Chapter 8
The Impact of Evolving Technologies on Restaurant Consumer Health:
A Systematic Review

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ABSTRACT

As technological facilities and devices become increasingly popular in restaurants, restaurant consumers are increasingly influenced by technologies. With the increase in consumer health needs, the impact of technology on consumer health has gradually received more attention. This study employs bibliometrics and thematic analysis methods to review and analyse 52 English journal articles from WoS and Scopus from five aspects: research focus, time overlay, methodological characteristics, theoretical framework, and research topics. The results reveal that previous studies have explored the relationship between various types of restaurant technology and consumer health behaviours, health literacy, physical health, mental health, social health, and health literacy from multiple disciplines. In addition, existing studies mainly focus on the impact of health information presented by technology on consumer health. Finally, after a comprehensive review and summary of previous studies, this study puts forward specific suggestions for future research based on the gaps in existing research.

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INTRODUCTION

With the improvement of people's living standards, consumer demand for the restaurant industry is no longer limited to meeting basic dietary needs but has expanded to pursue added value offered by restaurants. For example, consumers' demand for personalization, speed and variety of restaurant products is increasing (Ma et al., 2023; Manhas et al., 2024). The application of technology in the restaurant industry adapts to these increasingly diversified needs of consumers. For example, the smart ordering system meets consumers' demand for personalized product combinations, and the restaurant's self-service checkout platform meets consumers' demand for speed (Gu et al., 2023; Wong et al., 2022). While meeting the diverse needs of consumers, the application of technology in the restaurant industry also has some basic advantages. For example, compared with human employees, the services provided by robot waiters are more advantageous and attractive in terms of quality stability and accuracy (Zhang et al., 2022).

With the diversification of consumer needs, the demand for healthy products in the restaurant industry has also been gradually increasing. Especially affected by global events related to health and hygiene, such as COVID-19, consumers' attention to health needs has been further enhanced, and health problems in restaurants have gradually been exposed to the public's attention (Dai et al., 2022). Restaurant consumers pay more attention to the quality of food and beverages, the nutritional value of food, and even the impact of services on consumers' physical and mental health (Ganesh, 2024; Mahmoud et al., 2024). Some technologies that can be applied in restaurants can meet consumers' health needs to a certain extent. For example, the smart ordering system can provide a more balanced food combination according to consumers' needs, which not only makes the best use of food's nutritional value but also supports consumers' physical health by improving the dietary structure (Mandracchia et al., 2022).

However, limited research have focused on exploring the impact of restaurant technology on consumer health. Many related studies are scattered across research on other topics. In particular, most of the research on how restaurant technology affects consumer health is included in the research of other topics. However, as consumers' health needs continue to increase, researchers and restaurant managers need to have a deeper understanding of how restaurant technology impacts consumers' health. In addition, health includes multiple dimensions. According to the recommendations of the World Health Organization, health refers not only to physical health but also to mental health and social health (The World Health Organization, 1946). At the same time, some scholars point out that while paying attention to individual health status, we should also pay attention to their health behaviours and health literacy (Rudd et al., 2023). The limited existing articles that focus on the impact of restaurant technology on consumers only explore it from a single health dimension. For example, Abell et al. (2024) proved through 4 studies that the digital ordering system in restaurants will increase the proportion of consumers choosing unhealthy foods. Therefore, there is still a lack of research exploring the impact of restaurant technology on consumers' health experience from a holistic perspective.

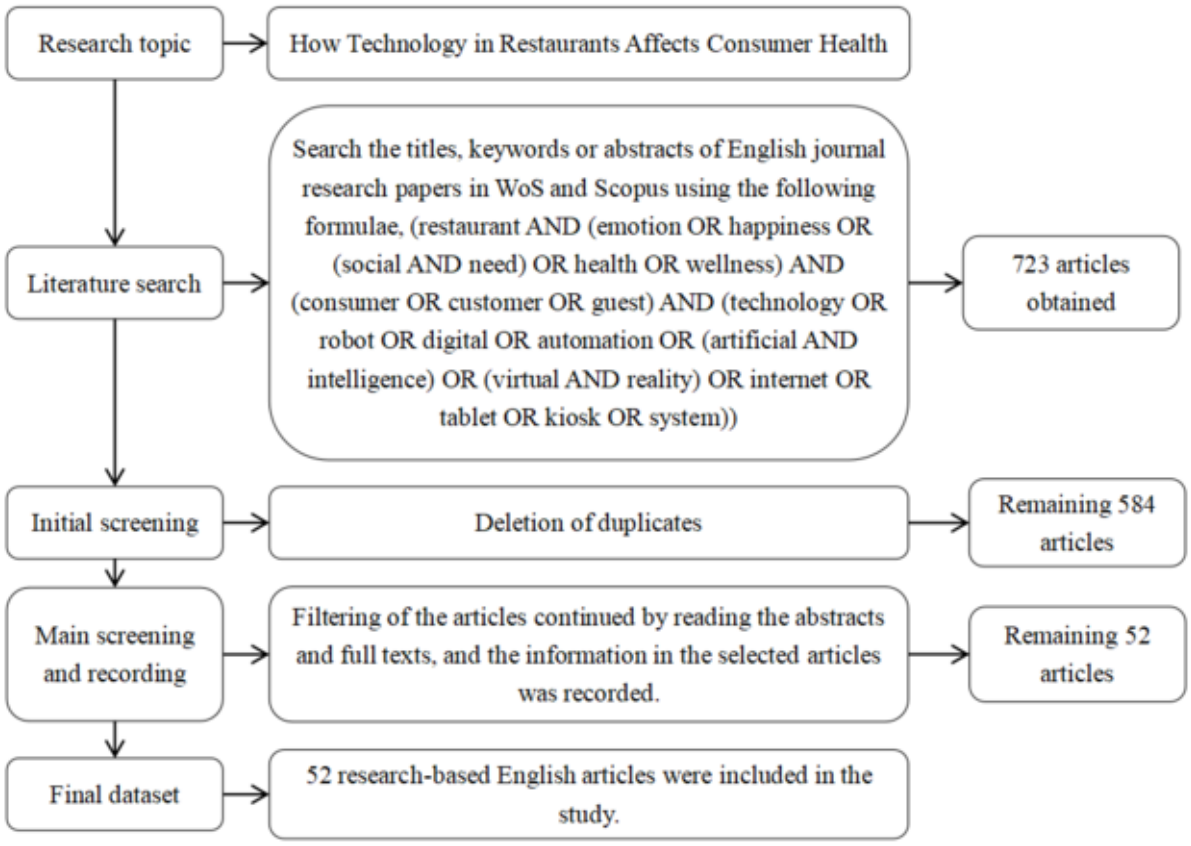
Therefore, in the context of a lack of research to describe how restaurant technology affects consumer health in an overall manner, this study attempts to extract and integrate relevant clues from existing research. This study aims to enrich the research perspectives related to restaurant technology, provide theoretical support for researchers to explore restaurant consumer health, and emphasize the important role of the rational application of restaurant technology in improving consumer health.

METHODOLOGY

This paper follows the systematic quantitative approach for conducting a literature review (Pickering & Byrne, 2014). This method has been widely used in high-quality literature reviews in the hospitality industry (Jia et al., 2024; Le et al., 2019; Li et al., 2023). Specifically, the research process in this study includes five steps. The first step is to select the research topic and determine the research objectives. Second, the search criteria are formulated to ensure that the literature related to the research objectives can be obtained with minimal omissions. Then, the literature search is conducted in the selected database, and the first round of screening is performed. The fourth step is to carefully read the screened literature, conduct the second round of screening and record the information related to the research objectives of this study. In addition, the problems found during the reading process should also be recorded. Finally, the recorded information and the problems are discussed and conclusions that can explain the research objectives are proposed.

