

## LETTER

# Trends in severe allergic reactions of adults in Finland between 1999 and 2020: A national population study

To the Editor,

Increases in both the incidence of, and hospitalisation for, anaphylaxis and other severe allergic reactions has increased in recent years.<sup>1</sup> Indeed, a British study provided evidence of such increase up to sevenfold between 1992 and 2012.<sup>2</sup> We previously reported on the temporal patterns amongst the paediatric population, in Finland and Sweden.<sup>3</sup> Herein, we report the on trends of severe allergic reactions, between 1999 and 2020 in the entire Finnish adult population, that resulted in hospitalization, as well as anaphylaxis not leading to hospitalization (visits).

We used the Finnish National Hospital Discharge register<sup>4</sup> to obtain information about hospitalizations using International Classification of Diseases, 10th Revision (ICD-10) (codes of primary diagnoses). Anaphylaxis codes included T78.0 (anaphylactic shock due to adverse food reaction) and T78.2 (anaphylactic shock unspecified). Codes for other allergic reactions included T78.1 (other adverse food reactions not elsewhere classified), T78.3 (angioneurotic oedema) and T78.4 (allergy unspecified). To calculate the annual incidence (per 100,000 person-years [PY]) of hospitalizations, we used annual age-specific mid-populations from Official Statistics of Finland. An incidence rate ratio (IRR) with corresponding 95

percent confidence intervals (95%CI) was used to evaluate mean annual change in hospitalizations.

From 1999 to 2020, the cumulative observation time was 93,394,237 PY, during which 9766 Finnish adult persons hospitalized due allergic reactions (Table 1; incidence rate [IR] 10.96/100,000 PY (95%CI 10.48–11.44)). With consideration to anaphylaxis triggers, 3.0% were due adverse food reactions, 0.5% other adverse food effects, 29.7% unspecified anaphylactic reactions, 21.6% angioneurotic oedema and 45.2% unspecified allergic reactions. However, the distribution with specific diagnoses should be interpreted with caution, as the methodology is not able to discern about the aetiology of allergic reactions. The hospitalization incidence increased during the study period approximately by 1% per year (IRR=1.01; 95%CI 1.00–1.02). Corresponding numbers for anaphylaxis to food and unspecified were 1.05 (95%CI 1.03–1.07) and 1.02 (95%CI 1.01–1.02), respectively (Figure 1). An increase was also noted for angioneurotic oedema (IRR=1.04; 95%CI 1.03–1.04). Unspecific allergic reactions remained stable over the study period (IRR=0.99; 95%CI 0.99–1.00). Hospitalizations were lowest in 2008 (IR 9.04; 95%CI 6.53–11.56) and peaked in 2016 (IR 13.26; 95%CI 10.77–15.75). For more detail about results check Appendix S1.

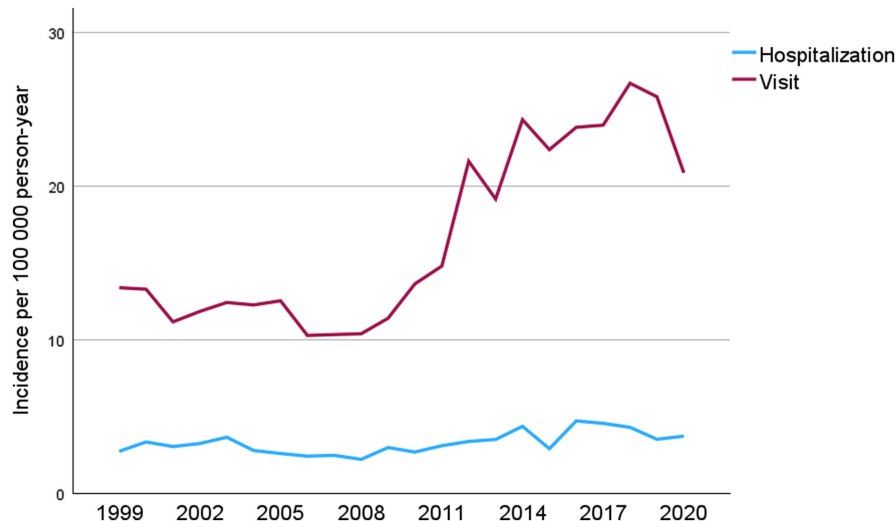
**TABLE 1** All hospitalizations and their distribute for different diagnoses between 1999–2009 and 2010–2020, by ICD-10 diagnostic code and age group.

