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DATA JUSTICE IN FOOD MARKETING: WILL ALGORITHMS ELIMINATE DATA BIAS ON PLATFORMS?

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Abstract. The increasing reliance on algorithmic systems in food marketing creates both opportunities and risks for equity and accountability. This study is motivated by concerns that algorithms, while promising personalisation and efficiency, may also reproduce biases and obscure power relations. The objective is to examine whether and how existing research addresses three facets (nutrition disclosure, misinformation, and big data/AI) and to assess the relationship between data justice, algorithmic decision-making, and marketing practices. Methods include a systematic literature review of studies published between 2013 and 2023, resulting in twelve works meeting defined criteria, combined with a one-month monitoring of 3,300 social media posts across major platforms. Findings indicate that algorithms enable more targeted and personalised marketing yet frequently amplify biases due to flawed inputs and limited training diversity. Only a small share of studies integrate all facets, while platform monitoring shows substantial reach and enduring visibility via news/blogs, with topical salience around “food,” “nutrition,” “data,” and “precision nutrition.” The results suggest algorithmic “nutrition labels,” diverse datasets, and transparent governance mechanisms are essential innovations to align data-driven marketing with principles of justice and public interest.

Keywords: *algorithms, food marketing, misinformation, consumer behaviour, data justice, economics and management, sociology*

Rezumat. Dependența tot mai mare de sistemele algoritmice în marketingul alimentar creează atât oportunități, cât și riscuri pentru echitate și responsabilitate. Acest studiu este motivat de îngrijorarea că algoritmi, deși promit personalizare și eficiență, pot reproduce și prejudecăți și pot ascunde relațiile de putere. Obiectivul este de a examina dacă și cum cercetările existente abordează trei fațete (dezvăluirea informațiilor nutriționale, dezinformarea și big data/IA) și de a evalua relația dintre justiția datelor, luarea deciziilor algoritmice și practicile de marketing. Metodele includ o analiză sistematică a literaturii de specialitate a studiilor publicate între 2013 și 2023, rezultând douăsprezece lucrări care îndeplinesc criteriile definite, combinată cu o monitorizare de o lună a 3.300 de postări pe rețelele sociale pe principalele platforme. Constatările indică faptul că algoritmi permit un marketing mai direcționat și personalizat, dar amplifică frecvent prejudecățile din cauza

inputurilor eronate și a diversității limitate a formării. Doar o mică parte din studii integrează toate fațetele, în timp ce monitorizarea platformelor arată o acoperire substanțială și o vizibilitate durabilă prin intermediul știrilor/blogurilor, cu o importanță actuală în jurul „alimentelor”, „nutriției”, „datelor” și „nutriției de precizie”. Rezultatele sugerează că „etichetele nutriționale” algoritmice, seturile de date diverse și mecanismele de guvernare transparente sunt inovații esențiale pentru alinierea marketingului bazat pe date cu principiile justiției și interesului public.

Cuvinte cheie: *algoritmi, marketing alimentar, dezinformare, comportamentul consumatorilor, justiție bazată pe date, economie și management, sociologie.*

1. Introduction

In an era when data-driven decision-making is increasingly influencing consumer behaviour, the intersection of algorithms, data justice, and food marketing has emerged as a critical field of research. However, the landscape presents challenges that require careful examination. A brief literature review was first conducted on three key aspects of this field. However, it is imperative to demonstrate whether and how the existing studies contain these three facets. Therefore, a mixed-methods research design was conducted, including a systematic review and a social media content analysis. This review consolidates findings from 12 selected studies, each rigorously examining aspects of this intersection. Additionally, a one-month social media content monitor was deployed to understand the algorithm and food-related information disseminated to the public.

Traditional nutritional science has been ambiguous and unconvincing. Despite the development of diet marketing and food pyramids, nutrition research contains some misinformation that leads to unhealthy food marketing [1]. Most studies in this field are observational, establishing associations rather than causes. Food marketing's bias and misinformation make it important to critically examine algorithms' role in amplifying or mitigating these issues. As a result, nutrition research increasingly relies on algorithms, such as artificial intelligence and machine learning models, to process and analyse data. However, bias and misinformation are widespread in the digital age. These aspects of food marketing must be addressed, especially in algorithmic decision-making.