After determining the research goal to explore the impact of restaurant technology on consumer health, this study selected Web of Science (WoS) and Scopus as databases to search for research papers in English journals related to this topic. The selection of databases was based on previous systematic literature reviews (Elkhwesky & Elkhwesky, 2023; Jia et al., 2024; Li et al., 2023). The search keywords included restaurant, consumer, health, technology, and synonyms for these four terms. The search scope included title, keywords, and abstract. To examine the changes in the sub-topics over time, this study did not set a time limit when searching for articles. The authors conducted a search in August 2024 and obtained 412 and 311 articles from WoS and Scopus, respectively. Because there are overlapping parts in the journals included in the two databases, this study first screened non-duplicate literature and obtained a total of 584 non-duplicate literature. Subsequently, the researchers conducted further screening by reading abstracts and full texts. Finally, 52 research papers closely related to the research topic were obtained. The process of literature retrieval and screening in this study is illustrated in Figure 1.

Figure 1. Screening Process



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Subsequently, this study conducted statistics and analysis of the 44 documents obtained. The analysis process consisted two parts. The first part involved basic descriptive statistics to show the development status of research related to this topic. It included statistics and simple analysis of the journals to which the articles belong, as well as statistics and analysis of the number of articles published year by year. In addition, this study also employed VOSviewer software to conduct co-occurrence analysis and temporal analysis on the keywords in the selected articles, referencing to previous studies (H. Kim & So, 2022; Li et al., 2023). Keyword co-occurrence analysis could show the potential connection between keywords, thereby helping researchers to identify research hotspots in the field. Overlay analysis could show the frequency changes of keywords over time. The combination of the results of overlay analysis and the overall trend of the number of articles published each year could reveal the migration of hotspots that researchers were concerned about under this topic. When using VOSviewer for keyword analysis, this study chose to include the keywords specified by the article, the author's keywords, and the keywords generated by the database in the research scope to make up for the problems caused by the limited number of overall articles. After setting up synonym replacement, VOSviewer identified a total of 428

keywords, of which 74 keywords appeared 2 times or more. After manual screening of the keywords, the remaining 59 keywords were included in the analysis.

Subsequently, to gain a deeper and more detailed understanding of the progress and status of the sub-topics under this research topic, the authors coded and classified the literature included in the statistics. According to the topics of concern, the authors marked the restaurant technology-related content involved in each study and the categories of consumer health affected. Since a total of 52 articles were included in the study, the coding process was divided into 4 rounds, and two authors coded 11 articles in each round. After each round of coding, the two authors involved in the coding need to compare their coding results to ensure that the degree of consensus is 90% or more before the next round of coding. The opinions that cannot be unified are decided after discussion by a third researcher. The coding process and the recording of the basic content of the article were carried out simultaneously. During this process, the researchers also needed to record in detail the research methods, theoretical basis, conclusions and limitations of the research used in the article.

CHARACTERISTICS OF RESEARCH

Temporal and Journal Distribution of Publications

By sorting out the publication time of relevant studies and the frequency of their appearance in different journals, this study obtained Figure 2 and Table 1. Figure 2 shows the number of publications in each year and the cumulative number of publications obtained from the WoS and Scopus databases. As can be seen from the figure, the topic of the impact of technology on consumer health has received less attention. Although the annual number of publications on this topic generally showed a fluctuating and slowly rising trend, compared with the overall development trend and publication volume of restaurant technology-related research (Gonzalez et al., 2022; Moreno & Tejada, 2019; Wang & Wang, 2021), this topic still received relatively limited attention. Between 2013 and 2015, the growth rate of the number of related studies accelerated and then slowed down. This might be related to the entry into force of the Affordable Care Act (ACA) in the United States in 2010, which required restaurants to provide product impact information to help consumers make healthier choices (Bedard & Kuhn, 2015). In 2020 and thereafter, the growth rate of the number of related studies had increased slightly again. Combined with the findings of other studies (Wang & Wang, 2021), this study speculated that this increase in growth rate may be due to the impact of the COVID-19 pandemic. In order to reduce the risk of infection caused by interpersonal contact, the popularity of technology in restaurants has increased overall, and related topics have received more attention (J.K. Kim et al., 2023).

Figure 2. Publication Count by Year

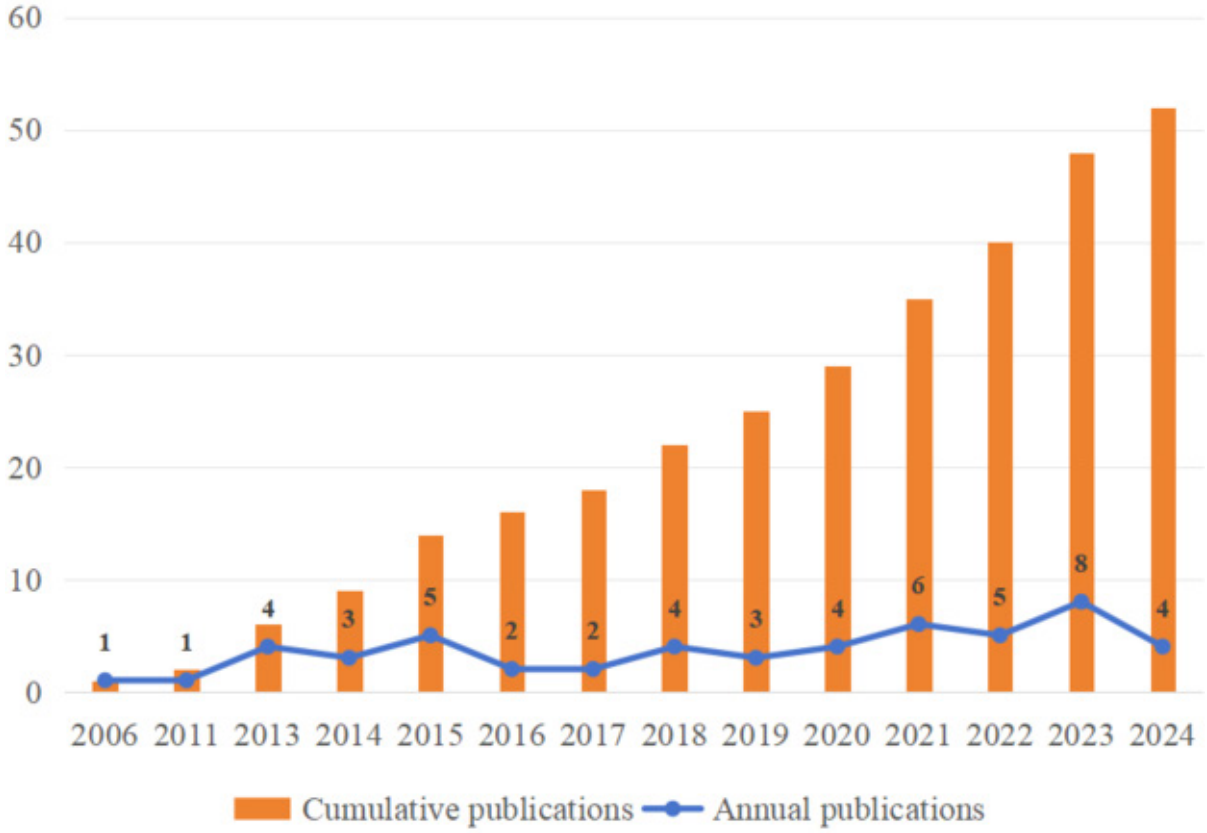

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Table 1 shows the publications corresponding to the included literature with a frequency greater than 2, as well as the specific frequency of occurrence. Among them, Appetite has the largest number of articles related to the impact of technology in restaurants on consumer health, including 6 related articles. The second is the International Journal of Hospitality and Management, which contains 4 related articles. Then followed by American Journal of Preventive Medicine, Journal of Hospitality and Tourism Technology and Plos One, each with 3 related articles. There are 29 journals that are not displayed, each containing 1 related article. The journals containing 2 related articles are Foods and Public Health Nutrition. From the overall journal distribution, this topic has attracted the attention of multiple disciplines, such as public health, hotel and tourism management, food science, and behavioural science.

