

# Adult food-induced anaphylaxis hospital presentations in New Zealand

Bridget Kool,<sup>1</sup> Devika Chandra,<sup>2</sup> Penny Fitzharris<sup>3</sup>

<sup>1</sup>Section of Epidemiology and Biostatistics, School of Population Health, University of Auckland, Auckland, New Zealand

<sup>2</sup>Faculty of Medical and Health Sciences, University of Auckland, Auckland, New Zealand

<sup>3</sup>Immunology Department, Auckland City Hospital, Auckland, New Zealand

## Correspondence to

Dr Bridget Kool, Section of Epidemiology and Biostatistics, School of Population Health, University of Auckland, Private Bag 92019, Auckland 1142, New Zealand;  
[b.kool@auckland.ac.nz](mailto:b.kool@auckland.ac.nz)

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## ABSTRACT

**Background** Food allergy including anaphylaxis is an increasing clinical problem in many countries. Little information is available regarding prevalence, causative foods and time trends in the New Zealand adult population.

**Objective** This cross-sectional study investigated the incidence of hospital presentation with food-induced anaphylaxis in New Zealand among adults and adolescents over a 10-year period.

**Methods** Ministry of Health hospital discharge data from 2002 to 2011 were analysed using food allergy and anaphylaxis-related International Classification of Diseases (ICD) codes to identify acute hospital presentations.

**Results** There was an average annualised rate of hospital food-induced anaphylaxis presentations of 4.8 per 100 000 adults (aged  $\geq 15$  years) for the period reviewed. Subgroup analyses revealed significant differences by gender, age group and ethnicity, notably higher rates in females, younger adults (15–34 years) and Pacific Island populations. Seafood was the most common food allergen group, followed by nuts. Time trend analysis revealed a 1.7-fold increase in the 10-year period, mainly attributable to an increase in rates in the Pacific Island population.

**Conclusions** These data confirm food-induced anaphylaxis as an increasing problem in New Zealand and show significant differences in incidence of hospital presentation in different ethnic populations. Future research will be required to understand and address disparities in the incidence of these conditions.

## INTRODUCTION

Food allergy is an adverse immune system response to exposure to a food protein. Adverse responses to food can range from mild allergic reactions through to death as a result of anaphylaxis.<sup>1 2</sup> In the USA, food-induced anaphylaxis is the leading cause of anaphylaxis treated in emergency departments (EDs).<sup>3 4</sup> Around 44% of ED presentations for food-related allergic reactions in the USA are estimated to be probable cases of anaphylaxis.<sup>5</sup> Heterogeneity in diagnostic criteria, study design and methodology lead to challenges in comparing studies and ascertaining accurate incidence, prevalence and time trends for food allergy and anaphylaxis.<sup>6–9</sup>

Epidemiological data on food anaphylaxis show variable rates.<sup>7 10</sup> A review by the US National Institute of Allergy and Infectious Diseases estimated the incidence of anaphylaxis to be between 1 and 80 per 100 000 people, with food-induced anaphylaxis ranging from 13% to 65% of those cases.<sup>11 12</sup>

New Zealand has a population of over 4.4 million people. Nearly three-quarters of the population (74%) identify with one or more European ethnicities, 15% as Māori (New Zealand's indigenous race), 12% as Asian, 7% as Pacific people and the remainder as 'other' ethnicities.<sup>13</sup>

Food allergy has emerged as an important public health issue in high-income countries in the last 20 years,<sup>5 7</sup> with evidence of increase based on hospital admission rates for food allergy/anaphylaxis,<sup>14–17</sup> community-based studies and increase in rates of prescription of allergy-related medications such as infant hypoallergenic formula and epinephrine auto injectors.<sup>18–20</sup> While a number of studies from abroad have shown evidence of increases, little New Zealand specific information is available upon which to base public policy.<sup>21 22</sup> Changes to the demography of New Zealand over the last two decades and increased food diversity may have altered the profile of food allergy/-induced anaphylaxis in New Zealand.<sup>9</sup> The aims of this study therefore were to examine the characteristics of patients admitted to New Zealand hospitals with a diagnosis of food-induced anaphylaxis and to examine time trends in specific demographic factors in those affected.

