of Death Unit Record Data (COD). Population data were sourced from the Australian Bureau of Statistics (ABS).

METHODS

OVERVIEW OF METHODS USED TO DETERMINE PATTERNS OF ADVERSE FOOD REACTIONS

For the correct interpretation of the presented Emergency Department, hospital admission and death data statistics, an understanding of the case selection for each data source is essential.

CASE SELECTION FOR DEATH DATA

Fatal adverse food reaction data were extracted from the Cause of Death (COD) dataset supplied by the Australian Coordinating Registry (ACR) and based on the Australian Bureau of Statistics (ABS) cause of death data. Case selection was limited to deaths registered over the 10-year period from January 2010 to December 2019. Deaths due to adverse food reactions were selected as those with T78.0 *anaphylaxis and anaphylactic shock due to adverse food reaction* or T78.1 *other adverse food reactions, not elsewhere classified* listed in the ICD-10 Record Axis Data (RACS codes). K52.2 *allergic and dietetic gastroenteritis and colitis*; L27.2 *dermatitis due to ingested food*; and L23.6 *allergic contact dermatitis due to food in contact with skin* did not occur in the RACS codes in the Victorian COD data for this time period.

CASE SELECTION FOR EMERGENCY DEPARTMENT PRESENTATIONS

Emergency Department cases were selected from the Victorian Emergency Minimum Dataset (VEMD) which records all presentations to Victorian public hospitals with 24-hour emergency departments (currently 39 hospitals). Case selection was limited to the 10-year period from 1 July 2011 to 30 June 2021. Adverse food reaction-related ED presentations were selected based on the occurrence of diagnosis code: T78.0 *anaphylaxis and anaphylactic shock due to adverse food reaction*, T78.1 *other adverse food reactions, not elsewhere classified* and L27.2 *dermatitis due to ingested food.* Cases were selected if one of these were listed as the first-occurring diagnosis code. Other relevant ICD-10-AM codes (K52.2 *allergic and dietetic gastroenteritis and colitis*; L23.6 *allergic contact dermatitis due to food in contact with skin*) are not captured in the VEMD diagnosis fields and could therefore not be used for ED presentation case selection. Data was sampled and manually checked to verify that (i) cases selected based on diagnosis codes were generally relevant to adverse food reactions, and (ii) narrative searches using key words do not contribute substantially to case selection (i.e., no more than 5%), and selection based on diagnosis codes only is adequate. Further details about case selection are provided in Appendix A.

CASE SELECTION FOR HOSPITAL ADMISSIONS

Hospital admission cases were selected from the Victorian Admitted Episodes Dataset (VAED). The VAED records all hospital admissions in public and private hospitals in the state of Victoria. Case selection was limited to the 10-year period from 1 July 2011 to 30 June 2021. Adverse food reaction-related hospital admissions were selected based on the occurrence of a relevant ICD-10-AM principal diagnosis code. The following codes were considered relevant to adverse food reactions: T78.0 *anaphylaxis and anaphylactic shock due to adverse food reaction*; T78.1 *other adverse food reactions, not elsewhere classified*; K52.2 *allergic and dietetic gastroenteritis and colitis*; L27.2 *dermatitis due to ingested food*; and L23.6 *allergic contact dermatitis due to food in contact with skin*. Further details about case selection are provided in Appendix A.

RESULTS

Section A provides an overview of deaths due to adverse food reactions, for all years of available Cause of Death data.

Section B is a detailed examination of hospital-treated adverse food reactions from the past three years, in terms of various demographic and clinical details.

Section C is a broad examination of hospital-treated adverse food reaction trends over the past 10 years.

SECTION A:
FATAL ADVERSE FOOD REACTIONS 2010–2019

DEATHS DUE TO ADVERSE FOOD REACTIONS: 2010 TO 2019, VICTORIA

Data from the Australian Coordinating Registry – Unit Record File were examined to determine the number of deaths due to adverse food reactions in Victoria, 2010–2019. Over this ten-year period, a total of nine deaths had *Anaphylaxis and anaphylactic shock due to adverse food reaction* (T78.0) or *Other adverse food reactions, not elsewhere classified* (T78.1) recorded in the Record Axis Data: this equates to almost one fatality per year.

To maintain data confidentiality and privacy of the individuals, further breakdowns of the death data by demographic variables or causes cannot be provided.

SECTION B: HOSPITAL-TREATED ADVERSE FOOD REACTIONS 2018/19–2020/21

EMERGENCY DEPARTMENT PRESENTATIONS

In the three-year period from 2018/19 to 2020/21, there were 12,568 ED presentations for adverse food reactions, by Victorians. The majority (78.2%) resided in Melbourne metropolitan areas and a smaller proportion (21.8%) resided in regional/rural Victoria. The number of cases per year, and the distribution across age groups and sex, are shown in Table 1. Over one-third of cases (38%) were children below five years of age; children aged up to 15 years accounted for more than half (55%) of cases and persons up to 25 years accounted for 72% of cases. Slightly more than half (53%) were female.

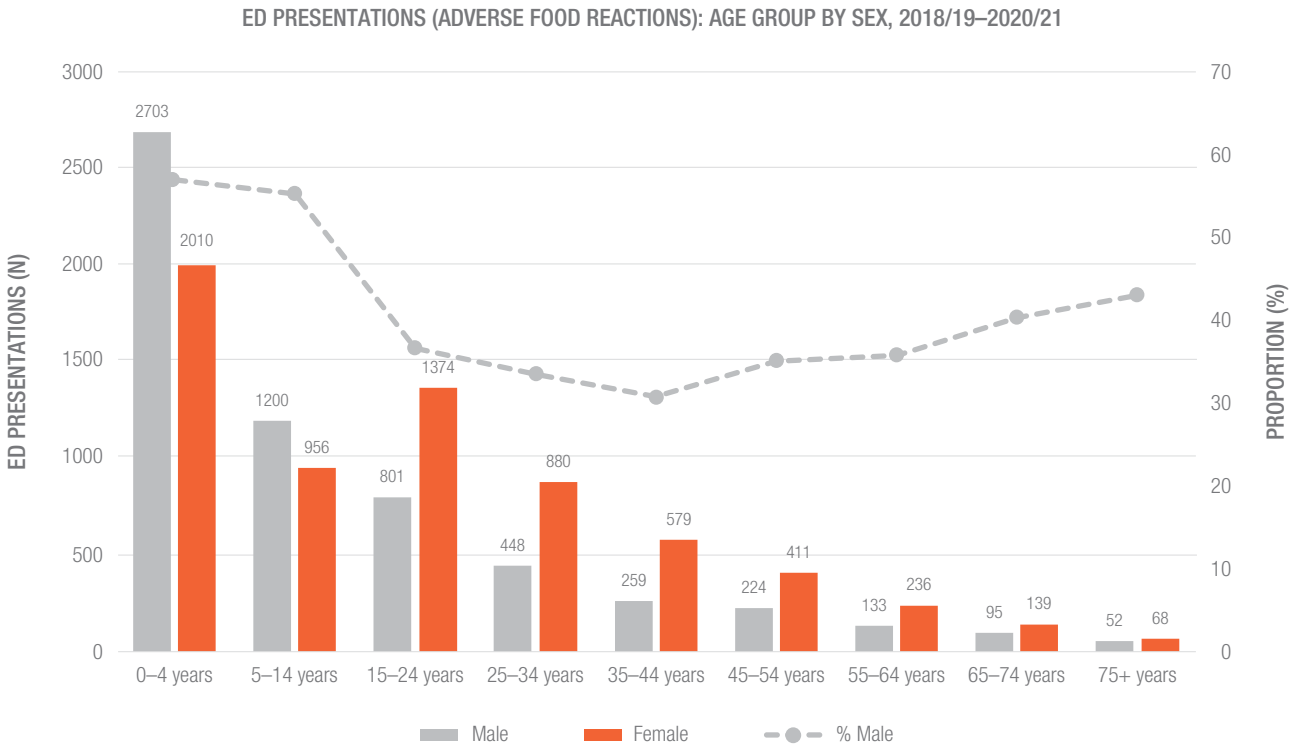
TABLE 1
EMERGENCY DEPARTMENT PRESENTATIONS FOR ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21: PRESENTATIONS BY YEAR, AGE GROUP AND SEX

	Emergency Department (ED) presentations	
	N	%
Year		
2018/19	4147	33.0
2019/20	3960	31.5
2020/21	4461	35.5
Age group		
0–4 years	4713	37.5
5–14 years	2156	17.2
15–24 years	2175	17.3
25–34 years	1328	10.6
35–44 years	838	6.7
45–54 years	635	5.1
55–64 years	369	2.9
65–74 years	234	1.9
75 and above	120	1.0
Sex		
Males	5915	47.1
Females	6653	52.9
Total:	**12,568**	**100.0**

EMERGENCY DEPARTMENT PRESENTATIONS: DEMOGRAPHICS

The age distribution for males was strikingly different to the age distribution for females, as shown in Figure 1. Adverse food reaction-related ED presentations in males were most common at ages below 5 years and decreased as age increased. For females, the distribution was bimodal with a first peak at 0–4 years and a second peak at 15–24 years. The median age for males was 6 years, whereas the median age for females was 17 years. For both males and females, the incidence decreased after the age of 25 years, and adverse food reactions resulting in ED presentations were relatively uncommon at ages 65 years and above.

FIGURE 1
EMERGENCY DEPARTMENT (ED) PRESENTATIONS RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21: PRESENTATIONS PER AGE GROUP AND SEX



Country of birth of persons presenting to the Emergency Department in relation to adverse food reactions is presented in Table 2. The majority of patients were born in Oceania and Antarctica; of these 11,370 patients, 11,249 (99%) were born in Australia. The next most common region of birth was South East Asia with 230 ED presentations. Third most common region of birth was North-West Europe; of these 216 patients, 117 (54%) were born in England. Only 0.7% and 0.8% of persons presenting to the ED for adverse food reactions were recorded as born in China and India, respectively. To provide context: people born in China or India made up 2.7 and 2.9% (respectively) of the Victorian population, as calculated from the 2016 census (Australian Bureau of Statistics, 2016); these proportions are likely to have increased since 2016.

TABLE 2
EMERGENCY DEPARTMENT PRESENTATIONS FOR ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21: PRESENTATIONS BY COUNTRY OF BIRTH, IN MAJOR GROUPS

	ED presentations	
	N	%
Country of birth (major groups)		
Oceania and Antarctica	11,370	90.5
North-West Europe	216	1.7
Southern and Eastern Europe	132	1.1
North Africa and the Middle East	104	0.8
South-East Asia	230	1.8
North-East Asia	136	1.1
Southern and Central Asia	190	1.5
Americas	81	0.6
Sub-Saharan Africa	58	0.5
Not stated	51	0.4
Total:	**12,568**	**100.0**

EMERGENCY DEPARTMENT PRESENTATIONS: DIAGNOSES

The most common diagnosis among ED presentations for adverse food reactions was *other adverse food reactions, not elsewhere classified*, accounting for two-thirds of cases (Table 3). Almost one-third of all cases involved *anaphylaxis due to adverse food reaction. Dermatitis due to ingested food* was relatively uncommon in the ED presentations for adverse food reactions, accounting for less than two percent of cases. Notably, the incidence of *allergic and dietetic gastroenteritis and colitis* (food hypersensitivity gastroenteritis or colitis) could not be captured in the data because this diagnosis is not specifically coded in the Emergency Department (VEMD). For the same reason, the incidence of *allergic contact dermatitis due to food contact with skin* was not captured.

TABLE 3
ED PRESENTATIONS RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21: NUMBER OF PRESENTATIONS PER FIRST-LISTED DIAGNOSIS

	ED presentations	
	N	%
First occurring diagnosis		
Anaphylaxis and anaphylactic shock due to adverse food reaction (ICD-10-AM T78.0)	4020	32.0
Other adverse food reactions, not elsewhere classified (ICD-10-AM T78.1)	8333	66.3
Dermatitis due to ingested food (ICD-10-AM L27.2)	215	1.7
Total:	**12,568**	**100.0**

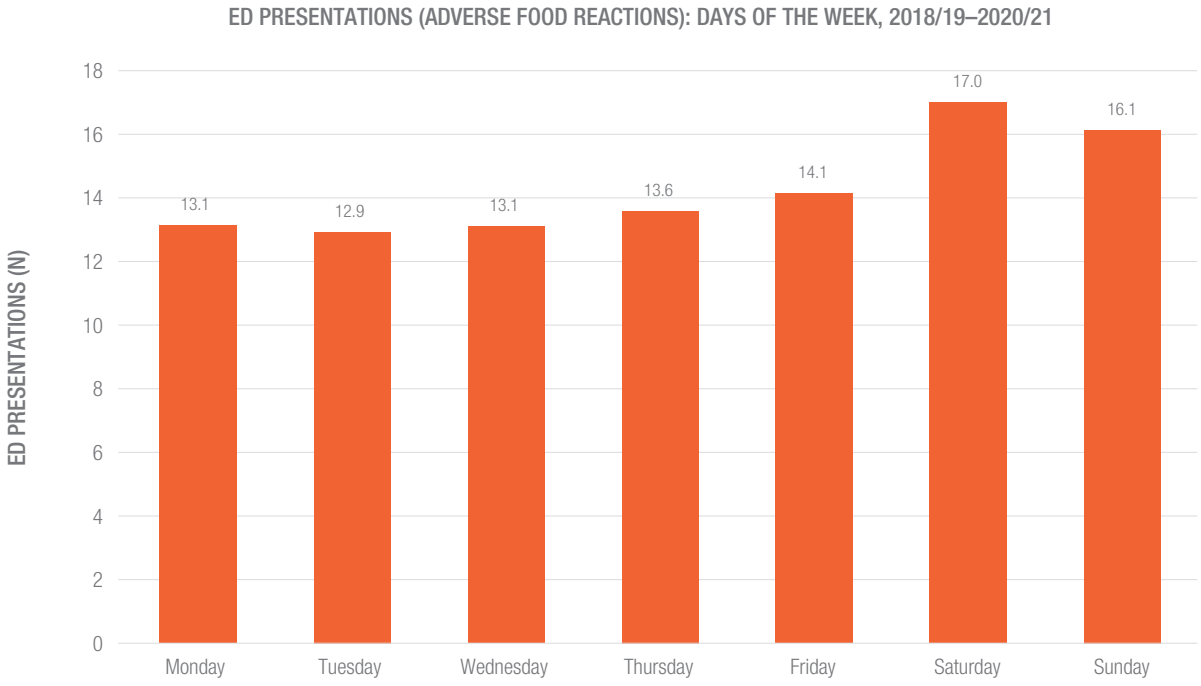
EMERGENCY DEPARTMENT PRESENTATIONS: PLACE OF OCCURRENCE

In this report, the place of occurrence (i.e. place of onset of symptoms) of adverse food reactions is not reported because >60% of the data was missing in the adverse food reaction cases recorded in the Emergency Department data. A further 16% was coded as place of occurrence: 'unspecified'. With place of occurrence specified in less than one in four cases, it was considered that the data was unlikely to give an accurate reflection of place of occurrence for all cases.