Table 1. Publication Distribution

Publication Title	Frequency
Appetite	6
International Journal Of Hospitality Management	4
American Journal Of Preventive Medicine	3
Journal Of Hospitality And Tourism Technology	3
Plos One	3
Foods	2
Public Health Nutrition	2

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Keyword Co-occurrence Analysis

The word frequency co-occurrence results obtained by the researchers through VOSviewer are shown in Figure 3, and the temporal analysis result of the keywords is shown in Figure 4. The lines between the keywords represent that they appear in the same document. The thicker the lines, the higher the number of co-occurrences. The closer the distance between the keywords with higher the correlation. In addition, the diameter of the circle represents the frequency of keyword occurrence. The higher the frequency of the keyword, the larger the diameter of the circle. According to the processing results of VOSviewer, it can be found that the keywords are divided into four clusters. The red cluster is the largest cluster with the largest number of keywords, containing a total of 27 keywords. The keywords with the highest proportion in this cluster are obesity, consumer, fast, food, child, nutrition information, and menu labeling, and their weight of links are all over 20. This cluster mainly focuses on issues related to nutritional health and dietary health, including both health information provided by restaurants and consumers' healthy eating behaviours. From the overlay visualization in Figure 4, we can see that the topics related to emotion, food safety, and digital marketing in this cluster are new topics, while the topics related to menu planning, behaviour, purchases, and consumer health information are the topics that have received attention in the early years.

Figure 3. Keywords Co-occurrence

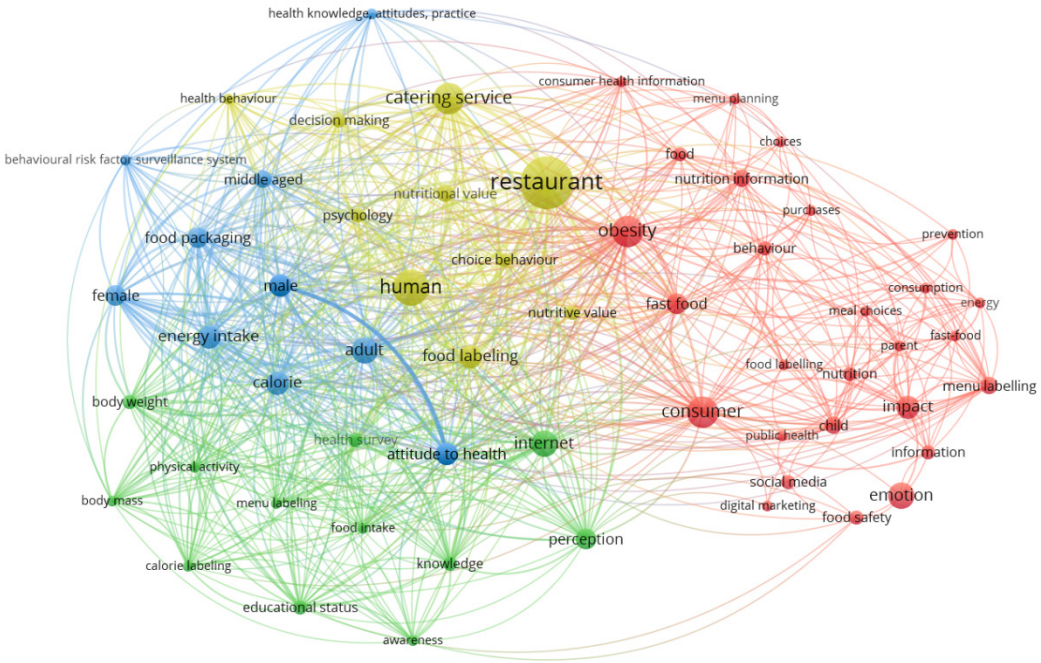

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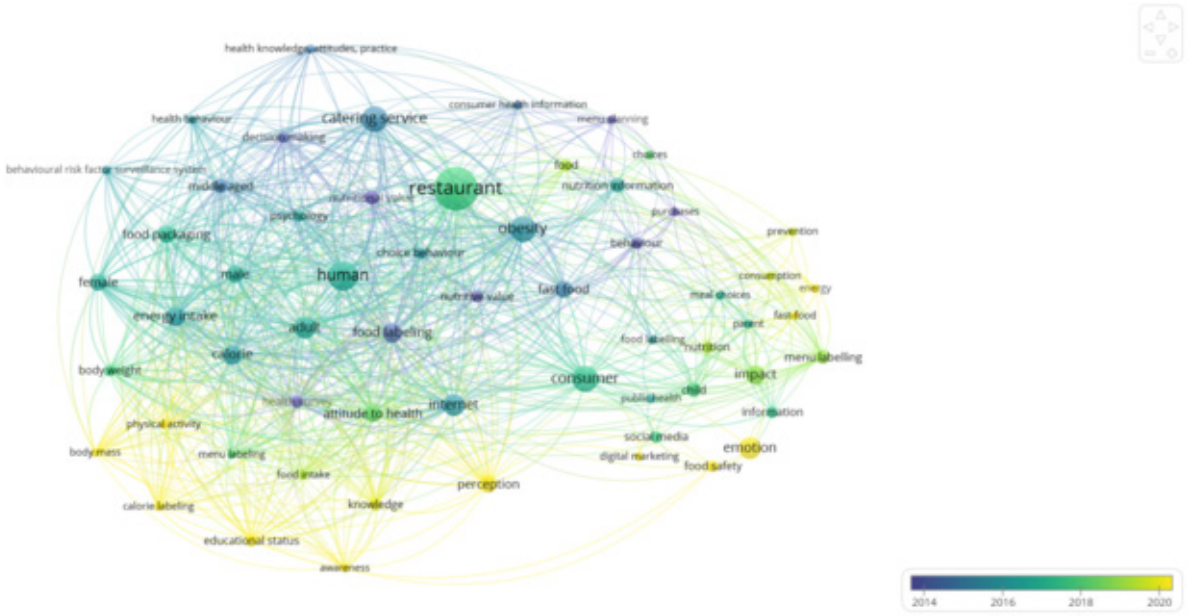
Figure 4. Overlay Visualization



Note. Created by the authors.

The green cluster contains 12 keywords, among which the high-frequency keywords are body mass, calorie labelling, and physical activity. This shows that this cluster mainly focuses on issues related to health behaviour and weight management. In addition, according to Figure 4, it can be found that compared with other clusters, the distribution of the year of appearance of this cluster is relatively new. The average year of appearance of most keywords is after 2018. This shows that research related to restaurant consumers' weight management and health behaviour has received attention in recent years. The blue cluster contains 10 keywords, among which the high-frequency words related to health include calories, energy intake, and attitude to health. This shows that this cluster focuses on issues related to consumers' health attitudes and dietary behaviours. In this cluster, some words related to demographic characteristics appear, indicating that the content of this cluster not only focuses on consumers' health attitudes and dietary behaviours but also emphasizes the differences between different groups. The clues provided in Figure 4 show that the average publication year of keywords in this cluster is between 2015 and 2018.