## MATERIALS AND METHODS

We examined time trends for New Zealand public hospital presentations with food-induced anaphylaxis over a 10-year period from 1 January 2002 to 31 December 2011. Coded discharge data are collected routinely by the New Zealand Ministry of Health (National Minimum Dataset—NMDS). The study population included all people aged 15 years and older with a primary hospital presentation as the result of food-induced anaphylaxis recorded in the NMDS. To ensure we had a complete sample, we also examined cases with a potential food-related allergic reaction. The population includes all cases, regardless of length of stay in ED. Cases were identified by the presence of relevant International Classification of Diseases, Tenth revision (ICD-10 AM) codes in any of the 20 diagnosis fields (table 1). The codes selected were based on a review of the published literature<sup>23 24</sup> and in consultation with experts in the field. Cases were classified as probable 'food-induced anaphylaxis', comprising Code T78.0 and code T78.2 (the latter only when accompanied by terms relating to either the consumption of food or specific food types in the corresponding text field) or 'non-anaphylaxis food allergy'. We took a conservative approach to classify cases as 'non-anaphylaxis food allergy'. Our decision rule specified that in order to be classified as a 'food allergy' case, the remaining

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**Table 1** ICD 10 codes used to identify 'food-induced anaphylaxis' and 'non-anaphylaxis food allergy' cases

ICD-10 code	ICD-10 code description	Number of cases with these codes present
<i>Food-induced anaphylaxis</i>		
T78.0	Anaphylactic shock due to adverse food reaction	1588
T78.2*	Anaphylactic shock, unspecified	10
<i>Non-anaphylaxis food allergy*</i>		
J30*	Vasomotor and allergic rhinitis	0
J45*	Asthma	0
K52.2	Allergic and dietetic gastroenteritis and colitis	217
L20*	Atopic dermatitis	0
L23.6	Allergic contact dermatitis due to food in contact with skin	1
L25.4	Unspecified contact dermatitis due to food in contact with skin	0
L27.2	Dermatitis due to ingested food	83
L50*	Urticaria	60
T78.1	Other adverse food reactions, not elsewhere classified	1275
T78.3*	Angioneurotic oedema	3
T78.4*	Allergy, unspecified	10
Z910*	Personal history of allergy, other than to drugs and biological substances	22

\*Cases identified by these codes accompanied by text field stating food or food consumption.

ICD, International Classification of Diseases.

diagnostic codes listed in [table 1](#) are needed to be accompanied by mention of terms relating to either the consumption of food or specific food types in the corresponding text field. 'Poisoning' and 'toxic effect' related codes were excluded. In this study, the term 'seafood' included both fin fish and all types of seafood.

Due to the absence of an identifier to indicate if cases were seen in the ED only and not admitted to hospital, we used length of stay of <24 h as a proxy for a possible ED only visit. However, it is recognised that patients may have hospital admissions of <24 h.

Variables of interests included: demographic information, ICD diagnosis codes and free text descriptors, and length of stay. Data analysis was conducted in EpiData (V.2.2). Population-based age-specific rates per 100 000 were calculated using 2006 Census data. Differences in rates and proportions were assessed using the z-score and  $\chi^2$  test, respectively. Health and Disability Ethics Committee approval was not required as the study used routinely collected anonymised data. The electronic data used in this study were password protected and stored on secure servers.

## RESULTS

During the 10-year period from 2002 to 2011, we identified 3157 presentations to hospital for food-related allergic reaction among adults and adolescents aged 15 years and over in New Zealand, an average annualised rate of 9.6 per 100 000 people. Of these, 1598 (50.6%) were classified as food-induced anaphylaxis (4.8 per 100 000 people; 95% CI 4.6 to 5.1), and the remainder non-anaphylaxis food allergy (n=1559; 4.7 per 100 000 people 95% CI 4.5 to 5.0). There were significant differences in rates of food-induced anaphylaxis by gender, age group and ethnicity ([table 2](#)). Almost two-thirds of cases were

**Table 2** Characteristics of adult ( $\geq 15$  years) hospital presentations with a discharge diagnosis of food-induced anaphylaxis,\* New Zealand, 2002–2011 (n=1598)

