Journal of Scientometric Research, 2024; 13(2):535-546.
https://www.jscires.org

Research Article

Evolution of Food Labeling Research and Current Publication Trends: A Scientometric Analysis

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ABSTRACT

Food Labeling is a critical communication mechanism to support consumers in making informed choices during purchase and to secure good health. The food safety standard authorities around the globe are working very hard to make food labeling world-class and user-friendly. In the present study, scientometric analysis is performed on the publication data extracted from the Web of Science (Clarivate™) database on food labeling. The publications are analyzed by the years, keywords, prolific authors and evolution of the research field is traced. The analysis of publication data in the realm of food labeling shows that the food labeling research got attention of researchers during the first decade of 21st century as many new laws and regulations were formed in US and Europe during this time. It is observed that the researchers of developed countries are publishing majorly on different aspects of food labeling followed by developing countries.

Keywords: Food Labels, Food Labeling, Scientometric Analysis, Ingredients, Nutrition.

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Received: 26-12-2023;
Revised: 08-01-2024;
Accepted: 08-03-2024.

INTRODUCTION

Food Labeling is a science and commerce communication, which is mandatory to be declared by the manufacturers of food articles to target consumers, law enforcement authorities, supply chain authorities, food scientists, researchers and policy-makers during the intended business domestically or globally. Therefore, it is necessary for food safety and nutrition amongst the public for their informed and correct choice of food articles. Knowledge and dissemination of these communications are to be correct, empirical and validated by studies. Food labeling policy is critical to ensuring that consumers have access to accurate information about the food products they purchase.[1] Various events have shaped food labeling research and policy over the years. A few crucial events in the field of food labeling policy highlight its importance.[2] A landmark legislation, 'Pure Food and Drug Act-1906', in the United States marked the beginning of federal food regulation.[3] It required accurate labeling of food and drugs and aimed to prevent adulteration and misbranding. Nutrition Labeling and Education Act (NLEA) of 1990 (NLEA) mandated standardized nutrition labeling on most packaged foods in the US, including the Nutrition Facts panel, which provides information about serving sizes, calories and nutrient content.[4] Further, with the 'Trans Fat Labeling Rule' (2006), the US FDA required the inclusion of trans fat information on food labels, helping consumers make informed choices regarding their dietary fat intake.[5] In the US, the Food Allergen Labeling and Consumer Protection Act (FALCPA) mandated the clear labeling of major food allergens, ensuring that those with allergies could easily identify potential allergens in food products.[6] GMO Labeling (Various Years): Several countries and US states have introduced or considered regulations requiring the labeling of Genetically Modified Organisms (GMOs) in food products.[7]

Similarly, many countries have introduced front-of-package labeling systems to help consumers quickly assess the nutritional quality of food products. Examples include the "Traffic Light" system in the UK[8] and the "Nutri-Score" in some European countries.[9] In the US, the Affordable Care Act required chain restaurants and similar food retail establishments to display calorie information on menus and menu boards to inform consumers about the nutritional content of restaurant food due to the Menu Labeling Rule (2010).[10] Efforts have been made to standardize date labeling on food products, reducing consumer confusion about "sell by," "use by," and "best before" dates. Under organic labeling, regulations for organic food labeling have evolved over the following several years, with many countries establishing standards for what can be labeled as "organic."[11] Several countries have implemented Country of Origin Labeling (COOL) requirements, mandating the disclosure of where certain foods and ingredients originate.[12] Regulations

DOI: 10.5530/jscires.13.2.42

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surrounding health claims on food labels have been established to ensure that such claims are substantiated and not misleading to consumers. Governments have implemented or proposed policies to include added sugar information on food labels, as excessive sugar consumption is a public health concern. These updates represent a subset of the many developments in food labeling policy. Food labeling policies continue to evolve to address emerging health and safety concerns and meet consumer demand for more transparent and informative labeling. The primary food regulations in India encompass the FSSAI (Food Safety and Standards Authority of India), the *Legal Metrology Act of 2009* and the Consumer Protection Act of 2019.[13,14] There are additional food-related laws in India like AGMARK, BIS (Bureau of Indian Standards), etc., all of which have their specific guidelines and regulations, including rules for food labeling.[14]

Food labels serve as a valuable tool for consumers, providing essential information about the contents of a product and assisting in making healthier choices among processed foods. Whether it's the front, back, or sides of a package, these labels are designed to inform us about the food's composition and offer guidance on better dietary decisions.

The scientometric analysis is a powerful and established method for assessing the status and progress of a particular field of study. It systematically evaluates research publications, encompassing articles, reviews, conference papers and other forms of scientific communication. By applying scientometric techniques, researchers comprehensively understand evolution of the specific area of research over time, key contributors, the most cited works, the emerging themes and paradigms. Food labeling research has evolved with societal shifts in attitudes toward health, nutrition and sustainability. In the past, food labels primarily focused on basic nutritional information. However, as consumer demands and regulations have grown more stringent, researchers and policymakers have expanded their focus to include allergen disclosure, sustainability claims and ethical labeling. The scientometric analysis conducted in this study provides a historical overview of these developments, allowing us to trace the evolution of food labeling research and its current state.

The present study employs scientometric techniques to achieve several key objectives, including the identification of research trends, contributions by different institutes and countries, mapping collaborations among institutions and countries, analyzing highly cited works and highlighting the prominent funding agencies cited in the published documents. This study aims to contribute valuable knowledge that will inform future research, policy decisions and industry practices in the ever-evolving field of food labeling.

METHODOLOGY

For the scientometric analysis, the 'Web of Science' (WoS) database was utilized for downloading the relevant data, which was accessed from CSIR-National Institute of Science Communication and Policy Research, New Delhi, India on 11th Sept 2023. The WoS database is regarded as one of the most reliable sources for obtaining information on published work within a specific research area and as such, it has been widely utilized by researchers.[15] Various types of publications, including peer-reviewed journal articles, proceedings, editorials, book chapters and review papers, are covered by this database. The data collection process from the WoS database involved a general search which was conducted using the terms "food labeling" and "food label" in 'topics' section to retrieve the publications within this field and avoid irrelevant documents. Publication years of these scholarly articles starting from year 1964 in which the article 'Food labeling- A new approach' published in the Royal Society of Health journal is listed as the oldest article in the WoS database on food labeling. The documents published till December 2022 from the beginning (1964) were taken in to account in the study. Microsoft Excel and other relevant graph plotting software were used for analysis and plotting the graphs. The VOSviewer 1.6.17 is used for making network diagrams with the help of tab-delimited files for collaborations and keywords network. The top highly cited publications were also downloaded from WoS database.