EMERGENCY DEPARTMENT PRESENTATIONS: DAY AND MONTH OF OCCURRENCE

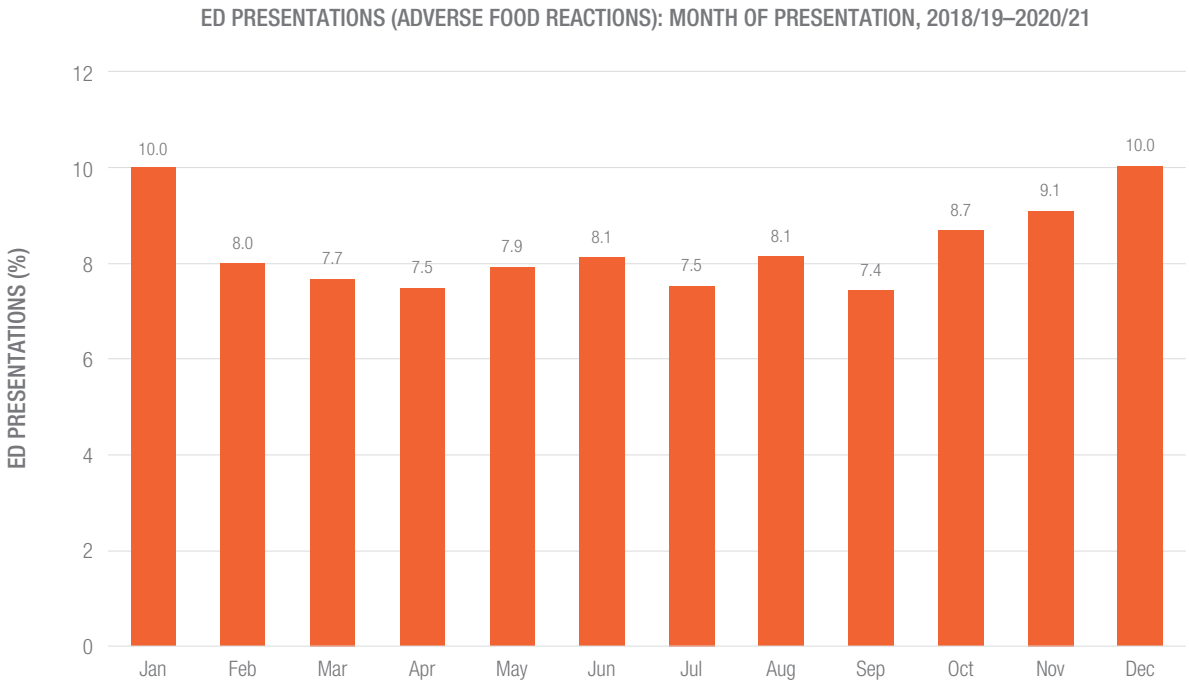
The number of ED presentations for adverse food reactions differed by day of the week: this pattern is shown in Figure 2. ED presentations for adverse food reactions occurred most frequently on Saturdays (17%), followed by Sundays (16%). Adverse food reaction related ED presentations were least common on Monday through to Wednesday.

FIGURE 2
EMERGENCY DEPARTMENT (ED) RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21: PRESENTATIONS PER DAY OF THE WEEK



The monthly variation in adverse food reaction ED presentations is shown in Figure 3. A (modest) seasonal pattern is observed, with adverse food reactions most common in Summer (n=3515, 28%) and least common in Autumn (n=2900, 23%). There were 2988 (24%) cases in Winter and 3165 (25%) cases in Spring. Specifically, adverse food reaction related ED presentations were most common in December (10%) and January (10%) and least common in September (7.4%), April (7.5%) and July (7.5%).

FIGURE 3
EMERGENCY DEPARTMENT (ED) PRESENTATIONS RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21: PRESENTATIONS PER MONTH OF THE YEAR



EMERGENCY DEPARTMENT PRESENTATIONS: TRIAGE CATEGORY AND DEPARTURE STATUS

An overview of triage categories and departure status of those presenting to the ED in relation to adverse food reactions is shown in Table 4. More than one-third of cases were triaged as 'emergency' or 'resuscitation' and a further 50% of cases were 'urgent'. As expected, anaphylaxis cases were more likely to be triaged as 'resuscitation' (4.2%) or 'emergency' (50.5%).

Following ED presentation for adverse food reactions, more than half (56%) of patients returned to their usual residence. A further 42% were transferred elsewhere on the same hospital campus: mostly commonly, the Short Stay Unit (34%). Less than one percent of patients were transferred to another hospital campus. Two percent of cases left before the treatment was completed; most commonly, leaving at their own risk after the treatment was started.

TABLE 4
ED PRESENTATIONS RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21: OVERVIEW OF TRIAGE CATEGORY AND DEPARTURE STATUS

	ED presentations	
	N	%
Triage category		
Resuscitation	219	1.7
Emergency	4105	32.7
Urgent	6225	49.5
Semi urgent	1888	15.0
Non urgent	131	1.0
Departure status		
Departure before treatment completed:		
Left at own risk, without treatment	17	0.1
Left after clinical advice regarding treatment options	16	0.1
Left at own risk, after treatment started	167	1.3
Died within ED	*	*
This campus:		
Emergency Department (ED) Short Stay Unit	4331	34.5
Intensive Care Unit – this campus	103	0.8
Coronary Care Unit – this campus	*	*
Medical Assessment and Planning Unit	135	1.1
Other Mental Health Bed – this Campus	*	*
Other operating theatre/procedure room	*	*
Ward not elsewhere described	698	5.6
Transfers to another hospital campus:		
Another Hospital Campus	35	0.3
Another Hospital Campus – Intensive Care Unit	16	0.1
Another Hospital Campus – Coronary Care Unit	*	*
Returning to usual residence:		
Home	7033	56.0
Residential Care facility	*	*
Correctional/Custodial Facility	8	0.1
Total:	**12,568**	**100.0**

*Cases have been supressed due to small cell counts.

EMERGENCY DEPARTMENT NARRATIVES

The ED narratives were explored in terms of word frequencies. The words ‘unknown’ and ‘nil’ occurred frequently but were not considered to contribute meaningful information, and were excluded from the narrative analysis. From the remaining narrative data, the (stemmed) words ‘reaction’, ‘allergic/allergies’, ‘rash’, ‘vomit’, ‘anaphylaxis’, ‘swelling’, ‘nuts’, ‘ate’, ‘develop’, ‘eggs’, ‘given’ and ‘peanuts’ were the most frequently occurring. An overview of frequently occurring narrative words is provided in Figure 4; the raw data is used for this, without correction of spelling mistakes. Nota bene: ‘Biba’ generally refers to ‘brought in by ambulance’.

FIGURE 4
EMERGENCY DEPARTMENT NARRATIVES: WORD CLOUD OF MOST FREQUENTLY OCCURRING WORDS. “NIL” AND “UNKNOWN” (AND SPELLING VARIATIONS) WERE EXCLUDED FROM THE WORD CLOUD.

HOSPITAL ADMISSIONS

From 2017/18 to 2020/21, there were 7414 hospital admissions related to adverse food reactions in Victoria. The majority (81.3%) resided in Melbourne metropolitan areas and a smaller proportion (18.7%) resided in regional/rural Victoria. The annual number of adverse food reaction admissions and the distribution across age groups and sex are shown in Table 5. Adverse food reactions were particularly common in those aged 0–4 years: over one-quarter of all admission occurred in this age group. The age group 0–14 years made up 42% of the admissions (Figure 5). Adverse food reaction admissions were less common at ages 35 years and above, and relatively uncommon above the age of 75 years.

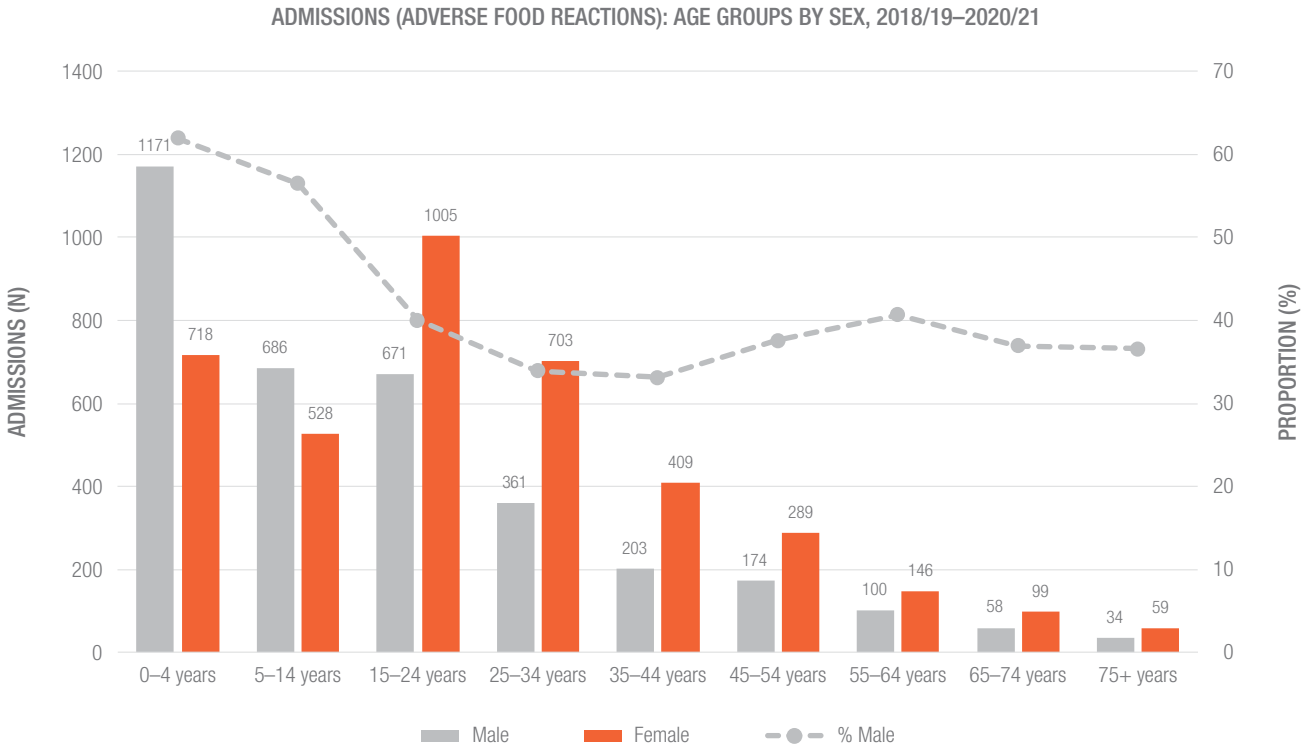
HOSPITAL ADMISSIONS: DEMOGRAPHICS

Slightly more than half of those admitted to hospital in relation to adverse food reactions were female (53%); however, the male to female ratio was age-dependent, as shown in Figure 5. Males constituted 62% of admissions in the age group 0–4 years, but this percentage dropped to less than 50% at ages 15 years and above. At ages 35–44 years, only 33% of hospital admissions for adverse food reactions were male.

TABLE 5
HOSPITAL ADMISSIONS RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21: ADMISSIONS BY YEAR, AGE GROUP AND SEX

	Hospital admissions	
	N	%
Year		
2018/19	2544	34.3
2019/20	2392	32.3
2020/21	2478	33.4
Age group		
0–4 years	1889	25.5
5–14 years	1214	16.4
15–24 years	1676	22.6
25–34 years	1064	14.4
35–44 years	612	8.3
45–54 years	463	6.2
55–64 years	246	3.3
65–74 years	157	2.1
75 and above	93	1.3
Sex		
Males	3458	46.6
Females	3956	53.4
Total:	**7414**	**100.0**

FIGURE 5
HOSPITAL ADMISSIONS RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21:
ADMISSIONS PER AGE GROUP AND SEX



Country of birth of persons admitted to hospital in relation to adverse food reactions is presented in Table 6. The majority of patients were born in Oceania and Antarctica; of these 6589 patients, 6508 (99%) were born in Australia. The next most common region of birth was North-West Europe; of these 170 patients, 94 (55%) were born in England. Only 0.6% and 0.9% of persons admitted for adverse food reactions were recorded as born in China and India, respectively. To provide context: people born in China or India made up 2.7 and 2.9% of the Victorian population in 2016, as calculated from the 2016 census (Australian Bureau of Statistics, 2016); these proportions are likely to have increased since 2016.

TABLE 6
HOSPITAL ADMISSIONS RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21:
ADMISSIONS BY COUNTRY OF BIRTH, IN MAJOR GROUPS

	Hospital admissions	
	N	%
Country of birth (major groups)		
Oceania and Antarctica	6589	88.9
North-West Europe	170	2.3
Southern and Eastern Europe	74	1.0
North Africa and the Middle East	69	0.9
South-East Asia	155	2.1
North-East Asia	75	1.0
Southern and Central Asia	131	1.8
Americas	58	0.8
Sub-Saharan Africa	43	0.6
Not elsewhere classified/not stated/missing	50	0.7
Total:	**7414**	**100.0**

HOSPITAL ADMISSIONS: DIAGNOSES

Almost two-thirds of admissions related to adverse food reactions were for anaphylaxis (65%), as shown in Table 7. The next most common group were other adverse food reactions (32%). These are non-anaphylactic food reactions, but exclude bacterial food-borne intoxications. Food-related dermatitis (1.2%) and food-hypersensitivity gastroenteritis and colitis (1.7%) were relatively uncommon.

TABLE 7
HOSPITAL ADMISSIONS RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21: NUMBER OF ADMISSIONS PER PRINCIPLE DIAGNOSIS GROUP

	Hospital admissions	
	N	%
Principal diagnosis		
Anaphylaxis and anaphylactic shock due to adverse food reaction (ICD-10-AM: T78.0)	4808	64.9
Other adverse food reactions, not elsewhere classified (ICD-10-AM: T78.1)	2388	32.2
Dermatitis due to ingested food (ICD-10-AM: L27.2)	71	1.0
Allergic contact dermatitis due to food in contact with skin (ICD-10-AM: L23.6)	18	0.2
Allergic and dietetic gastroenteritis and colitis (ICD-10-AM: K52.2)	129	1.7

HOSPITAL ADMISSIONS: ALLERGENS

Allergen types for adverse food reactions that are classified as anaphylaxis or 'other adverse food reactions' are captured in the code for exposure to or contact with allergens (ICD-10-AM code Y37). This code was only recorded in admissions for adverse food reactions from 2019/20 onwards: i.e., the most recent two years of currently available hospital admissions data. An overview of the main allergen categories is shown in Table 8. To provide a comprehensive overview, all Y37 categories are listed, but Y37.1, Y37.6, Y37.7 and Y37.9 do not relate to food exposure (shown in italics). The most common food allergy was to fruit, grains, nuts, seeds and vegetables. Seafood and dairy allergies were less common; egg allergies were more likely to be recorded in 'other adverse food reactions' (10%) than in anaphylaxis (5%). Food additive allergies were relatively rare.

