

Global food allergy research trend: a bibliometric analysis

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Abstract In this study, our aim is to evaluate the global scientific publications produced in the field of food allergy over the past 14 years. The Web of Science was considered as the primary database consisting of both Science Citation Index and Social Sciences Citation Index. This analysis provides an insight into the number of papers, journals, subjects, citations and the overall trend of research. A total of 8327 articles were considered for this study published between 2001 and 2014 in over a hundred journals. There has been a growing concern in the population as the food allergies are on an alarming rise over the past decade. Till date, research has failed to come up with a solution for this issue except for a complete abstinence of that food/ingredient from the diet. This new Bibliometric method would help the researchers in this field to understand the landscape of food allergy research, and set up the future research direction.

Keywords Web of Science · Journal citation report · Literature review · Food allergy

Introduction

Food is an integral part of our life and in this era of globalization it's not just the population that is migrating but also food from across the globe. Researchers, industries and professionals, all are trying to cater the food needs of the global population but for some people, food can be deadly. Sufferers of food allergies are medically required to avoid consumption of any food that may lead to serious consequences including breathing difficulties, swelling of throat and lips, vomiting and abdominal cramps and under worst circumstances possibly death (Hadley 2006). An allergic reaction to food is usually defined

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as an IgE-mediated response to a particular food protein or a group of proteins (Vanga et al. 2015). Any food can cause an immune response but most common cases of food allergy include foods such as peanuts, tree nuts, milk, soybean, wheat, egg, fish and shellfish (Eigenmann 2009; Hadley 2006; Vanga et al. 2015).

Assessment of the prevalence of food allergies is not an easy task. The difference in the scientific and societal definitions of food allergy makes it difficult to gather relevant and comprehensive data. This situation becomes more complex as perception of food allergy differs from person to person or one society to another. People find it difficult to recognize that food allergies is not a food preference it's a medical condition. In North America alone it has been estimated that approximately 3 % of adults and 3–8 % of infants are allergic to one or more foods and this number is growing (Sicherer et al. 2010). At present across major developed nations majority of research on food allergies is working towards gathering comprehensive data on its prevalence (Al-Hammadi et al. 2010; Asher et al. 2006; Boye 2012; Gupta et al. 2011; Hadley 2006). In recent years research on policy development and its implementation to prevent food allergies has garnered considerable interest but until and unless a clear understanding of true extent of food allergies are known the policies implemented by both governments and public health services will all go in vain.

One has to view the problem of food allergy on a macro-scale not on the micro-scale. For example, when a person in a family is diagnosed with food allergy the whole family tends to follow a restrictive diet and this influences their purchasing decisions and in the long run this will lead to a ripple effect that will affect the food industries (Hadley 2006). Both food industries and researchers are trying to find ways to prevent allergen cross-contamination of food products and also design and develop novel processing methods and food products that can be catered to allergic populations (Vanga et al. 2015).

A wide number of literature surveys and meta-analysis conducted on prevalence of food allergies are available (Rona et al. 2007; Anandan et al. 2009). But more and more research is required to find accurate interventions to prevent the advent of food allergies from medical, social and engineering perspective. Hence the objective of this study was to apply bibliometric analysis (BA) technique to qualitatively and statistically analyse the distribution patterns of research articles in the field of food allergies within the time period of 2000–2014 and provide an insight of the research trend and make recommendations for future research opportunities.

Data sources and methodology

Data retrieved

In this study, Web of Science (WoS) database which included all the available sub databases were included and used for data analysis as listed below:

1. Web of Science™ Core collection (1900-present)—containing Science Citation Index Expanded—SCI and Social Sciences Citation Index—SSCI
2. Derwent Innovations IndexSM (1963-present)
3. FSTA®—the food science resource (1969-present)
4. KCI—Korean Journal Database (1980-present)
5. MEDLINE® (1950-present)
6. SciELO Citation Index (1997-present)

They have been recognised as the most comprehensive, technical and scientific literature indexing tool covering wide range of subjects. The Journal citation reports (JCR) by WoS is divided into two groups: JCR science edition with data from 8000+ journals in 171 subjects and JCR social science edition which covers 2900+ journals in 55 subjects. The impact factor of the journals considered was determined by the JCR of Institute for Scientific Information (ISI) operated by the Thomson Scientific, Philadelphia, PA, USA.