Tailoring diets and food marketing in the big data era requires processing massive amounts of personal data, from genetic profiles to lifestyle choices. This has exciting potential but raises data privacy and ethical concerns. The need to balance personalised nutrition and data justice becomes clear. AI and machine learning have reached nutrition research and food marketing, promising more effective and personalised dietary recommendations [2]. Unhealthy dietary marketing's impact on diet preferences and choices is a growing concern. The societal effects of algorithmic biases, data justice, and unhealthy dietary marketing on public health can be illuminated by studying these phenomena [3]. In addition, algorithmic 'nutrition labels' may improve food marketing transparency [4]. These labels could help consumers understand how their dietary information is processed and presented, improving data justice. By critically examining these aspects, this study highlights the need for ongoing research in this area, particularly in addressing the limitations of existing studies and determining the responsible use of algorithms in food marketing.

1.1. Nutritional Information Disclosure

Dietary data and information affect people's perception of benefits and food safety, as well as their choice of food options. Nutritional information disclosure research focuses on how access to food products' nutritional information affects consumer decisions and perceptions. This is closely connected to marketing as a means of accessing information on food products. Emerging research on access and use of food product information has also employed artificial intelligence and big data capabilities.

Over the decades, government agencies have kept developing dietary guidelines. The food pyramid was adopted by the US. Department of Agriculture in 1992; however, the disclosed version was extremely distinct from the one that nutritionists proposed due to the business profit [5]. This deficiency and conflict of interest have a significant impact on citizens' food choices, resulting in a period of unfavourable health outcomes for citizens. Realising the gravity of the situation, governments are gradually developing nutrition disclosure policies. In the US, the Nutrition Labelling and Education Act (NLEA) is one of the first laws that required food packaging to have detailed information using a standard nutrition facts label, which has since been revised [6]. Currently, an updated U.S. Food and Drug Administration (FDA) nutrition facts label is in place to inform consumers of the nutritional facts of the food they purchase [6]. The Nutrition Labelling Regulations in Canada were further identified in the B.01.401 of Food and Drug Regulations (C.R.C., c. 870) by the Canadian Food Inspection Agency [7].

In addition, access to information on food nutritional information has a significant impact on consumers, as has been shown in different studies. Researchers evaluated how nutritional information affects online food sales [8]. They used an eye-tracking experiment to determine the purchase habits of people buying food products online and found that having nutritional information boosted sales, especially for healthy food options [8]. This is also dependent on the sellers' reputation, whereby having a good reputation is associated with better sales with nutritional information disclosure [8]. Nutritional information disclosure, therefore, may be one way of boosting sales, specifically in the online environment.

Moreover, researchers have evaluated the effect of front of pack labelling (FOPL) on purchase and consumption trends. A systematic review focused on interrupted time series studies on the question [9]. They reported that FOPL choices had lower sodium and sugar levels compared to no-FOPL [9]. Having FOPL has also been associated with healthier choices on the part of consumers [9]. A narrative review was also conducted and indicated with evidence to support the recommendation for FOPL [10]. Requiring that manufacturers and marketers maintain front of pack labelling is a potentially viable approach to improving healthy food choices and improving public health [10]. These studies indicate that the approach to providing information is a major determinant of consumption patterns and the selection of healthy food options.

1.2. Food Marketing and Misinformation

The marketing of food items is a major determinant of how consumers access information and use it to make decisions. This is also an avenue for a lot of misinformation, as seen in extensive research on the issue. Researchers conducted a systematic review of unhealthy food and beverage marketing and explored the impacts on children's diets [11]. Exposure to unhealthy food marketing content increases preference and dietary intake of

energy-dense, low-nutrition foods and beverages [11]. Similarly, a study illustrated that exposure to these unhealthy food adverts increased children's preference for foods with high fat, sugar, and sodium [12]. Marketing is specifically targeted to demographics with the aim of influencing behaviour; hence, unhealthy food marketing to children increases their unhealthy food preferences and consumption [11,12].

Misinformation and lack of adequate information are major determinants of the impact of food marketing on food preferences and intake. Researchers report the omission of certain information and presentation of only positive information in adverts as the main reason for the influence on food preferences [12]. Advertisers will minimise any adverse effects of their product while promoting visual cues that are attractive to the young target population [11,12]. Simple information presentation through recipes and processed food products can 'nudge' consumers to make food choices that affect their health outcomes [13].

