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BIBLIOMETRIC ANALYSIS OF FRONT-OF-PACK-LABELLING ATTRIBUTES

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ABSTRACT

Front-of-pack labelling is a prominent tool to inform consumers about the product's nutritional value and guide them in choosing healthier products. Therefore, it is considered a tool to combat obesity and non-communicable diseases. Considering the potential of front-of-pack labelling (FoPL), many researchers are interested in this domain. Since no such bibliometric analysis has been done so far, this research paper attempts to fill the gap and provide readers insight into the topic. The study represents a comprehensive review from 2008 to July 2022 of 393 papers obtained. This paper will concentrate on the results of influential authors, articles, countries, and journals. This paper also attempted to recognize various themes formed and evolved over the active years with the help of co-citation and co-occurrence networks. A growing number of research articles and the adoption of FoPL in multiple countries make it essential to conduct bibliometric analysis to provide a complete set of information that will help researchers approach the most appropriate work done so far by using VOS Viewer and Biblioshiny software to unravel various areas of the FoPL research domain and provide some of the future research directions.

Keywords*: Front-of-pack-labeling, Bibliometric analysis, Food label, Nutritional information, Biblioshiny, VOSViewer*

Abbreviations: *FoPL- front-of-pack-labeling, BoPL-back-of-pack-labeling, DIG- daily intake guide, GDA-guideline daily amount, HSR- health star rating, NCD- non-communicable diseases.*

1. INTRODUCTION

According to the World Health Organization (WHO), since 1975 obesity has increased almost threefold (*Obesity and Overweight*, 2021). Additionally, non-communicable diseases (NCDs) are responsible for 71% of annual deaths, which amounts to around 41 million deaths per year (*Non Communicable Diseases*, 2021). Hence, Obesity and NCDs are increasing at an increasing rate. The consumption of high-energy foods and the intake of sugary and fatty items are significant

contributors to the increase in obesity cases. Obesity is directly associated with non-communicable disorders such as heart attacks, hypertension, and diabetes.

WHO is actively working on diminishing the mortality rate associated with obesity and NCDs. As per the WHO 2030 Agenda of Sustainability mission statement, the objective of WHO is to decrease one-third of premature deaths caused by non-communicable diseases (*Non* Communicable *Diseases*, 2021). To reduce the cases of obesity WHO is emphasizing a healthy diet and regular activity.

In order to have a substantial impact on mitigating the consequences of obesity and NCDs, it is imperative that all parties collaborate collectively. Several action plans incorporate strategies such as advocating for nutritious eating habits, reducing the prevalence of fast food ads, implementing higher taxes on packaged foods, and implementing nutrition labelling and front-of-pack labelling (FoPL). FoPL is regarded as a promising method for raising awareness about the nutritional content of a product (nestle and Jacobson, 2000). A present incentive in place

is nutrition labelling, often known as back-of-pack labelling (BoPL). The presence of BoPL on packages has been mandated by practically every country for many years to assist consumers in evaluating a product's nutritional worth. However, several researchers argue that BoPL does not effectively tackle the problem of product healthiness because of its reputation for being perplexing (Byrd-Bredbenner et al., 2000; Cowburn and Stockley, 2005; Feunekes et al., 2008) and non-interpretable (Jones and Richardson, 2007). Since the implementation of BoPL there has been discussion regarding the use of FoPL as a means of enhancing decision-making in combination with BoPL. Multiple studies have demonstrated that FoPL has a substantial impact on consumers' decision-making process when selecting a healthy product.(Mejean et al., 2013)

FoPL provides a short overview of key elements essential for making informed decisions with reference to the nutritional value it carries. The components of FoPL mostly consist of sugar, salt, fat, saturated fat, and energy/calories. The implementation of FoPL motivates consumers to purchase a nutritious product due to its capacity to make comparisons and provide concise information (Feunekes et al., 2008). Several studies have been undertaken on FoPL's impact of FoPL on purchase intention, decision-making, and the comparison of healthy and unhealthy items in various nations, including the United States of America (USA), New Zealand, Australia, and

the European region. Several of these research demonstrate the substantial impact of FoPL on influencing customers' decision-making (Watson et al., 2014). The interpretability of FoPL should be efficient and rapid in order to determine the healthiness of a product (Grunert & Wills, 2007; National Preventative Health Taskforce, 2009).

The rest of the paper will be organized in the following steps. An attempt to review the existing literature to identify the need for FoPL is in part (2). The work will answer to various questions given through Bibliometric analysis in part (3). The methodology for bibliometric analysis will be presented in part (4) and followed by results and conclusion in parts (5) and (6) respectively.

2. LITERATURE REVIEW AND NEED FOR FOPL

The need for FoPL was felt when BoPL failed to address its primary purpose of informing the consumers about the nutritional profile of a product (Jordan Lin, Lee, & Yen, 2004; Kurtzweil, 1993). It can eventually help consumers to understand nutritional information which is highly user-friendly and differentiate between healthy products and unhealthy products (Cowburn & Stockley, 2005; Feunekes, Gortemaker, Willems, Lion, & van den Kommer, 2008) verified by(Watson et al., 2014). That is when the idea of FoPL struck the minds of many policymakers. As discussed earlier, obesity has been caused due to the unhealthy lifestyle adopted by today's generation. The primary purpose of FoPL is to guide the consumer while choosing a product so that they can opt for a healthy product (Ducrot et al., 2016). Arguably, FoPL reduces the costs by saving direct and indirect healthcare costs for individuals and the government. Besides being present in many countries, it only appeals to consumers to make healthy choices rather than buying. Therefore, the choice remains in the hands of consumers for selecting different product categories according to their choices, preferences, mood, and situation. For instance, to justify the need for FoPL helps in making healthy food choice much research has been carried out which shows that FoPL is indeed a required initiative. (Graham et al., 2015) reviewed that consumers are more likely to view FoPL than BoPL. (Feunekes et al., 2008) tested the effectiveness of different FoPLs in European countries and found that FoPL helps consumers make healthier choices. (Pettigrew et al., 2017) tested which FoPL is preferred by adults and children and found that the Health Star Rating(HSR) is the most preferred. (Santos et al., 2020) studied different FoPL in online food choices and they support the implementation of FoPL. Hence, the need for FoPL can be summarized in two

categories. Firstly, it helps promote healthier food choices and saves on healthcare costs. These are the reasons why the research community is interested in studying the FoPL initiative as it benefits both individuals by building sustainable habits and society as a whole.