Characteristic	n (%)	Rate per 100 000 (95% CI)	p Value
Gender			<0.001
Male	620 (38.8)	3.9 (3.6 to 4.2)	
Female	978 (61.2)	5.7 (5.4 to 6.1)	
Age group (years)			<0.001
15–24	360 (22.5)	6.0 (5.4 to 6.6)	
25–34	361 (22.6)	6.6 (5.9 to 7.3)	
35–44	306 (19.1)	4.8 (4.3 to 5.4)	
45–54	237 (14.8)	4.2 (3.6 to 4.7)	
55–64	192 (12.0)	4.5 (3.9 to 5.2)	
65+	142 (8.9)	2.8 (2.3 to 3.3)	
Ethnicity			<0.001
Māori	192 (12.0)	5.3 (4.5 to 6.1)	
Pacific people	198 (12.4)	13.1 (11.4 to 15.1)	
Asian	151 (9.4)	5.6 (4.7 to 6.6)	
NZ European and other	1031 (64.5)	4.3 (4.1 to 4.6)	
Unknown	26 (1.6)	n/a	
Length of stay			n/a
<24 h	707 (44.2)	n/a	
2 days	851 (53.3)	n/a	
>2 days	40 (2.5)	n/a	

\*International Classification of Diseases (ICD) Codes T78.0, T78.2.

female. The highest rates were among people aged 15 to 34 years, and the lowest among older adults ( $\geq 65$  years). Rates of food-induced anaphylaxis among Pacific peoples were more than twice that of Māori and Asian rates, and three times that of those identified as 'New Zealand European and Other'. The median length of stay for cases of food-induced anaphylaxis was 1 day (IQR 0–1 days), with more than half (55.8%) staying longer than 24 h.

In only 21% of cases (n=337/1598), the food type involved was recorded in the diagnostic fields ([table 3](#)). Of the 337 food types that were specified, the most common were seafood (31%), followed by nuts (30%).

The majority (n=1534, 96%) of the food-induced anaphylaxis codes were located in the first of the potential 20 available diagnosis fields in the Ministry of Health data set. Of note, almost all (99%) of food-induced anaphylaxis cases were located in the first two diagnostic codes. Less than 1% (n=13/1598) of people had a 'Personal history of allergy' (ICD code Z910) recorded in any of their potential 20 diagnostic fields. Three quarters (n=10/13) of these were recorded in the second or third diagnostic fields.

Rates of food-induced anaphylaxis presentations rose from 3.3 per 100 000 people in 2002 to 5.8 per 100 000 people in 2011 ([figure 1](#)). Of note, food-related allergic reaction hospital presentations increased significantly during the decade reviewed, with rates increasing 2.5 times from 5.7 per 100 000 people in 2002 to 13.9 per 100 000 people in 2011.

Stratifying the food-induced anaphylaxis presentation data by ethnicity revealed that the greatest increase in rate has been among Pacific people ([figure 2](#)). During the 10-year period reviewed, rate per 100 000 people rose from 6.0 to 20.6 for Pacific people, compared with 3.5–5.2 for New Zealand Europeans.

Analysis of food allergen type by the individual's ethnicity revealed that among anaphylaxis cases where the food type was

**Table 3** Food type (where specified) by ethnicity for adult ( $\geq 15$  years) hospital presentations for food-induced anaphylaxis, New Zealand, 2002–2011 (n=337)

Ethnicity	Food type						Total, n (%)
	Eggs and dairy, n (%)	Seafood, n (%)	Fruit and vegetable, n (%)	Wheat/gluten, n (%)	Nuts, n (%)	Other food, n (%)	
Māori	1 (2.0)	24 (48.0)	0 (0.0)	4 (8.0)	13 (26.0)	8 (16.0)	50 (100)
Pacific	0 (0.0)	27 (64.3)	3 (7.1)	1 (2.4)	6 (14.3)	5 (11.9)	42 (100)
Asian	1 (4.5)	9 (40.9)	1 (4.5)	0 (0.0)	3 (13.6)	8 (36.4)	22 (100)
NZE/other/unspecified*	16 (7.2)	45 (20.2)	29 (13.0)	5 (2.2)	79 (35.4)	49 (22.0)	223 (100)
Total	18 (5.3)	105 (31.2)	33 (9.8)	10 (3.0)	101 (30.0)	70 (20.8)	337 (100)