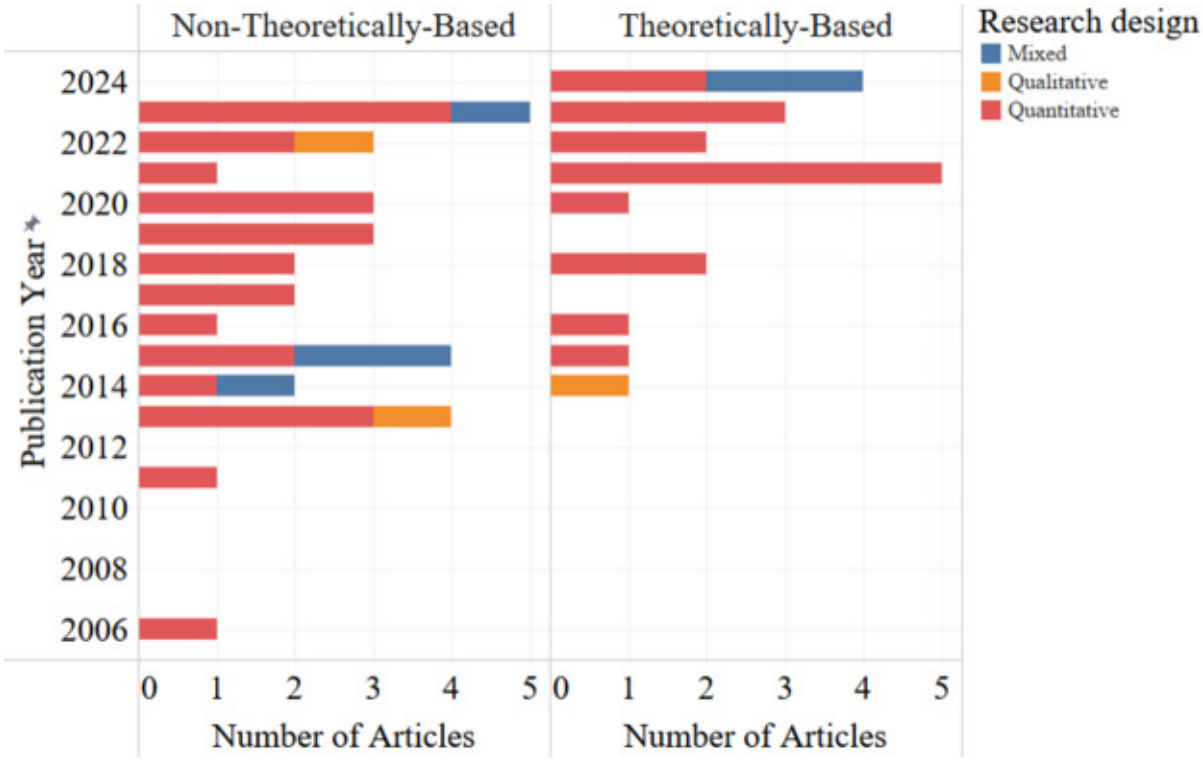
The yellow cluster contains 10 keywords. High-frequency keywords include catering service, food labelling, nutritional value and choice behaviour. Although the themes represented by this cluster overlap to some extent with the red cluster, there are significant differences. The yellow cluster mainly focuses on discussing the impact of nutritional information on labels on consumer choice behaviour. The research scope is relatively specific, and the average appearance time of most keywords is concentrated from 2014 to 2017. The red cluster is an extension of the yellow cluster and has a wider range. In terms of content, the red cluster covers the impact of nutritional information on the micro level (consumers' personal behaviour) and even the macro level (public health of consumer groups). In terms of time range, the red cluster covers a wider time span (2009 to 2022). The visualization results of the time distribution of keywords (Figure 4) show that with the development of time, the research topics are constantly being

refined. For example, the content of food labels is refined into specific contents such as energy, nutritional value, calories, etc., and consumer health is refined into personal health behaviours, health attitudes, public health, etc. However, it is worth noting that the topic of this study is the impact of restaurant technology on consumer health, but technology-related words appear less frequently. During a detailed reading of the literature, the authors found that most past studies focused on how technology, as a carrier of information, affects consumers' health. The specific content will be explained in detail below.

Methodological Nature

The 52 articles obtained were divided into three categories according to the research design, namely qualitative research articles, quantitative research articles and mixed research articles. Based on this classification standard, the authors drew Figure 5 according to the publication year and whether the article has a clear theoretical basis. Figure 5 shows that the vast majority of studies attempt to explain the impact of restaurant technology on consumer health through quantitative methods. There are 43 quantitative research articles, accounting for 82.7 of the total. Limited studies explored this research topic using purely qualitative methods. Among the 52 articles collected, only 3 articles attempted to conduct research through qualitative methods, accounting for 5.8% of the total. And the number of purely qualitative research articles did not show a downward trend. Although the total number of articles using mixed research methods is not large, it has tended to increase in recent years compared to purely qualitative research articles.

Figure 5. Evolution of Research Types Over Time



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The most commonly used data collection method in the quantitative research articles collected in this study is the survey method, and the most commonly used survey method is to distribute self-administered questionnaires to restaurant consumers (e.g., Chen & Girish, 2023; Kumar & Shah, 2021; Palisidis et al., 2016; Pang & Hammond, 2013). Some researchers have pointed out that self-administered questionnaires may affect the quality of the data obtained. For example, self-administered questionnaires distributed online exclude users who are not familiar with the Internet or do not use online survey platforms (C. Chen & Girish, 2023). Although the questionnaire informs participants that there is no right or wrong answer, some participants may be affected by the social desirability effect when filling out the questionnaire, leading their answers to deviate from their actual thoughts and actions (Jaeger & Cardello, 2022). Therefore, some studies have proposed that field experiments should be conducted and non-recall data should be collected through observation, expression information capture technology, etc., to improve the authenticity and reliability of the data (T. Kim et al., 2022; Okumus et al., 2018; Ruiz-Mafe et al., 2020).

Among the articles obtained in this study, the experimental method is the data collection method used the second most frequently after the survey. However, only a few studies adopted field experiments (Ong et al., 2023). Most studies that adopted the experimental method simulated different experimental scenarios by providing videos, texts or pictures on the Internet (Musicus et al., 2019; Prowse et al., 2020; Ratilla et al., 2022; Reinholdsson et al., 2023; Wei et al., 2022). Among the studies that adopted the experimental method, most studies used questionnaires to collect data during the experiment (X. Y. Leung & Wen, 2021; Musicus et al., 2019; Wei et al., 2022), and only a few collected data by observing the responses

of participants (Lassen et al., 2014). Customer-generated content on the Internet and data in restaurant management systems also provide researchers with valuable research materials. For example, some studies collected online reviews posted by consumers who had dining experiences in restaurants that employed service robots, converted them into quantifiable data, and conducted quantitative analysis (Park et al., 2024). Some studies utilized sales data from restaurant management systems and the nutritional value of food to quantitatively study consumers' behaviour in choosing healthy food (Lee-Kwan et al., 2016).

Among the 52 articles obtained, 6 used a combination of qualitative and quantitative methods. In these articles, the most frequently used method for collecting quantitative data is still survey methods, and 5 articles used surveys to collect quantitative data. Interviews are the most common method for collecting qualitative data, and 3 articles used this method in the process of qualitative data collection. Some studies are based on qualitative research and use quantitative methods to conduct in-depth exploration and interpretation of the conclusions raised in the qualitative research process. For example, Peng et al. (2024) first interviewed restaurant consumers, constructed a conceptual framework based on the interview content, and then tested the conceptual framework through the collected questionnaires. Some are based on the conclusions of quantitative research and explain the relationships found in quantitative research through qualitative data. For example, questionnaires were first collected in Foodom restaurants in China in the form of surveys, and then content analysis was conducted on online reviews related to Foodom restaurants to provide qualitative insights related to the conclusions of quantitative research (Jiao et al., 2024). A total of 3 articles used only qualitative methods to explore the impact of technology on consumer health in restaurants. Two of them used the focus group method to collect data, and one collected online reviews as qualitative data.

Theoretical Framework and Applications

The statistical results of publications show that the research related to the topic of this study has a wide range of disciplinary backgrounds. Therefore, it is necessary to count and analyse the theories applied in these studies. The sorting of relevant theories is conducive to a deeper understanding of the theoretical connections between different disciplines and promotes the theoretical integration and innovation of this interdisciplinary theme. The statistical results show that 61.54% of the collected articles lack a theoretical basis. Figure 5 clearly shows the gap in the number of studies with a theoretical basis and those without a theoretical basis. Figure 5 also shows that before 2017, the research on this topic was not significantly based on a theoretical foundation. However, after 2017, this situation has changed. The number of studies with a theoretical basis has increased rapidly and exceeded the number of studies without a theoretical basis in a short period of time. This study sorted out the theories mentioned in the articles, and the results are shown in Table 2.

Table 2. Theoretical Application Frequency

Theory	Frequency
Stimulus-Organism-Response (SOR) Theory	3
Cognitive Appraisal Theory	2
Nudge Theory	2

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Table 2. Continued

Theory	Frequency
Consumer Values Theory	1
Customer Mind-Set Model	1
Elaboration Likelihood Model	1
Emotional Contagion Theory	1
Equity Theory	1
Expectancy-Disconfirmation Theory	1
Feelings-As-Information Theory	1
Fogg Behaviour Model	1
Halo Effect Theory	1
Health Belief Model	1
Pleasure Arousal Dominance Theory	1
Self-Determination Theory	1
Service Dominant Logic Theory	1
Social Comparison Theory	1
Social Exchange Theory	1
Theory Of Planned Behaviour	1
Uncanny Valley Theory	1
Unified Theory of Acceptance and Use of Technology (UTAUT)	1
Value-Attitude-Behaviour Model	1

Note. Created by the authors.