As discussed, FoPL has been introduced in many countries worldwide. For instance, the USA, European region, Chile, Australia, New Zealand, etcetera. This section will discover the various FoPLs implemented by different countries. To start with, Australia implemented a daily intake guide in 2006 later on, it switched to a health star rating in 2013 (Pettigrew et al., 2017). The same case exists for New Zealand, which implemented a health star rating (Pettigrew et al., 2017). Talking about the UK it adopted the Percentage Guideline Daily Amount (%GDA) (Watson et al., 2014). France implemented Nutri-score in 2017 (Talati et al., 2019). Chile and Israel gave a green signal to the warning label (Talati et al., 2019).

There was no significant bibliometric analysis done on the FoPL topic. Therefore, taking up the task of performing bibliometric analysis will encourage scholars, practitioners, business houses, industry, and policymakers to find innovative ways to study the effect of FoPL and it is strongly believed that it will spur a more holistic understanding of the topic. One can also discover many research gaps through bibliometric analysis that will eventually encourage researchers to study more about the topic. Bibliometric analysis has yet to be made towards front-of-pack food labelling because dedicated Bibliometric analysis has not been conducted on FoPL. This paper goal is to do an analysis of the literature for providing details and breakthroughs in the FoPL domain. This paper will contribute by providing substantial information about authors and documents. Additionally, it will thematically analyze the topic and its evolution with the help of networks and links using software. It is an attempt to investigate the various efforts made up to this point so that new researchers can find it easy to start and have ideal research papers to get references from to get a basic idea about the topic. The paper will contribute to comprehending the information related to front-of-pack labelling through the adhesion of various factors and themes which will ultimately help potential researchers in this field.

3. RESEARCH QUESTIONS ANSWERED BY THIS PAPER

1. What is the total number of publications?

2. How many research papers are published year on year i.e. publication trend?
3. What are the names of influential journals covering the front-of-pack labelling research papers?
4. Which Countries lead the chart with the numbers of research papers published?
5. Who are the most relevant authors towards FoPL publications?
6. Who are the most influential authors towards FoPL publications?
7. What are the titles of highly cited research papers through global citation?
8. What are the titles of highly cited research papers through local citations?
9. What is the title of research papers cited or referred to the maximum number of times?
10. What is the thematic structure of front-of-pack-labelling?
11. What are evolving themes in the area of FoPL?

4. METHODOLOGY

The bibliometric analysis will be done by using the bibliometric toolbox. The toolbox contains two techniques: (1) the main technique and (2) the enrichment technique. The main technique is further divided into two parts: (A) performance analysis and (B) science mapping. A variety of analyses can be done through the main techniques, but this research paper will focus on some of the analyzing techniques. The bibliometric was aided by two software namely R software and VOSViewer software. Bibliometric analysis is a quantitative analysis performed on a large set of data to review and analyse it to present the results in the form of themes, networks, research constituents and descriptive analysis. This bibliometric analysis assists in studying a specific area's development and thematic structure (Valtakoski, 2019). This analysis is also subjective bias bias-free. For analyzing the bibliographic data this paper followed (Donthu et al., 2021). The trends and research direction were extracted using science mapping and performance analysis.

Performance analysis is a method of examining the contribution of research constituents such as authors, counties, publishers, publications, and institutions in the area of the study This is the essential step to do bibliometric analysis. This descriptive analysis answers the foundational meaning/questions of any research field (Donthu et al., 2021). The performance analysis was done by R software in this paper.

Science mapping is done to establish relationships between research constituents. Combining science mapping and enrichment techniques provides us intellectual structure of a research field and the foundational themes of the topic, creating a link between various research constituents (Donthu et al., 2021). In science mapping, co-citation analysis, co-occurrence analysis and thematic analysis was done by using VOS Viewer software whereas thematic evolution was done using R software.

4.1. Bibliometric search

The Scopus database is used to collect a bibliometric analysis database. For bibliometric analysis, the Scopus database is considered the most scientific and systematic database (Paul et al., 2021). In addition to the above statement, Scopus has been identified as the finest database for bibliometric analysis (Donthu, Kumar, Mukherjee, et al., 2021). These statements are referred to in (Kumar et al., 2021). Hence, it can be said that Scopus is the most comprehensive database that contains various information about articles as well as inclusion of papers in this database requires a high quality and a firm set of rules.

Several keywords are recognized for the optimal search, including “front-of-pack labelling”, “front-of-pack food labelling”, “front-of-pack nutrition labelling”, and “nutrition labelling”. The optimal keyword was “front-of-pack food labelling”. This article will analyze front-of-pack labelling on packaged food goods. A search was performed on the Scopus database using the phrase "front-of-pack food labelling," resulting in the retrieval of 495 papers.

4.2. Filtration

The first filter used was the language filter where only English language papers were selected. Afterwards, the chosen articles were those which were published in journals. The final papers selected for the analysis were 393. Besides these two filters, no other sorting criteria were performed because further filtration can reduce the article count and potentially influence the bibliometric analysis.

5. RESULTS

5.1. Total publication and number of active years of publication

The total publication is a technique of performance analysis. It considers the total number of publications on the research subject. The annual scientific production takes into account the papers published in every year from 393 collected findings. The publications were categorized according to the year of their publication in the journals. Through Figure (1) it can be said that research in the field of FoPL is increasing year by year. In 2008 there were only 3 publications, jumping to the year 2015 total number of publications increased to 27 while in the years 2020 and 2021 the total number of publications was 56 and 53 respectively. Till July 2022 counts for 44 documents. Active years of publication is a term that indicates the number of years in which research has been conducted related to the domain to study the phenomenon. The active year starts in 2008 and groundbreaking research is still being done. Seeing the trend, there are still relatively fewer studies that have been carried out every year therefore, this topic has the potential to be researched in the future.