	1999–2009						2010–2020						1990–2020 all age groups	
	18–39 years		40–59 years		Over 60 years		18–39 years		40–59 years		Over 60 years		n	%
	n	%	n	%	n	%	n	%	n	%	n	%		
T78.0	38	12.79	54	18.18	29	9.76	95	31.99	54	18.18	27	9.09	297	100.00
T78.1	7	14.89	8	17.02	5	10.64	8	17.02	11	23.40	8	17.02	47	100.00
T78.2	387	13.32	477	16.42	358	12.32	580	19.97	613	21.10	490	16.87	2905	100.00
T78.3	120	5.69	284	13.47	419	19.88	148	7.02	294	13.95	843	39.99	2108	100.00
T78.4	633	14.36	702	15.92	822	18.64	731	16.58	702	15.92	819	18.58	4409	100.00
All diagnoses	1185	12.13	1525	15.62	1633	16.72	1562	15.99	1674	17.14	2187	22.39	9766	100.00

Note: T78.0 (anaphylactic shock due to adverse food reaction), T78.1 (other adverse food reactions not elsewhere classified), T78.2 (anaphylactic shock unspecified), T78.3 (angioneurotic oedema) and T78.4 (allergy unspecified).

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial](https://creativecommons.org/licenses/by-nc/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

© 2023 The Authors. *Allergy* published by European Academy of Allergy and Clinical Immunology and John Wiley & Sons Ltd.



**FIGURE 1** Incidence of anaphylactic reactions by discharge type.

The majority (17,382/20,584 reactions; 84.4%) of anaphylaxis (T78.0+T78.2) did not lead to hospitalization (IR=16.66; 95%CI 15.45–17.87). During the study period, diagnoses increased (Figure 1), on average, 4%–7% annually (T78.0 IRR=1.07; 95%CI 1.06–1.08); T78.2 IRR=1.04; 95%CI 1.04–1.05).

Strengths of this study include the longest follow up of which we are aware, data from well-established Finnish registers and the examination of a spectrum of severe allergic diseases, which reflects the overlapping diagnoses noted in real life. Moreover, our study period spans the duration of the Finnish Allergy Program (2008–2018),<sup>5</sup> with a noted increased incidence shortly after the commencement of this program. Similarly, our study period includes a period before and after the introduction of anaphylaxis criteria in 2006.<sup>6</sup> In year 2013 emergency medicine training program was implemented for physicians working in emergency department settings.

Notable limitations include the lack of individual patient data and thus the inability to evaluate the aetiology of allergic reactions or the fulfilment of anaphylaxis criteria, and an inability to assess the severity of anaphylactic reaction. Moreover, it is possible that a single person may have had multiple visits for the same allergic reaction, that is, first in emergency care setting and later in outpatient clinic.

In summary, amongst Finnish adults, hospitalizations due allergic reactions and anaphylaxis have been increasing, by approximately 1% and 4%–5% annually, the latter which may be partly attributable to a shift from hospital admissions to emergency care follow up.

## AUTHOR CONTRIBUTIONS

**Lasse Saarimäki:** Planning the study, designing the methodology, collecting data, performing statistical analyses, writing the article and being responsible for the publication process. **Juho Kivistö:** Planning the study, designing the methodology and writing the article. **Sauli Palmu:** Writing the article and providing expertise in processing results. **Heini Huhtala:** Performing statistical analyses and writing the article. **Jennifer L. P. Protudjer:** Writing the article and providing expertise in processing results. **Jussi Karjalainen:** Planning the study, designing the methodology and writing the article.