Information and misinformation in food marketing could be addressed through healthy food recommendations. Researchers evaluated a recipe collection and evaluated people's selection of recipes. They found that the majority of recipe users were unable to determine the recipes with high levels of fat due to misinformation, misleading cues, and a lack of knowledge on the subject [13]. Similar to Carthy and her colleagues' findings [12], this study found that omission of crucial data and highlighting specific attractive features of a food product misled consumers on dietary information. In general, the findings indicate the role of marketers in misleading consumers and the impact of misinformation and marketing on poor food choices.

1.3. Exploiting Big Data and Artificial Intelligence in Food Marketing

The growth and extensive use of big data and artificial intelligence (AI) have gained a lot of use in food research and marketing. A study explored the possibility of gaining knowledge from food data using machine-learning approaches, which evaluated domain bias in predicting nutrient information using machine learning [14]. Researchers also exploit a nutrition algorithm with the focus of improving metabolic models and feeds in fish [15]. Both studies use machine learning to predict trends and outline the utility of AI in data collection and consolidation of information in making important decisions on nutrition [14,15]. Domain knowledge and the use of AI have been associated with higher accuracy in predicting nutrient content in food products and hence promoting knowledge and outcomes of food choices.

Algorithm bias has been identified as affecting data justice and access to information in nutritional AI analyses. Research demonstrated the potential for domain biases and advised knowing beforehand regarding food domains to influence nutrient content production and collection [14]. Likewise, a study identified the potential for machine-learning biases in algorithms used in nutritional marketing [16]. The need to integrate diverse perspectives was identified when designing and implementing AI in food and nutrition data and marketing applications [16]. Nevertheless, AI has presented a promising approach to collating food and nutrition data and information. A recent research successfully used an algorithm to match 98% of Euromonitor International's Passport Nutrition with Canadian Nutrient File (CNF) database items [17]. Despite the biases introduced by AI as captured by previous studies [14,16], the platform has been demonstrated as effective in matching nutritional data. Despite the research on the topic thus far, there is insufficient research on how algorithms can reduce data biases on food marketing platforms. Further research on the topic is warranted.

2. Materials and Methods

Based on the preliminary literature review encompassing three categories, the research question can be defined as:

How can algorithms eliminate bias in food marketing, and what is the relationship between data justice, algorithmic decision-making, and food marketing?

It is imperative to understand food research (prior to the use of algorithms) and the current state of food marketing based on this. Subsequently, since nutritional research increasingly relies on algorithms (artificial intelligence, deep learning, neural networks, and machine learning models) for the collection, training, processing, and analysis of food and nutritional data, the study transitions to the second stage of the question. The interpretability of algorithms emerges as a critical facet that requires nuanced investigation. While these algorithms may achieve remarkable accuracy in predicting nutrient content, understanding how these predictions are communicated to consumers is also paramount.

Thus, this study adopted a mixed-methods research design. In the literature review section, a preliminary analysis was conducted on the three aspects of the research question. However, it is crucial to integrate these three aspects and conduct a comprehensive review. The first method involved a systematic review addressing the research question. In the second phase, this study also conducted a social media content analysis to obtain implementation, content, and public perception of food marketing and algorithms.

This mixed approach ensures a thorough exploration of the intricate relationship between data-driven strategies, algorithmic decision-making, and their impact on food marketing, particularly focusing on the potential for bias elimination and the pursuit of data justice.

2.1. Systematic Review

A systematic review was undertaken to determine the intersection of food marketing and big data algorithms, as well as to analyse the trends in this field. Due to time constraints, however, the review was limited to literature from 2013 to 2023 to identify key findings relevant to the research question. This review encompassed two databases: Scopus and Web of Science.

Boolean operators (AND, OR) were utilised to refine the search parameters. The primary topics and search strings employed were: (food AND marketing AND algorithm) OR (food AND marketing AND artificial AND intelligence). Additionally, the review was expanded through manual scanning of the reference lists of identified articles to ensure inclusiveness.