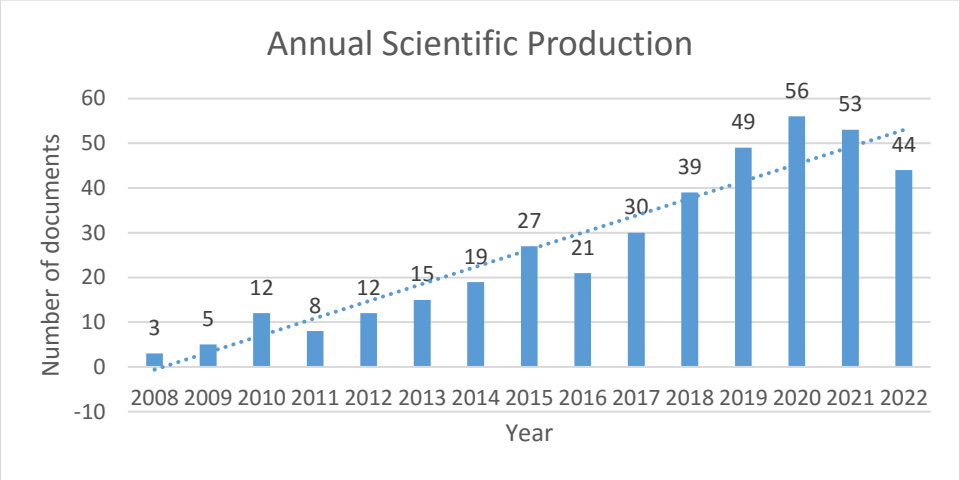

Figure 1. Shows year-to-year publications from 2008 to 2022.

5.2. Most promising journals

Promising journals are those that publish the greatest number of papers in the journal related to a topic. Promising journals were determined through R software on the basis of Bradford's law. This law ranks different journals according to the number of articles they publish. The most promising journals in the field of FoPL are visible in Table (1) which provides the top 10 promising journals. The Nutrients journal has an edge over other journals with a total of 69 publications in the field of FoPL. Public Health, Appetite, and BMC Public Health were at the positions of 2nd, 3rd, and 4th

respectively. Bradford's law was selected for analysis of promising journals. The outcome was attained by a graph showing the source name and the number of papers published by a journal. Later, the graph was moulded into a table, as shown in Table (1). Bradford's law analysis will contribute to finding out the most relevant journals which are ahead in publishing content related to FoPL through which researchers can quickly identify and select some journals which will be helpful to them in studying FoPL and carrying out further research. The more articles a journal publishes in a particular field, the more promising it becomes in that particular field to influence future researchers.

Table 1. shows the name of the journal along with the number of a paper published.

Name of journals	No. of papers published
Nutrients	69
Public Health	33
Appetite	30
BMC Public Health	14
International Journal of Behavioral Nutrition and Physical Activity	13
Food Quality and Preference	10
PLoS ONE	10
Food Policy	9
British Journal of Nutrition	8

5.3. Dominant countries

The countries having the most papers published combined with the number of citations they receive are considered to be dominant countries in the research domain. For the analysis work, the database is studied in R software. Countries' Scientific Production and citations are used to interpret the result to find the dominant countries in the FoPL field. Dominant countries are decided upon both the parameters i.e., the number of documents and the number of citations. The top 10 countries are selected for analyzing both aspects. By knowing the dominant country By scanning figures (2) and (3) it is obtained that Australia is ahead of all the countries, both in terms of documents (421) as well as citations (2100). The Netherlands is a surprising factor as it is the 2nd most cited country with only 78 documents. The Netherlands trailed many countries in citation count such as the USA, UK, France, Uruguay, etc. even though these countries have more

documents published. The same is the case with New Zealand. This country received more citations with fewer documents from its counterpart the USA. Some nations, such as Spain and Italy, have been placed in the section number of documents but are not receiving enough citations to get placed in the top 10 cited countries. On the other hand, Germany and Denmark have fewer documents than the top 10 countries in terms of document count but were able to hold positions in the top 10 countries in terms of citation counts. To make the analysis easy to interpret information from figures (2) and (3) was converted into a tabular form in Table (2). Accordingly, it can be concluded that Australia is leading the research in the FoPL domain. The Netherlands, France, the UK, and the USA are prominent countries in the subject domain.

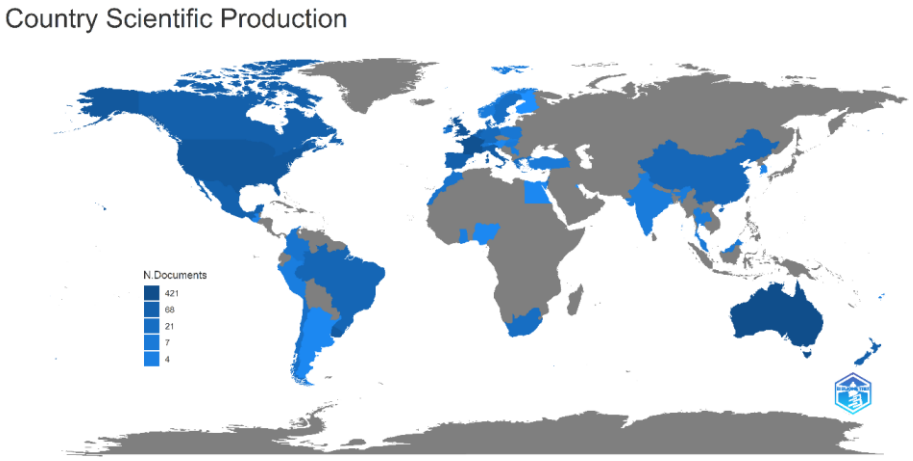

Figure 2. shows a world map depicting the number of documents published by each country.

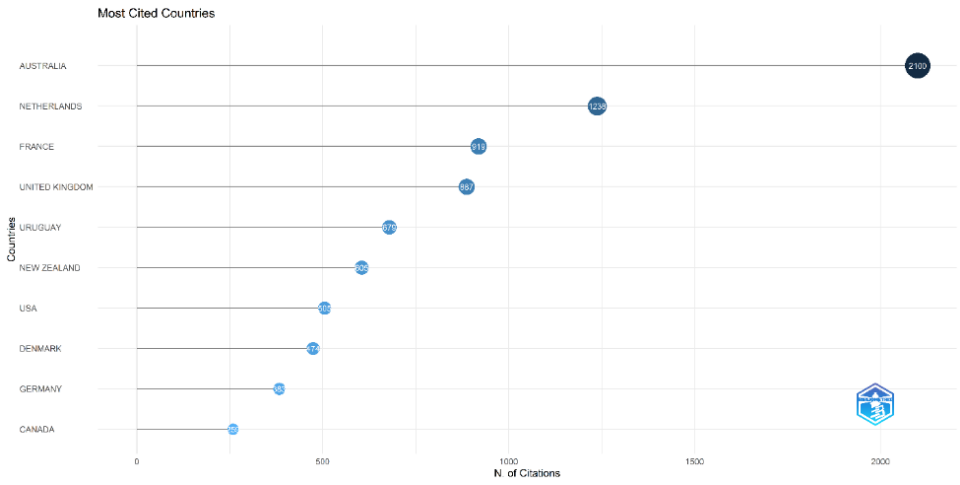

Figure 3. shows the number of citations received by each country's documents.