TABLE 8
HOSPITAL ADMISSIONS RELATED TO ADVERSE FOOD REACTIONS, 2019/20 TO 2020/21 (MOST RECENT TWO YEARS ONLY): FOOD ALLERGENS

	Anaphylaxis and anaphylactic shock due to adverse food reaction (ICD-10-AM: T78.0)		Other adverse food reactions, not elsewhere classified (ICD-10-AM: T78.1)	
	N	%	N	%
Code for exposure to or contact with allergens (ICD-10-AM: Y37)	3181	99.7	1527	99.7
Allergy to fruit, grains, nuts, seeds and vegetables (ICD-10-AM: Y37.0)	1702	53.3	720	47.0
Allergy to natural flora, not elsewhere classified[§] (ICD-10-AM: Y37.1)	*	*	*	*
Allergy to seafood (ICD-10-AM: Y37.2)	234	7.3	138	9.0
Allergy to dairy products (ICD-10-AM: Y37.3)	178	5.6	105	6.9
Allergy to eggs (ICD-10-AM: Y37.4)	157	4.9	157	10.3
Allergy to food additives (ICD-10-AM: Y37.5)	21	0.7	*	*
Allergy to animals[§] (ICD-10-AM: Y37.6)	*	*	*	*
Allergy to latex[§] (ICD-10-AM: Y37.7)	0	0.0	0	0.0
Allergy to other specified allergen (ICD-10-AM: Y37.8)	395	12.4	220	14.4
Allergy to unspecified allergen[§] (ICD-10-AM: Y37.9)	536	16.8	198	12.9
Total:	**3192**	**100.0**	**1531**	**100.0**

*Cases have been supressed due to small cell counts.
[§]Not a food allergen.

Allergy to fruits, grains, nuts, seeds and vegetables was common and therefore, this is shown in more detail in Table 9. Tree nuts (i.e., nuts such as almonds, cashews, brazil nuts, walnuts) were the most commonly listed food allergy, followed by nuts – not elsewhere classified. Third-most common were allergies to legumes, which include peanuts, also known as groundnuts. This ordering of the three most common allergies was observed in food related anaphylaxis as well as other adverse food reactions. Nuts and legumes combined constituted 45% of food anaphylaxis hospital admissions and 38% of admissions due to other food reactions, not elsewhere classified. Less common were allergies to sesame seeds, allergies to seeds – not elsewhere classified and allergy to grains containing gluten. Please note that *Grain allergy* is distinct from *coeliac disease*, which is an immune reaction to eating gluten, resulting in inflammation in the lining of the small intestinal lining. Coeliac disease is outside of the scope of this *Hazard*.

TABLE 9
HOSPITAL ADMISSIONS RELATED TO ADVERSE FOOD REACTIONS, 2019/20 TO 2020/21 (MOST RECENT TWO YEARS ONLY): DETAILS OF FRUIT, GRAINS, NUTS, SEEDS AND VEGETABLE FOOD ALLERGENS

	Anaphylaxis and anaphylactic shock due to adverse food reaction (ICD-10-AM: T780)		Other adverse food reactions, not elsewhere classified (ICD-10-AM: T781)	
	N	%	N	%
Allergy to fruit, grains, nuts, seeds and vegetables (ICD-10-AM: Y37.0)	1702	53.3	720	47.0
Allergy to fruit and vegetables, unspecified (ICD-10-AM: Y37.00)	21	0.7	9	0.6
Allergy to tree nuts (ICD-10-AM: Y37.01)	565	17.7	215	14.0
Allergy to legumes [groundnuts][§] (ICD-10-AM: Y37.02)	399	12.5	161	10.5
Allergy to nuts, not elsewhere classified (ICD-10-AM: Y37.03)	464	14.5	200	13.1
Allergy to sesame seed (oil) (ICD-10-AM: Y37.04)	56	1.8	20	1.3
Allergy to seeds, not elsewhere classified (ICD-10-AM: Y37.05)	43	1.4	*	*
Allergy to berries (ICD-10-AM: Y37.06)	10	0.3	11	0.7
Allergy to grains containing gluten (ICD-10-AM: Y37.07)	44	1.4	14	0.9
Allergy to grains, not elsewhere classified (ICD-10-AM: Y37.08)	13	0.4	*	*
Allergy to other fruits and vegetables (ICD-10-AM: Y37.09)	118	3.7	88	5.8
Total:	**3192**	**100.0**	**1531**	**100.0**

*Cases have been supressed due to small cell counts.
[§]Peanuts (also known as groundnuts) are classified as legumes.

HOSPITAL ADMISSIONS: PLACE OF OCCURRENCE

Place of occurrence (i.e., place of symptom onset) of the food reaction is summarised in Table 10. Notably, in more than half of admissions (56%), the place of occurrence was coded as unspecified. In almost one in four admissions, the place of occurrence was coded as home. Place of occurrence was also relatively commonly coded as school, other institution and public administrative area, and trade and service area. Of the 486 cases coded as having taken place in School, other institution and public administrative area, 223 (46%) took place in *schools*, specifically.

TABLE 10
HOSPITAL ADMISSIONS RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21: PLACE OF OCCURRENCE

	Admissions related to adverse food reactions	
	N	%
Place of occurrence		
Home	1796	24.2
Residential institution	30	0.4
School, other institution and public administrative area	486	6.6
Sports and athletics area	29	0.4
Street and highway	*	*
Trade and service area	661	8.9
Industrial and construction area	*	*
Other specified place of occurrence	88	1.2
Unspecified place of occurrence	4125	55.6
Missing	183	2.5
Total:	**7414**	**100.0**

*Cases have been suppressed due to small cell counts.

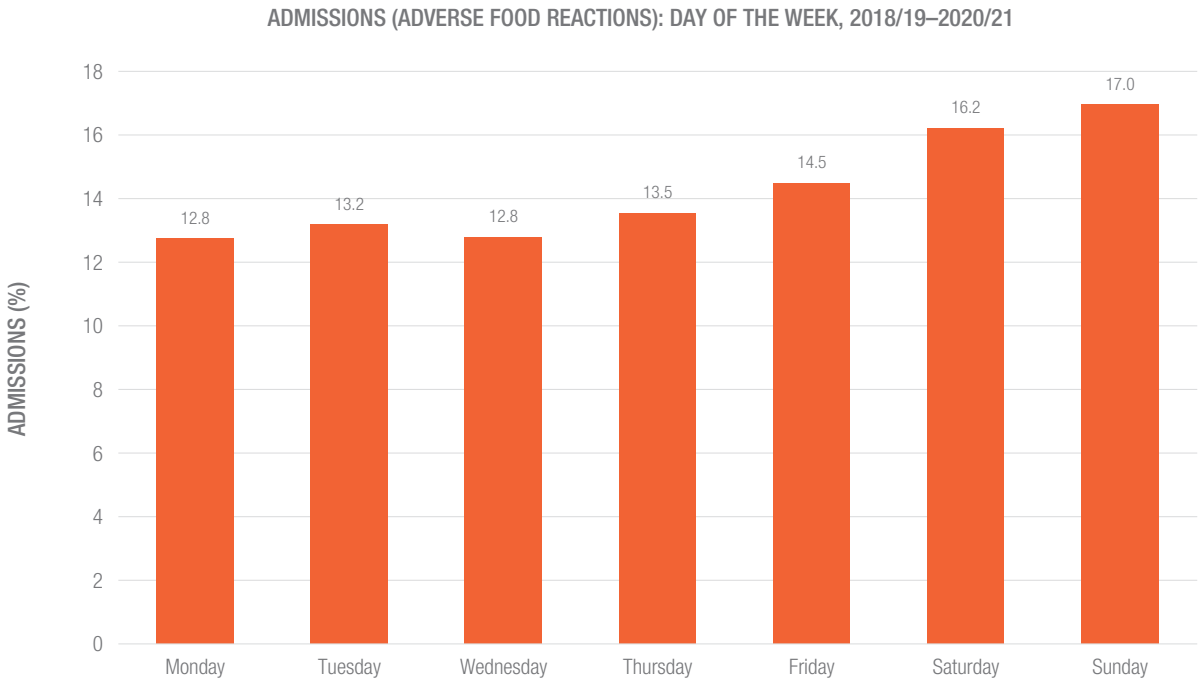
HOSPITAL ADMISSIONS: CO-OCCURRENCE OF ASTHMA

Supplementary codes for chronic conditions (U78 – U88 in the ICD-10-AM coding) were relatively common in the adverse food reaction admissions: 1524 (21%) admissions had a supplementary chronic conditions code. In total, 1870 supplementary codes were recorded, as more than one could be recorded for each admission. The most commonly occurring supplementary chronic conditions code was for *asthma, without mention of chronic obstructive pulmonary disease* (n=1089, 14.7% of admissions). A further 52 admissions (0.7%) had a diagnosis code for asthma (J45, J46): in these cases, asthma played a role in the admission for adverse food reactions. This was relatively rare.

HOSPITAL ADMISSIONS: DAY AND MONTH OF OCCURRENCE

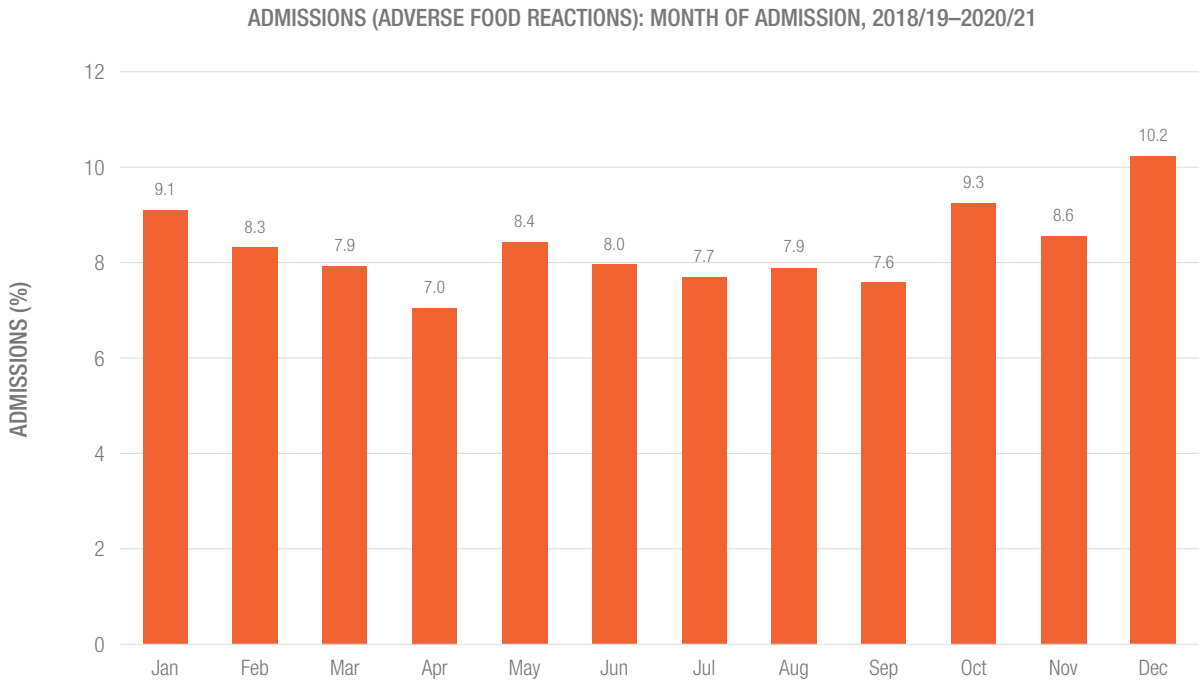
The number of hospital admissions for adverse food reactions differed by day of the week: this pattern is shown in Figure 6. Adverse food reaction related hospital admissions occurred most frequently on Sundays (17%), followed by Saturdays (16%). Admissions were least common on Monday through to Wednesday.

FIGURE 6
HOSPITAL ADMISSIONS RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21: ADMISSIONS PER DAY OF THE WEEK



The monthly variation in adverse food reaction admissions is shown in Figure 7. A modest seasonal pattern is observed, with admissions more common in Summer (n=2050, 28%) than in Autumn (n=1734, 24%), Winter (n=1747, 24%) or Spring (n=1883, 25%). Specifically, adverse food reaction admissions were most common in December (10.2%) and least common in April (7.0%).

FIGURE 7
HOSPITAL ADMISSIONS RELATED TO ADVERSE FOOD REACTIONS, 2018/19 TO 2020/21:
ADMISSIONS PER MONTH OF THE YEAR



BURDEN OF ADVERSE FOOD REACTIONS: 2018/19–2020/21 (THREE YEARS)

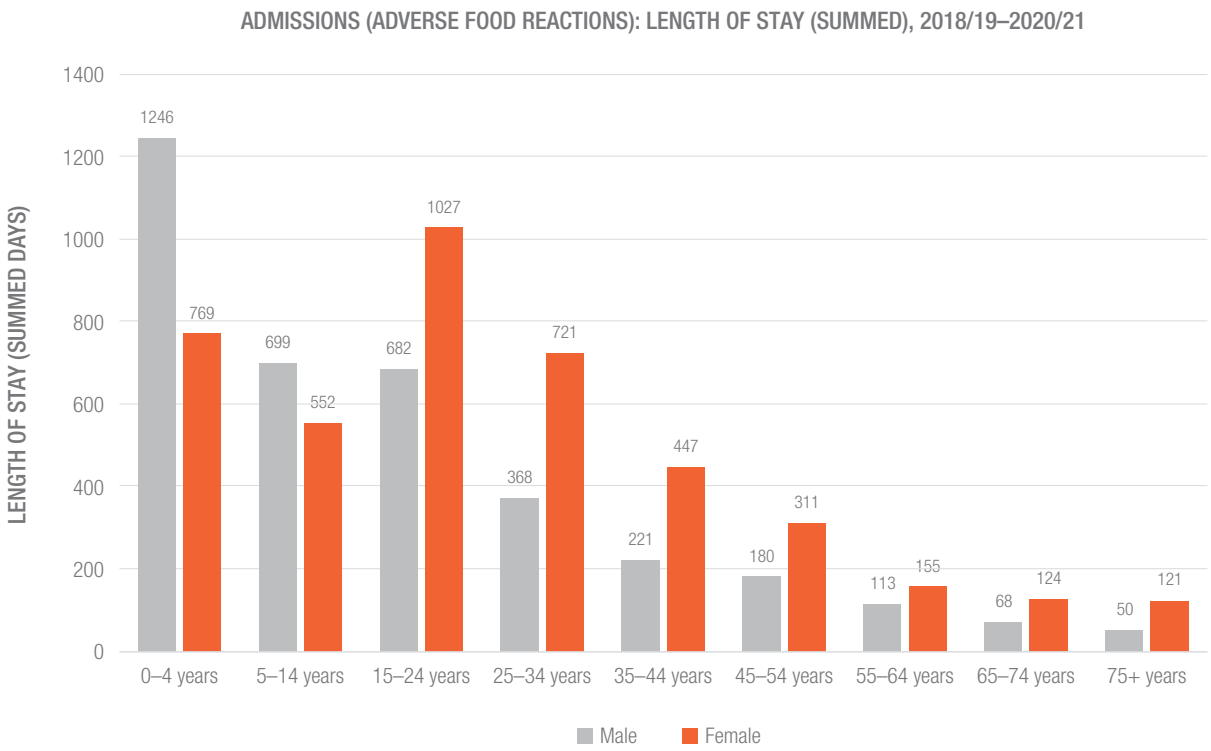
For the analyses of injury burden, data selection is not limited to incident cases, but transfers are also included, to capture the full extent of hospital care. Notably, less than 5 cases were statistical admissions (change in Care Type within the hospital) and n=58 (0.78%) were transfers from acute hospital/extended care/rehabilitation/geriatric centre. By comparison, in the whole VAED, 0.86% were statistical admissions and 4.1% of cases were transfers from acute hospital/extended care/rehabilitation/geriatric centre. This may be related to the relatively young patient group experiencing adverse food reactions.