The online version of the WoS is updated regularly and hence it was the main source from where the data was collected. Data presented in this study was mined on June 10th, 2015 using the topic = “food allerg*” selecting years 2001–2014 which extracted a total of 17,816 results.

Out of the 17,816 results, only about 8327 articles have been used for this study. The remainder of the retrieved results consist reviews, abstracts, meeting reports, editorials, books, case reports, reference materials, patents and unspecified documents which are discarded. The message generated is shown below:

TOPIC: (“food allerg*”)

Refined by: [excluding] DOCUMENT TYPES: (MEETING OR STANDARD OR REPORT OR REVIEW OR EDITORIAL OR BOOK OR UNSPECIFIED OR OTHER OR CASE REPORT OR NEWS OR BIOGRAPHY OR ABSTRACT OR LETTER OR REFERENCE MATERIAL OR BIBLIOGRAPHY OR PATENT OR CLINICAL TRIAL OR CORRECTION OR RETRACTION)

Timespan: 2001–2014.

Method of analysis

Any bibliometrics study deals with the number of articles, subject of the articles, journals published, year of publication, countries and institutes participating in publishing papers which is studied deeply using various methods of quantitative analysis. This paper analyses the trends of food allergy research after the year 2000. The study is restricted to the articles published between 2001 and 2014. The data for 2015 was ignored as it is still incomplete.

Result analysis

Productivity based on the year of publication

Figure 1 illustrates an increasing number of articles being published in the field of food allergy between 2001 and 2014. It is clear that with 251 published articles in 2001, food allergy research is already an established field at the start of new millennium, though there is a slight reduction (of 1.1 %) in articles published in 2002. But, the research output has consistently increased after that between 2002 and 2014. The articles published rose by nearly 49 % from 251 in the year 2001 to 376 in 2006 within a 5 years span. By 2009, the productivity doubled and by the end of 2013 it tripled and reached the peak of 774 compared to the number of articles in 2002. The total number of articles published increased to 791 by the end of 2014. Table 1 provides the numerical value of the articles published each year and also the articles that were cited the most among the articles published in that year. The Journal of allergy and clinical immunology (JACI) published five (35.72 %) of the most cited articles in the field of food allergy. It is followed by Pediatrics—three (21.43 %), LANCET—two (14.29 %), and one (7.14 %) article each in

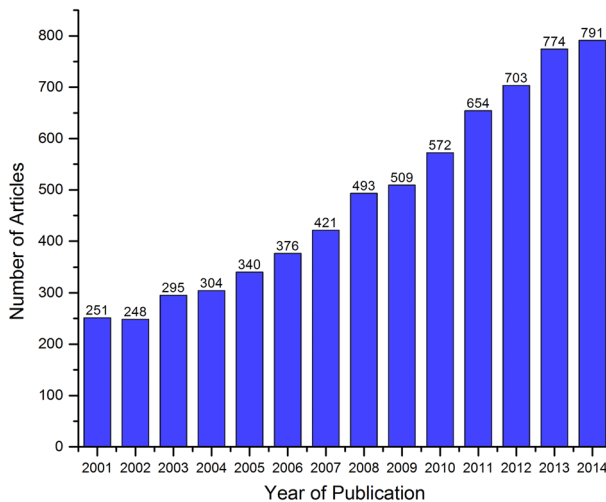


Fig. 1 Total number of articles published each year between 2001 and 2014

Journal of experimental medicine, Allergy, New England journal of medicine and PLOS ONE.