RESULTS AND DISCUSSION

Each publication record, including its abstract, was meticulously examined to record details such as the publication's title, authors and their affiliations, year of publication, journal, country of researchers, the journal's disciplinary areas, funding sources. Subsequently, an analysis of the collected data was conducted to elucidate global publication patterns; research endeavors in diverse geographic regions worldwide, publication areas and collaborative efforts across disciplines by researchers etc. Notably, each journal defines its area(s) of interest and specialization and data on the publication areas were extracted from the records to determine if researchers had contributed to journals with broad thematic scopes and whether scientists from distinct research backgrounds engaged in collaborative efforts. In this study, we regarded (a) publications across interdisciplinary journals with a wider readership and (b) co-authorship involving researchers from multiple disciplines as indicators of interdisciplinary research.

The research field attracted the attention of researchers in 21st century and numbers of publications are approximately doubled in 2006 in comparison to the year 2005. According to Web of Science database, total 1565 documents are published till December 2022. Journal articles are the most published document in the field of food labeling. There are a very small number of conference proceedings on the subject. Figure 1 shows the distribution of

number of publications in different years from 1991 to 2022. In year 2019, the research field witnessed publication of the more number of conference proceedings before COVID-19.

The published document types include journal articles, conference proceedings, reviews, corrections, news items, book reviews, etc., The types of publications and their numbers are shown in Figure 2. The data is for the years 1964-2022. The researchers published the highest number of research articles in the journals in comparison to other document types since the first paper in 1964. However, the term food-labeling was the term of attention for editors and science journalists as 76 editorial materials were published and 33 news items were published in the SCI-indexed journals.

Figure 3 lists the major research areas in which food labeling research has been published. The research area of food labeling is very interdisciplinary which spans from agriculture to food technology, nutrients to psychology, biochemistry to metabolism; and local governments' laws to international policy. Researchers of different fields collaborate to conduct research in the field. The nutrients and dietetics researchers evaluate the effect of food labeling on client picks, dietary habits and standard vitamins. They also inspected how one-of-a-kind labeling techniques have an effect on perceptions of well-being and fitness and guide people in making knowledgeable nutritional choices.[16] In food technology research, the scientists investigated the technical factors of food labeling, together with the improvement of the latest labeling technology, the assessment of food high-quality through the years and the impact of labeling on food preservation.[17] This vicinity additionally encompasses studies on the accuracy of dietary facts on labels. Occupational health researchers look at the potential health risks associated with particular ingredients or substances present in food products.[18] This ought to encompass inspecting the outcomes of occupational publicity for the duration of food manufacturing or processing. Agriculture and food labeling has notable intersection which performs an essential function in the production of raw materials for food merchandise.[19] Research on this area also recognized sustainable and ethical labeling practices, traceability of elements and the environmental impact of food manufacturing techniques. Researchers in enterprise economics delved into the economic implications of food labeling, studying patron behavior, market trends and the financial effect on food companies.[20] They examined how labeling affects market demand, emblem popularity and competitiveness. Chemistry researchers contribute by analyzing the chemical composition of food merchandise and the accuracy of labeling with ingredients, additives and nutritional content.[21] It is crucial to ensure that labels provide specific and dependable records to customers. Understanding how consumers perceive and interpret food labels is an essential aspect of studies in psychology and client conduct. Researchers in psychology discovered the mental factors that influence consumer alternatives primarily based on labeling records create awareness of the legal and regulatory components of food labeling, compare present policies and provide upgrades among public.[22] They could also explore the enforcement of labeling guidelines and their effectiveness in protecting public health and making sure ethical business practices. Pharmacological research in food labeling also contain investigating the capacity pharmacological consequences of bioactive compounds found in foods.[23] Researchers discovered how certain components may engage with medicines or effect physiological practices, influencing the formula of warning labels for people with precise scientific conditions. Researchers in endocrinology and metabolism awareness explore the questions on how food additives impact hormonal regulation and metabolic tactics.[24] This information contributes to the improvement of

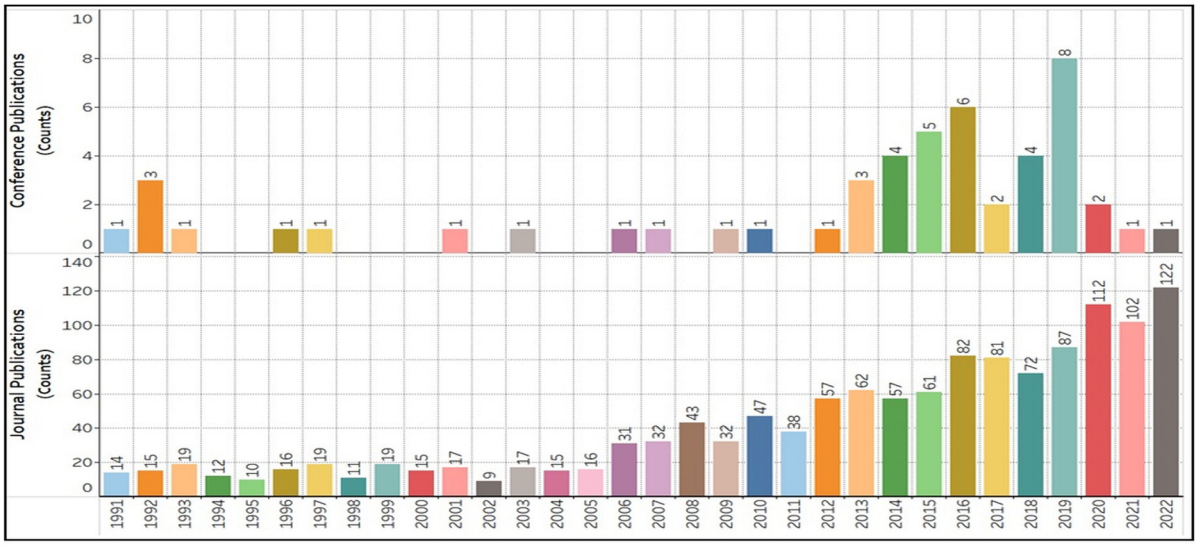


Figure 1: Year-wise distribution of the journal and conference publications from 1991-2022 in the field of food labeling