In the 20 articles with a theoretical basis, a total of 22 theories were mentioned. The most frequently appearing theory is the Stimulus-Organism-Response (SOR) Theory, which was applied in 3 articles. The second most frequently appearing theory is the Cognitive Appraisal Theory and the Nudge Theory, which appeared 2 times respectively. The remaining theories appeared once each. The disciplinary backgrounds involved in these theories are mainly concentrated in three disciplines, including psychology (such as SOR Theory, Cognitive Appraisal Theory and Emotional Contagion Theory), sociology (such as Equity Theory and Social Exchange Theory), and marketing (such as Consumer Values Theory, Customer Mind-Set Model and Service-Dominant Logic Theory).

RESEARCH TOPICS ANALYSIS

This study categorised and coded the types of technology and consumer health involved in each article. It should be noted that it has become common to use electronic menus on flat plates, electronic screens, self-service machines, and mobile clients to order and view food information in restaurants (Zhang et al., 2020). In this context, the authors also took into account some content that did not clearly indicate whether electronic technology was used to display menu information or food label information during the coding process and classified them into the electronic menu category. Based on the coded data, the authors produced Figures 6 and 7, which show the distribution of different research topics in different

regions and at different times. It should be noted that because some studies focus on multiple types of technology or multiple types of consumer health at the same time, the total number of these topics is greater than the total number of included articles. The authors identified 6 types of technology in previous studies on the impact of restaurant technology on consumer health, namely electronic menus or labels, ordering or delivery systems, social media, restaurant data management systems, virtual reality and service robots. One study which is also related to restaurant technology, but the technology in this article refers to multiple categories, so it is coded separately as technology (Ling et al., 2023). As can be seen from Figure 6, the most popular technology type is electronic menus and electronic labels, the most popular health type is health behaviour, and the country that pays the most attention to this research topic is the United States, followed by China. Next, this study will analyse the status and main conclusions of each research topic according to different health types.

Figure 6. Regional Distribution of Research Topics

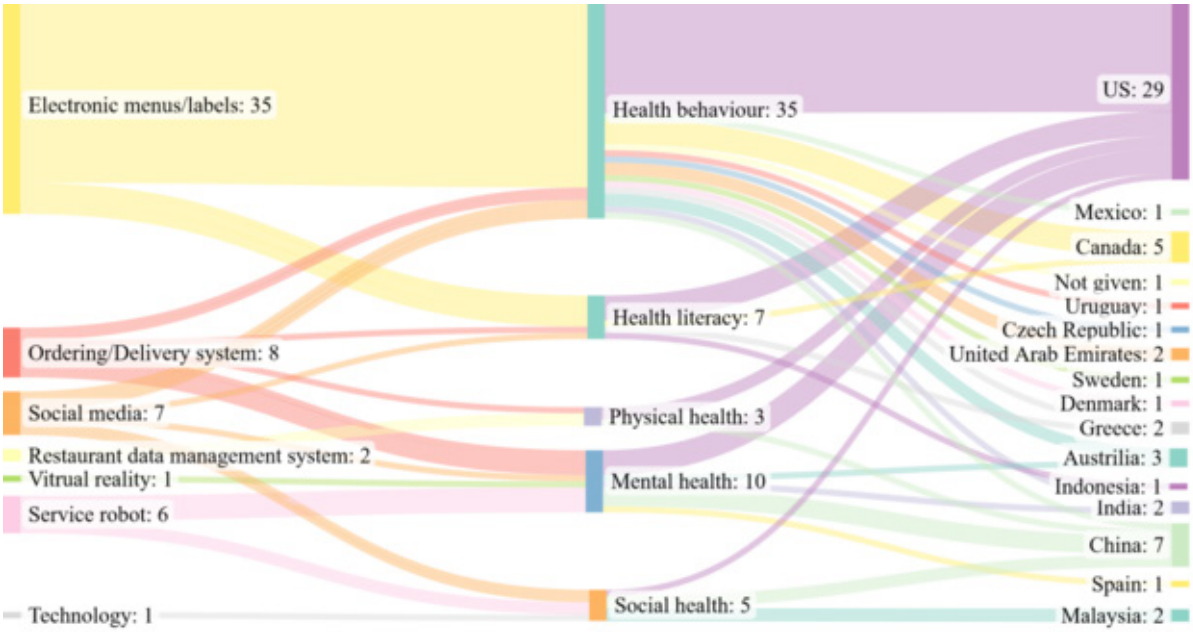

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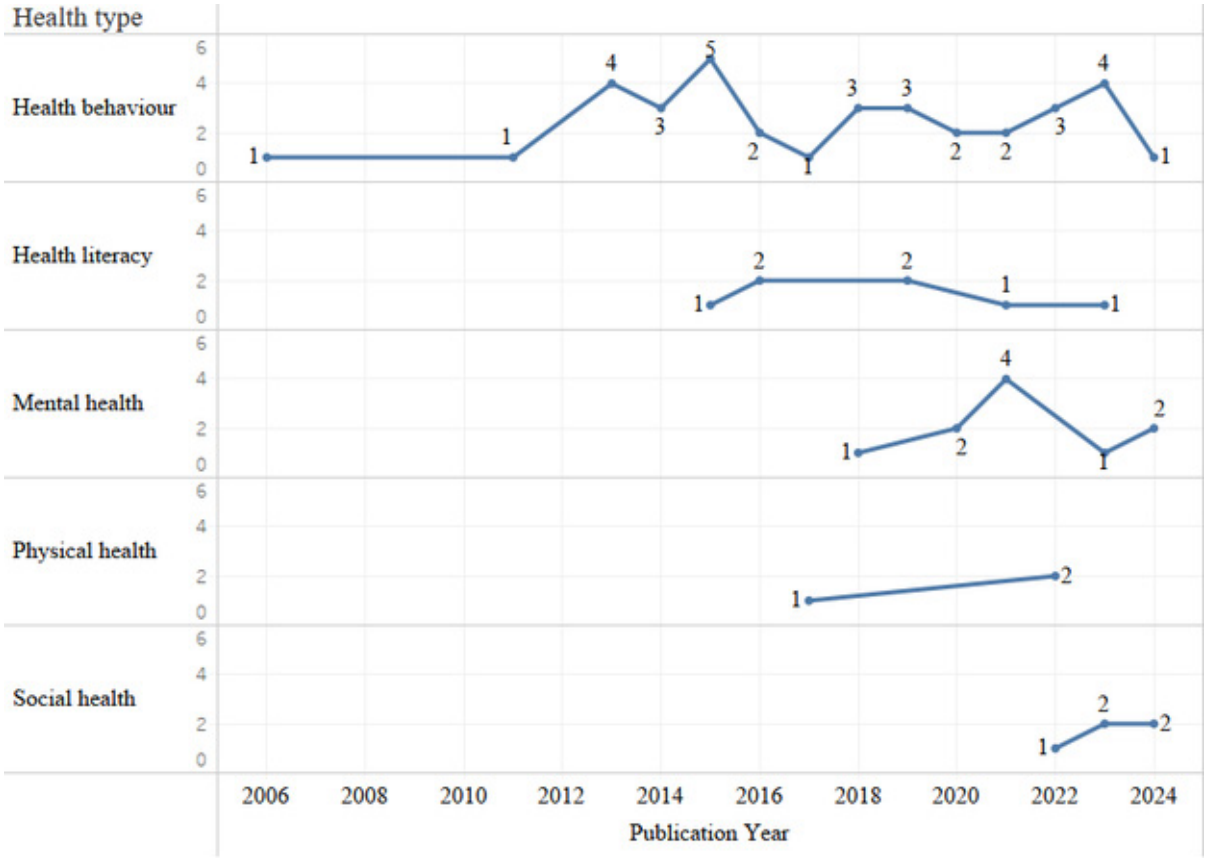
Figure 7. Publication Trends by Health Type Over Time



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Consumer's Health Behaviour

Health behaviour is closely related to the overall health level of an individual, especially for restaurant consumers, whose food choices are closely related to their health. Because the safety, nutritional value and energy of food affect the health of an individual (Dai et al., 2022; T. Kim et al., 2022; Sadilek et al., 2017). Therefore, health behaviour, especially the behaviour of choosing healthy food, has become the research focus of researchers who are concerned about the health of restaurant consumers. Figures 6 and 7 show that 35 articles focus on consumers' health behaviour. Researchers have paid attention to this topic for the longest time, and related research has been published every year since 2013.