2.1.1. Study Selection

In the initial search, a total of 358 pieces of literature were identified. 345 of these were excluded due to the lower relevance to the primary themes of the study. The focus of this review was primarily on the intersection of Food Marketing and three key areas: 1) Nutrition Disclosure, 2) Misinformation, and 3) Big Data and Algorithms.

73 were not included since the time frame was restricted to 2013–2023 (n=73). Besides, it was found that 96% of the literature related to food and algorithms fell under disciplines including medicine, pharmaceuticals, chemistry, agriculture, and biological sciences, accounting for 272 records (n=272). Consequently, these studies were excluded from the review due to their low relevance to the core themes of this study. In terms of publication type, there were no restrictions imposed. However, a language limitation was set to include only English-language articles. As a result, 15 non-English articles (n=15) were excluded from the review.

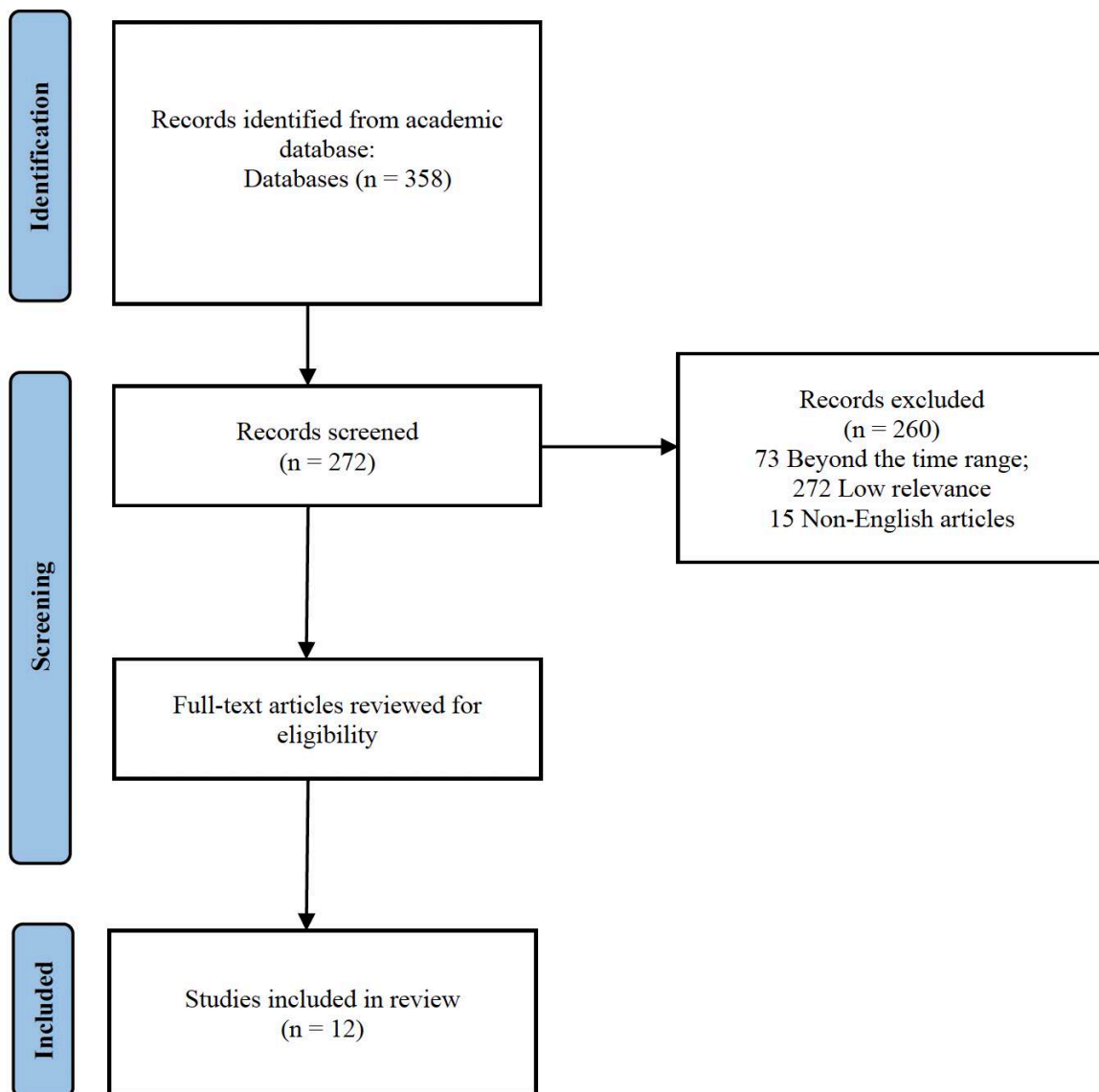


Figure 1. Flow diagram for the Systematic Review.