labels that offer statistics relevant to individuals with metabolic issues or those looking for precise nutritional interventions for metabolic health. Behavioral scientists explored the interpretation of individuals and their reply to food labels.[25] This consists of research on elements influencing purchaser selection-making, the impact of label design on perceptions and techniques to inspire healthier food selections. Behavioral insights contribute to the design of labels that effectively speak facts and force positive behavior change. Biochemistry and molecular biology researchers examined the molecular composition of meals and the way it pertains to health. This consists of analyzing the presence of specific compounds, allergens, or genetically changed organisms.[26] Their findings contribute to accurate labeling regarding the composition and potential health consequences of food products. Allergy researchers made the contribution to food labeling by way of identifying commonplace allergens found in foods. Understanding allergenic components allows for correct allergen labeling, imparting essential statistics for individuals with food-hypersensitive reactions to make secure picks and keep away from ability health dangers. Immunology researchers recognize understanding how food additives may additionally interact with the immune gadget.[27] This understanding is vital for accurately labeling potential immunological outcomes and making sure that people with autoimmune conditions or compromised immune structures can make knowledgeable food picks. Further, government law and regulatory bodies play a pivotal role in shaping and implementing food labeling requirements. Researchers in this field attempt to take cognizance of evaluating the effectiveness of present regulations, offering amendments and ensuring that labels observe felony necessities.[28] They make contributions to the improvement of rules that safeguard client rights and public health.[29] The interdisciplinary nature of food labeling studies includes collaboration throughout diverse fields to deal with prison, scientific, behavioral and biochemical components.[30] The insights from these disciplines collectively contribute to the development of comprehensive and informative food labels that prioritize consumer health and protection. Figure 4 represents the top 27 author keywords' network for the minimum occurrence of a keyword 10 times in the literature.

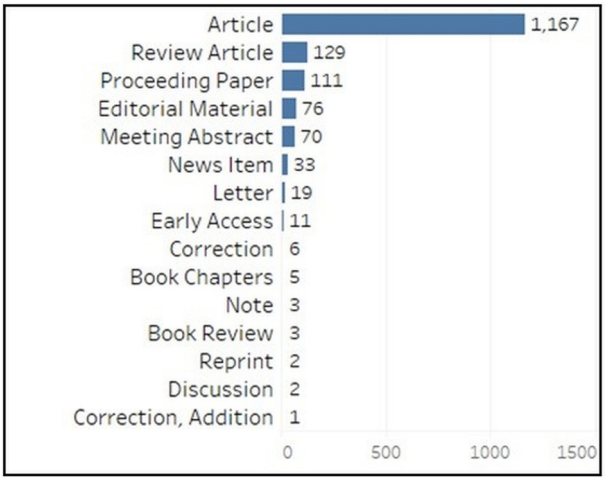


Figure 2: Different types of publications from 1964-2022.

Research papers on food labeling replicate an extensive spectrum of interdisciplinary topics, underscoring the complexity and numerous impacts shaping this area and it reflects in the citation topics of the published papers. The major citation topics in the published literature include smell and taste science, nutrition, dietetics, allergy, economic theory, lipids, agricultural policy, social psychology, food science and technology, entomology, chemometrics, urology and nephrology, climate change, *etc*. Scholars delve into the intricacies of smell and taste technological know-how to apprehend how sensory perceptions contribute to food choices and labeling options.[31] Nutrition

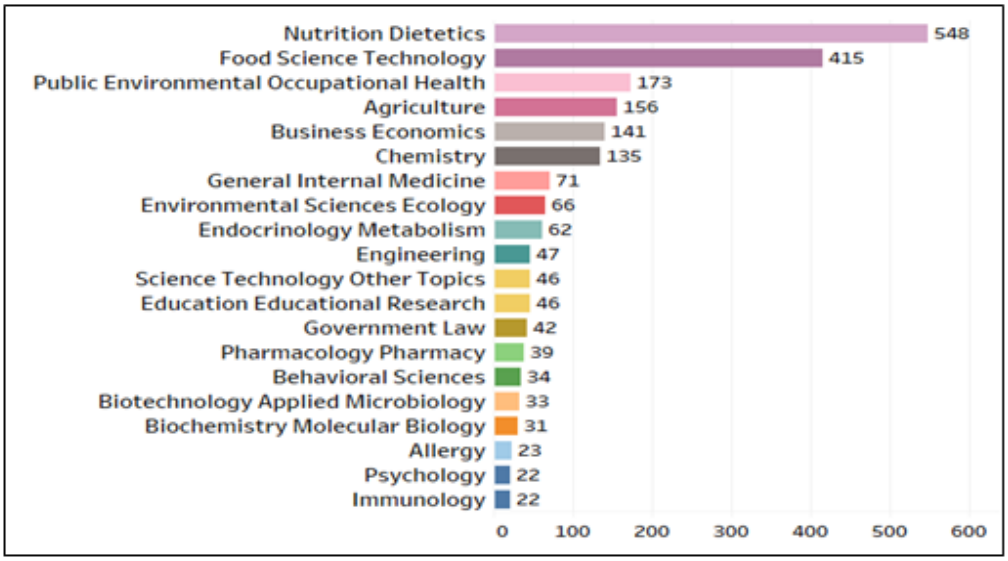
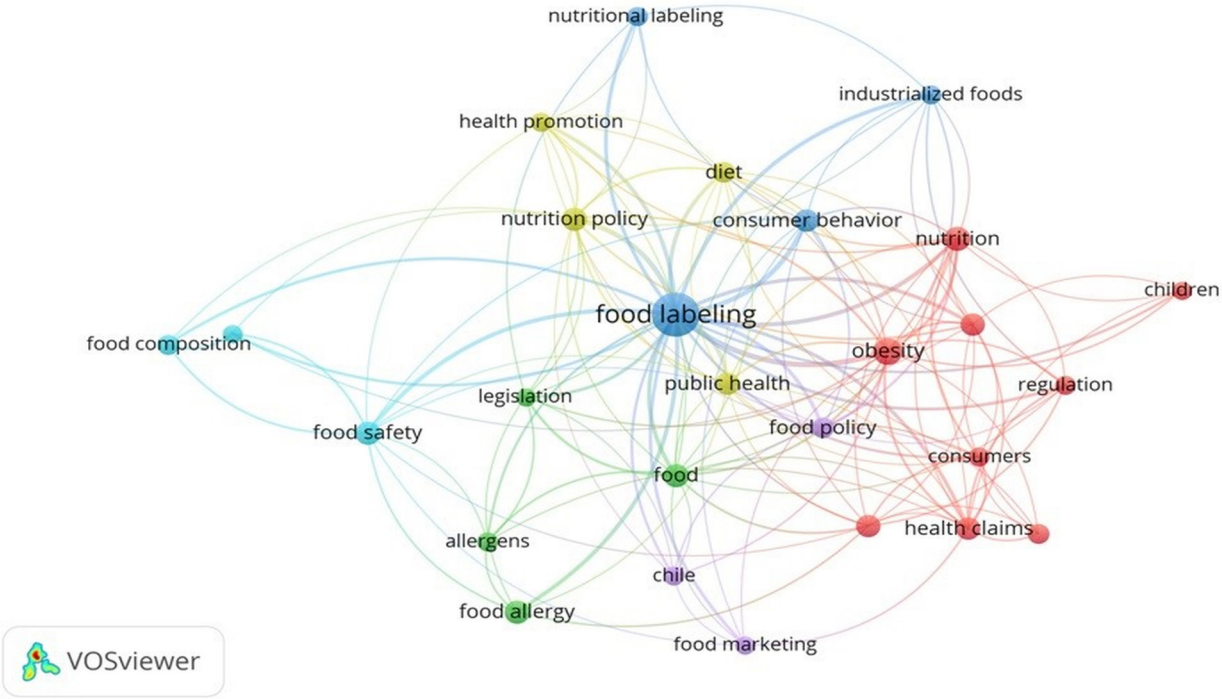