In-hospital death was rare with less than five deaths occurring in the 7475 hospital admissions for adverse food reactions in 2018/19 to 2020/21.

LENGTH OF STAY

Hospital beds were occupied for 7854 days as a result of adverse food reactions. More than half (n=4227, 54%) of total bed days were accounted for by males but the sex difference in bed days differed markedly by age group (Figure 8). At ages below 15 years, males accounted for 60% of bed days (n=1945/3266). At ages 15 years and above, females accounted for 63% of bed days (n=2906/4588).

FIGURE 8
SUMMED LENGTH OF STAY (DAYS) FOR ADVERSE FOOD REACTION HOSPITAL ADMISSIONS, BY AGE GROUP AND SEX, VICTORIA, 2018/19–2020/21



NB. Calculations for length of hospital stay included transfers within and between hospitals to more accurately estimate burden of injury.

An overview of hospital admission bed days by type of adverse food reaction and patient demographics is provided in Table 11. Dermatitis due to ingested food or contact with food and allergic and dietetic gastroenteritis and colitis were relatively uncommon and only made up 1% and 4% respectively of adverse food reaction hospitalisation bed days. Relative overrepresentation of hospital bed days by males aged 0–14 years and females aged 15+ years is observed for *anaphylaxis* as well as *other adverse food reaction*.

TABLE 11
SUMMED LENGTH OF HOSPITAL ADMISSION STAY (DAYS) PER ADVERSE FOOD REACTION DIAGNOSIS GROUP (PRINCIPAL DIAGNOSIS ONLY), BY AGE GROUP AND SEX, VICTORIA, 2018/19–2020/21

	Hospital admission length of stay (summed)							
	Anaphylaxis and anaphylactic shock due to adverse food reaction		Other adverse food reactions, not elsewhere classified		Dermatitis due to ingested food or contact with food[†]		Allergic and dietetic gastroenteritis and colitis	
	N	(col %)	N	(col %)	N	(col %)	N	(col %)
Males								
0–4 years	614	(12.3%)	532	(21.6%)	35	(35.4%)	65	(22.9%)
5–14 years	526	(10.5%)	166	(6.7%)	7	(7.1%)	0	(0.0%)
15–24 years	508	(10.1%)	169	(6.9%)		*		*
25–34 years	239	(4.8%)	124	(5.0%)		*		*
35–44 years	147	(2.9%)	59	(2.4%)		*		*
45–54 years	119	(2.4%)	57	(2.3%)		*		*
55–64 years	82	(1.6%)	24	(1.0%)		*		*
65–74 years	36	(0.7%)	24	(1.0%)	0	(0.0%)	8	(2.8%)
75+ years	28	(0.6%)	10	(0.4%)		*		*
Male Total:	**2299**	**(45.9%)**	**1165**	**(47.3%)**	**57**	**(57.6%)**	**106**	**(37.3%)**
Females								
0–4 years	345	(6.9%)	329	(13.4%)	15	(15.2%)	80	(28.2%)
5–14 years	422	(8.4%)	129	(5.2%)		*	0	
15–24 years	742	(14.8%)	279	(11.3%)		*		*
25–34 years	496	(9.9%)	216	(8.8%)		*		*
35–44 years	287	(5.7%)	134	(5.4%)		*		*
45–54 years	203	(4.1%)	94	(3.8%)		*		*
55–64 years	106	(2.1%)	46	(1.9%)		*		*
65–74 years	73	(1.5%)	47	(1.9%)		*		*
75+ years	36	(0.7%)	23	(0.9%)	8	(8.1%)	54	(19.0%)
Female Total:	**2710**	**(54.1%)**	**1297**	**(52.7%)**	**42**	**(42.4%)**	**178**	**(62.7%)**
Grand Total:	**5009**	**(100.0%)**	**2462**	**(100.0%)**	**99**	**(100.0%)**	**284**	**(100.0%)**

*Cases have been supressed due to small cell counts.
[†]Combined categories: L23.6- Allergic contact dermatitis due to food in contact with skin and L27.2- Dermatitis due to ingested food.
Calculations for length of hospital stay included transfers within and between hospitals to more accurately estimate burden of injury.

An analysis of the length of stay categories (Table 12) showed that over two-third of admissions (n=5058, 67.7%) were same-day stays whereby patients were admitted and separated on the same day. Less than one-third (n=2250, 30.1%) were overnight admissions. Multi-day stays were relatively rare (n=167, 2.2%). There were no pronounced gender differences across the length of stay categories; overall, females were slightly overrepresented in each length of stay category. There were slight differences in age distribution across the three length of stay categories: most notably, multi-day stays were relatively common at ages 75+ years (n=20, 21.1%). Overall, however, adverse food reaction hospital admissions were rare in this older age group.

TABLE 12
LENGTH OF STAY (CATEGORIES) OF ADVERSE FOOD REACTION HOSPITAL ADMISSIONS BY AGE GROUP AND SEX, VICTORIA, 2018/19–2020/21

	Hospital admissions[†]							
	Same-day		Overnight		Multi-day		Total	
	N	(%)	N	(%)	N	(%)	N	(%)
Males								
0–4 years	823	(16.3%)	329	(14.6%)	30	(18.0%)	1182	(15.8%)
5–14 years	454	(9.0%)		*		*	697	(9.3%)
15–24 years	464	(9.2%)	201	(8.9%)	8	(4.6%)	673	(9.0%)
25–34 years	253	(5.0%)		*		*	361	(4.8%)
35–44 years	134	(2.6%)		*		*	205	(2.7%)
45–54 years	103	(2.0%)		*		*	174	(2.3%)
55–64 years	64	(1.3%)	33	(1.5%)	6	(3.6%)	103	(1.4%)
65–74 years	36	(0.7%)	15	(0.7%)	7	(4.2%)	58	(0.8%)
75+ years	16	(0.3%)	10	(0.4%)	8	(4.8%)	34	(0.5%)
Male Total:	**2347**	**(46.4%)**	**1067**	**(47.4%)**	**73**	**(43.7%)**	**3487**	**(46.6%)**
Females								
0–4 years	500	(9.9%)	202	(9.0%)	20	(12.0%)	722	(9.7%)
5–14 years	372	(7.4%)	161	(7.2%)	7	(4.2%)	540	(7.2%)
15–24 years	678	(13.4%)	315	(14.0%)	16	(9.6%)	1009	(13.5%)
25–34 years	501	(9.9%)	195	(8.7%)	11	(6.6%)	707	(9.5%)
35–44 years	281	(5.6%)	120	(5.3%)	11	(6.6%)	412	(5.5%)
45–54 years	196	(3.9%)	88	(3.9%)	7	(4.2%)	291	(3.9%)
55–64 years	98	(1.9%)		*		*	147	(2.0%)
65–74 years	59	(1.2%)	34	(1.5%)	6	(3.6%)	99	(1.3%)
75+ years	26	(0.5%)		*		*	61	(0.8%)
Female Total:	**2711**	**(53.6%)**	**1183**	**(52.6%)**	**94**	**(56.3%)**	**3988**	**(53.4%)**
Grand Total:	**5058**	**(100.0%)**	**2250**	**(100.0%)**	**167**	**(100.0%)**	**7475**	**(100.0%)**

*Cases have been supressed due to small cell counts, or to balance out cell suppression and prevent small cell counts from being calculated by subtracting from the total.
[†]Includes transfers within and between hospitals to more accurately estimate burden of injury.

SECTION C:
HOSPITAL-TREATED ADVERSE FOOD REACTIONS 10-YEAR TRENDS: 2011/12–2020/21

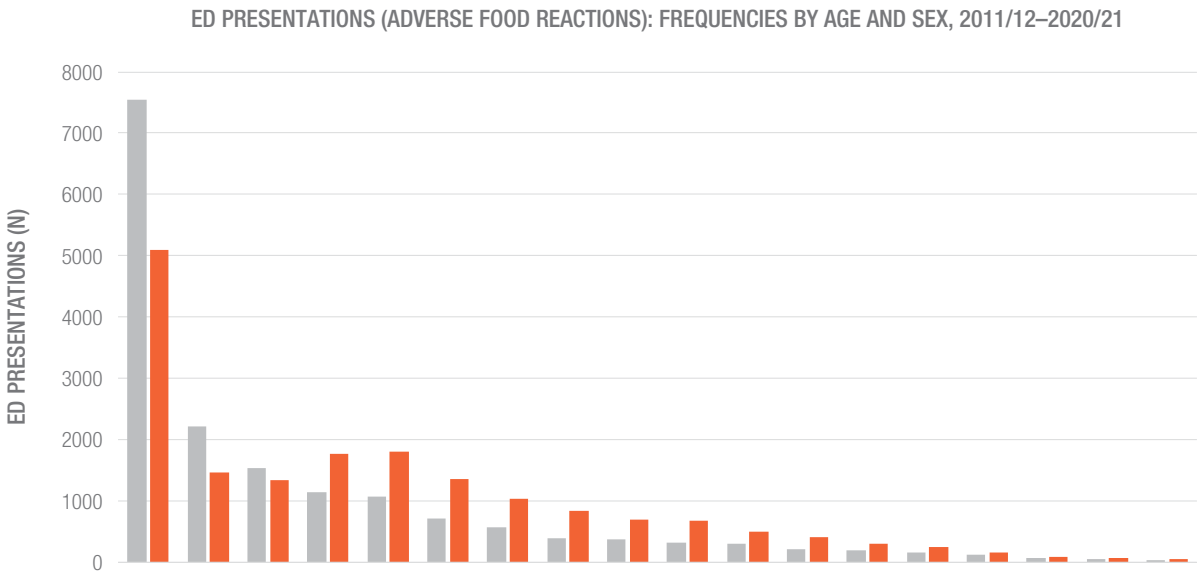
In the ten-year period from 2011/12 to 2020/21, there were 34,986 Emergency Department presentations (an average of 3,499 per year) and 17,010 hospital admissions (an average of 1,701 per year) in relation to adverse food reactions in Victoria. An overview of the frequencies, population-based rates and trends are given in the tables and figures below; these are described in more detail in the following sections: Emergency Department presentations; and Hospital admissions. Details of the impact of COVID-19 on the overall number of injury/external cause related ED presentations and admissions can be found in the E-bulletin on hospital-treated injury, Edition 25, 2020/21, available on the VISU website:

www.monash.edu/muarc/visu

EMERGENCY DEPARTMENT PRESENTATIONS

The profile of Emergency Department presentations related to adverse food reactions for males and females, by age group, is shown in Figure 9 for the 10-year period. Among males, ED presentations were most common in the age group 0–4 years, and frequency decreased progressively with increasing age. Among females, the incidence was also most common in the age group 0–4 years, but there was a second, smaller peak around the ages of 20–24 years. Among males and females, adverse food reaction related ED presentations were uncommon above the age of 60 years. Overall, 49% of ED presentations over the 10-year period were male. At ages 0–9 years, however, 60% were male; this proportion dropped to 37% by the age group 20–24 years. The lowest proportion of males was observed in the age groups 35–39 years and 45–49 years, at 32.4% each.

FIGURE 9
TEN YEARS OF ADVERSE FOOD REACTION ED PRESENTATIONS IN VICTORIA, 2011/12 TO 2020/21: FREQUENCIES BY AGE GROUPS AND SEX



Years	0–4	5–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85+
Male	7537	2225	1538	1135	1075	719	573	401	373	326	295	207	200	162	123	75	47	33
Female	5097	1470	1336	1766	1813	1367	1031	837	705	681	493	408	305	243	168	94	76	52

Age-standardised rates of adverse food reaction related ED presentations over the ten-year period 2011/12 to 2020/21 are shown in Figure 10, Figure 11 and Figure 12; the results are shown per broad age group (Figure 10) and per 5-year age group for males (Figure 11) and females (Figure 12), up to the age of 24 years. Statistical analysis of population-based rates and trends are summarised in Table 13. The average age-standardised annual rate over the ten-year period was 58.2 ED presentations per 100,000 population. The adverse food reaction ED presentation rate increased statistically significantly by 4.2% per year. An increase was observed among both males (+3.4%) and females (+4.2%). Among both males and females, the steepest rate of increase was observed in the age group 15–24 years, at +6.0% and +6.8% per year, respectively. Over the ten-year period, a decrease in rate was observed among both males and females in the age group 65 years and above, but these trends were not statistically significant.

FIGURE 10
TEN YEARS OF ED PRESENTATIONS FOR ADVERSE FOOD REACTIONS IN VICTORIA, 2011/12 TO 2020/21: AGE-STANDARDISED RATES BY AGE GROUP

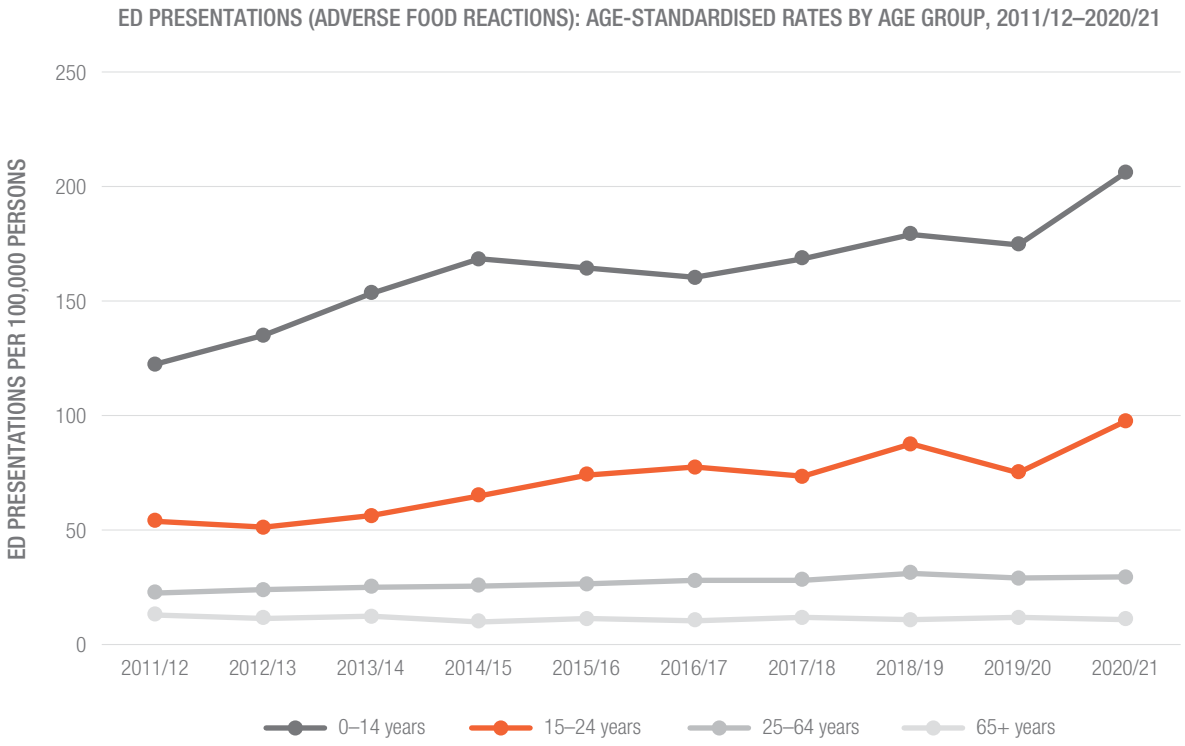


FIGURE 11
TEN YEARS OF ED PRESENTATIONS FOR ADVERSE FOOD REACTIONS: VICTORIA, 2011/12 TO 2020/21:
AGE-SPECIFIC RATES FOR MALES BY 5-YEAR AGE GROUP, FOR 0–24 YEARS