Table 2. shows the countries' names, the number of documents published and the number of citations received.

Rank	Country	Documents	Rank	Country	Citation
1	Australia	421	1	Australia	2100
2	France	313	2	Netherlands	1238
3	UK	205	3	France	919
4	USA	155	4	UK	887
5	Uruguay	122	5	Uruguay	679
6	Italy	94	6	New Zealand	605
7	Netherlands	78	7	USA	505
8	Canada	75	8	Denmark	474
9	New Zealand	75	9	Germany	383
10	Spain	73	10	Canada	259

5.4. Most relevant authors

The most relevant authors are decided upon by the number of documents each author publishes. Therefore, R software determined it based on the number of articles they have published related to FoPL. The analysis says that the more an author has published the articles, the greater the author's relevance. Figure (4) shows the top 10 most relevant authors. It clearly indicates that Hercberg S and Julia C are at par with 34 documents each. Readers can approach their work to get an idea of the work and what more needs to be done from the top 10 authors mentioned. Ares G and Pettigrew S have significant contributions with 25 and 24 documents respectively. Although Kesse-Guyot E, Talati Z, Curutchet Mr, and Egnell are among the top 10 most relevant authors, they did not manage to secure a spot in the top 10 locally cited authors.

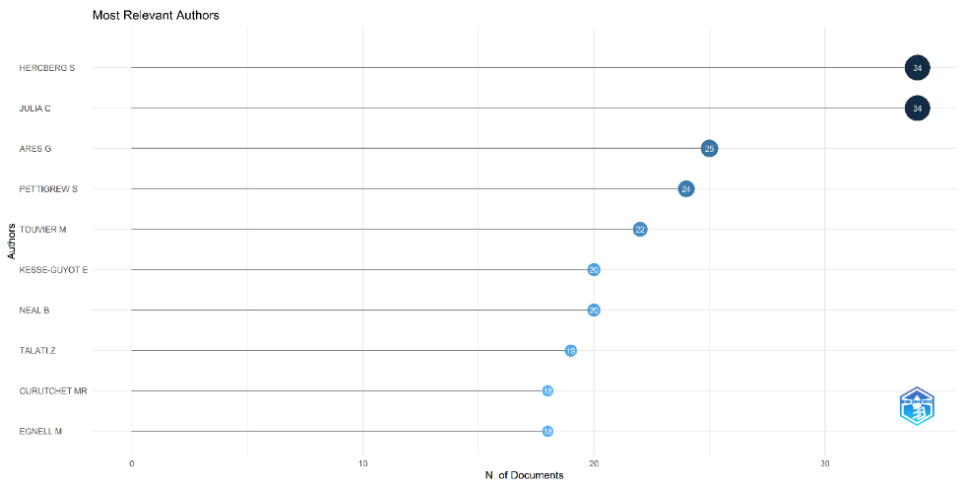

Figure 4. shows the authors' names and the number of papers published by them.

5.5. Influential authors

The most influential authors are the ones who have received the highest number of citations in their field. It is solely based on the citations. Therefore, influential authors were determined by the citation count an author receives. Authors with the highest citations in their account will be the most influential, and authors with fewer citations will be less influential. Authors such as Julia C with 152 citations, and Hercberg S with 147 citations are clearly leading the chart. But authors such as Vandevijvere S and Vanderlee L are in 3rd and 4th position respectively given the fact that both the authors have a lower number of documents, i.e., 13 and 8 respectively, having fewer documents than most authors in the top 10 most relevant authors list and still manages to come under top 10 influential authors it can be due to the quality of research conducted by them. The rest of the authors are shown in figure (5). We also must recognize the citations received by authors Neal B and Galan P because these two authors have eye-catching citations of 124 and 89 respectively, whereas their document counts are 20 and 15 respectively, which is much lower than the most relevant authors. In the same manner, as discussed in the above section, authors such as Vandevijvere S, Vanderlee L, Barquera S, and Galan P have secured a spot in the top 10 most locally cited authors but have less number of documents published than most of the top 10 relevant authors.

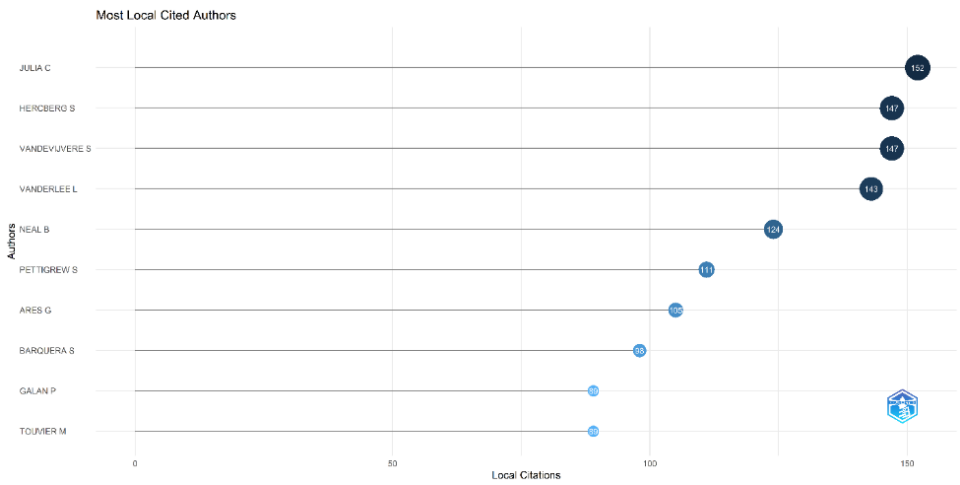

Figure 5. shows authors' names and numbers of citations received by their papers.

5.6. Citation analysis

Citation analysis is a technique of science mapping. It works by linking the publication when a publication is cited by another publication (Donthu et al., 2021). Citation analysis is done based on two criteria: (1) global citation and (2) local citation. In citation analysis, the influence of articles can be determined by the number of citations it receives from readers.