Figure 3: Major Research Areas in the field of Food Labeling.

and dietetics researchers explore the nutritional implications of food merchandise, ensuring that labels provide accurate and complete facts for consumers. Allergy-associated research does the needful to figure out and label allergens, safeguarding people with food allergies.[6] Economics researchers perform an important role in assessing the economic implications of labeling regulations, guiding policymakers in balancing patron protection with economic concerns. Investigations into lipids contribute to a nuanced understanding of fats and oils in food products, influencing labeling strategies. Agricultural policy



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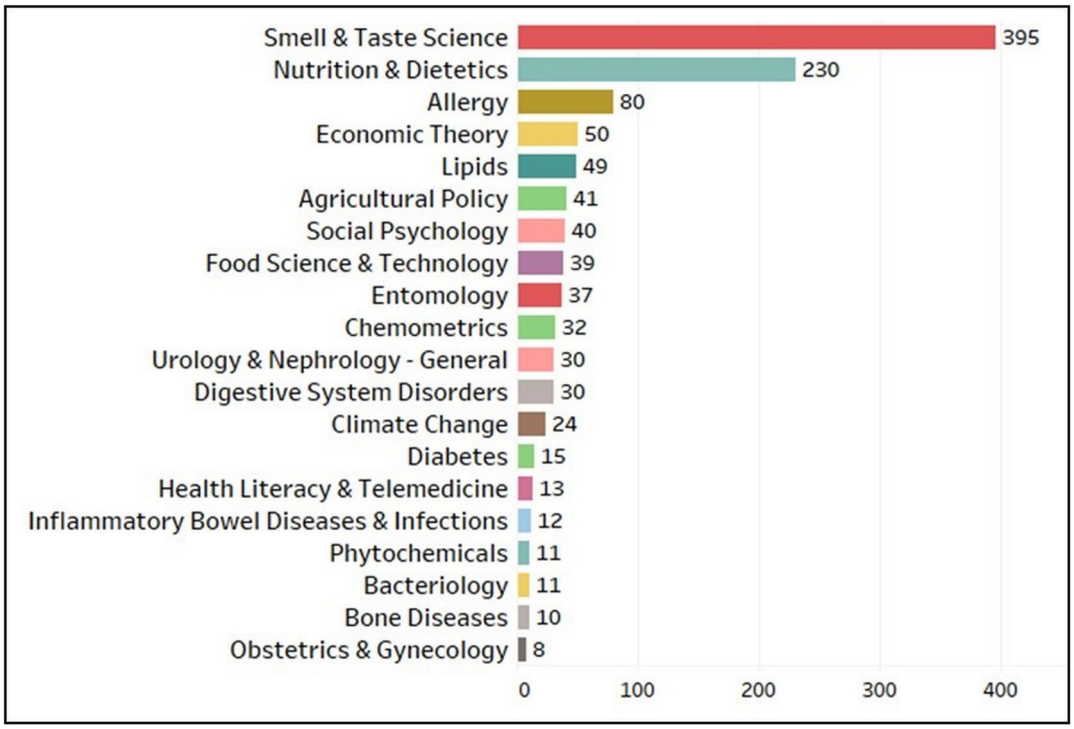

Figure 5: Macro Citation topics in the published literature on Food Labeling.

research addresses sustainability, traceability and moral issues in food manufacturing, informing labeling practices aligned with broader agricultural dreams.[19] Social psychology research lights up the psychological factors shaping client responses to food labels, contributing treasured insights to label layout. Entomology, chemometrics, urology, nephrology, climate alternate, diabetes and bone diseases exhibit the various array of specialties contributing their perspectives to the multifaceted realm of food labeling, demonstrating the tricky interplay among technology, health, economics and societal elements in shaping how we understand and engage with the statistics supplied on meals labels.[32] Figure 5 depicts the macro citation topics in the published literature on Food Labeling.