2.1.2. Data Extraction

A structured data extraction process was employed to systematically analyse the 13 selected studies. The extraction was developed to collect thorough and relevant findings from each study, ensuring the reliability and validity of the review's findings. The identified study information includes authors and publication years. The selected studies should concentrate on at least two of the following topics: Food Marketing, Algorithm/AI, Food Misinformation, Nutrition, and Food Bias. The key findings focus on 1) whether data mitigates food marketing prejudices, 2) whether algorithmic applications in food/nutrition are examined, and 3) whether the relationship between data justice and marketing practices is observed.

2.2. Social Media Content Analysis

As part of this research, the content of food marketing on social media, specifically algorithm-based food and nutritional information, also requires to be collected and analysed. The design of this social media content analysis study aims to provide a supplementary understanding of related topics, data, and discourse within the selected social media platforms.

2.2.1. Data Collections

The content analysis collected 3,300 social media posts from the period of November 10, 2023, to December 8, 2023, and employed statistical methods to identify trends and patterns. This timeframe is selected to capture both short-term trends and more persistent patterns in food marketing and algorithms. Due to the limited content available on major social media platforms, among X (Twitter), Instagram, and Facebook within a month, the research also contains sources from Reddit, News/Blogs, and web pages for a more comprehensive review.

Web scraping tools were used to collect publicly available data from the selected platforms. The process involved the use of an automated, licensed social media analytics tool that accesses public data via APIs. The collection process prioritised ethical considerations, respecting user privacy and platform terms of service. All data analysed in this study were publicly available at the time of collection. No private or personally identifiable information was accessed, and all procedures complied with platform terms of service and institutional research-ethics standards.

2.2.2. Data Preprocessing

Data preprocessing was applied to enhance the quality and reliability of the collected dataset. A key aspect is the strategic selection of keywords and tags that align with the research goals. The data sources include posts, videos, webpages, and blogs tagged with #FoodAI, #Foodalgorithms, #Foodmisinformation, #Fooddisinformation, #Nutritionmisinformation, #NutritionData, or containing keywords like “Food algorithms”, “Food misinformation”, “Food disinformation”, “Nutrition misinformation”, “Nutrition disinformation”, “Food data”, “Food and AI”, and “Nutrition data”. The selection of these thematic tags and keywords is consistent with the research focus and facilitates targeted content collection.

Moreover, the exclusion of irrelevant keywords is also important for refining the dataset. To prevent the inclusion of content not directly related to discussions of food marketing and algorithm applications, the following commonly mentioned keywords in this field were excluded: “Medical”, “Grain industry”, and “Agriculture industry”. This exclusion ensured the dataset’s relevance and specificity to the intended research question.

3. Results

3.1. Systematic Review

The systematic review contained 12 studies that rigidly examined the intersection of data usage, bias elimination, data justice, and algorithmic decision-making in the context of food marketing. As previously stated, selected studies should concentrate on at least two of the following topics: 1) Food Marketing, 2) Algorithm/AI, 3) Food Misinformation, 4) Nutrition, and 5) Food Bias.

Table 1

Summary of Key Terms and Findings of Included Studies (n = 12)

Ref. No.	Author	Year	Thematic Analysis					Findings
			Food Marketing	Algorithm/AI	Food Misinformation	Nutrition	Food Bias	
[17]	Gilbert et al.	2023	X	X	X	X	X	“This paper constitutes the first algorithm-aided matching of any marketing database’s branded food and beverage products sold in Canada to their nutritional equivalents in the CNF” (p. 17).