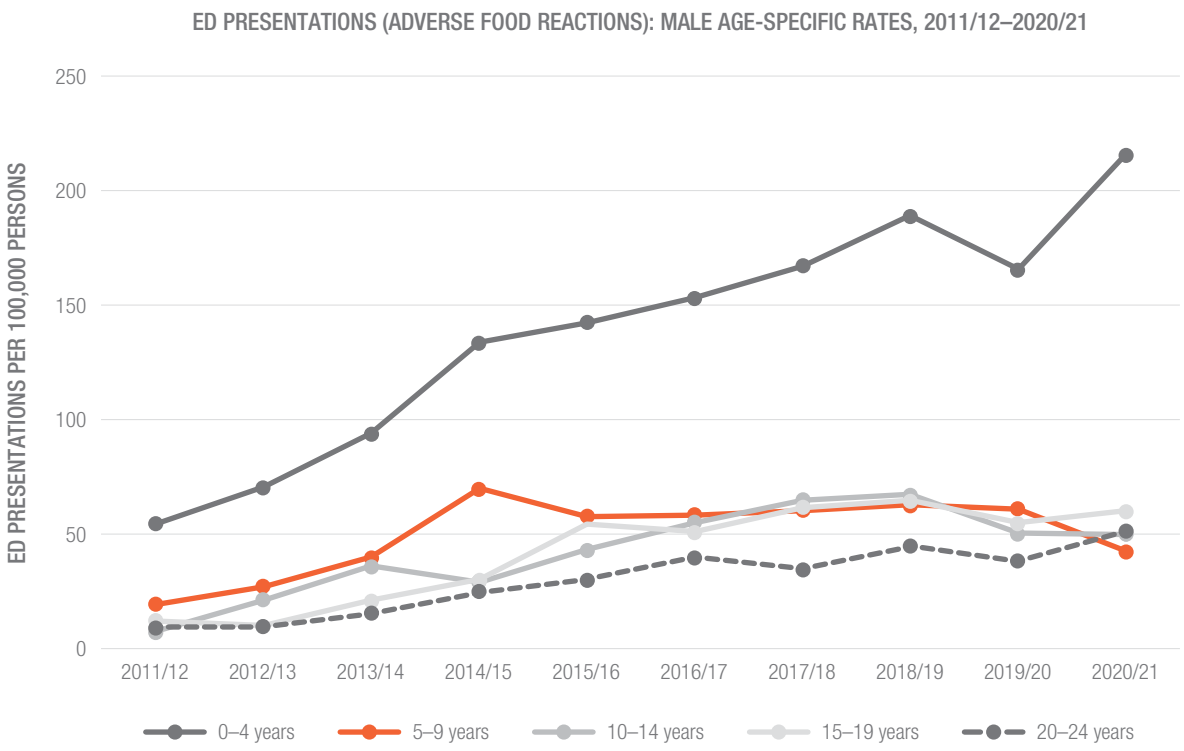
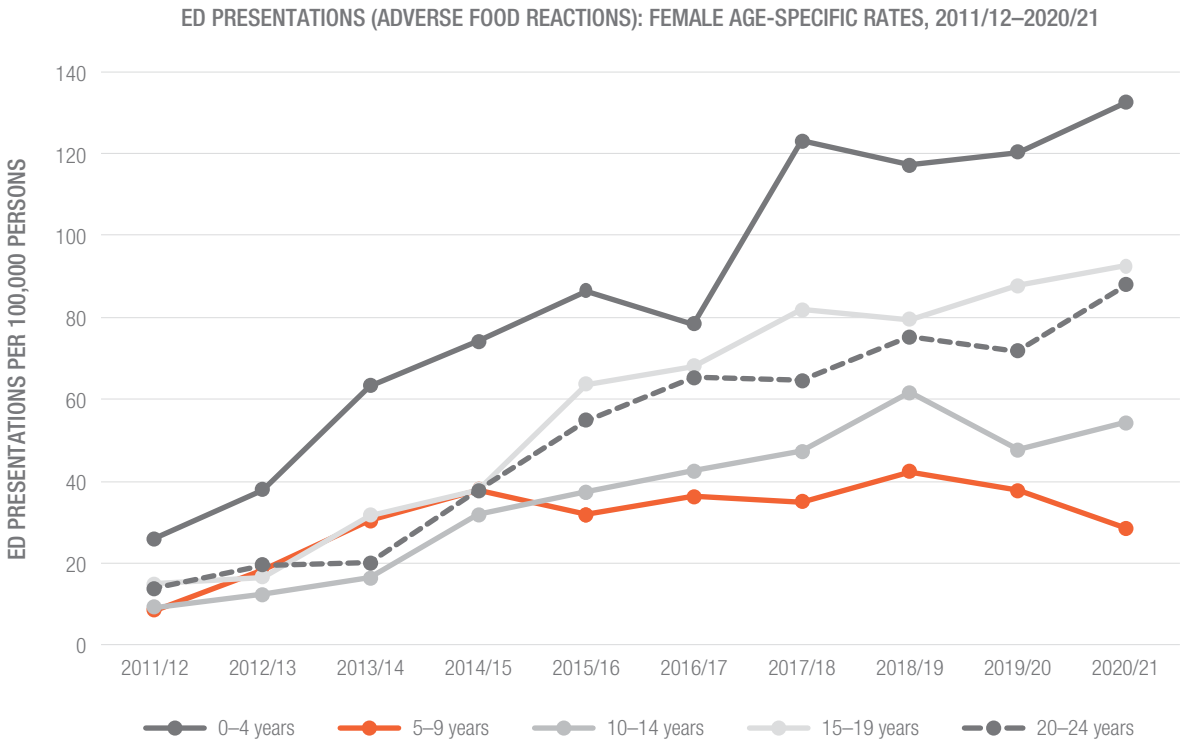


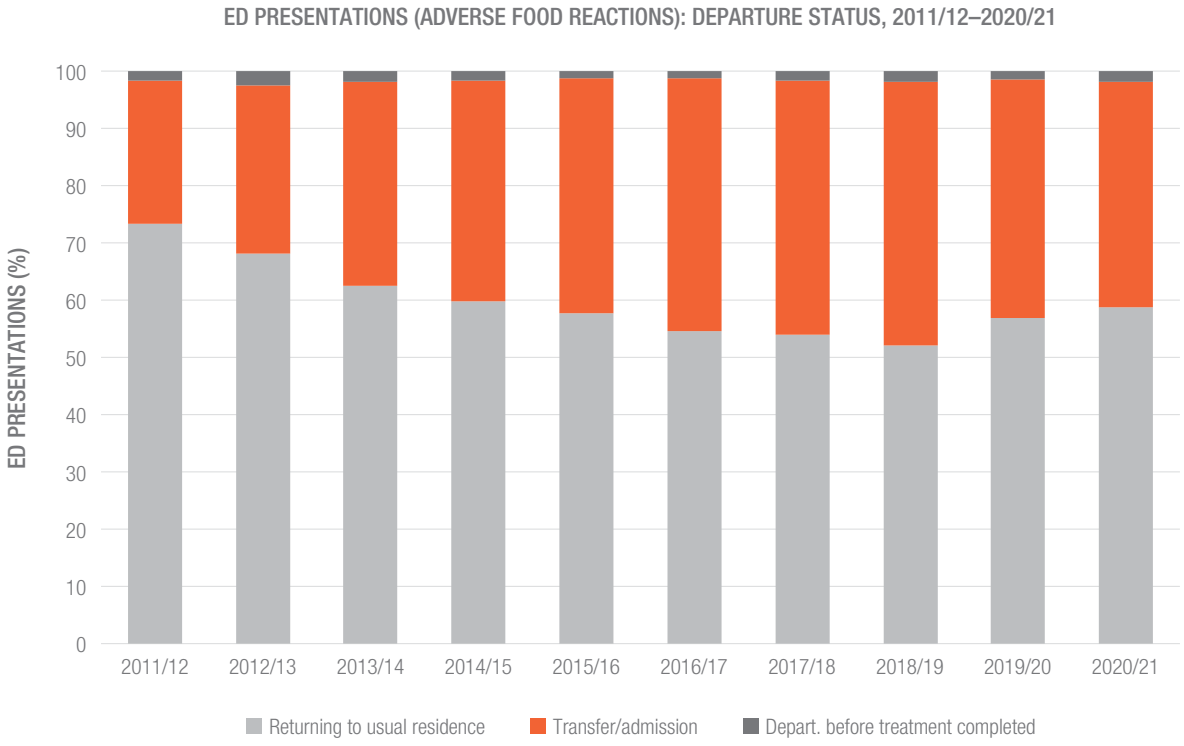
FIGURE 12
TEN YEARS OF ED PRESENTATIONS FOR ADVERSE FOOD REACTIONS: VICTORIA, 2011/12 TO 2020/21:
AGE-SPECIFIC RATES FOR FEMALES BY 5-YEAR AGE GROUP, FOR 0–24 YEARS



The increase in hospital-treated adverse food reactions over the 10-year period, as summarised in Table 13, was less pronounced in Emergency Department presentations (+4.2% per year) than in hospital admissions (+14.3%; discussed in more detail in the next section). Therefore, to better understand this trend, the departure status (return to usual residence, left without treatment completed, transfer within this campus or transfer to another hospital campus) was explored. Departure status trends are shown in Figure 13. In 2011/12, 73% of ED presentations returned to their usual residence and 25% were transferred/admitted. *Return to usual residence rates* decreased over time, reaching a minimum of 52% in 2018/19; in that year, 46% of ED presentations for adverse food reactions were admitted/transferred. Transfer/admission rates decreased slightly in the following two years, reaching 39% in 2020/21: this was still well above the 25% observed in 2011/12.

During the 10-year period from 2011/12 to 2020/21, there were also noteworthy trends observed in the triage category allocations (result not shown graphically). In 2011/12, 26.1% of ED presentations were triaged as Resuscitation (1.4%) or Emergency (24.7%). This proportion increased over time, with Resuscitation/Emergency cases reaching 33.3% of adverse food reaction ED presentations in 2019/20 and 32.9% in 2020/21. Over this time period, the proportion of ED presentations for adverse food reactions that were triaged as semi urgent/non urgent progressively decreased from 27.7% in 2011/12 to 15.0% in 2020/21 (results not shown in table or figure). Both the observed trends in departure status and triage category suggest a gradual increase of severity of food allergy related ED presentations in the first eight years of the 2011/12 to 2020/21 period.

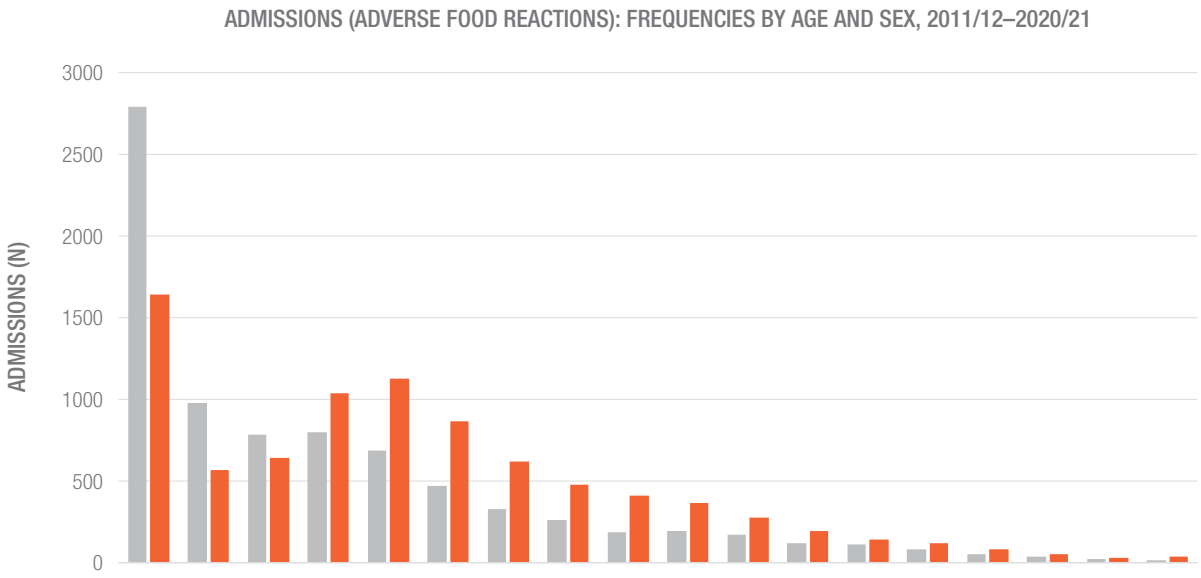
FIGURE 13
TEN YEARS OF ED PRESENTATIONS FOR ADVERSE FOOD REACTIONS: VICTORIA, 2011/12 TO 2020/21: DEPARTURE STATUS. 'TRANSFER/ADMISSION' IS A COMBINATION OF TRANSFERS TO ANOTHER HOSPITAL CAMPUS AND ADMISSION TO THIS CAMPUS.



HOSPITAL ADMISSIONS

The hospital admissions profile related to adverse food reactions for males and females, by age group, is shown in Figure 14 for the 10-year period. Among males, hospital admissions were most common in the age group 0–4 years, and the number of admissions generally decreased with increasing age. Among females, hospital admissions were also most common in the age group 0–4 years, but there was a second, smaller peak at ages 20–24 years. For both males and females, adverse food reaction related hospital admissions were relatively uncommon above the age of 70 years. Overall, 48% of hospital admissions for adverse food reactions over the 10-year period were male. At ages 0–9 years, however, 63% were male; this proportion dropped to 38% by the ages 20–24 years. The lowest proportion of males was observed in the age group 40–44 years, at 32%.