In the case of micro citation topics, the research papers based on food labeling cite the following focused topics- health claims, obesity, food allergy, contingent valuation, environmental concerns, docosahexaenoic acid, starch, melamine, celiac disease, salt intake, science communication, diabetes, health literacy,

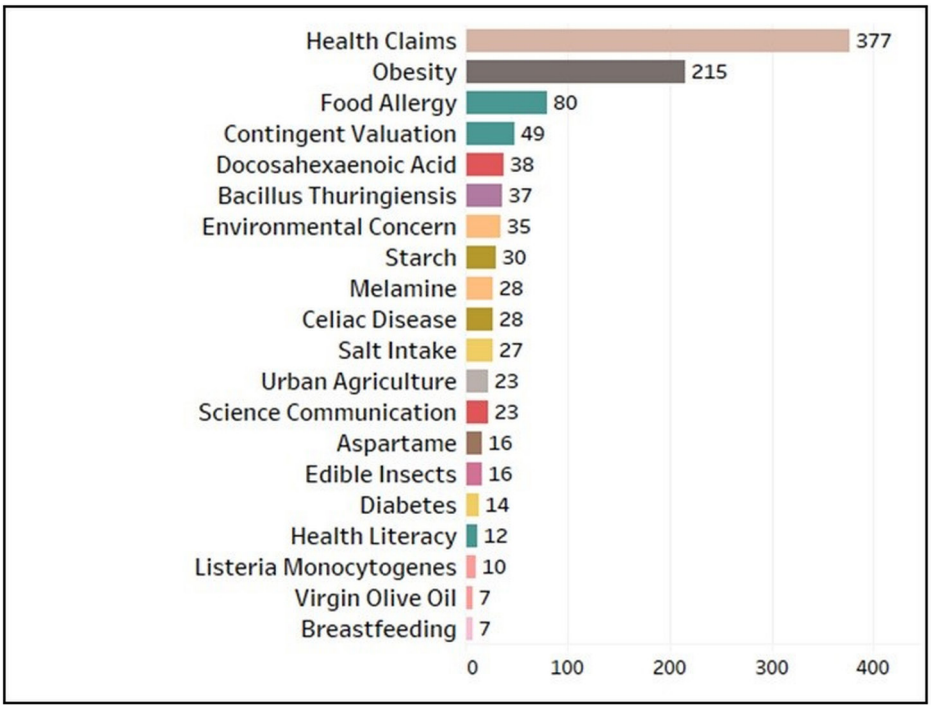

Figure 6: Micro-Citation topics in the published literature on Food Labeling.

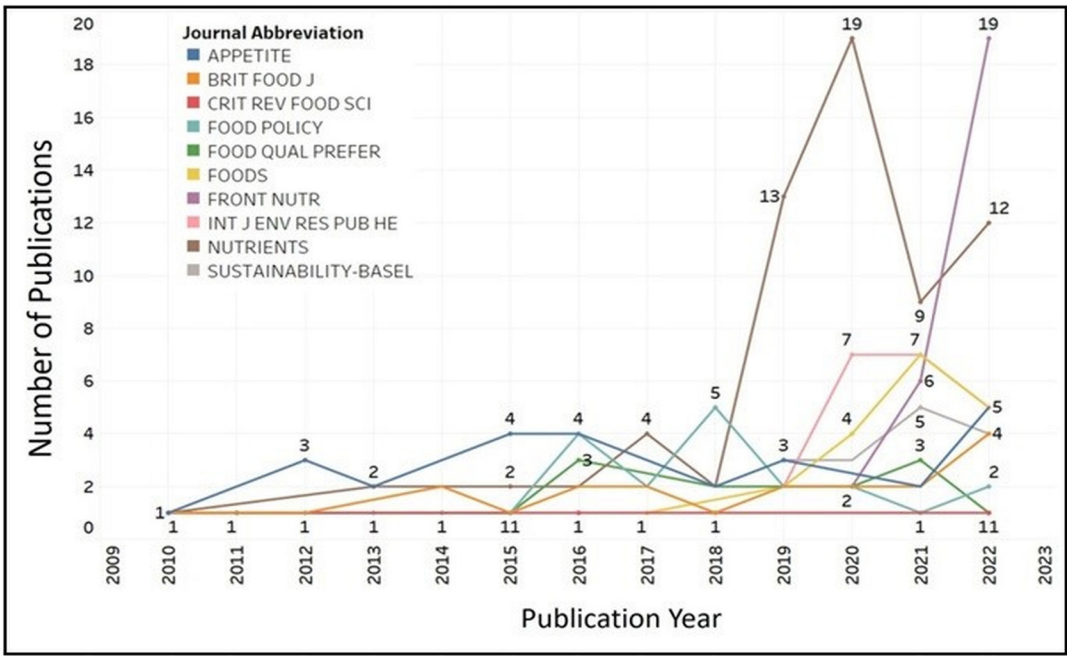

Figure 7: The year-wise distribution of the number of articles published by the top 10 journals.

Table 1: The list of the highest cited papers in the field of food labeling.

Article Title	Document Type	Journal Abbreviation	Publication Year	Times Cited, All Databases
Methods of measurement and evaluation of natural antioxidant capacity/activity (IUPAC Technical Report).	Article	Pure and Applied Chemistry- De Gruyter.	2013	373
CODEX-aligned dietary fiber definitions help to bridge the 'fiber gap'.	Article	Nutrition Journal.	2014	262
An evaluation of Chile's Law of Food Labeling and Advertising on sugar-sweetened beverage purchases from 2015 to 2017: A before-and-after study.	Article	PLOS Medicine.	2020	221
A Meta-Analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices.	Review	American Journal of Preventive Medicine.	2019	176
Impact of Cereal Seed Sprouting on Its Nutritional and Technological Properties: A Critical Review.	Review	Comprehensive Reviews in Food Science and Food Safety.	2019	121
What is the effectiveness of obesity related interventions at retail grocery stores and supermarkets? - a systematic review.	Review	BMC Public Health.	2016	120
Responses to the Chilean law of food labeling and advertising: exploring knowledge, perceptions and behaviors of mothers of young children.	Article	International Journal of Behavioral Nutrition and Physical Activity.	2019	106
Development of the Chilean front-of-package food warning label.	Article	BMC Public Health.	2019	105
Experimental Studies of Front-of-Package Nutrient Warning Labels on Sugar-Sweetened Beverages and Ultra-Processed Foods: A Scoping Review.	Review	Nutrients	2020	88

breastfeeding, etc. Obesity is one of the highest cited terms in the food labeling literature.[33] Contingent valuation research addresses the monetary aspects of labeling, assessing how consumers cost facts approximately the health attributes of food products. Environmental worries are increasingly more included in labeling discussions and inspecting the ecological footprint of food items. Docosahexaenoic Acid (DHA),[34] starch, melamine and celiac disorder studies[35] contribute to the specificity of labeling records, making sure correct representation of dietary content and ability allergens. Salt intake studies inform techniques for labeling to guide consumers in coping with sodium stages for cardiovascular fitness. Interestingly, science communication research topics also include food labeling topics.[36] In essence, the research on those focused subjects together shapes the evolving panorama of food labeling, aligning it with modern-day health concerns and the broader societal discourse on nutrients and properly-being. Figure 6 lists the micro-citation topics in the published literature on Food Labeling.