Electronic menus and labels are the type of technology most associated with consumer health behaviours. However, such technological devices do not directly affect consumers' health. What directly impacts on consumer health is the health information provided by such technological devices, and these devices only serve as carriers of health information. Information about food on electronic menus and labels can influence consumers' food choices, and health-related information can increase consumers' probability of choosing healthy foods. For example, research has found that labels on calories and sodium

content on menus can have a significant impact on consumers' healthy food choices, especially when choosing foods for children (Prowse et al., 2020). Such positive effects on health behaviours may be long-lasting. One study showed that if personalised health advice was provided on the printed receipt when consumers checked out, consumers who received the advice experienced an impact on their healthy eating behaviours for the next 50 weeks (Bedard & Kuhn, 2015). Health information on electronic menus can not only improve consumers' health status by improving their healthy food selection behaviour but also encourage consumers to actively increase their physical activity to maintain health. A study conducted by Restrepo (2017) in the United States showed that after restaurants used menus with calorie information, consumers not only consumed fewer calories per day but also consumed more calories per day.

Although consumers and researchers are optimistic about the positive impact of health information, some studies have pointed out that the presentation of health information alone is not enough for consumers to make wise food choices (Kalaivani et al., 2021; Ratilla et al., 2022). This is because consumers' health behaviours are not only affected by health information but also by other factors, such as the price and taste of food, as well as consumers' health literacy and personal preferences (Lassen et al., 2014; Ratilla et al., 2022).

Some scholars also pointed out that the reason why health labels on menus fail to play an ideal role may be because the information displayed on the labels is too complex or unattractive (Kalaivani et al., 2021). Therefore, in addition to the health labels on electronic menus affecting consumers' health behaviours, the design of the menu is also one of the important factors that affect consumers' health behaviours. Some researchers have found that improving the attractiveness, operability, and visibility of healthy food options on electronic menus increases the likelihood of consumers choosing healthy foods (Ratilla et al., 2022). In addition to the content and display form of information directly related to health on electronic menus that can have an impact on consumers' health behaviours, the promotional content on electronic menus also has the effect of improving consumers' health behaviours. For example, the position of healthy food promotion information on electronic menus has a significant role in improving consumers' behaviour of choosing healthy foods (Reinholdsson et al., 2023).

In addition to the health information on electronic menus or labels that can provide reference for restaurant consumers when making purchasing decisions, online reviews from social media are also an important reference source for consumption. For example, information about the ingredients of dishes in restaurants, information about the types of food, and the specific taste of dishes on Yelp can promote consumers' healthy eating behaviours (Ariyasriwatana et al., 2014). However, social media may also have a negative impact on consumers' health behaviours because it becomes a marketing tool for restaurants' unhealthy foods. For example, exposure of unhealthy diets and persuasive advertisements on social media have a negative impact on adolescents' food choice behaviours (Ares et al., 2022). In addition to the fact that the promotional information provided by merchants on social media may undermine consumers' healthy behaviours, the sharing of meals between consumers through social media may also lead to the same results. Compared with health information, consumers are more likely to share the taste and appearance of food on social media (Ariyasriwatana et al., 2014). The sharing and recommendation of fast food among consumers, as well as the eWOM of fast food on social media platforms, will affect consumers' fast food intake patterns, and fast food has been shown to be one of the causes of many health problems (Ali-Alsaadi et al., 2023). In addition, with the development of technology, some food ordering software attempts to introduce virtual service and influence consumer behaviour through the persuasion of virtual customer service. The persuasion strategy of virtual images with aspirational appeal in the

food ordering system can influence consumers' choice of healthy food, and a beauty-oriented persuasion focus is more effective than a health-oriented persuasion focus (Hao et al., 2024).

Mental, Physical and Social Health

The World Health Organization pointed out that an individual's mental health, physical health and social health are three important components of health (The World Health Organization, 1946). Considering that mental health is a multidimensional concept, it includes emotional health, emotional health and cognitive health. Therefore, when coding, the authors referred to previous studies to identify factors associated with consumer mental health from multiple dimensions (Galderisi et al., 2015; Jia et al., 2024). However, during the coding process, it was found that the number of articles related to the mental health of restaurant consumers in the included articles was limited, and it was difficult to fully cover all dimensions of mental health. These articles only focus on consumers' emotional health or affective health, and they are not the core topics of these articles, but rather marginal ones.

Previous studies have explored the sources and processes of the impact on consumers' mental health and the sources and processes of the impact on consumers' health behaviours. Most previous research has primarily focused on the impact of information presented on restaurant technology devices or facilities when exploring consumers' health behaviours. In contrast, when exploring the impact of restaurant technology on consumers' mental health, previous studies have focused more on non-information factors of restaurant technology devices.

Among the 52 articles obtained, only one explored the positive impact of information presented on social media on consumer emotions (Ruiz-Mafe et al., 2020). Most articles, however, ffocus on the impact of the non-information instrumentality of restaurant technology devices on consumers' mental health. For example, the operability of the basic functions, entertainment functions and personalized customization functions of the ordering system based on interactive restaurant self-service technology can significantly enhance consumers' positive emotional responses (Ahn & Seo, 2018; X. Leung et al., 2021). Restaurant technology can also enhance consumers' positive emotions by stimulating their visual senses. For example, Torrico et al. (2020) used virtual reality technology to provide consumers with a virtual dining background and found that whether it is a bright virtual environment or a dark virtual environment, it will cause changes in consumers' mental status. However, not all visual cues presented by technology devices can have a significant impact on consumers' emotional responses. For example, the appearance of interactive self-service devices in restaurants has been found in some studies to be unable to significantly enhance consumers' emotional responses. Positive emotions (Ahn & Seo, 2018). Service robots have outstanding performance in improving consumers' mental health. Under appropriate circumstances, service robots' language style, service capabilities and appearance characteristics can have a positive impact on consumers' emotional health (C. Chen & Girish, 2023; Lu et al., 2021; Park et al., 2024; Peng et al., 2024). However, some studies have pointed out that due to the uncanny valley effect, some anthropomorphic features will have a negative impact on consumers' emotional health, but when robot services perform outstandingly, consumers can still have positive emotional experiences (Park et al., 2024).

There are only three articles related to consumers' physical health, the fewest among all health categories, and two of them involve technologies that do not provide direct catering services to consumers. Restaurant management systems, including their complaint management systems and adaptive inspection systems based on big data, can reduce the occurrence of foodborne diseases by monitoring and predicting

the safety of restaurant food, thereby reducing the chances of consumers' health being harmed (T. Kim et al., 2022; Sadilek et al., 2017). This big data-based restaurant food safety management system has a significant effect on detecting foodborne outbreaks caused by pathogens with short incubation periods (T. Kim et al., 2022). In addition, technologies that provide direct catering services to consumers can also have an impact on consumers' physical health, but not directly. Dai et al. (2022) pointed out that the nutritional level of food available through the online ordering and delivery system is low, and this ordering method is popular with consumers because it provides convenience for consumers. However, this also leads consumers who order restaurant food through online ordering to face physical health problems such as weight gain and gastrointestinal discomfort.