FIGURE 14
TEN YEARS OF HOSPITAL ADMISSIONS DUE TO ADVERSE FOOD REACTIONS: VICTORIA, 2011/12 TO 2020/21: FREQUENCIES BY AGE GROUPS AND SEX



Years	0–4	5–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85+
Male	2794	984	790	798	691	475	328	266	193	199	177	125	115	89	58	42	29	21
Female	1644	572	645	1041	1128	865	624	482	415	367	277	200	145	126	89	57	33	38

Age-standardised rates of adverse food reaction related hospital admissions over the ten-year period 2011/12 to 2020/21 are shown in Figure 15, Figure 16 and Figure 17. The results are shown per broad age group (Figure 15) and per 5-year age group for males (Figure 16) and females (Figure 17), up to the age of 24 years. Statistical analysis of population-based rates and trends are summarised in Table 13. The average age-standardised annual rate over the ten-year period was 27.7 hospital admissions per 100,000 population. The adverse food reaction hospital admissions rate increased statistically significantly by 14.3% per year, on average. An increase was observed among both males (+12.8%) and females (+15.7%). Among both males and females, the steepest rate of increase was observed in the age group 15–24 years, at +17.6% and +19.1% per year, respectively. Over the ten-year period, the slowest rate of increase was observed for males aged 65 years and above, at 5.6% increase per year (statistically significant).

FIGURE 15
TEN YEARS OF HOSPITAL ADMISSIONS FOR ADVERSE FOOD REACTIONS IN VICTORIA, 2011/12 TO 2020/21: AGE-STANDARDISED RATES BY AGE GROUP

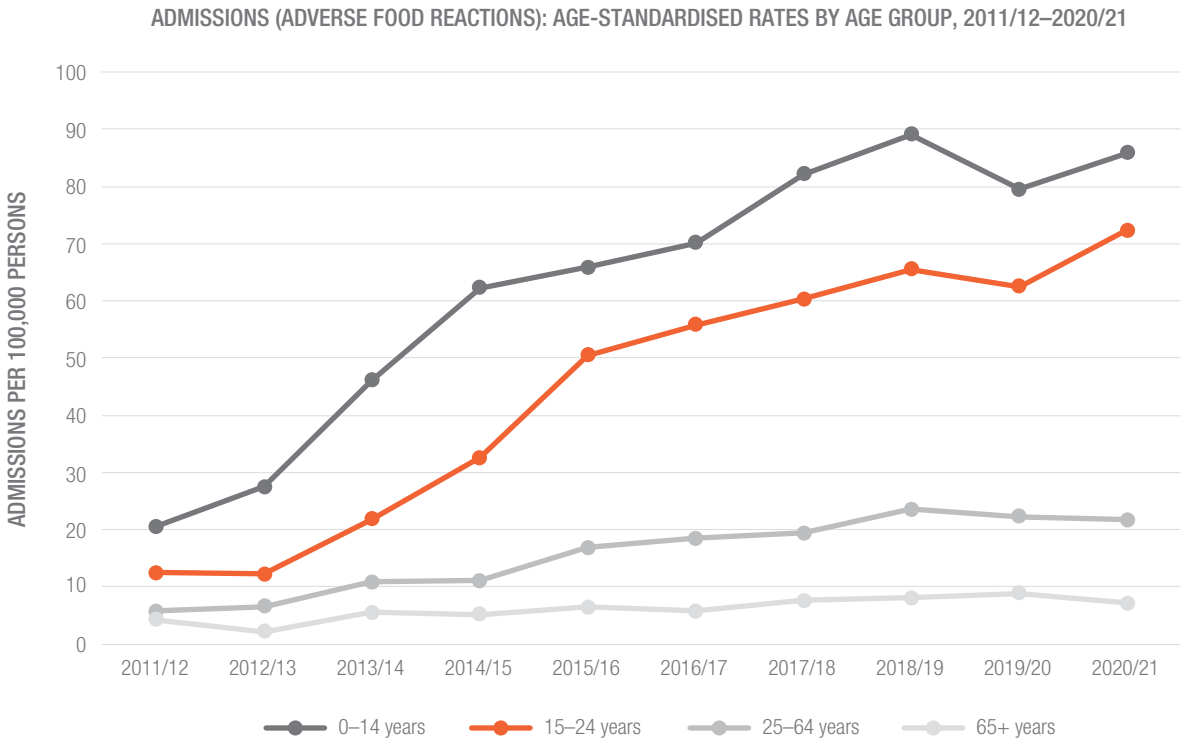


FIGURE 16
TEN YEARS OF HOSPITAL ADMISSIONS DUE TO ADVERSE FOOD REACTIONS: VICTORIA, 2011/12 TO 2020/21: AGE-SPECIFIC RATES FOR MALES BY 5-YEAR AGE GROUP, FOR 0–24 YEARS

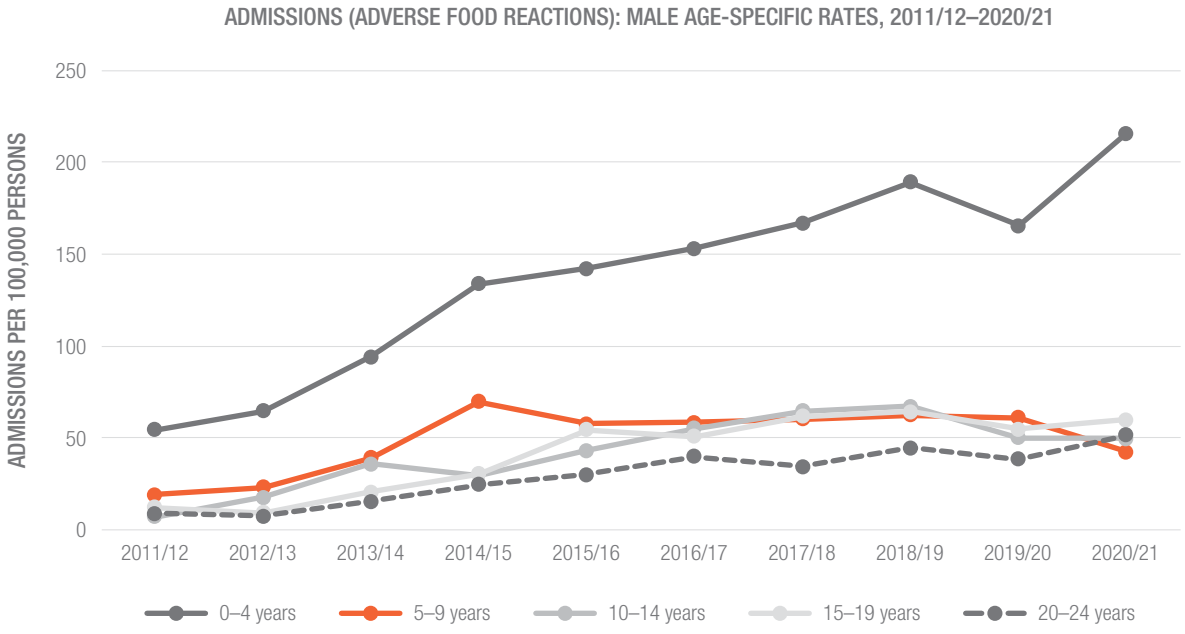
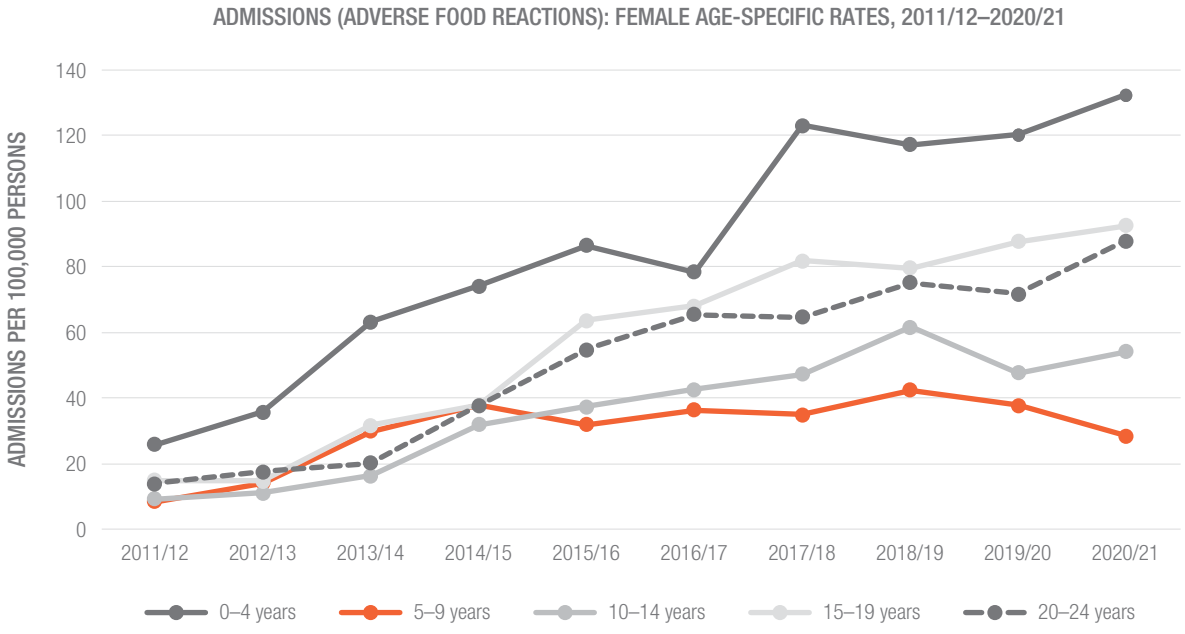
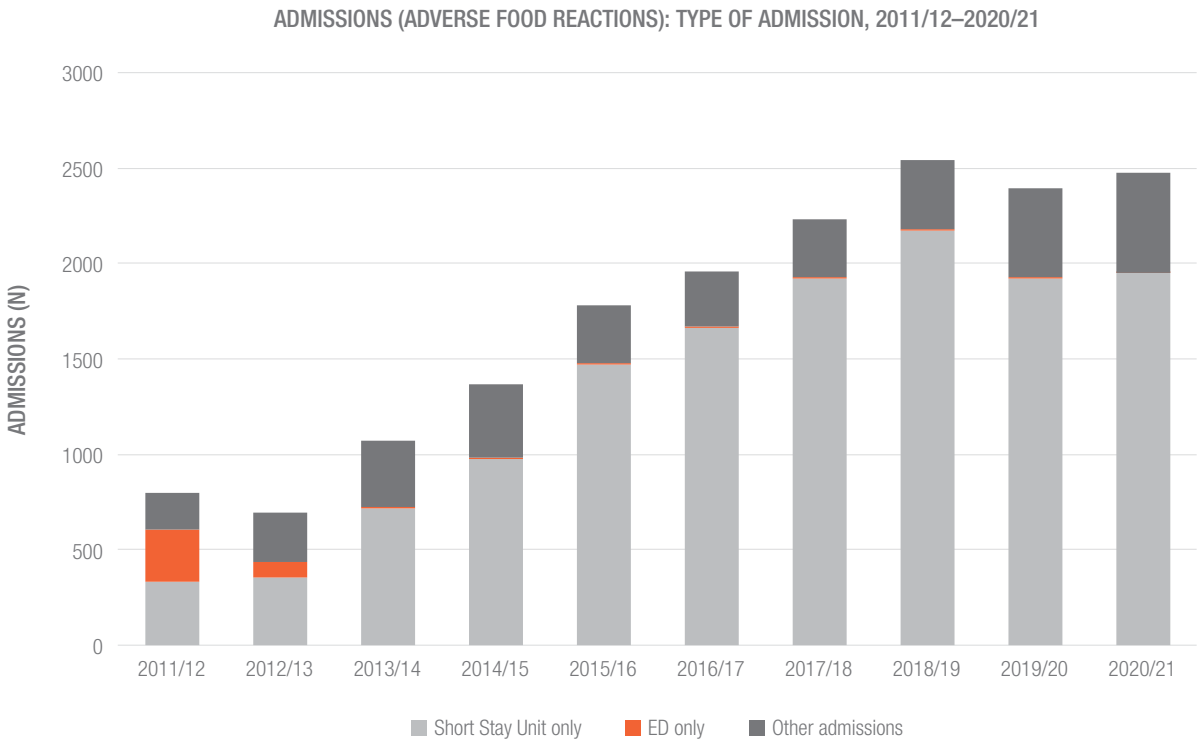


FIGURE 17
TEN YEARS OF HOSPITAL ADMISSIONS DUE TO ADVERSE FOOD REACTIONS: VICTORIA, 2011/12 TO 2020/21: AGE-SPECIFIC RATES FOR FEMALES (BOTTOM) BY 5-YEAR AGE GROUP, FOR 0–24 YEARS



To better understand the observed increase in rate of hospital admissions related to adverse food reactions, the breakdown of admissions by *admission type* is shown in Figure 18. Hospital admissions that were limited to stay in the Emergency Department only were rare after 2012, when the Victorian Hospital admission policy was introduced.[2] From 2012/13 onwards, the majority of adverse food reaction admissions were limited to stay in the Short Stay Observation Unit. ED-only admissions were uncommon after 2011/12 and below ten cases per year after 2012/13. Disregarding 2011/12 when the policy change had not yet taken effect, and considering the nine-year period from 2012/13 to 2020/21, Short Stay Observation Unit only admissions increased by 449%. Over that same nine-year period, 'other' admissions (i.e., admissions where stay was not limited to the ED or Short Stay Observation Unit) increased by 107%.

FIGURE 18
TEN YEARS OF HOSPITAL ADMISSIONS DUE TO ADVERSE FOOD REACTIONS: VICTORIA, 2011/12 TO 2020/21: TYPE OF ADMISSIONS CATEGORISED AS EMERGENCY DEPARTMENT (ED) ONLY*, SHORT STAY OBSERVATIONAL UNIT ONLY, AND ALL OTHER ADMISSIONS.



*Please note that ED only admissions have been excluded from the hospital admissions data in this edition of Hazard.

2. In July 2012 the Victorian Hospital Admission Policy changed significantly meaning that patients who received their entire care within a designated emergency department or urgent care centre could no longer be eligible for admission regardless of the amount of time spent in the hospital.