In the Web of Science literature, the highest-cited publications in the field of food labeling are mainly research articles and reviews. These papers were published after the year 2013.The year 2013 is notable in the context of food labeling due to a significant regulatory development in the United States. In that year, the U.S. Food and Drug Administration (FDA) announced the finalization of two key rules related to food labeling as part of the implementation of the Food Safety Modernization Act (FSMA).[37] These rules aimed at improving the clarity, comprehensibility and relevance of nutritional information on food labels. The second-highest cited paper is based on the CODEX rules.[38] The Codex Alimentarius, often referred to CODEX, is a collection of international food standards, guidelines and codes of practice developed by the Codex Alimentarius Commission, a joint program of the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). Codex standards cover various aspects of food safety, quality and trade, providing a foundation for international harmonization of food standards. Other publications include different food labeling practices and awareness about it in common public. Table 1 exhibits a detailed list of the highest-cited papers in the field of food labeling.

The analysis of the WoS data reveals that Elsevier stands as the primary publisher, contributing the highest number of publications at 18.15% share. Following closely is MDPI, securing the second position with a 9.3% share in publications, while Wiley takes the third spot, publishing the third highest number of publications, accounting for 7.2% of the total publications in this field. There are a large number of journals that publish generally

about food but being an interdisciplinary subject that includes the interest of social scientists, policymakers and law professionals the articles about food labeling are published in a range of journals that focus on nutrition, social behavior, food chemistry, food composition, policy and law. According to the Web of Science database, the highest number of articles is published by the journal Nutrients. The journal 'Nutrients' published by MDPI is publishing the highest share of the publications which is 4.9 % and the journals 'Appetite' is second with 2.1% share among the food labeling publications. The Journal "Food Policy" is among top three highest publishing journals on food labeling with 1.98% share of total publications. The other journals such that 'Frontiers in Nutrition', 'Annals of Nutrition and Metabolism', 'American Journal of Clinical Nutrition' and 'Public Health Nutrition'. Figure 7 depicts the year-wise distribution of the top 10 journals that published the highest number of articles related to the field of food labeling. The research field related to food labeling got attention since 2018 which is clearly visible in the graph.

As per the Web of Science database, most of the articles published related to food labeling are in English. Out of the total documents 1565 published on food labeling since 1964, 1447 documents are in English and the remaining 108 documents are published in different European languages including Japanese, Chinese and others. While the majority of scholarly literature on food labeling is found in English, a noteworthy subset exists in different languages including German, Spanish, Japanese, French, Portuguese and others. This multilingual frame of research reflects the worldwide nature of food labeling worries, with diverse linguistic contributions imparting insights into local views, regulatory frameworks and patron behaviors.

In terms of publication output, the United States is the top contributor in the field of food labeling. The US has published 38.8 % of the research publications in the field. Canada has published 7.15% of the total publications since 1964 and is the second top research output in terms of publications. Brazil (5.1%), Italy (4.6%), Australia (4.3%), Spain (3.9%), Germany (3.9%), Japan (3.9%), England (3.9%), China (3.4%) and the Netherlands (2.6%) follow, each offering a varied number of publications, with the Netherlands having the lowest count at 41 publications in the top 10 list. This data sheds light on the involvement and interest of different nations in producing literature or research concerning food labeling, with the USA being the most prolific in this regard. India published a total 28 articles in the field which constitutes 1.7% of the total published documents from 1964 to 2022. Figure 8 demonstrates the world map with the number of articles published by each country during 1964-2022.

The field of food labeling research is characterized by enormous worldwide collaboration, showcasing a collective attempt to deal with global concerns and standards. Several nations actively contribute to collaborative research endeavors in this domain. Notable individuals consist of the USA, wherein regulatory corporations and educational institutions explore on food labeling regulations and customer behavior. European countries, especially the United Kingdom, Germany and France, are actively engaged in advancing food labeling methods. Australia and Canada additionally play extensive roles, contributing knowledge in nutrition science and regulatory frameworks. Additionally, emerging economies including China and Brazil are increasingly more prominent in worldwide food labeling studies, reflecting the growing significance of these nations in shaping global standards. The collaborative efforts amongst these nations sell the trade of expertise, diverse perspectives and attempt to formulate best practices, ultimately contributing to the evolution and development of food labeling practices on a global scale. As per the Web of Science database on food labeling, the network diagrams for the collaboration of different top-performing countries are plotted with the help of VOS viewer software. It shows that France, Scotland, England Slovenia and Japan collaborate and publish good number of papers. Germany, Turkey and the Czech Republic form a network in publishing on food labeling. The USA and Canada have strong collaborations in the field. Korea and China also have good collaborations in the field of food labeling research. The network diagram is shown in Figure 9.

The top-performing institutes within the field of food labeling research were also analyzed. Notably, the United States Food and Drug Administration (FDA) emerge as a frontrunner with 62 publications (3.96%), reflecting its pivotal function in shaping regulatory requirements and carrying out studies at the intersection of science and policy. Academic institutions, which include the University of Toronto (3.1%), the University of California System (2.2%) and the University of North Carolina (2.17%), feature prominently, underscoring the important role universities play in advancing food labeling understanding. The international nature of this study is clear with the inclusion of worldwide establishments like the Universidad de Chile (1.66%), the University of Milan (1.2%) and Wageningen University and Research (0.9%). Government corporations just as the United States Department of Agriculture (USDA) (2.1%) and the National Agriculture and Food Research Organization in Japan (0.89%) make contributions of precious insights, emphasizing the importance of collaborative efforts between regulatory bodies and educational institutions. This listing showcases the interdisciplinary nature of food labeling research, related to fields inclusive of nutrients, regulation and public health. The high citation influences advise that the research performed using those establishments is influential, shaping the effective educational discourse and probably impacting coverage and industry practices. Overall, the collaboration among regulatory bodies, educational establishments and global studies companies highlights the worldwide significance and collective effort in advancing knowledge within the complex domain of food labeling. Figure 10 represents the collaboration Network of the

top universities and institutes. The similar color dots represent the dynamics of collaborating institutes with time and the distance between the two dots represents the degree of collaboration between the institutes.