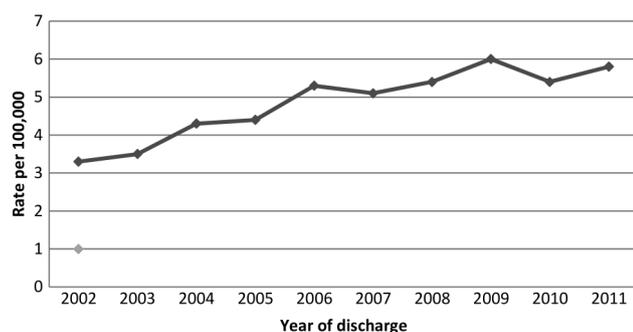
\*Unspecified=49 cases.

documented (n=337, 21%), people identified as Māori, Pacific and Asian were most likely to have ‘seafood’ recorded as the food allergen type (48%, 64% and 41%, respectively) (table 3). In contrast, among New Zealand Europeans and people of ‘Other’ ethnicities, ‘nuts’ were the most commonly recorded food allergen (35%).

## DISCUSSION

This study has identified an average annualised rate of food-induced anaphylaxis hospital presentations in New Zealand among adults and adolescents of 4.9 per 100 000 people. Importantly, the study has identified gender, age and ethnic disparities in incidence rates. Females, younger adults (15–34 years) and Pacific Island populations have significantly higher rates of food-induced anaphylaxis presentations than other subgroups. The majority of food-induced anaphylaxis cases were primary diagnoses, thus suggesting that the use of primary diagnoses only in future research can capture the majority of the desired cases. Although not the focus of this paper, the high incidence of food-related allergy identified in this study (4.7 per 100 000 people) is indicative of the public health burden to hospital EDs for this condition.

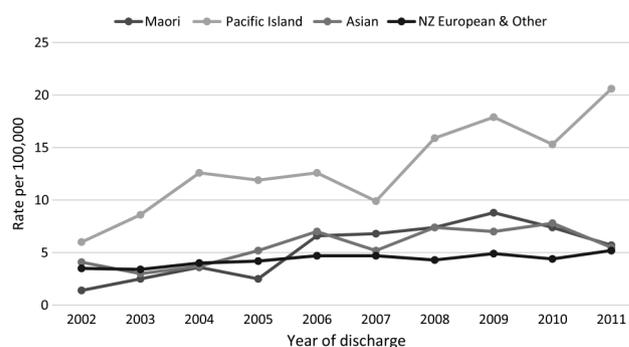
Time trends for food-induced anaphylaxis presentations demonstrated a 1.8-fold increase from 2002 to 2011, highlighting that food-related allergy is a growing public health concern in New Zealand. The increases for New Zealand European (3.5–5.2 per 100 000), Asian (4.1–5.5 per 100 000) and Māori (1.4–5.7 per 100 000) populations are more moderate, but the increase for people from the Pacific Islands of more than three-fold (from 6.0 to 20.6 per 100 000) is interesting and worthy of further investigation.

**Figure 1** Trends in adult and adolescent ( $\geq 15$  years) hospital presentations for food-induced anaphylaxis (rate per 100 000 people), New Zealand, 2002–2011.

While anaphylaxis admission rates vary between countries, there has been an upward trend in New Zealand consistent with findings in the UK, USA, Italy and Australia. The presentation rates we identified are somewhat higher than those identified recently in the UK, where hospital admissions for food-induced anaphylaxis rose from 1.2 to 2.4 per 100 000 between 1998 and 2012.<sup>15</sup> However, our data include ED presentations, which will account for some of the difference. Published rates of hospital attendance with food-induced anaphylaxis and food-related allergy in the USA are highly variable.<sup>5</sup>