TABLE 13
TEN-YEAR TRENDS IN HOSPITAL-TREATED ADVERSE FOOD REACTIONS, VICTORIA 2011/12 TO 2020/21: AGE-STANDARDISED RATES*

	Emergency Department presentations			Hospital admissions		
	Average annual frequency (N)	Average annual rate* (presentations per 100,000 population)	Annual change in rate (%)§	Average annual frequency (N)	Average annual rate* (admissions per 100,000 population)	Annual change in rate (%)§
Male						
0–14 years	1130.0	186.9	+3.5 [2.0, 5.1]	456.8	75.2	+11.6 [8.1, 15.3]
15–24 years	221.0	53.2	+6.0 [3.9, 8.3]	148.9	35.7	+17.6 [12.3, 23.1]
25–64 years	309.4	19.0	+1.8 [0.5, 3.1]	187.8	11.3	+13.1 [10.8, 15.4]
65 and above	44.0	10.4	–0.8 [–4.1, 2.7]	23.9	5.5	+5.6 [1.0, 10.5]
Total (male):	**1704.4**	**57.5**	**+3.4 [2.6, 4.2]**	**817.4**	**27.2**	**+12.8 [11.2, 14.4]**
Female						
0–14 years	790.3	138.4	+5.6 [3.9, 7.4]	286.1	49.9	+14.2 [10.6, 17.9]
15–24 years	357.9	90.3	+6.8 [5.1, 8.6]	216.9	54.1	+19.1 [14.8, 23.6]
25–64 years	582.7	35.1	+3.7 [2.6, 4.8]	337.5	20.0	+15.2 [12.9, 17.6]
65 and above	63.3	35.1	–1.1 [–4.4, 2.3]	34.3	6.6	+12.0 [6.5, 17.6]
Total (female):	**1794.2**	**58.9**	**+5.0 [4.2, 5.8]**	**874.8**	**28.3**	**+15.7 [14.1, 17.3]**
Grand total:	**3498.6**	**58.2**	**+4.2 [3.2, 5.2]**	**1692.2**	**27.7**	**+14.3 [12.8, 15.8]**

*Age standardised to the 2001 standard population.
§For ED presentations, annual changes were significant at p<0.0001 except for trend in males aged 25–64 which were significant at p=0.006 and trends in males and females aged 65 and above, which were not statistically significant. For admissions, annual changes were significant at p<0.0001 for all groups, except admissions by males 65+ years where the annual increase was significant at p<0.02

DISCUSSION

SUMMARY OF FINDINGS

In the last three years (2018/19 to 2020/21), there were 12,568 Emergency Department presentations and 7,414 hospital admissions related to adverse food reactions in Victoria. More than one-third (38%) of ED presentations and a quarter of hospital admissions (26%) were in the age group 0–4 years, and more than half (55%) of ED presentations and 42% of hospital admissions were in the ages 0–14 years. Almost one-third of ED presentations (32%) and almost two-third of hospital admissions (65%) for adverse food reactions concerned anaphylaxis. The most commonly listed food allergy in the hospital admissions was allergy to fruits, grains, nuts, seeds and vegetables. In this group, allergies to tree nuts, legumes (ground nuts) and nuts *not elsewhere classified* were the most commonly listed among those with anaphylaxis and among those with other adverse food reactions.

Over the ten-year period from 2011/12 to 2020/21, population-based rates of adverse food reaction-related ED presentations increased by 4.2% annually, and rates of adverse food reaction-related hospital admissions increased by 14.3% annually, on average. Adverse food reaction-related ED presentation rates were highest in the age group 0–14 years, among both males and females. Adverse food reaction-related hospital admission rates were highest in the age group 0–14 years for males, and the age group 15–25 years for females. Over the 10-year period, the *annual rate of increase* was highest in the age group 15–24 years, for both males and females, in both ED presentations and hospital admissions related to adverse food reactions in Victoria.

CAUSES AND RISK FACTORS

There are several theories regarding the development of food allergies: four of these will be discussed below, to provide context to the findings reported in this edition of *Hazard*.

THE HYGIENE HYPOTHESIS

Current understanding of risk factors for allergy, and explanations of the increased prevalence observed over the most recent two to three decades, are based on the hygiene theory. This theory originated from a study by Strachan who analysed birth cohort study data of British children who were followed up to 23 years to explore hay fever epidemiology (Strachan, 1989). An inverse correlation was observed between the number of children in the household and the prevalence of hay fever. It was suggested that allergic diseases could be prevented by early childhood infections, which are facilitated by contact with older siblings or prenatally through the mother's contact with her older children. Increasing hygiene standards in the household and smaller family size may therefore have contributed to progressively increased prevalence of atopic disease in Western countries. More recent work has related the hygiene theory with current knowledge of the importance of microbiome diversity and its role in immunoregulation (Lambrecht et al., 2017).

THE DRY SKIN THEORY

Following the hygiene theory, another factor that is currently considered to play a role in the development of allergies is impaired skin barrier: the dry skin theory, or dual allergen exposure hypothesis. Infants with dry skin and eczema, or otherwise damaged skin, are thought to be susceptible to food sensitisation through a compromised skin barrier (Brough et al., 2020; Tedner et al., 2022). This route of first contact with food allergens through the skin is considered to be more likely to result in sensitisation than through the preferred, oral route. Food allergies are more likely to occur with more severe eczema and with longer duration of eczema symptomology in infants. Furthermore, delayed oral exposure to allergens is the second factor in the dual allergen exposure theory: this widens the time window of sensitisation through skin exposure. This has suggested two possible approaches to prevention of food allergies: by improving the skin barrier, reducing the severity and duration of atopic dermatitis in infants, and by early oral introduction of potential food allergens to promote food tolerance (Brough et al., 2020). Intervention studies addressing the former have been mixed in their findings, and more research is needed to further determine the clinical role and practical approach to skin barrier improvement in food allergy prevention.

THE VITAMIN D HYPOTHESIS

Another recent hypothesis is that low vitamin D levels are associated with increased risk of food allergies (Allen et al., 2015). Rates of food allergies have been reported to be higher in children born in summer or spring vs. autumn or winter; this was observed in Australian children, based on children assessed for allergies in a referral clinic, as well as based on children prescribed EpiPens and infant hypogenic formula (Mullins et al., 2011). Australia's sunny climate and high rates of food allergies may seem contradictory according to the Vitamin D deficiency hypothesis, but Vitamin D deficiency is common in Australian infants and children, especially among those with dark skin colour, reduced sun exposure and/or excessive sunscreen use and those with low intake of Vitamin D containing foods – either as natural sources or fortified foods (Munns et al., 2006).

ASTHMA AND FOOD ALLERGY

A relationship between asthma and food allergy has been reported in observational studies. In a study of anaphylaxis-related hospitalisations and fatalities in the UK, of the 124 food allergy fatalities that occurred between 1992 and 2012, 78% were noted to have a doctor's diagnosis of asthma (Turner et al., 2015). Furthermore, underlying *bronchial hyperactivit*y is relatively common among those with food allergy, as described in a 2005 study of patients with food allergy, patients with asthma and controls (Kivity et al., 2005). Among patients with food allergy *but no asthma*, upon testing, 40% demonstrated bronchial hyperactivity. Asthma and food allergy are both manifestations of atopy: a likelihood to develop allergic diseases; therefore, a correlation between these conditions is not surprising. However, bronchial hyperactivity may contribute to respiratory problems in reaction to food. In the current study, asthma was the most commonly recorded supplementary chronic conditions code: this was found in 15% of admissions for food allergies. This is likely to be an underestimate of the prevalence of asthma in this group, as there is the possibility of under-diagnosis, under-reporting and under-recording of asthma in the hospital admissions data. Bronchial hyperactivity was not evaluated or captured in the data used in this study. On the whole, addressing any potential underlying respiratory conditions is of particular importance in food allergy patients.

COUNTRY OF BIRTH AND PARENTAGE

Food allergies are more common among children of immigrants (Loh et al., 2018): this association has been reported by Koplin et al. (Koplin et al., 2014). Among infants in Melbourne, peanut allergies were associated with having parents who were born in East Asia; there was no significant correlation between having parents born in UK/Europe and peanut allergies. Among the Asian-born parents, rates of allergies were relatively low. In the hospital admissions and Emergency Department data accessed in this edition of *Hazard*, there is no way to determine the country of birth of parents. The country of birth of the patient is recorded, but parentage is not captured in the VAED or VEMD. In Victoria, 28.1% of the population was born overseas and 49.1% of the population was born overseas or had a parent who was born overseas, according to the 2016 census (Australian Bureau of Statistics, 2016). The results of country of birth analysis in this edition of *Hazard* confirmed the under-representation of Chinese- and India-born residents of Victoria, in hospital-treated adverse food reactions; however, we could not establish patients' parents' country of birth. For more information on food allergy risk factors based on parentage, and how this affects trends in allergy prevalence in Victoria, a population-based survey study capturing this information (as well as food allergy information) is required. This would provide valuable insights into groups that would benefit most from promotion of the current allergy prevention guidelines and recommendations.

IMPLICATIONS OF FINDINGS FOR FOOD ALLERGY: FURTHER RESEARCH AND POLICY

The Victorian Department of Health currently operates an anaphylaxis notification system. This is a food-focused passive surveillance system launched in November 2018 as required by amendments made to the *Public Health and Wellbeing Act of 2009*. The amendments were in response to Coronial inquest recommendations following the death of a child from anaphylaxis after consumption of mislabelled packaged food. The notification system requires hospitals to notify the Department of Health Victoria of cases who present to the hospital for treatment of anaphylaxis. Data collected from notifications are used to assess risk and, if necessary, guide appropriate public health action to reduce broader public health risks from mislabelled packaged food sold in the market and poor allergen management in council-registered food premises.

A comprehensive and national food allergy register for all States and Territories in Australia is key to better understanding the rates, trends, and risk factors. This information will help to evaluate and improve treatments, prepare for anticipated allergy trends, address any current shortcomings in care, streamline transitions between various care systems, and ultimately, optimise the public health response to food allergy in terms of primary prevention and treatment.

PROPOSED NEW NATIONAL ALLERGY CENTRE OF EXCELLENCE: THE MURDOCH CHILDREN'S RESEARCH INSTITUTE

Following the 2020 Parliamentary Inquiry into Allergies and Anaphylaxis, funding allocation has been proposed for the establishment of the National Allergy Centre of Excellence at the Murdoch Children's Research Institute, Melbourne (Murdoch Children's Research Institute, 2022); this was announced in the 2022 Federal Budget. This new initiative, in response to specific recommendations, will help to address allergy and anaphylaxis morbidity and mortality in Australia, and contribute to improvements in treatment and prevention. If actioned, the National Allergy Centre of Excellence will establish the first national allergy registry in Australia, along with a live anaphylaxis reporting system and a Biobank capturing health care utilisation records and biological samples from patients with allergies. The registry is proposed to conduct allergy treatment trails, effectively carrying out large-scale post-market surveillance of allergy treatments. The Parliamentary Inquiry recommendations have also led to funding allocation proposed for the new National Allergy Council.

This edition of *Hazard* provides an overview of the current rates and increasing trends in adverse food reactions, including anaphylaxis, in Victoria. These can be used to identify high-risk groups and thereby inform resource allocation as well as to serve as a reference point for monitoring population food allergy related morbidity and mortality over time as well as assist with modelling of preventive interventions.

IMPLICATIONS OF FINDINGS FOR FOOD ALLERGY FURTHER DATA SURVEILLANCE

CURRENT LIMITATIONS

The data presented in this edition of *Hazard* is based on Victorian hospital admissions (recorded in VAED), Emergency Department presentations (recorded in VEMD) and fatalities (recorded in the COD-URF) only. Allergies, even severe allergies, do not always result in hospital presentation or admission. If an allergy diagnosis was made without hospital presentation or admission, this will not be included in the data presented here. Furthermore, patients who were admitted to hospital at the time of diagnosis (if a severe reaction occurred) may have successfully avoided further reactions. If the primary admission was prior to 2011/12, they will not be captured here. Therefore, the methodological approach used in this *Hazard* is based on the occurrence of allergic reactions but does not provide the prevalence of food allergies in Victoria.

Conversely, all hospital admissions and ED presentations are captured in the current analysis: some of these may be multiple visits by the same person. For a better understanding of *food allergy prevalence in the population*, a population-based survey could be used. An example of such an approach was a study by Peters et al. (Peters et al., 2015), following a cohort of infants in Melbourne and reporting on allergy testing results. Known allergies may never result in hospital admission; therefore, surveys provide a useful tool to determine prevalence in the population. In summary, the methods used in this edition of *Hazard* provide *the incidence of hospital-treated allergic reactions to food*; this is not equivalent to the prevalence of food allergies in the population.

In the ICD-10-AM coding system, specification of food allergens in the external cause codes was only implemented from 2019/20 onwards. The external cause code Y37 is used for this: Y37, *Exposure to or contact with allergens*, provides a relatively high level of detail regarding the allergen. Prior to 2019/20, the external cause code used for food allergy (T78.0, T78.1) was Y57.9, *Other and unspecified drugs and medicaments; Drug or medicament, unspecified*. Aside from the inconsistency between this code specification and its application to food allergy, this external cause code provides no further information on allergens. Therefore, the food allergen specifications in the hospital admissions results is limited to the latest two years of data only. Given the data limitations, a trend analysis of incidence of specific food allergies (tree nuts, legumes, grains, dairy, seafood, eggs) over time could not be provided.

Lastly, errors in diagnosis and coding of food allergies are research limitations in this edition of *Hazard* that must be acknowledged. Misdiagnosis of food allergies is not uncommon; for example, allergic reactions may be diagnosed as asthma or gastroenteritis. Coding errors, in the VEMD (Emergency Department) data in particular, can also occur. These data limitations are likely to have resulted in further *underestimates* of reported food adverse reaction incidence in Victoria.

PLACE OF OCCURRENCE

Place of occurrence of the allergy reaction can provide valuable information for prevention: in a study by Mullins et al. (Mullins et al., 2016), location of fatal food related anaphylaxis was reported, such as: hotel; shopping centre; home; school; preschool; work; and other settings. Adverse food reactions occurring in these settings can be prevented with implementation of guidelines and regulations relating to food sharing and potential cross contamination. Location information would have been valuable in the hospital admissions data, but unfortunately 56% of the adverse food reactions records were coded as location *unspecified* (out of the records with ICD-10-AM codes T78.0 and T78.1; 97% of all cases). In the Emergency Department data, >60% of presentations for adverse food reactions were not provided with a place of occurrence code and a further 16% of cases were coded as unspecified place of occurrence. More generally, place of occurrence is known to be poorly coded in the injury surveillance variables in the VEMD (Sheppard et al., 2022), with 24% unspecified in 2019/20 for all injury presentations, with a range from 5%–99.9%. A project addressing the injury surveillance coding quality has been carried out by the Victorian Injury Surveillance unit in 2020–2022; the effects of this will be evaluated in 2022–23.

AREAS FOR FURTHER ACTION

In light of the evidence and data reported in this edition of *Hazard*, VISU suggests the following areas for action:

IMPROVE AND DEVELOP FOOD ALLERGY SURVEILLANCE SYSTEMS

The VAED and VEMD provide a useful data resource for evaluating the incidence of hospital-treated food reactions in Victoria.

1. Until a national food allergy registry is in place, reporting of summary statistics on adverse food reactions in Victoria based on VAED and VEMD is recommended, for tracking food allergy trends, identifying high risk groups, and measuring changes in disease burden over time.

The current analysis provides an overview of the incidence of hospital-treated adverse food reactions in Victoria. It does not provide information on the prevalence of allergies in the population, repeated exposure or gaps in treatment.

2. Including adverse food reactions in population-based survey studies is recommended, to measure the prevalence of food allergies in Victoria and the changes in prevalence over time.

3. A VAED-VEMD data linkage study is recommended, to track individuals with food allergy over time. This could be used to determine risk factors (in terms of allergens, socio-demographics, settings) for repeated reactions that are suggestive of potentially avoidable exposures.

INCREASE PREVENTION AND MANAGEMENT

The incidence of hospital-treated adverse food reactions in Victoria has increased over the last ten years. The current advice is to encourage early introduction of allergens prior to one year of life; this aims to reduce the development of food allergy in children.

4. To continue to advocate the current feeding guidelines and extend the communication of this information to child safety and injury prevention platforms and organisations.

Adrenaline auto-injectors are generally considered effective and safe for treating severe allergic reactions. However, the use of these devices may be under-utilised for anaphylaxis.

5. To explore knowledge, skills and perceived barriers to using adrenaline auto-injectors, particularly among parents of children with severe food allergies, and address potential barriers though education and training.