The top-performing departments/schools within the large institutes in the field of food labeling are also mainly from US, Canada and Europe. The University of Toronto, particularly the Temerty Faculty of Medicine (2.8%) and the Department of Nutritional Sciences (2.86%), sticks out with its commitment to investigating excellence in the field. The University of North Carolina at Chapel Hill, via the Gillings School of Global Public Health, the Department of Nutrition (1.4%) and the Carolina Population Center (0.83%), showcases a comprehensive approach to studying food labeling's impact on public health. Similarly, the College of Agricultural and Environmental Sciences at the University of California, Davis (0.83%) demonstrates a robust focus on the agricultural and environmental elements of food labeling. The University of Auckland, together with the Faculty of Medical and Health Sciences (0.7%) and the School of Population

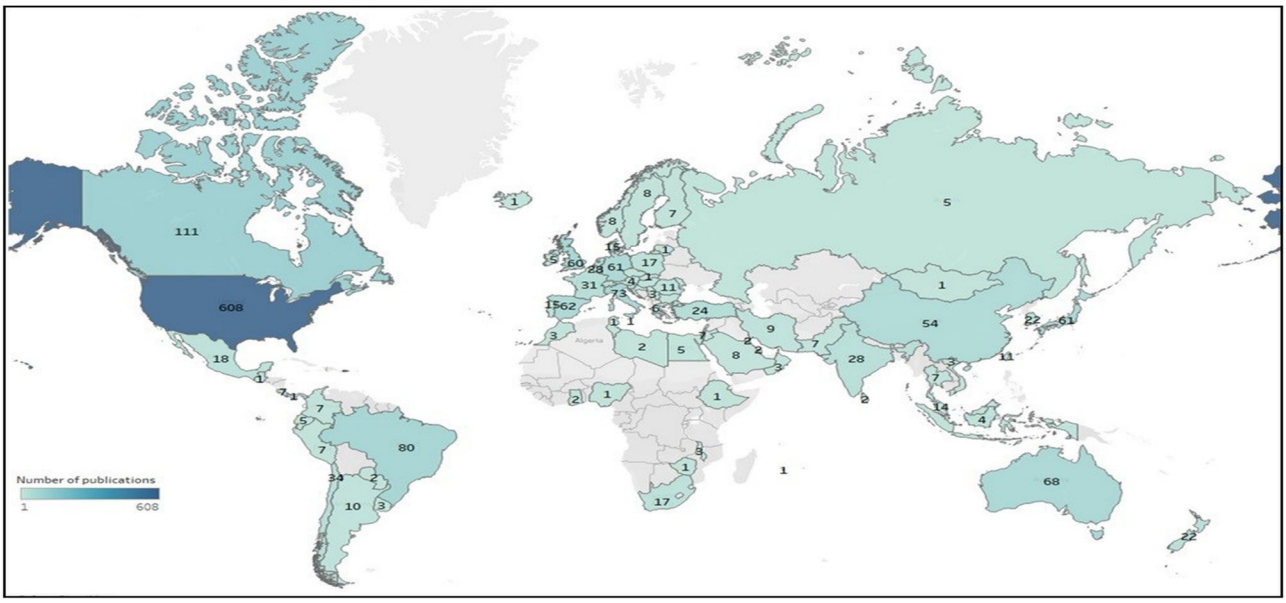

Figure 8: The number of articles published by different countries from 1964 to 2022.

*The world map is only intended to be used as a visual aid and does not indicate any view on the legal position of any country or territory or the delimitation frontiers or boundaries

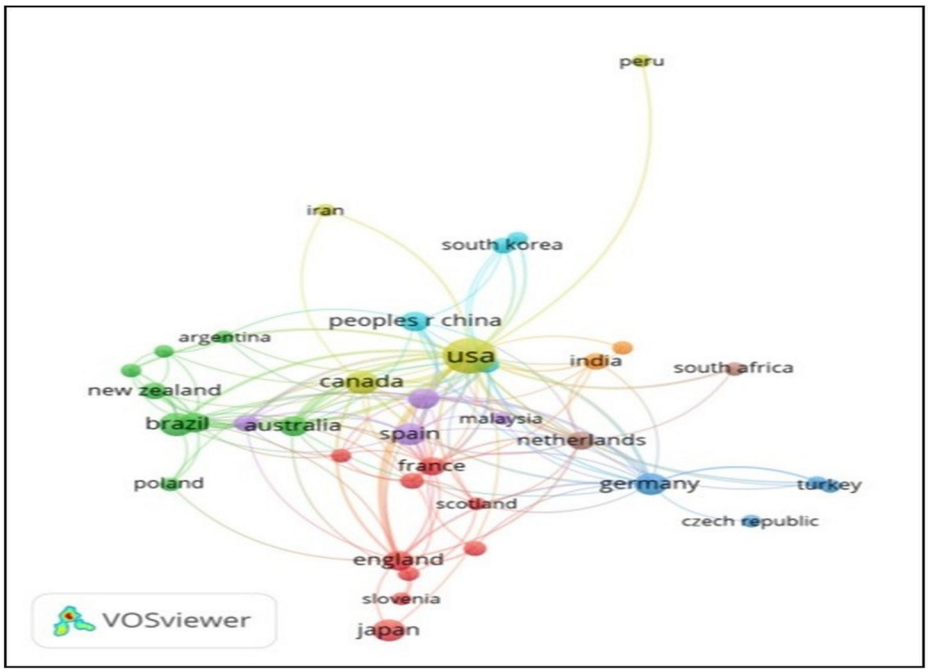

Figure 9: Collaboration Network of the top publishing 22 countries.