5.6.1. Most global cited documents

Most globally cited documents are described as articles receiving the highest number of citations without any filtration, viz., subject domain (Donthu et al., 2021). In other words, global citations are the citations received by the documents irrespective of whether the document has been cited within the subject domain or outside of the subject domain. The top 10 most Globally cited documents can also be viewed as documents that have a high influence on other authors to cite them in their articles. These documents are mentioned in papers related to FoPL as well as mentioned in papers not related to FoPL. The top 10 most influential papers are shown in figure (6) and analyzed in the table (3). Table (3) shows the article name, author name, and citation counts of the top 10 most globally cited documents that were analysed from Figure (6)

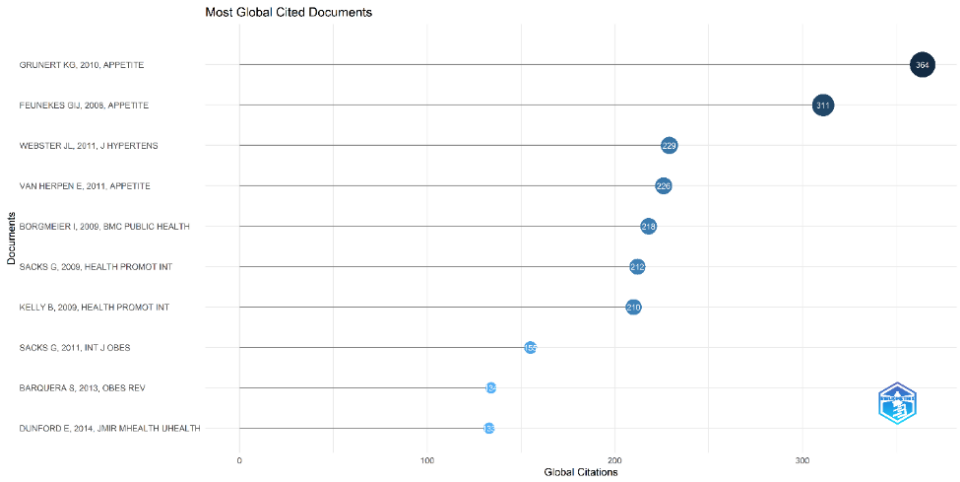

Figure 6. shows the most influential papers in terms of global citation.

Table 3. shows the article name, authors' name, and citations of the top 10 globally cited documents.

S.No.	Article Title	Authors	Global citation
1	Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the UK	Grunert K.G., Wills J.M., Fernández-Celemín L.	364
2	Front-of-pack nutrition labelling: Testing effectiveness of different nutrition labelling formats front-of-pack in four European countries.	Feunekes G.I.J., Gortemaker I.A., Willems A.A., Lion R., van den Kommer M.	311
3	Salt reduction initiatives around the world.	Webster J.L., Dunford E.K., Hawkes C., Neal B.C.	229
4	Front-of-pack nutrition labels. Their effect on attention and choices when consumers have varying goals and time constraints.	van Herpen E., Trijp H.C.M.V.	226
5	Impact of different food label formats on healthiness evaluation and food choice of consumers: A randomized-controlled study.	Borgmeier I., Westenhoefer J.	218
6	Impact of front-of-pack 'traffic-light' nutrition labelling on consumer food purchases in the UK.	Sacks G., Rayner M., Swinburn B.	212

7	Consumer testing of the acceptability and effectiveness of front-of-pack food labelling systems for the Australian grocery market.	Kelly B., Hughes C., Chapman K., Louie J.C.-Y., Dixon H., Crawford J., King L., Daube M., Slevin T.	210
8	Traffic-light nutrition labelling and junk-food tax: A modelled comparison of cost-effectiveness for obesity prevention.	Sacks G., Veerman J.L., Moodie M., Swinburn B.	155
9	Mexico attempts to tackle obesity: The process, results, push backs and future challenges.	Barquera S., Campos I., Rivera J.A.	134
10	FoodSwitch: A mobile phone app to enable consumers to make healthier food choices and crowdsourcing of national food composition data	Dunford E., Trevena H., Goodsell C., Ng K.H., Webster J., Millis A., Goldstein S., Hugueniot O., Neal B.	133

5.6.2. Most local cited documents

Local cited documents are those which are mentioned within the subject domain, i.e., one article receives citations from another article in the same subject area (Donthu et al., 2021). In other words, local citations are the citations received by the documents in their respective field only. For example, a paper related to FoPL is cited in another paper which is also associated with FoPL. Therefore, most locally cited documents analyze documents that are highly cited or referred to within the subject area. The papers shown in figure (7), are the documents on which one can rely to have knowledge about the subject domain. These documents can be regarded as reliable sources to grab initial papers and are most relevant in the field of FoPL. It should be noted that local citations are always less than global citations for obvious reasons mentioned in their meaning. Figure (7) analysis is done in the table (4).

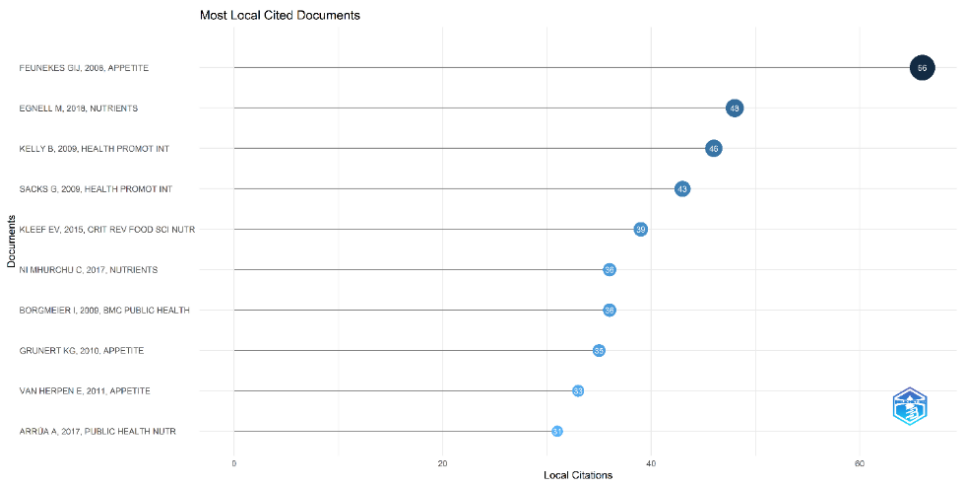

Figure 7. shows documents receiving a total number of local citations.

Table 4. shows the article name, authors' name, and citations of the top 10 locally cited documents.