A very recent study by Mullins and colleagues shows rates in 2011/2012 of hospital admission for food-induced anaphylaxis in Australia of 10.3 and 4.3 per 100 000 for adults of 15–29 years, and >30 years respectively.<sup>14</sup> These figures are a little higher for the younger adults and very similar for the >30 years group in the present study. Time trends in the Australian study suggested 1.5 and 1.3-fold increases for the two adult age groups over the 5-year period from 2005/2006 to 2011/2012.<sup>2,5</sup>

The strengths of the present study include the use of population-based routinely collected data and the use of internationally recognised diagnosis codes to identify cases. However, the study findings should be considered in light of the following limitations: The potential for missed cases who were treated only in the community (eg, in rural general practice) or treated solely in private accident and medical clinics or missed as a result of misclassification by the authors or miscoding by hospital coders of the event. The clinical identification of food-induced anaphylaxis occurring in regular practice, rather than having clear diagnostic criteria imposed, as would occur in

**Figure 2** Trends in adult and adolescent ( $\geq 15$  years) hospital presentations for food-induced anaphylaxis by ethnicity (rates per 100 000 people), New Zealand, 2002–2011 (n=1598).

a clinical trial. While clinical identification may have varied with different practitioners over the 10-year period, we are not aware of any systematic bias that would result in increased identification of cases of food-induced anaphylaxis over that time period, or of reasons for clinical identification to be different for different ethnic groups. The findings relating to the individual food types associated with hospital presentations may not be representative of all food-allergy-related presentations due to only 21% of cases having this information recorded. We were unable to establish from the data whether an individual was treated only in ED or admitted to a ward. Overall, our conservative approach means our figures are likely underestimates of case numbers.

Detailed audits of ED attendances with all cause adult community onset anaphylaxis of at Auckland Hospital, New Zealand, identified adult anaphylaxis rates of 42.8 per 100 000 (2001/2002) and 34 per 100 000 (2005/2006) per annum, one of the highest in the published literature.<sup>26</sup> In those cohorts, food-induced anaphylaxis made up 31% and 28%, respectively, of cases, with seafood and fish, followed by peanut the most commonly responsible food groups. Ethnicity for the combined cohorts was New Zealand European 62%, Asian 13%, Pacific Island 12%, other 8% but population-based rates were not presented. The authors found that only about 50% of cases which they determined to be anaphylaxis were coded as such (Dr Marianne Empson, personal communication). The presentation rate we identified during the 2002–2006 period (approximately 4.2 per 100 000) is indeed somewhat <50% of the estimated food-induced anaphylaxis rates of 13.3 (2001/2002) and 9.5 (2005/2006) found in that ED audit, suggesting that our figures are likely to be underestimates of the true incidence.

The female preponderance in food-induced anaphylaxis presentations noted in this study is consistent with other published studies.<sup>15 27–29</sup> A higher rate of food-induced anaphylaxis in younger adults is also consistent with the food anaphylaxis age distribution seen in Australia<sup>15 30</sup> and the UK.<sup>15</sup>

Adults of Pacific Island ethnicity had presentation rates of two to three times greater than other ethnicities in food-induced anaphylaxis cases in the present study. To our knowledge, these rates have been unexplored in the literature; however, our study findings are consistent with high prevalence of adverse food reactions in New Zealand Pacific Island children.<sup>22</sup> A number of studies from the USA based on the National Health and Nutrition Examination Surveys (NHANES) have noted increased food sensitisation among non-Hispanic blacks. Although cross-sectional in nature, these studies have highlighted disparities in sensitisation between African American and non-African American individuals.<sup>31</sup>

The higher presentation rates observed among Pacific peoples in the current study might in part reflect their over representation among self-presentations to public hospital EDs.<sup>32</sup> In the allergy clinic, patients of Pacific Island origin make up the majority of those identified as having anaphylaxis in response to a fish parasite *Anisakis*, likely a result of dietary habits. While this may contribute to the higher rate of anaphylaxis, it seems unlikely to be responsible for all cases. Unfortunately, we were unable to determine from the data available for this study if Pacific Island patients were New Zealand resident or not. No data are available regarding food allergy/anaphylaxis prevalence in the Pacific Islands. Some evidence from both Northern and Southern hemispheres has suggested that food allergy is more common at higher latitudes, with the speculative suggestion that vitamin D deficiency might play a role.<sup>33 34</sup> There is no reason

to consider that this factor, if relevant, would apply more to Pacific people than to Maori or Asian populations.