Distribution of food allergy articles based on subject and journal

Based on the data obtained from the Journal Citation Report (JCR), the articles have been published in over a hundred subjects. But, for the analysis, three subject categories have been chosen. Each category is a combination of closely related subject fields shown in the JCR report. The first category is ‘AIP’ which contains articles pertaining to subjects’ allergy, immunology and pediatrics which accounted to a total of 3638 articles between 2001 and 2014. The second category is ‘FAN’ containing articles related to subjects’ food science technology, agriculture and nutrition dietetics which accounted for 2355 articles. Third is BIOC category containing articles from the subjects biochemistry molecular biology, plant sciences, chemistry, toxicology, biotechnology applied microbiology, microbiology and biophysics accounting to 1334 articles. The articles related to the subjects AIP and FAN have increased almost in parallel to each other over the past 14 years as shown in Fig. 2. The total number of articles published in the group BIOC has never crossed 150 per year between 2001 and 2014, whereas AIP articles crossed the 150 mark in 2002 and FAN crossed it in 2007. The article output by AIP decreased by about 8.5 % between 2013 and 2014 from 388 to 355 which is a steep change making it interesting in looking how the research output would be for the coming years.

Table 2a shows the most productive allergy and immunology journals that published food allergy articles between 2001 and 2014. According to JCR, there are a total of 283 journals in the subject areas of allergy and immunology (including pediatrics) which accumulated over 1.5 million citations. Journal of allergy and clinical immunology is the most productive journal which published 489 articles with total citations accounting to 28,869 as per the WoS database. This is followed by Allergy with 347 articles and Clinical and experimental allergy with 303 articles published. Table 2b reports the data of the most productive food and nutrition based articles between 2001 and 2014. 2013 edition of JCR

Table 1 Food allergy publications every year between 2001 and 2014

Year	NA	Title	LA & J	NC
2001	251	Probiotics in primary prevention of atopic disease: a randomised placebo-controlled trial	Kalliomaki, M, LANCET	1343
2002	248	The use of skin prick tests and patch tests to identify causative foods in eosinophilic esophagitis	Spergel, JM, JACI	259
2003	295	Prevalence of peanut and tree nut allergy in the United States determined by means of a random digit dial telephone survey: a 5-year follow-up study	Sicherer, SH, JACI	443
2004	304	Allergen-responsive CD4(+)CD25(+) regulatory T cells in children who have outgrown cow's milk allergy	Karlsson, MR, Journal of experimental medicine	288
2005	340	Probiotics in the treatment of atopic eczema/dermatitis syndrome in infants: a double-blind placebo-controlled trial	Viljanen, M, Allergy	250
2006	376	Food allergy	Sicherer, SH, JACI	321
2007	421	The prevalence of food allergy: a meta-analysis	Rona, RJ, JACI	427
2008	493	Effects of early nutritional interventions on the development of atopic disease in infants and children: the role of maternal dietary restriction, breastfeeding, timing of introduction of complementary foods, and hydrolyzed formulas	Greer, FR, Pediatrics	382
2009	509	Food Allergy Among Children in the United States	Branum, AM, Pediatrics	237
2010	572	Food allergy	Sicherer, SH, JACI	309
2011	654	The Prevalence, Severity, and Distribution of Childhood Food Allergy in the United States	Gupta RS, Pediatrics	171
2012	703	Oral Immunotherapy for Treatment of Egg Allergy in Children	Burks A, New England journal of medicine	119
2013	774	Analysis of the Effects of Polymorphism on Pollen Profilin Structural Functionality and the Generation of Conformational, T- and B- Cell Epitopes	Jimenez-Lopez, JC, PLOS ONE	103
2014	791	Assessing the efficacy of oral immunotherapy for the desensitisation of peanut allergy in children (STOP II): a phase 2 randomised controlled trial	Anagnostou, K, LANCET	32

Year: Year of publication, NA: Number of articles published, Title: Title of the most cited article published that year, LA & J: Leading author and journal published of the most cited article published that year, NC: Number of citations for the article in all the databases of WoS

reports that about 320 journals are in circulation in the fields of agriculture, food science and technology and nutrition and dietetics. The journal with most number of articles related to food allergy is journal of agricultural and food chemistry which has 194 articles published and was cited 2894 times. The journals following are Food chemistry with 79 and Molecular nutrition and food research with 77. The combined total of these two journals in second and third places ($79 + 77 = 156$) is not even close to the number of articles published by the Journal of agricultural and food chemistry.