S.No.	Article title	Authors	Local citation
1	Front-of-pack nutrition labelling: Testing effectiveness of different nutrition labelling formats front-of-pack in four European countries	Feunekes G.I.J., Gortemaker I.A., Willems A.A., Lion R., van den Kommer M.	66
2	Objective understanding of front-of-package nutrition labels: An international comparative experimental study across 12 countries	Egnell M., Talati Z., Hercberg S., Pettigrew S., Julia C.	48
3	Consumer testing of the acceptability and effectiveness of front-of-pack food labelling systems for the Australian grocery market	Kelly B., Hughes C., Chapman K., Louie J.C.-Y., Dixon H., Crawford J., King L., Daube M., Slevin T.	46
4	Impact of front-of-pack 'traffic-light' nutrition labelling on consumer food purchases in the UK	Sacks G., Rayner M., Swinburn B.	43
5	The Growing Role of Front-of-Pack Nutrition Profile Labeling: A Consumer Perspective on Key Issues and Controversies	Kleef E.V., Dagevos H.	39
6	Effects of a voluntary front-of-pack nutrition labelling system on packaged	Ni Mhurchu C., Eyles H., Choi Y.-H.	36

	food reformulation: The Health Star rating system in New Zealand		
7	Impact of different food label formats on healthiness evaluation and food choice of consumers: A randomized-controlled study	Borgmeier I., Westenhoefer J.	36
8	Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the UK	Grunert K.G., Wills J.M., Fernández-Celemín L.	35
9	Front-of-pack nutrition labels. Their effect on attention and choices when consumers have varying goals and time constraints	van Herpen E., Trijp H.C.M.V.	33
10	Warnings as a directive front-of-pack nutrition labelling scheme: Comparison with the Guideline Daily Amount and traffic-light systems	Arrúa A., MacHín L., Curutchet M.R., Martínez J., Antúnez L., Alcaire F., Giménez A., Ares G.	31

5.7. Co-citation analysis

Co-citation analysis is a science mapping technique. It assumes that if two references are cited together in a third paper they are connected in some or the other way or have a similar content structure. Co-citation analysis is employed to reveal the conceptual structure of a specific field of study (Donthu et al., 2021). This analysis also helps us recognize the most influential articles according to the clusters formed. Every cluster is formed on a certain basis and every cluster has a theme. The co-citation analysis first divides the documents into cluster and then highlight the most connected papers in each theme. This analysis helps the researchers find out information about the paper according to the researcher's interest. Moreover, future researchers can refer to the connected papers to collect literature on a particular theme. For the analysis, a co-citation technique is used in VOSViewer software. Only those publications are selected which are cited at least 5 times in published papers. Of 16042 only 92 meet the citation limit. Giving weightage to linkages figure (8) was analysed.

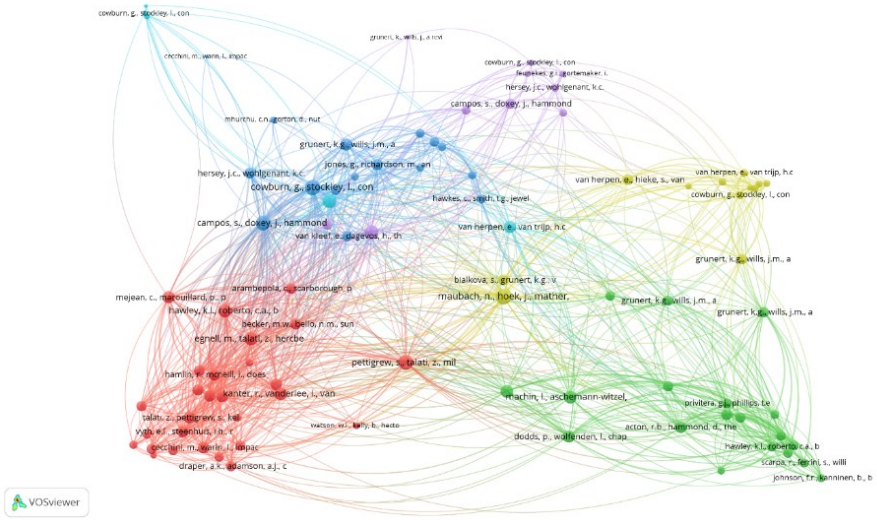

Figure 8. shows a map of co-citation analysis based on the authors' name

Altogether, six clusters are formed. Giving more weightage to the links signifies that the papers are linked with how many other papers are in the reference list. The more links a paper has, the more appropriate it is to be referred for study. The analysis will be done through table (5) for straightforward interpretation of the above diagram.

Table 5. shows the interpretation of the co-citation map.

Cluster colour	Paper title	Authors name	Links
Red	The types and aspects of front-of-pack food labelling schemes preferred by adults and children	Pettigrew S., Talati Z., Miller C., Dixon H., Kelly B., Ball K.	50
	Objective understanding of front-of-pack warning labels among Mexican children of public elementary schools. A randomized experiment	Egnell M., Talati Z., Galan P., Andreeva V.A., Vandevijvere S., Gombaud M., Dréano-Trécant L., Hercberg S., Pettigrew S., Julia C.	41
Blue	Consumer understanding and use of nutrition labelling: a systematic review	Gill Cowburn and Lynn Stockley	52
	Nutrition labels on pre-packed foods: a systematic review.	Campos S., Doxey J., Hammond D.	51

Green	Interpretive front-of-pack nutrition labels. Comparing competing recommendations	Maubach N., Hoek J., Mather D.	58
	Inferring product healthfulness from nutrition labelling. The influence of reference points.	Erica van Herpen., Sophie Hieke., Hans C.M. van Trijp.	28
Emerald	Does front-of-pack nutrition information improve consumer ability to make healthful choices? Performance of warnings and the traffic light system in a simulated shopping experiment	Machín L., Aschemann-Witzel J., Curutchet M.R., Giménez A., Ares G.	38
	Front-of-pack nutrition labelling: Testing effectiveness of different nutrition labelling formats front-of-pack in four European countries	Feunekes G.I.J., Gortemaker I.A., Willems A.A., Lion R., van den Kommer M.	36
Sky blue	Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the UK	Grunert K.G., Wills J.M., Fernández-Celemín L.	45
	Front-of-pack nutrition labels. Their effect on attention and choices when consumers have varying goals and time constraints	van Herpen E., Trijp H.C.M.V.	34
Purple	Impact of different food label formats on healthiness evaluation and food choice of consumers: A randomized-controlled study	Borgmeier I., Westenhoefer J.	46
	Nutrition labels on pre-packed foods: a systematic review.	Campos S., Doxey J., Hammond D.	23