Social health includes five aspects, namely social integration, social acceptance, social contribution, social actualization, and social coherence (Keyes, 1998). This study identified two types of social health: social integration and social contribution. Social integration refers to individuals' judgment of the quality of the relationship between them and the surrounding social individuals or groups. Social contribution refers to an individual's judgment of his own social value. The interaction between service robots and consumers in restaurants can enhance individuals' perceived social integration. For example, when a family with children goes to a robot restaurant to dine and interact with the robot, the sense of connection between family members of consumers is deepened (Peng et al., 2024). The interaction process between service robots and guests can also make guests feel that they have received social support, thereby enhancing their perceived social integration (Jiao et al., 2024). Social media also provides opportunities for restaurant consumers to improve their social integration. When consumers communicate about their dining experience in a restaurant on social media platforms, if they perceive that the interaction process is fair and they are understood, then the level of social integration perceived by consumers is higher (Wei et al., 2022). In addition, social media can also affect consumers' social contribution. When consumers are exposed to promotional content on restaurants' social media platforms that advocate reducing food waste, their sense of social responsibility will be positively affected, and they will be more willing to improve their social value by practising behaviours that resist food waste (Ong et al., 2023).

Health Literacy

The number of articles related to health literacy is only 7, but this study still describes it as a separate part. This is because, in addition to these 7 articles, many other articles did not focus on how consumer health literacy is affected, but they pointed out the importance of health literacy (Ariyasriwatana et al., 2014; Dai et al., 2022; Finkelstein et al., 2011; Liu et al., 2015). Health literacy refers to an individual's ability to acquire and internalise health-related information and services, as well as externalise health knowledge into healthy decisions and behaviours (Santana et al., 2021). Research related to health literacy has focused on the information presented by restaurant technology. For example, R. Chen et al. (2015) pointed out that although the calorie information on the menu did not significantly change consumers' behaviour of making healthy choices based on the information, calorie labels significantly improved restaurant consumers' knowledge of food calorie information and health consciousness. The presentation form of information on social media can affect consumers' ability to identify health risk information, that is, it improves individuals' ability to process information, and therefore can also improve consumers' health literacy (Ray & Merle, 2021). The experience of using online food delivery systems will also have an impact on consumers' food safety and health knowledge, however, this impact may be negative.

Because when they rely too much on prompts from the delivery system to make decisions, their ability to externalise food safety knowledge will be weakened (Mulyanto et al., 2023).

Other factors

These studies suggest that consumers' personal characteristics play an important moderating role in the impact of restaurant technology on health. Firstly, there are differences in the health needs of consumers with different education levels, which leads to differences in the impact of the health information provided on the menu on their health behaviours. Research shows that consumers with higher levels of education have more positive attitudes towards health labels (Ismail et al., 2023). Secondly, family responsibilities or roles also have a significant impact on consumers' choice of healthy foods based on health information on menus. Research by Doub et al. (2015) found that compared with young people without children, young people who became parents were more likely to make food choices based on health information on electronic menus or mobile ordering tools. This may be because family responsibilities require them to make more efforts for family health, and health information on electronic menus can reduce this effort, so they are more susceptible to the influence of these messages.

Individual health awareness, especially overall health literacy, also has an important impact on the relationship between restaurant technology and consumer health. Studies have shown that consumers with higher health literacy are more likely to use health resources in restaurants, thereby gaining a better health experience (Ariyasriwatana et al., 2014). In contrast, consumers with lower health literacy may fail to make health-friendly decisions because they are not sensitive enough to health information or lack sufficient health knowledge (Liu et al., 2015; Roberto et al., 2013). In addition, socioeconomic status also affects consumers' choices after seeing health information on the menu (Niven et al., 2019). Lastly, personal needs also play a role in the process of restaurant technology affecting consumer health. The types of needs explored in this study include health needs, recognition needs, and information needs (R. Chen et al., 2015; Wei et al., 2022). Individual needs can enhance individuals' identification and externalisation of information related to their needs. For example, when consumers have health needs, they are more likely to make health-promoting decisions based on the information provided by the restaurant (Courtney et al., 2018).

CONCLUSIONS AND IMPLICATIONS

Main findings

This systematic literature review is the first to summarize the impact of technology used in restaurants on consumer health. Unlike previous review articles that focused on restaurant technology, this study focuses on consumers' health. Previous studies have mostly focused on issues related to restaurant management, such as the current status of technology facilities in the catering industry (Kaman et al., 2024; Spence, 2023) and their role in enhancing operational management (Duong et al., 2020). There are few review articles from the perspective of consumers. In addition, this study has expanded the concept of consumer health as much as possible. In addition to incorporating physical health, mental health, and social health proposed by the World Health Organization into the research scope, this study also includes health behaviours and health literacy. This way of expanding the extension of consumer health provides

an opportunity to look at how restaurant technology affects consumer health from a more holistic and comprehensive perspective. In addition, this study used a variety of methods to analyse the obtained literature, such as bibliometric analysis, content analysis, and thematic analysis. This mixed review method can provide the authors with a dynamic perspective to look at the progress and status of this topic.

The results of bibliometrics show that although the number of studies on the impact of restaurant technology on consumer health is increasing, the growth trend is fluctuating and relatively slow. The two time points with large fluctuations both occurred after relatively influential health-related events. The first fluctuation was a leap-forward growth that occurred in 2013. Most of these studies mentioned the provisions of the 2010 Affordable Care Act related to health information labelling on menus (Lassen et al., 2014; Pang & Hammond, 2013; Roberto et al., 2013). The second fluctuation occurred in 2020. After remaining stable for 4 years from 2016 to 2019, it began to show a growth trend in 2020. Existing studies have pointed out that the number of consumer health-related studies in other hospitality industries also experienced similar fluctuations around 2020, and it is speculated that this may be caused by sudden public health events (Jia et al., 2024). Based on this, the authors speculate that the increase in the number of studies related to restaurant consumer health in 2020 is due to COVID-19 accelerating the use of technology in restaurants and raising people's health awareness.

The cluster analysis of keywords in this study clearly shows the focus of restaurant technology on consumer health. The results of word frequency co-occurrence indicate that all four clusters involve health-related information, such as food labelling, calorie labelling, and nutrition information. This indicates that in the existing research on the impact of restaurant technology on consumer health, researchers mainly focus on the impact of information presented on restaurant technology facilities on consumer health. This may be because the research hotspots change with the emergence and development of new phenomena. Information technology is the earliest and most widely used technology in restaurants (Doran, 2010), so the impact of information technology on consumer health is both the earliest and most concerning.

In addition, this study also analysed the subject areas that focus on this topic. The results show that the impact of technology on the health of restaurant consumers is a topic of common concern among multiple disciplines, and the subject area that has made the main contribution to this topic is the public health field of medicine. The results in Figure 5 show that in the early years of this topic, researchers tended to use quantitative methods to study the impact of restaurant technology on consumer health without theoretical support. The authors sorted out the disciplines of the journals corresponding to these articles and found that quantitative research articles without theoretical basis were mainly published in publications in the fields of public health, medicine, food science, and engineering technology. They mostly belong to the categories of applied science or natural science. Articles with a theoretical basis are mostly published in publications in the category of social science. With the increasing attention paid to consumer health in the field of social sciences, especially in the fields of management and marketing, the number of articles with theoretical basis has shown a clear growth trend in recent years.

Finally, the thematic analysis further comprehensively shows the specific situation of the impact of restaurant technology on consumer health in existing research, including the types of restaurant technology and the types of consumer health. The results of the theme analysis show that the types of technology that have an impact on consumer health in existing research mainly include six categories: electronic menus or labels, ordering or delivery systems, social media, restaurant data management systems, virtual reality, and service robots. The content related to consumer health that researchers focus on includes consumer health behaviour, mental health, physical health, social health, and health literacy. After completing the theme classification from two perspectives, the authors produced Figure 6 and explained in detail how

each type of technology affects consumer health and which type of health is affected in existing research. These findings not only help researchers identify gaps in existing research but also provide suggestions for restaurant managers to guide them to improve consumers' health experiences.

Future research suggestions

After analysing existing research on the impact of restaurant technology on consumer health from multiple perspectives, this study proposes suggestions for future research from the perspectives of the overall theme, research topics, and research methods. Overall, the impact of restaurant technology on consumer health from the perspective of social sciences is still a topic worth exploring. Although this study obtained a total of 52 articles, a considerable number of them, especially those in the field of social sciences, did not take consumer health as the main central theme, but addressed it as a marginal topic. This shows that in the field of social sciences, research topics related to consumer health are still an area to be developed. Therefore, researchers need to conduct in-depth discussions on the possible impacts on the health of restaurant consumers in a qualitative research method, so as to provide a theoretical basis for future quantitative research.