## ACKNOWLEDGEMENTS

None.

## FUNDING INFORMATION

None.

## CONFLICT OF INTEREST STATEMENT

Lasse Saarimäki, Juho Kivistö, Sauli Palmu, Heini Huhtala, and Jussi Karjalainen declare no conflicts of interest. Jennifer L. P. Protudjer: JP is Section Head, Allied Health; and Co-Lead, Research Pillar for the Canadian Society of Allergy and Clinical Immunology, and is on the steering committee for Canada's National Food Allergy Action Plan. She reports consulting for Ajinomoto Cambrooke, Novartis, Nutricia and ALK Abelló.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Lasse Saarimäki<sup>1</sup>

Juho Kivistö<sup>2</sup>

Sauli Palmu<sup>1,3</sup>

Jennifer L. P. Protudjer<sup>4</sup>

Heini Huhtala<sup>5</sup>

Jussi Karjalainen<sup>2</sup>

<sup>1</sup>Department of Paediatrics, Tampere University Hospital, Tampere, Finland

<sup>2</sup>Allergy Centre, Tampere University Hospital, Tampere, Finland

<sup>3</sup>Center for Child, Adolescent and Maternal Health Research, Faculty of Medicine and Health Technology, Tampere University, Tampere, Finland

<sup>4</sup>Department of Pediatrics and Child Health, University of Manitoba, Winnipeg, Manitoba, Canada

<sup>5</sup>Faculty of Social Sciences, Tampere University, Tampere, Finland

### Correspondence

Lasse Saarimäki, Department of Paediatrics, Tampere University Hospital, Tampere, Finland.  
Email: [lasse.saarimaki@fimnet.fi](mailto:lasse.saarimaki@fimnet.fi)

### ORCID

Lasse Saarimäki  <https://orcid.org/0009-0006-2182-8589>

Sauli Palmu  <https://orcid.org/0000-0003-3270-7660>

### REFERENCES

1. Jeppesen AN, Christiansen CF, Frøsløv T, Sørensen HT. Hospitalization rates and prognosis of patients with anaphylactic shock in Denmark from 1995 through 2012. *J Allergy Clin Immunol*. 2016;137(4):1143-1147. doi:10.1016/j.jaci.2015.10.027. <https://www.clinicalkey.es/playcontent/1-s2.0-S0091674915016334>
2. Turner PJ, Gowland MH, Sharma V, et al. Increase in anaphylaxis-related hospitalizations but no increase in fatalities: an analysis of United Kingdom national anaphylaxis data, 1992–2012. *J Allergy Clin Immunol*. 2015;135(4):956-963.e1. doi:10.1016/j.jaci.2014.10.021. <https://www.clinicalkey.es/playcontent/1-s2.0-S0091674914015164>

3. Kivistö JE, Protudjer JLP, Karjalainen J, Wickman M, Bergström A, Mattila VM. Hospitalizations due to allergic reactions in Finnish and Swedish children during 1999–2011. *Allergy*. 2016;71(5):677-683. doi:10.1111/all.12837
4. Sund R. Quality of the Finnish hospital discharge register: a systematic review. *Scand J Public Health*. 2012;40(6):505-515. doi:10.1177/1403494812456637
5. Haahtela T, Valovirta E, Saarinen K, et al. The Finnish Allergy Program 2008–2018: society-wide proactive program for change of management to mitigate allergy burden. *J Allergy Clin Immunol*. 2021;148(2):319-326.e4.
6. Sampson HA, Muñoz-Furlong A, Campbell RL, et al. Second symposium on the definition and management of anaphylaxis: summary report—Second National Institute of Allergy and Infectious Disease/Food Allergy and Anaphylaxis Network Symposium. *J Allergy Clin Immunol*. 2006;117(2):391-397. doi:10.1016/j.jaci.2005.12.1303. <https://www.sciencedirect-com.libproxy.tuni.fi/science/article/pii/S0091674905027235>

### SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.