Continuation Table 1

[18]	Olstad, D. L., Boyland, E.	2023	X	X	X	X	X	"AI will be essential to comprehensively and systematically study and monitor food marketing to children on digital media and can also be leveraged to study food marketing in non-digital environments such as broadcast media and outdoor streetscapes" (p. 3).
[19]	Prowse et al.	2018	X	X	X		X	"As the first validated and reliable marketing assessment tool, the FoodMATS represents a means to comprehensively track food marketing environments over time" (p. 10).
[13]	Elsweiler et al.	2017	X	X	X	X	X	"...demonstrating that we are indeed able to algorithmically "nudge" people and influence their food choices" (p. 583).
[14]	Ispirova et al.	2020		X			X	"There is an overwhelming amount of nutrition-related data available, and most of it comes in textual form, structured and unstructured. Data Science can help us utilize this data for our benefit" (p. 3569).
[20]	Philp et al.	2022	X	X				"In a novel utilization of the Google Vision AI machine learning algorithm, this research finds that the confidence score given to food objects positively relates to engagement" (p. 743).
[16]	Akter et al.	2022	X	X			X	"Today, as big datasets have been amassed by firms, marketers are increasingly using ML to recommend appropriate content based on user queries via search engines while co-locating the most profitable advertisements alongside the search results" (p. 212).
[21]	Ahmed et al.	2022	X	X		X	X	"this paper introduces FLIP 2020, an Artificial Intelligence (AI)-enhanced/powerful Optical Character Recognition (OCR) (AI-enhanced OCR) approach to the collection and evaluation of the Canadian packaged food and beverage supply and presents the methods used in the development of this database" (p. 2).
[22]	Sharma et al.	2021	X	X		X	X	"By employing Neural Network Analysis as a platform using Big data, both online-based customer reviews and promotional marketing strategies play a huge role in predicting product demand" (p. 5).
[23]	Berciano et al.	2022	X	X		X	X	"There are several channels through which the general public can access nutrition information; some reflect general recommendations (e.g., DGA), while others provide a biased view that creates opportunities for nutrition misinformation" (p. 9). "Precision Nutrition (PN) is a data-driven approach to assessing health that tailors dietary recommendations to individual needs" (p. 9).

Continuation Table 1

[24]	van der Bend et al.	2022	X	X	X	X	“policy makers should be made aware that the predictive validity of a nutrient profile model is not a measure of effectiveness of a label using that model, and should be accompanied by an investigation of actual purchases of products with the label” (p. 19).
[25]	Garcia-Esteban et al.	2018		X	X	X	“...the machine learning techniques along with instrumental measures appear as an intelligent solution to obtain a reliable estimate of the sensory parameters of the food products” (p. 225).

In the review of the existing literature, it was observed that only 2 studies cover the entirety of the topics [13,17]. 10 out of 12 studies explored the role of algorithms in shaping food marketing strategies [13,16,17-24]. These studies indicated that algorithmic decision-making could lead to more targeted and personalised food marketing, but also raised concerns about reinforcing existing biases. Some studies highlighted instances where algorithms amplified biases due to flawed data inputs or a lack of diversity in training datasets. 4 out of 12 studies conducted case studies to evaluate specific algorithm tools and how to mitigate biases [17,19-21]. 8 out of 12 studies discussed the substantial integration of algorithmic techniques and nutrition [13,14,17,21-25].

3.2. Content Analysis on Social Media

This analysis focused on examining social media content related to food marketing, with a particular emphasis on understanding how algorithms influence content reach and engagement. Throughout the research period, a total of 136 mentions related were identified across various social media platforms (Figure 2). These mentions collectively reached an audience of approximately 978,100 users, providing a significant dataset for analysis (Figure 3).

Mentions

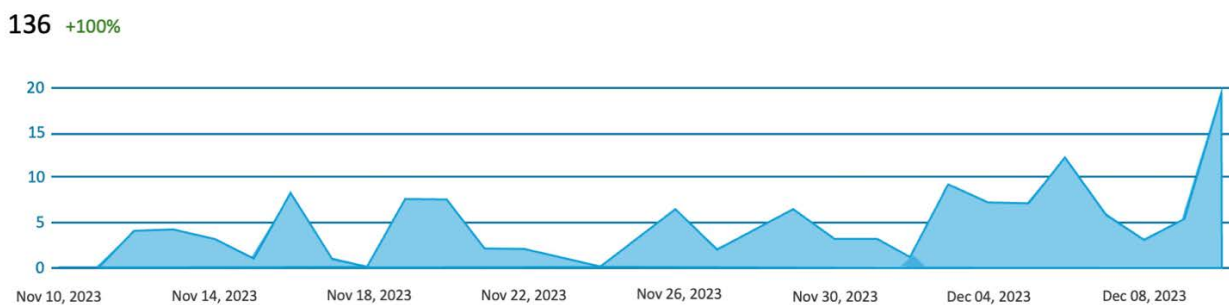


Figure 2. Social Media Monitor: Mentions.