In addition to showing the specific distribution of existing research topics, Figure 6 also indicates which topics still have research gaps. For example, Figure 6 indicates that researchers have verified that electronic menus or labels have an impact on consumer health behaviour and health literacy, but have ignored the impact of electronic menus or labels on consumers' physical health, mental health, and social health. In addition, there are some other research gaps, such as the relationship between ordering or delivery system and consumer social health, the relationship between social media and physical health, the relationship between virtual reality and other health factors besides mental health, the relationship between the restaurant management system and other health factors besides physical health, and the relationship between service robot and health behaviour, health literacy, and physical health are all topics that need to be explored.

In addition, among the articles included in this study, most of the articles focus on the positive impact of technology on consumer health, and only a few studies point out the negative impact of technology on consumer health (Ares et al., 2022; Dai et al., 2022; Park et al., 2024). Therefore, future research can also continue to improve this research topic by focusing on the negative impact of restaurant technology on consumer health. Researchers can try to explore the negative impacts of technology on consumers' health from multiple perspectives. In addition to examining the negative health effects of technological devices directly on consumers during the interaction process, researchers can also investigate how some technical drawbacks of technological devices indirectly, invisibly, or persistently affect consumers' health. For example, if consumers' information is leaked by technological devices in a restaurant, will it have a psychological impact on them, leading to lasting psychological disorders? As pointed out in many studies, some technological devices can rely on big data to make reasonable dining recommendations to consumers. Whether algorithmic bias will further damage consumers' health through the mismatch between dining recommendations and consumers' health status is also a topic worthy of in-depth discussion.

When conducting thematic analysis, the researchers also sorted out the countries where the was conducted, as shown in Figure 6. Future research can also explore research gaps from a regional perspective. Figure 6 shows that except for the United States, other countries do not cover all types of consumer health factors. Taking China as an example, although existing research has focused on the impact of restaurant technology on consumer health behaviours, physical health, mental health, and social health, it

has not focused on the impact on health literacy. Therefore, researchers who focus on Chinese restaurant technology and consumer health might consider exploring how restaurant technology impacts consumer health literacy.

Finally, specific suggestions are made on research methods. Most of the existing quantitative studies related to this topic are cross-sectional studies, and although some topics have received attention in the early stage, they lack continuous follow-up and attention in the later stage. Some researchers who focus on this topic also pointed out that it is necessary to conduct dynamic observations on the impact of technology on consumer health through longitudinal studies (Hao et al., 2024; T. Kim et al., 2022; Kumar & Shah, 2021; Peng et al., 2024). Longitudinal studies not only allow researchers to observe the duration of the impact of technology in restaurants on consumer health, but also allow researchers to continuously observe the dynamic changes in the relationship between restaurant technology and consumer health. With the development of science and technology, the types and functions of technology are gradually enriched, and consumers' usage experience and adaptability have changed. Therefore, the impact of technology on consumers is also changing. In order to confirm the explanatory power of the research conclusions in the current context, the relationship between variables should be tested through longitudinal research.

Theoretical and practical implications

The theoretical implications of this study are mainly reflected in three aspects. First, this study sorted out and summarised previous studies on the impact of restaurant technology on consumer health, providing researchers who are concerned about the health of restaurant consumers with a holistic perspective on this topic. Second, this study classified previous studies according to restaurant technology type and consumer health type. This classification method can show the specific impact of different types of technology on consumer health in more detail, and can specifically show the status of research topics under this research topic. This study also sorted out, analysed and explained the reasons for the different impacts of different types of technology based on the conclusions of existing research. It provides evidence to support the gaps in existing research identified in this study.

In addition, through the classification of topics, this study also emphasises the multiple dimensions of consumer health, which enhances researchers' understanding of consumer health. Finally, this study summarises the research gaps in existing research based on the results of collation, summary and analysis and puts forward specific future research suggestions based on these gaps. Researchers can continue to explore the relationship between restaurant technology and consumer health based on these suggestions to enrich this research topic.

The summary of the conclusions from various studies on the impact of restaurant technology on consumer health can provide practical suggestions for restaurant consumers, restaurant practitioners, and suppliers of restaurant technology facilities. First, this article emphasises the importance of health to consumers and the importance of maintaining consumers' healthy experience in restaurants. Therefore, in order to enhance consumers' healthy experience, increase consumers' satisfaction and loyalty to restaurants, and contribute to the sustainable development of restaurants and even society, restaurant stakeholders should enhance the positive impact of restaurant technology on consumer health from multiple perspectives.

First, restaurant consumers should enhance their understanding of their own health status and improve their health literacy. Consumers who know they have health problems are more likely to improve their health status through the health information provided by restaurant technology. For example, obese people are more likely to notice the calorie information and impact information on the menu (Goodman et al., 2018). Therefore, when consumers can accurately grasp their health status and know what health problems they have, they are more likely to pay attention to and actively use the information related to their health problems in the restaurant. In addition to being more likely to notice health-related information, consumers with high levels of health literacy can also use this information more reasonably and effectively, thereby enhancing the positive effects of this information on health (Ismail et al., 2023).

Secondly, restaurant practitioners should make reasonable use of technological facilities and devices in restaurants to enhance consumers' health experience. Managers can place health-related information in noticeable places on electronic menus, or set up recommended food packages for consumers with different health conditions in electronic menus because some studies have shown that consumers prefer options that can reduce their cognitive effort (Doub et al., 2015). By increasing the visibility of health information and the accessibility and operability of healthy food options, consumers' effort expectations can be reduced, thereby increasing the possibility of consumers using this health information and choosing healthy packages. In addition to the health information provided on electronic menus and ordering systems that can affect consumer health, health information on social media also has a similar effect. Information on social media can provide a reference for predicting the outbreak of foodborne diseases. The rational use of information on social media can reduce the probability of consumers suffering from foodborne diseases and improve restaurant food safety. Therefore, restaurant managers should also strengthen the management of health information posted on social media and manage and prevent food safety issues through data management systems. Finally, the health literacy of restaurant staff should be enhanced so that restaurant staff can assist consumers in making correct health decisions.

It is worth noting that it is not difficult for restaurant managers to improve consumers' health experiences through technology. The practical suggestions mentioned above, such as changing the order of dishes on electronic menus and providing more health information on social media, are easy to implement for both large and small restaurants, as they do not require complex technology or high-cost technological devices. However, these small changes made by restaurants to benefit consumer health can have lasting health effects on large groups of consumers. Therefore, this study suggests that restaurant managers can actively use existing technological means and platforms to improve the overall health of customers while also enhancing the restaurant's social responsibility and brand loyalty, ultimately achieving a mutually beneficial outcome for multiple stakeholders.

Finally, suppliers should strengthen the technologies' ability to identify health-related information in big data. In terms of design, suppliers should improve the aesthetic value of technology facilities and devices, especially service robots. Because existing research shows that health information provided by virtual images that meet consumers' aesthetic requirements is more persuasive (Hao et al., 2024). At the same time, although previous studies have shown that overly anthropomorphic service robots can harm consumers' emotional health (Huang et al., 2021). However, suppliers do not need to worry too much about whether the degree of anthropomorphism of service robots will affect consumers' emotional health. Because some new evidence shows that consumers pay more attention to robot functions, when the functions of service robots meet consumers' expectations, the degree of anthropomorphism of robots can be more conducive to consumers' emotional health (Park et al., 2024).

LIMITATIONS

This study has some limitations that cannot be ignored. First, this study was searched in only two databases, and only English articles published in journals were selected. Therefore, researchers who focus on this topic can expand the search scope and relax the screening rules in the future on the basis of ensuring the quality of the research. Second, this study only focuses on the impact of technology used in restaurants on consumers' health. Restaurants are a complex environment, and there are many factors that may affect consumers. Therefore, in the absence of retrospective studies related to the health of restaurant consumers, researchers can try to review and analyse this issue from a broader perspective. Last, as a review article, although this study has referred to the conclusions of the included studies as fully as possible, it has not made full use of the quantitative data in these studies. Therefore, future studies can try to analyse the data from previous studies in a quantitative way to draw more reliable conclusions.

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