Distribution based on author's country

The contribution to the field of food allergy based on the country was estimated by using the location of the affliction/university of at least one author in an article (Li et al. 2009). Though there have been authors from over hundred nations, the top 15 countries

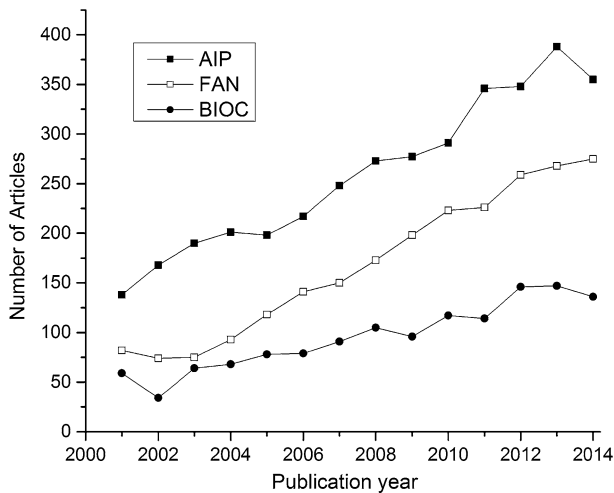


Fig. 2 Number of articles published each year between 2001 and 2014 in respective subject category (*AIP* Allergy–Immunology–Pediatrics, *FAN* Food Processing–Agriculture–Nutrition and Dietetics, *BIOC* Biochemistry and related fields)

contributing to the field of food allergy have been tabulated in Table 3. It has to be noted that articles from England, Scotland, Wales and Northern Ireland have been combined and classified as United Kingdom (UK) in the Table 3. United States of America (USA) has the most number of published articles accounted to 1280 (15.37 %) between 2001 and 2014.

Distribution based on the language of publication

Analysis of the origin language for the food allergy articles published in the period considered was also evaluated (Table 4). Majority of the articles are published in English which accounts for 91.59 %. It is followed by French (3.27 %) and German (2.2 %). This shows that English is widely accepted language medium for disseminating research data among peers.

Most cited publications

The total number of citations generated by the food allergy articles published was evaluated to be around 108,912 with an average 16.18 citations per article for the publications between 2001 and 2014. Tabulated are the top 15 articles that have been cited the most in the field of food allergy between 2001 and 2014. It has to be noted that the number of citations generated by a paper is an indicator of the impact of that particular article on the field, but not necessarily the quality and eminence of it (Ma et al. 2012). This analysis yielded three articles (20 %) published in 2001 and 2007, two articles (13.33 %) published in 2003 and 2010 and an article (6.67 %) each published in the years 2002, 2004, 2005, 2006 and 2008. None of the articles published in 2009 had made into the top 15 list. JACI has published a total of 10 articles (66.67 %) from the list. It is interesting to note that Sicherer, SH, from USA has contributed to four articles as the lead author which made into the list.