Place of occurrence for food allergy is poorly coded in the VAED and the VEMD. This information is crucial for informing adverse food reaction prevention, for example though better food allergy awareness and action plans in schools, workplaces, health care settings and in the home.

6. Hospitals should be advised to capture information on the place of symptom onset or occurrence of food allergies and to record this information as (ICD-10-AM coded) place of occurrence.

VEMD narrative information can provide valuable information on the setting, circumstances and allergens involved in adverse food reactions. For example, issues such as incorrect food product labelling or lacking policy and procedure in school settings can be recorded in the VEMD free text field.

7. To communicate to VEMD-contributing hospitals that data collection on adverse food reactions can contribute to prevention efforts: particularly details of the setting, circumstances and food product involved should be noted.

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APPENDIX A:
DATA SOURCES AND CASE SELECTION

The scope of this Hazard is limited to adverse food reactions in Victoria, resulting in hospital treatment or death. All ages are included.

DEATHS

Fatal adverse food reaction data were extracted from the Cause of Death (COD) dataset supplied by the Australian Coordinating Registry (ACR) and based on the Australian Bureau of Statistics (ABS) cause of death data. Case selection was limited to deaths registered over the 10-year period from January 2010 to December 2019. Only deaths where the person's usual residence was Victoria were included. Deaths due to adverse food reactions were selected as those with T78.0 *anaphylaxis and anaphylactic shock due to adverse food reaction* or T78.1 *other adverse food reactions, not elsewhere classified* listed in the ICD-10 Record Axis Data (RACS codes). K52.2 *allergic and dietetic gastroenteritis and colitis*; L27.2 *dermatitis due to ingested food*; and L23.6 *allergic contact dermatitis due to food in contact with skin* did not occur in the RACS codes in the Victorian COD data for this time period.

To improve the quality of ICD coding, the ABS introduced a revisions process for all coroner certified deaths registered after 1 January 2006. The process means data are *preliminary* when published for the first time, *revised* when published the following year and *final* when published two years after initial publication. For this *Hazard* publication, Cause of Death data were final for the years 2010 to 2017, revised for 2018 and preliminary for 2019. For more detailed information regarding the ABS causes of death coding and revisions processes, readers are directed to the ABS website and in particular:

http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/3303.0Technical+Note12012

EMERGENCY DEPARTMENT PRESENTATIONS

Emergency Department presentations data were extracted from the Victorian Emergency Minimum Dataset (VEMD), which records all presentations to Victorian public hospitals with 24-hour emergency departments (currently 38 hospitals). The VEMD records cases that are treated and discharged from the ED, and cases that are assessed in the ED and admitted to a ward for treatment.

An emergency department (ED) presentation is an injury or illness that results in a person presenting to a hospital emergency department for treatment who is triaged (assessed for urgency), including those patients who leave before treatment commences (Department of Health Victoria (DH), 2020).

ED presentations between 01 July 2011 and 30 June 2021 were selected. To prevent over-counting, return visits and pre-arranged visits were excluded. ED presentations due to adverse food reactions were selected as those with codes: T78.0, T78.1, L27.2 in the first-listed diagnosis code. Selection of additional cases based on the occurrence of adverse food reaction key words in the narrative could potentially add a further 5% of cases; however, many of these are 'false positives', i.e. key words are listed but the ED presentation was not for an adverse food reaction. Given the size of the sample and good capture of coded data, it was decided to limit case selection to coded cases only, using the diagnosis codes listed above. Diagnosis codes K52.2 and L23.6 were not used for VEMD case selection as these codes do not feature in the VEMD diagnoses codes.

HOSPITAL ADMISSIONS

Hospital admissions data were extracted from the Victorian Admitted Episodes Dataset (VAED), which records all admissions to public and private hospitals in the state of Victoria. The VAED includes demographic, clinical and administrative details for every admitted episode of care. The coding in the VAED conforms to the definitions in the National Health Data Dictionary (NHDD) (Australian Institute of Health and Welfare, 2015).

The clinical details include forty diagnosis codes that include injury and external cause information coded according to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM). Hospital admissions between 01 July 2011 and 30 June 2021 were selected.

Case selection of hospital admissions was limited to incident admissions: repeat admissions were excluded; transfers within and between hospitals were also excluded to avoid over-counting the incidence, but were included when providing estimates of hospital bed-days and in-hospital death, as their inclusion provides a more accurate estimate of the burden of injury. Only Victorian residents were included. Those whose admission was limited to stay in the Emergency Department only were excluded from the hospital admissions data selection.

Table A1 shows the ICD10-AM external cause codes used for selection of hospital admissions from the VAED. Records were retained if the principal diagnosis code contained one of the ICD10-AM diagnosis codes listed as *used for sample selection*=Y in the table below.

TABLE A1
ICD10-AM CODES RELEVANT TO ADVERSE FOOD REACTIONS IN THE VAED

ICD10-AM principal diagnosis codes	Description	Years in use in Victoria, in the 2011/12–2020/21 period	Used for sample selection
T78.0	Anaphylaxis and anaphylactic shock due to adverse food reaction	2011/12–2020/21	Y
T78.1	Other adverse food reactions, not elsewhere classified	2011/12–2020/21	Y
K52.2	Allergic and dietetic gastroenteritis and colitis – Food hypersensitivity gastroenteritis or colitis	2011/12–2020/21	Y
L27.2	Dermatitis due to ingested food	2011/12–2020/21	Y
L23.6	Allergic contact dermatitis due to food in contact with skin	2011/12–2020/21	Y
Y37	Exposure to or contact with allergens	2019/20–2020/21	N
Y57.9	Drug or medicament, unspecified	2011/12–2020/21*	N

*Marked reduction in use from 2019/20 onward.

APPENDIX B: STATISTICAL ANALYSIS

Rates for ED presentations and hospital admissions per 100,000 population, by age, sex and year were calculated using population data sourced from the Australian Bureau of Statistics (ABS), Estimated Residential Population. Population data was provided by age, sex, and year.

Trend analysis: changes in the rates of ED presentations and hospital admissions per population were modelled using Poisson models, as trends in the annual number of events, with the log of the Victorian population as offset. All models contained financial year (time indicator) and were adjusted for age group and sex, where possible (i.e. unless the analysis was limited to a single age group or sex). The percentage change per year was calculated as: $[e^{\alpha} - 1] \times 100$, where α is the model-estimated rate of increase or decrease. The analyses were conducted using the PROC GENMOD procedure in SAS V9.4.

HAZARD EDITION INDEX

VISU GENERAL INFORMATION AND RESOURCES

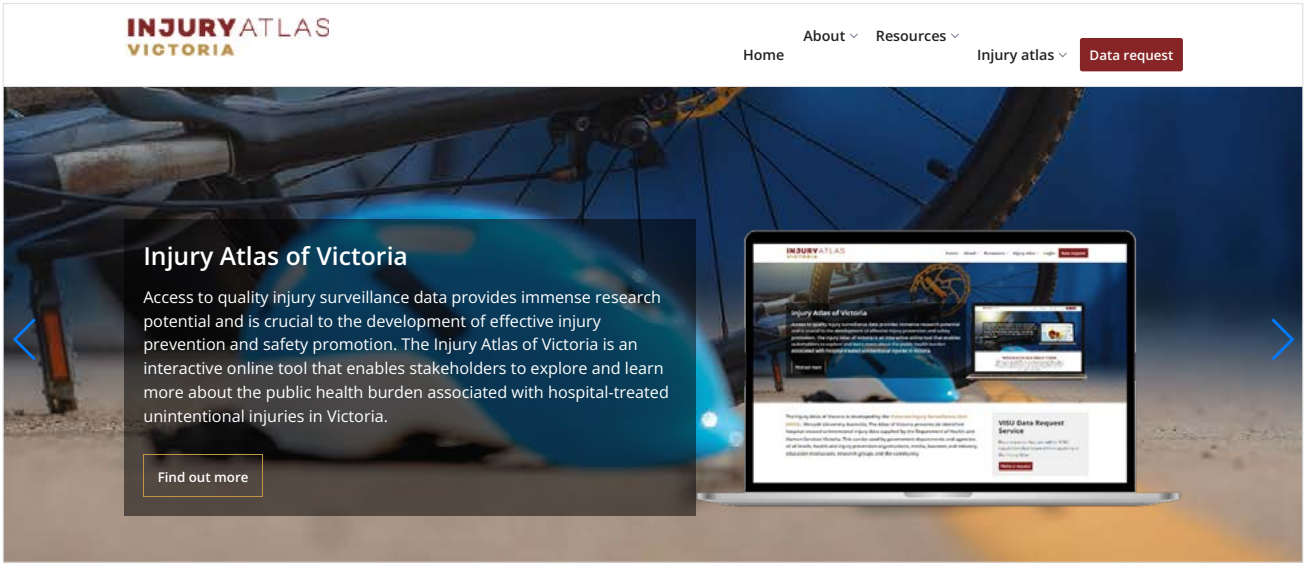
VAED INCLUDES ALL VICTORIAN PUBLIC AND PRIVATE HOSPITALS

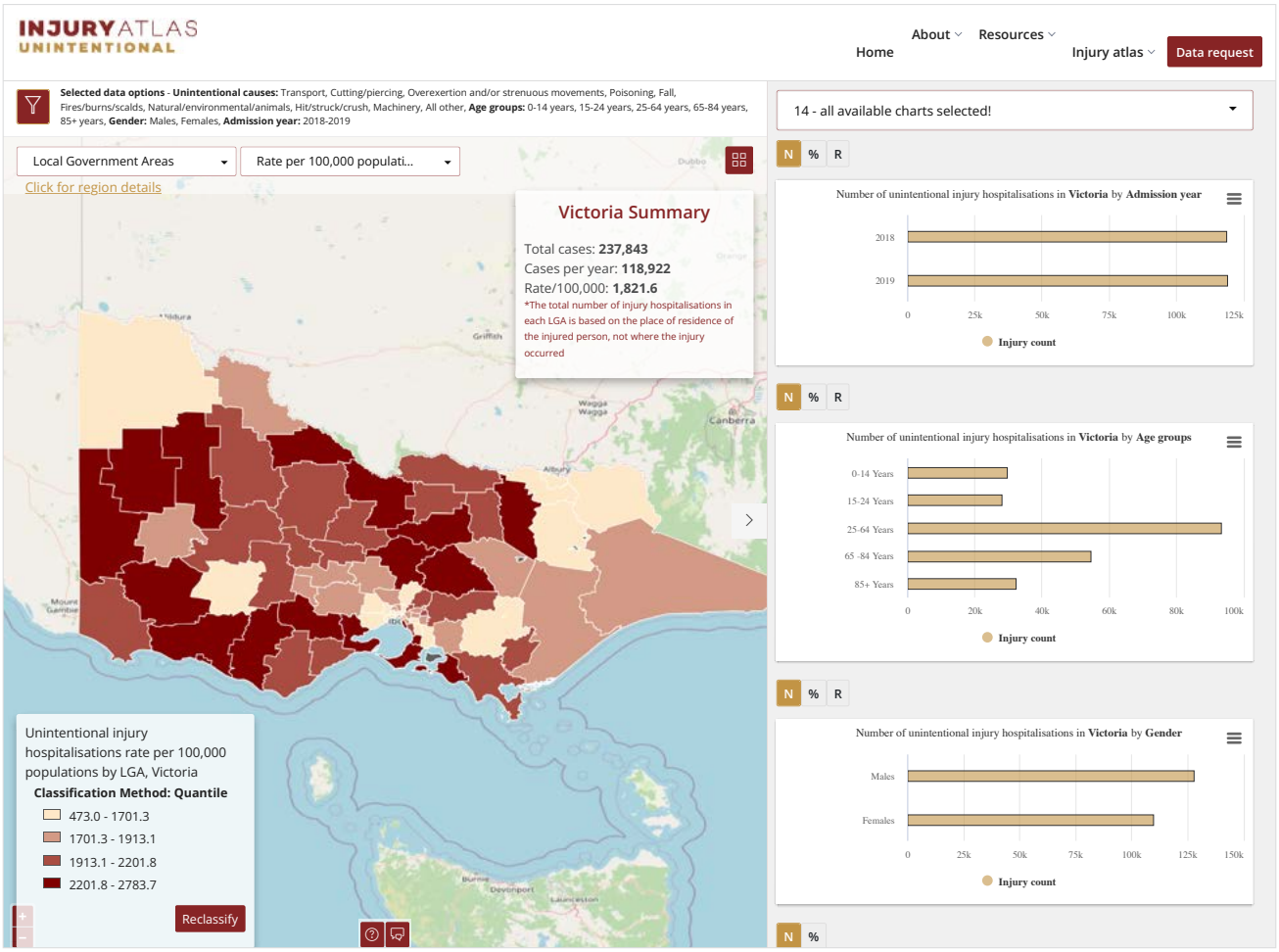
VEMD Participating hospitals	
From October 1995 Austin & Repatriation Medical Centre Ballarat Base Hospital The Bendigo Hospital Campus Box Hill Hospital Echuca Base Hospital The Geelong Hospital Goulburn Valley Base Hospital Maroondah Hospital Mildura Base Hospital The Northern Hospital Royal Children's Hospital St Vincent's Public Hospital Wangaratta Base Hospital Warrnambool & District Base Hospital Western Hospital – Footscray Western Hospital – Sunshine Williamstown Hospital Wimmera Base Hospital **From December 1995** Royal Victorian Eye & Ear Hospital Frankston Hospital **From January 1996** Latrobe Regional Hospital **From July 1996** Alfred Hospital Monash Medical Centre **From September 1996** Angliss Hospital	**From January 1997** Royal Melbourne Hospital **From January 1999** Werribee Mercy Hospital **From December 2000** Rosebud Hospital **From January 2004** Bairnsdale Hospital Central Gippsland Health Service (Sale) Hamilton Base Hospital Royal Women's Hospital Sandringham & District Hospital Swan Hill Hospital West Gippsland Hospital (Warragul) Wodonga Regional Health Group **From January 2005** Mercy Hospital for Women **From April 2005** Casey Hospital **From July 2011** Bass Coast Regional Health

INJURY ATLAS OF VICTORIA

The *Injury Atlas of Victoria* is a new web-based tool that allows the exploration of hospital-treated unintentional injury, transport injury, sports injury and fall injury in Victoria and further enhances the services that VISU provides. It was developed by VISU at Monash University and presents de-identified hospital-treated unintentional injury data supplied by the Department of Health and Human Services Victoria. This can be used by government departments and agencies of all levels, health and injury prevention organisations, media, business and industry, education institutions, research groups and the community.

The **Injury Atlas of Victoria** web-based application can be accessed at this address: **https://vicinjuryatlas.org.au/**





How to Access VISU Data

VISU collects and analyses information on injury problems to underpin the development of prevention strategies and their implementation. VISU analyses are publicly available for teaching, research and prevention purposes. Requests for information can be lodged via the data request form on the VISU website or by contacting the VISU office by phone.

Contact VISU at

MUARC – Monash University Accident Research Centre
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All issues of *Hazard* and other information and publications of the Monash University Accident Research Centre can be found on our internet home page: **www.monash.edu/muarc/visu**

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