5.8. Co-occurrence analysis

Co-occurrence analysis is yet another technique of science mapping which is performed by using "author keywords." It includes words used as keywords by the author because the study wants to focus on the author's preference for doing research. In co-word analysis themes/ clusters are formed based on the words that are appearing together (Donthu et al., 2021). For the analysis, only those keywords are used which occur at least in 5 papers because only those keywords are preferred

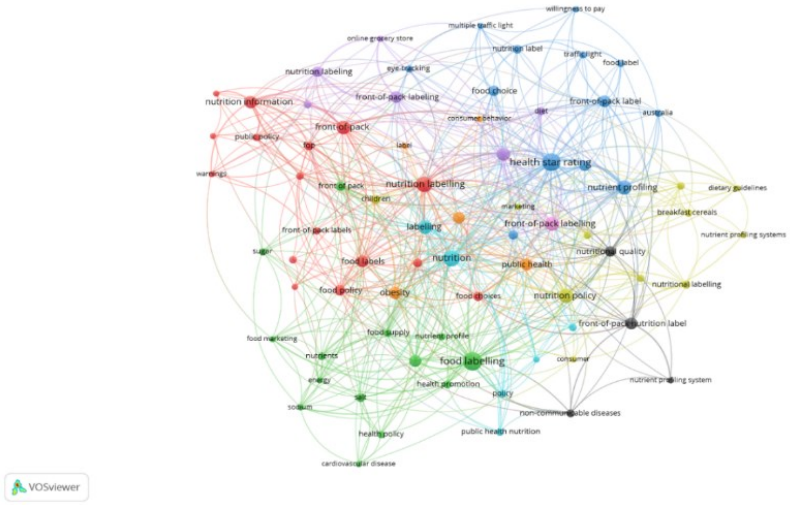

Figure 9. shows a map of the co-occurrence of keywords.

which are repeatedly used by many authors to gauge the working of a research area as well as only impactful words can be analyzed. 76 words meet the threshold limit. Co-occurrence analysis was done through figure (9), which forms 9 clusters. The bigger the size of the circle, the more impactful a word is. The word nutritional labelling appeared 28 times in a cluster (1) of red highlight words, and the word front-of-pack appeared 21 times. In cluster(2) of emerald colour include words food labeling(38), front of pack(10). The focus is on words like "Health Star Rating" (36), "nutrient profiling" (22), and "Front-of-Pack label" (15) in a blue-coloured cluster (3). Green-coloured cluster (4) included words such as nutrition policy which appeared 23 times and nutritional labeling (13). Cluster (5) is purple and words are front-of-pack labeling (16), and Nutrition Labeling (13). Cluster no.6 is of sky blue colour and contains words namely nutrition (30), and labeling (21). Cluster (7), which is of orange colour highlights words such as obesity (17), and food labeling (16). Cluster (8) of black colour includes front-of-pack-nutrition label(16) and nutritional quality(13). In the last cluster (9) of pink colour, it focuses on one-word front-of-pack labeling which occurs 22 times. In short, more emphasis has been on keywords such as food labeling, health star rating, front-of-pack, nutrition information, traffic light, and public health. This analysis also helped us to pinpoint the research area, for instance, FoPL is used to promote public health or reduce obesity or health star rating and traffic light are emergent FoPL designs, or it helps to comprehend nutritional information or influence decision making while choosing food.

5.8.1. Thematic analysis

Thematic clusters were formed using co-occurrence analysis. Co-occurrence analysis is a technique of science mapping that concentrates on keywords to form clusters of various themes by grouping the words that appear together frequently (Donthu et al., 2021). All keywords were selected to identify the multiple themes formed. This is because all keywords depict a more precise picture for theme formation and it takes into account the words used in the title, keywords, and abstract. Words that appeared at least 10 times in keywords were selected for the thematic analysis as coverage of all keywords is greater than the author's keyword therefore, a greater number of times words appearing in documents was chosen for the thematic analysis. We have to provide a weightage of at least 10 times a keyword should appear in papers first because if a keyword appears more times in different papers more relevant a keyword becomes in that field. Secondly, a hit and trial method was applied with different weights; 10 times weightage provided clear and information results. A total of 186 words met the baseline where the weightage was given to the occurrences of keywords. A total of five clusters were formed. Table (6) will illustrate the underlying theme concerning the colours of the cluster formed. The articles are based mainly on these themes formed. Theme 1 is all about how consumers evaluate nutrition information based on FoPL. Theme 2 aims to check consumer behaviour and attitude towards FoPL. Theme 3 talks about the role of FoPL as a health promotion tool. Theme 4 studies how consumers have changed their preferences post the implementation of FoPL through experimental testing. Theme 5 studies how FoPL impacts the choice of Food. The same concept goes here for analysis as in co-occurrence, i.e., the bigger the circle, the more weightage is given to a word, which can be observed

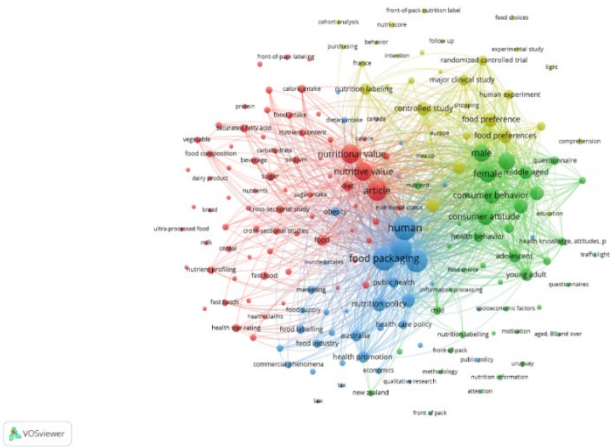

Figure 10. shows a map of co-occurrence analysis to form themes through all keywords.

Table 6. shows various themes formulated through co-occurrence analysis.