Table 2 (a) Top 10 Allergy and Immunology journals based on number of articles published, (b) Top 10 Food and Nutrition journals based on number of articles published

Journal name	NA	NA/Y	IF	Cit	Cit/A
<i>(a)</i>					
Journal of allergy and clinical immunology (JACI)	489	34.93	11.28	28,869	59.04
Allergy	347	24.79	5.99	9303	26.81
Clinical and experimental allergy	303	21.64	4.32	8760	28.91
Pediatric allergy and immunology	294	21.00	3.86	4974	16.91
International archives of allergy and immunology	235	16.79	2.43	3630	15.44
Annals of allergy asthma immunology	187	13.36	2.75	3136	16.91
Journal of investigational allergology and clinical immunology	92	6.57	2.64	862	9.37
PLOS ONE	87	6.21	3.53	408	4.69
Journal of pediatric gastroenterology and nutrition	62	4.43	2.87	1150	18.54
Pediatrics	62	4.43	5.30	3360	54.19
<i>(b)</i>					
Journal of agricultural and food chemistry	194	13.86	3.11	2894	14.92
Food chemistry	79	5.64	3.26	597	7.56
Molecular nutrition and food research	77	5.50	4.91	1222	15.87
Food and chemical toxicology	46	3.29	2.61	743	16.15
Food and agricultural immunology	41	2.93	0.98	126	3.07
Journal of the science of food and agriculture	28	2.00	1.88	136	4.86
Food control	22	1.57	2.82	117	5.32
Food research international	21	1.50	3.05	86	4.10
European food research and technology	21	1.50	1.39	169	8.05
Journal of nutrition	16	1.14	4.20	410	25.62

NA: Number of articles published, NA/Y: Average number of articles published per year, IF: 2013 Impact factor of the article, Cit: Total number of citations produced by the articles in the journal, Cit/A: Average Citations per article published

Table 3 Articles distribution based on the author's country

Country	No. of articles	% (of total 8327)
USA	1280	15.37
Germany	598	7.18
Italy	501	6.02
France	468	5.62
UK	442	5.31
Spain	414	4.97
Japan	349	4.19
Netherland	305	3.66
Austria	228	2.74
China	220	2.64
Australia	217	2.61
Canada	213	2.56
Sweden	208	2.50
Switzerland	184	2.21
Finland	147	1.77

Table 4 Articles distribution based on the language of publication

Language	No. of articles	% (of total 8327)
English	7627	91.59
French	272	3.27
German	183	2.20
Korean	115	1.38
Japanese	41	0.49
Spanish	41	0.49

Table 5 Top 15 most cited articles between 2001 and 2014 (as on 11th June 2015)

Title	Year	LA & J	NC	NC/Y
Probiotics in primary prevention of atopic disease: a randomised placebo-controlled trial	2001	Kalliomaki, M, LANCET	1343	103.31
Utility of food-specific IgE concentrations in predicting symptomatic food allergy	2001	Sampson, HA, JACI	738	56.77
Fatalities due to anaphylactic reactions to foods	2001	Bock, SA, JACI	731	56.23
Prevalence of peanut and tree nut allergy in the United States determined by means of a random digit dial telephone survey: a 5-year follow-up study	2003	Sicherer, SH, JACI	443	40.27
The prevalence of food allergy: a meta-analysis	2007	Rona, RJ, JACI	427	61
Effects of early nutritional interventions on the development of atopic disease in infants and children: the role of maternal dietary restriction, breastfeeding, timing of introduction of complementary foods, and hydrolyzed formulas	2008	Greer, FR, Pediatrics	382	63.67
Probiotics and prebiotic galacto-oligosaccharides in the prevention of allergic diseases: a randomized, double-blind, placebo-controlled trial	2007	Kukkonen, K, JACI	327	46.71
Food allergy	2006	Sicherer, SH, JACI	321	40.13
Food allergy	2010	Sicherer, SH, JACI	309	77.25
Allergen-responsive CD4(+)CD25(+) regulatory T cells in children who have outgrown cow's milk allergy	2004	Karlsson, MR, Journal of experimental medicine	288	28.8
The natural history of IgE-mediated cow's milk allergy	2007	Skripak, JM, JACI	260	37.14
The use of skin prick tests and patch tests to identify causative foods in eosinophilic esophagitis	2002	Spergel, JM, JACI	259	21.58
Probiotics in the treatment of atopic eczema/dermatitis syndrome in infants: a double-blind placebo-controlled trial	2005	Viljanen, M, Allergy	250	27.78
Anaphylactic and anaphylactoid reactions occurring during anesthesia in France in 1999–2000	2003	Mertes, PM, Anesthesiology	245	22.27
US prevalence of self-reported peanut, tree nut, and sesame allergy: 11-year follow-up	2010	Sicherer, SH, JACI	243	60.75