Source: Author’s re-produced visualisation based on aggregated data collected via a licensed social media monitoring platform (November–December 2023).

The distribution of mentions varied across platforms, with obvious emphasis on X (Twitter), YouTube, and Facebook. New/Blogs and web pages, on the other hand, reached a greater percentage of users than social media posts. This occurred because articles and blog postings are typically accessible and relevant for longer periods. Social media posts can easily become buried beneath new content. Furthermore, when it comes to food marketing and

questions inform strategies to counteract misinformation and promote transparent communication in food marketing. The effectiveness of food information disclosure is context-dependent. The existing literature needs a comprehensive exploration of the diverse channels through which nutritional information and data are disclosed. Understanding how different disclosure methods resonate with varied consumer groups across distinct platforms is crucial for developing a holistic understanding of the impact of nutritional information.

4.2. Integration of Algorithms in Food Marketing and Nutrition

Both the algorithm-aided method of matching branded food and beverage products sold in Canada with their nutritional equivalents in the Canadian Nutrient File [17], and the use of Google Vision AI's machine learning algorithm in food marketing [20], exemplify a new frontier in interactive food marketing techniques. The development of various algorithmic techniques signifies a pivotal step in merging marketing databases with nutritional information, offering a more holistic view of food and nutrition. Furthermore, beyond mere data analysis of nutritional information, the algorithm and AI play a crucial role in monitoring and researching food marketing strategies.

One significant limitation in the existing literature on algorithm techniques in food marketing is the insufficient attention given to the potential unintended consequences of algorithmic predictions. While current literature focuses on prediction accuracy, there is still a substantial gap in our understanding of how these forecasts may influence consumer behaviour and dietary choices. Future research should bridge this gap by adopting a more holistic approach incorporates AI's technical aspects and its behavioural implications.

In the technical focus, the studies do not extensively explore the societal implications of relying on algorithmic decision-making in food marketing. Understanding how AI may exacerbate existing social inequalities or contribute to the homogenization of dietary choices is imperative. Future research could adopt a critical perspective, employing qualitative methods to examine the broader societal impacts of algorithmic applications in food marketing.

Moreover, an aspect that warrants consideration is the potential reinforcement of existing biases within the data used to train these algorithms. Researchers highlight algorithmic bias as a persistent concern, emphasising the need to integrate diverse perspectives to mitigate biases in AI applications [16]. Future research should delve deeper into the sources and manifestations of algorithmic bias in food marketing, considering cultural, geographical, and socioeconomic diversity factors. By comprehensively addressing these biases, researchers can contribute to developing more equitable and inclusive AI algorithms in food marketing.

4.3. Limitations

One of the primary limitations of this research is the time constraint. Due to the limited timeframe for conducting the systematic review and social media content analysis, there was an inherent restriction of conducting a more extensive search of the literature, potentially resulting in the exclusion of relevant studies that could have provided additional insights into the intersection of algorithms, data justice, and food marketing. To address these limitations, future research will seek to expand the scope of the systematic review, especially those emerging research in the field. This approach will provide a more up-to-date and promote understanding of how algorithms impact food marketing and the associated ethical considerations.

5. Conclusions

The research's thorough mixed-method approach, which included both a systematic review and a social media content analysis, provides a multidimensional understanding of the intersection of algorithms, data justice, and food marketing. By offering an in-depth review of the application of algorithmic techniques to food marketing tactics, this study attempted to bridge the gap between theoretical research and practical observations. Future research in this field should focus on expanding the scope of studies and incorporating diverse methodologies. These efforts are critical in ensuring that advances in algorithmic tools in food marketing benefit public health and data justice.

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