Colour of cluster	Theme formed	Major Keywords
Red	Consumer evaluation of the nutritional value of products by product components	Sodium, Sugar, Nutrients, Carbohydrate, Calories, Health star rating
Emerald	Consumer behaviour and attitude towards FoPL	Male, Female, Adult, Traffic light, Information processing
Sky blue	Food labelling as a health promotion tool	Public Health, Obesity, Nutrition Policy
Green	Study of consumer food preferences post FoPL	Controlled study, Consumer, Nutrition labelling, Psychology
Purple	Nutritional claims on a food label	Nutritional claim, Food label, Canada

5.9. Thematic evolution

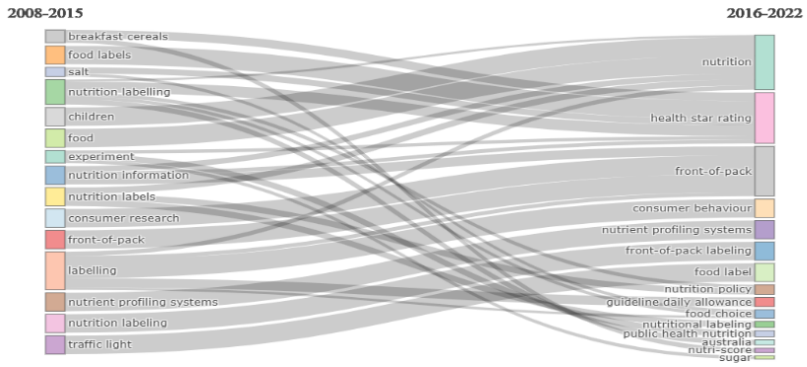

Figure 11. showcases thematic evolution.

Thematic evolution is used to see where the trend is going and how the study has diversified itself over the years and the paradigm shift. In thematic evolution, time is divided into groups to study the changes over a period of time. Furthermore, this analysis helps us to compare time slots identified by the author as deemed fit. We can cut time accordingly, but to analyze this segment time has been cut into two parts. From 2008 to 2022, 14 years of research time is divided into two slots of 7 years each. This is done to study the work done in one half of and the other half of the

part as well as to see the shift in the topic of study. Author keywords are used to examine thematic evolution.

After scrutinizing the data in two time slots, it was observed that there was a paradigm shift in the manner study of FoPL was conducted in terms of keywords and topics of FoPL. Firstly, in the 2008-2015 time slot "labelling" keyword was used more frequently. Recently, it was majorly studied in consumer behavior and one of the famous FoPL systems i.e., Daily Guideline Amount. Likewise, major terms such as food labels, nutrition information, breakfast cereals, nutrition labelling, and experiments are now part of Health Star Rating. From the above two points it can be concluded that in recent studies more focus has been shifted towards the study of specific labels such as GDA and HSR. The major portion of the 2016-2022 time slot is acquired by "nutrition" which included terms such as children, food, nutrition information, labelling, and nutrition labels. These terms might have evolved into nutrition because the mentioned terms are used to study the nutritional value. Nutrition labelling diversified into a health star rating, food choice, nutrition labelling, and nutrition policy. Looking from a broader point of view previously terms such as front-of-pack, labelling, nutrition labelling food labels so on are used. It might be because the field was naive and there was less clarity about major attributes and a lack focus on specific areas, but with changing time, more focus is laid on specific FoPL systems such as HSR, Nutri-score, and GDA. Through this it can be concluded that among all the FoPL systems these three are the more prominent ones. Additionally, in later time slots FopL is linked to Consumers compared to former time slots. For example, new keywords include consumer choice, nutrition policy, consumer behaviour, and public health nutrition. This shift has benefited from analyzing FoPL's impact on consumers while making healthier food choices. The two main ingredients highlighted for each time period were salt and sugar. So, we can say that among the five (calories, salt, fat, sugar, and saturates) factors, salt and sugar were likely more influential in decision making. Definitely, there has been a change in schools of thought between the time slots and focal points in the research domain. Figure (11) clearly shows that the focal point of research has changed over the years. New concepts and keywords have been used for research purposes in recent years compared to previous years.

6. CONCLUSION AND IMPLICATION

The primary goal of the paper was to conduct a bibliometric analysis of the collected data to gain a deeper understanding of the field of FoPL. This analysis focused on the direction of research, the formulation and evolution of themes, network analysis, and trends in FoPL. The bibliometric analysis helped collect vital information about the FoPL and to uncover the topic's various constructs, constituents, and intellectual structure. Firstly, it was discovered that FoPL is a growing field of research and is still at its initial stage because of the upward movement of the trend line in the total number of papers published. It is evident from the examination that FoPL is an emerging area of research in many fields including science, commerce and management, sociology, public health, etc. hence, the topic can be diversified into many strata. Secondly, the information about the relevant and influential author, journals and documents have been provided which can be considered as a piece of useful information as clear information can result in excellent research. The authors, journals, and documents identified by this paper provided the most value in the area of FoPL. Thirdly, the co-citation and co-occurrence technique fulfilled the objective of network formation, theme identification and connection among the papers. These techniques have identified the papers and keywords that are more frequently used or referred to by the community of FoPL researchers. Lastly, the theme evolution has rightly highlighted the trends in FoPL as discussed in the section on theme evolution. It can be said that Traffic Light and Health star rating are the most preferred and researched and Nutri-score has also emerged as a potential FoPL in recent years.

Front-of-pack labelling is a powerful technique for influencing customers to choose and eat nutritious food. Various forms of FoPL have been established in the market to serve this goal, including Health Star Rating (HSR), Traffic Light (TL), Daily Intake Guide (DIG), Nutri-score, warning labels, and more. This bibliometric analysis will have many implications for future researchers, policymakers, industrial organizations and public health practitioners. This literature review will be helpful to future researchers in many ways as it provides information about authors, journals, countries, and documents so that they can directly approach the stated work to gain key knowledge about the topic and save time. This information is also reliable as it is software generated and one can use it without any doubt. Organizations resorting to such methods of nutritional information can attract new customers and build brand value by having an edge over

their competitors in the countries where the implementation has yet to take place. In some or another ways FoPL can influence the industry's decision to adopt it and industries can affect FoPL in its adoption. For policymakers and public health practitioners this bibliometric analysis of literature can guide them in decision-making such as how, when, and where to incorporate FoPL. What trends and parameters in FoPL should be considered while making decisions. They can also refer to countries which have implemented FoPL for further consideration.

It has been said earlier that FoPL is an emerging topic and there is a need for much scholarly interference into the topic by testing different types of FoPL, the study of consumer preference in many situations such as online buying situations or time-constrained situations, study to be in real-time supermarket scenarios under many methods such as experiment method, focus conducted group study, randomized method, eye tracking or attention span method, cross-sectional study, etc. One can also study the effect of FoPL on the demand side as well as on the supply side. For example, is there a demand for FoPL among societies regarding its implementation? Or does FoPL influence the various industries to resort to the decision of adopting FoPL in their products?

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