LA & J: Leading author and journal published of the most cited article published that year, NC: Number of citations for the article in all the databases of WoS, NC/A: Number of citations per year recorded in WoS after it is published

Table 6 List of most proficient authors between 2001 and 2014

Author	Affiliation	Country	NA	NA/Y	Cit	Cit/A	Cit/Y
Sampson, Hugh	Icahn School of Medicine at Mount Sinai	USA	206	14.71	12,518	60.77	894.14
Vieths, Stefan	Paul-Ehrlich-Institut	Germany	171	12.21	4796	28.05	342.57
Sicherer, Scott	Icahn School of Medicine at Mount Sinai	USA	159	11.36	7047	44.32	503.36
Burks, Wesley	University of North Carolina	USA	141	10.07	5275	37.41	376.79
Moneret-Vautrin, Anne Denise	Epinal Hospital & CHU de Nancy	France	104	7.43	2064	19.85	147.43
Niggemann, Bodo	University Children's Hospital Charite	Germany	100	7.14	3681	36.81	262.93
Ballmer-Weber, Barbara	University Hospital Zurich	Switzerland	100	7.14	2921	29.21	208.64
Mills, Clare	University of Manchester	United Kingdom	97	6.93	2716	28	194.00
Beyer, Kirsten	University Children's Hospital Charite & Icahn School of Medicine at Mount Sinai	Germany & USA	95	6.79	3870	40.74	276.43
Hourihane, Jonathan O' Brien	Cork University Hospital	Ireland	88	6.29	1691	19.22	120.79
Wood, Robert	The Johns Hopkins School of Medicine	USA	84	6.00	2762	32.88	197.29

NA: Number of articles published, NA/Y: Average number of articles published per year, Cit: Total number of citations produced by the articles in the journal, Cit/A: Average Citations per article published, Cit/Y: Average citations per year between 2001 and 2014

Distribution of most cited authors

The food allergy research in various universities and hospitals around the world has resulted in high end publications as shown in Table 5. But, some authors have constantly published during the period considered for research by this paper as listed in Table 6. There are always some authors who are very proactive in publishing in every field of research. Dr. Hugh Sampson from Icahn School of Medicine at Mount Sinai, NY, USA has been the most productive researcher not only in terms of articles published, but also in total number of citations and citations generated per year. In fact, the Icahn School of Medicine at Mount Sinai, NY, USA has a total of three authors (one co-affiliated with Germany) in the list of most proficient publishers in the field of food allergy research. USA has five researchers (one co-affiliated with Germany) followed by Germany—three (one co-affiliated with USA) and France, Switzerland, UK and Ireland have one each.

Conclusion

In this study, the food allergy research progress has been evaluated for the first time ever based on the bibliometric analysis method. A total of 8327 articles have been considered for this analysis which were published in over a hundred journals between 2001 and 2014. As a flagship journal, JACI published about 489 articles in this period in subject areas of AIP and Journal of agricultural and food chemistry published about 194 articles in subject areas of FAN. Also the research produced by the G7 countries (USA, Germany, Italy, France, UK, Japan and Canada) accounts to about 47 % thus suggesting a major contribution from research centres and universities located in these regions. The number of articles published each year has been increasing continuously and major innovation are taking place in the field with advent of omic technologies (genomics, proteomics etc.). And the prospects of this multidisciplinary research giving solutions in terms of food allergy is higher than ever.

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Compliance with ethical standards

Conflict of interest The authors report no conflict of interest.

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