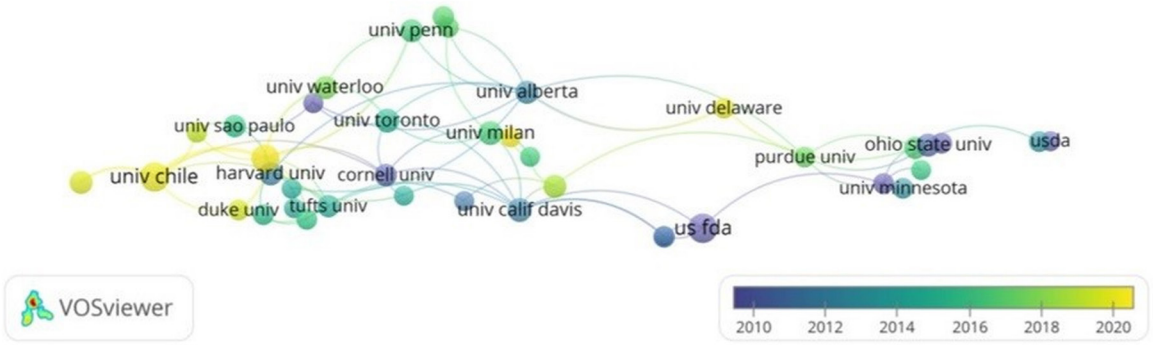

Figure 10: Collaboration Network of the top Universities and Institutes.

Table 2: Funding agencies acknowledged by the publications in the field of food labeling.

Funding Agencies	Acknowledging publications	% of 1,564
United States Department of Health and Human Services.	73	4.668
National Institutes of Health (USA).	60	3.836
Canadian Institutes of Health Research (CIHR).	47	3.005
European Union (EU).	23	1.471
United States Department of Agriculture (USDA).	20	1.279
Nih National Institute of Diabetes Digestive Kidney Diseases (NIDDK).	17	1.087
Coordenacao De Aperfeicoamento De Pessoal De Nivel Superior (CAPES).	16	1.023
Conselho Nacional De DesenvolvimentoCientifico E. Tecnologico (CNPQ).	15	0.959
Bloomberg Philanthropies	13	0.831
NIH National Heart Lung Blood Institute (NHLBI).	12	0.767

Health, brings a global attitude to the discourse, contributing valuable insights from New Zealand. The University of Waterloo (0.64%), with its Faculty of Applied Health Sciences and the School of Public Health and Health Systems, underscores the significance of interdisciplinary collaboration in knowledge and addressing the complexities of food labeling. These institutions collectively spotlight the global and multidimensional nature of food labeling research, emphasizing the critical role of training and studies establishments in shaping guidelines, promoting public fitness and advancing our understanding of nutrients and food-associated practices.

The prominent funding agencies acknowledged in the publications about food labeling research are listed in Table 2. The investment groups associated with food labeling research publications display a variety of entities contributing monetary aid to growth of the subject. The United States Department of Health and Human Services emerges as a main supporter, with seventy-three publications citing it. This underscores the business enterprise's pivotal function in fostering studies at the intersection of health and nutrition, particularly inside the context of food labeling. The National Institutes of Health (NIH) within the USA, a famous research funding agency, follows having acknowledged in 60 publications. The NIH's National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) in addition emphasizes the enterprise's dedication to investigating the complicated connections between food, fitness and metabolism. Internationally, the Canadian Institutes of Health Research (CIHR) and Brazilian agencies, inclusive of Coordenacao de Aperfeicoamento de Pessoal de Nivel Superior (CAPES) and Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq), make contributions prominently, reflecting the global collaboration and numerous views in meals labeling research. Non-governmental agencies like Bloomberg Philanthropies play an important role in supporting the research field of food labeling. The European Union, with its research initiatives, demonstrates a collective dedication to advancing clinical expertise inside the European network. In essence, those funding organizations play an important position in using studies and projects that underpin

improvements in food labeling information, influencing policy, public health and purchaser conduct on a worldwide scale. The funding agencies in developing countries need to focus on funding their institutes on food labeling research.

Food labeling studies perform a pivotal role in advancing key Sustainable Development Goals (SDGs), with a profound impact on international health, sustainability and responsible consumption. Foremost amongst these is SDG 3: Good Health and Well-being, in which the 65.1% of the total publications map the critical link between food labeling and public health. The provision of accurate and comprehensive information on labels empowers people to make informed dietary picks, promoting ordinary well-being and lowering the superiority of weight-reduction plan-associated fitness problems.[39] Addressing SDG 2: Zero Hunger, the 7.9% publications signify the position of food labeling in fostering food security and removing starvation. Transparent labeling practices contribute to more green food distribution, reducing food waste and supporting global efforts to obtain zero hunger. Furthermore, Food labeling aligns with SDG 13: Climate Action, with 3% publications highlighting the intersection of labeling and environmentally sustainable practices. By selling focus on the environmental footprint of food products, labeling helps climate-conscious consumers' picks. SDG 12: Responsible Consumption and Production is at once impacted by using food labeling practices (1.4% of the total publications), encouraging consumers to pick sustainably sourced and produced gadgets, thereby contributing to responsible consumption styles.[40]

CONCLUSION

In conclusion, this scientometric study on food labeling research presents crucial insights into the evolving landscape of this multidisciplinary subject. The detailed analysis of publication patterns, collaboration networks, citation impacts and other parameters shed light on the key contributors and influential bodies shaping the discourse. Following are the highlights of the study.

It presents the year-wise publication pattern of the food labeling research publications which gained attraction from researchers since 2006.

It highlights that the primary published documents in the field are the research articles. The food labeling research needs publication of more number of good quality reviews and opinions.

Food labeling research prioritizes the nutrition, health and agriculture in terms of prominent research areas. However, topics of legal and metrological importance focusing of food packaging and labeling are not in explored in the relevant publications.

The list of highly cited publications comprise the documents published after year 2013 which shows that although the research field is quite old but its academic importance is realized in last decade.

The United States of America is the most prolific contributor in the field followed by Canada and European countries.

Collaboration networks exhibit the collaboration among the different countries and institutes. The prominence of institutions including the US-FDA, universities like the University of Toronto and the University of North Carolina and investment agencies like the U.S. Department of Health and Human Services underscores the collaborative and global nature of food labeling research.

Moreover, the food labeling research has links to important Sustainable Development Goals (SDGs), significantly SDG 3 (Good Health and Well-being) and SDG 2 (Zero Hunger). As food labeling keeps evolving in reaction to medical improvements, regulatory adjustments and consumer needs, the findings of this scientometric study serve as a basis for future research directions, policy concerns and collaborative efforts geared toward fostering a greater obvious, sustainable and health-conscious international food system. Food labeling research need more focus and support in the developing countries especially in the different languages due to diverse customer base.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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Cite this article: Paliwal BK, Wan M. Evolution of Food Labeling Research and Current Publication Trends: A Scientometric Analysis. J Scientometric Res. 2024;13(2):535-46.