An Australian population-based study of 5276 infants showed higher rates of food allergy in the children of immigrants of Asian origin.<sup>35</sup> Peanut allergy was three times more likely among infants with parent/s born in East Asia compared with infants whose parent/s were born in Australia (OR 3.4, 95% CI 2.1 – 5.1). The mechanisms responsible for this are unknown but could also affect people from the Pacific Islands.

Reasons for differences in food-induced anaphylaxis presentations by gender and ethnicity observed in this and previous studies are diverse and could potentially include: genetics, dietary food patterns and environmental factors (eg, latitude, vitamin D exposure).<sup>6</sup> However, the presence or absence of cause-and-effect relationships need to be confirmed by controlled trials.

Time trend analysis revealed that food-induced anaphylaxis presentations increased 1.8 times from 2002 (3.3 per 100 000) to 2011 (5.8 per 100 000). This increase in rate is mainly, but not entirely, attributable to a threefold increase in Pacific Island rates over the 10-year period. This increase in time trend is consistent with other studies in both adult and paediatric populations, including increases in hospitalisations for allergic conditions in Australia.<sup>23 28 36</sup> and the UK.<sup>15</sup> However, the increase in rates could in part also be due to changes in awareness of food allergy by patients and coding behaviour by clinicians.<sup>37</sup>

Seafood was the most common food allergen identified in this study, consistent with data from the USA that estimated 2% of adults were allergic to shellfish compared with only 0.2% who were allergic to eggs<sup>38</sup> and consistent with the previous Auckland ED audit data.

There is a relative lack of access to specialist allergy services in New Zealand,<sup>9</sup> with specialist Clinical Immunology and Allergy services based only in the three largest cities during this study period. The development of effective health policy relies on robust information on the prevalence and severity of disease, evidence of effective treatments and associated healthcare costs.<sup>39</sup>

The economic impact of food-related allergy/anaphylaxis in New Zealand is unknown and requires further investigation. A recent cost-effective analysis of specialist services and epinephrine autoinjectors in the treatment of anaphylaxis revealed that autoinjectors are cost-effective at a threshold of £20 000 per Quality Adjusted Life Year.<sup>40</sup> Studies have shown that the use of epinephrine autoinjectors can reduce the need for further hospital treatment. An Australian observational study of epinephrine autoinjector use in a sample of children with a history of anaphylaxis found that admission to hospital occurred in 15% of occasions when the device was administered compared with 47% of occasions when the device was not used.<sup>41</sup> These devices are not funded by New Zealand's Pharmaceutical Management Agency, a government agency that decides which medicines and related products are subsidised—this did not change in the period reviewed. Their use is far from universal even in patients with known food allergy, and patients are encouraged to come to hospital if the autoinjector has been used in the community.

These findings provide novel New Zealand data on the epidemiology of adult food-induced anaphylaxis presentations that can be used for future research, policy development and health practice in New Zealand, with emphasis on health disparities.

## Main messages

- ▶ Food-induced anaphylaxis presentation rates among adults and adolescents aged 15 years and older in New Zealand have increased more than 1.7-fold over 10 years.
- ▶ Seafood and nuts were the most commonly identified foods.
- ▶ Food-induced anaphylaxis presentation rates varied with ethnicity and were highest among Pacific people, where the rate increased threefold in the 10-year period reviewed.
- ▶ Food-induced anaphylaxis presentation rates in New Zealand adults are highest among those aged 15–34 years.

## Current research questions

- ▶ What is the economic impact of food-induced anaphylaxis in New Zealand?
- ▶ What are the incidence and characteristics of food-induced anaphylaxis among childhood hospital presentations in New Zealand?

**Contributors** BK and DC developed the initial study concept and design. PF provided advisory input into the study design. DC cleaned and analysed the data. BK provided academic oversight for the data cleaning and analysis. DC prepared the first draft of the paper. BK and PF contributed to the interpretation of the data, the preparation of the manuscript, and revised it critically for important intellectual content. Final approval of the version to be published has been given by all authors.

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