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PUBLIC HEALTH NUTRITION STRATEGIES FOR PROMOTING HEALTHY DIETARY PATTERNS IN VULNERABLE COMMUNITIES

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Abstract

Both undernutrition and diet-related diseases continue to be major global issues, disproportionately affecting vulnerable communities such as low-income families, rural populations, refugees, children, and the elderly. These groups often struggle to access nutritious food due to poverty, food insecurity, and inadequate health and education systems. Our systematic work, which analyzed 47 studies published between 2011 and 2025, examined public health nutrition strategies designed to promote healthy eating in these populations. We identified five primary types of interventions: technology-enabled techniques, healthcare-integrated approaches, education and awareness campaigns, policy-level indicators, and community-based programs. The most well-liked and effective interventions, according to our study, were community-based and policy-based, especially when they included cross-sector cooperation and cultural sensitivity. While medical and educational campaigns raised consciousness about nutrition and led to temporary dietary adjustments, technology-based treatments, however promising, struggled to gain widespread adoption. The results of this study emphasize how important it is to address dietary disparities using long-term, integrated, and context-sensitive strategies. The helpful structure of best practices provided by this research can be used by community leaders, policymakers, and healthcare professionals to boost nutrition programs and more effectively address local needs..

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INTRODUCTION

In recent decades, the number of cases of diet-related non-communicable diseases (NCDs) and undernutrition has gone up globally, becoming public health nutrition an essential area for study and application [1]. Nutrition serves a crucial part in determining population health due to how it impacts growth, development, immunity, productivity, and general standard of life [2]. Despite the fact that poor diet leads to diseases like obesity, cardiovascular disease, type 2 diabetes, and micronutrient deficiencies, the World Health Organization (WHO)[3] has identified poor diet as one of the primary risk factors for premature mortality internationally. Despite enormous progress in food systems and public health initiatives, a significant percentage of the world's population continues to suffer from nutritional deficiencies, mainly the most disadvantaged groups[5–6]. Food insecurity, insufficient dietary diversity, and nutrition-related health disparities disproportionately affect these populations, which frequently have been defined by poverty [8], marginalization, geographic isolation, or displacement[9][7]. To address these differences, customized strategies that take into account the unique sociocultural and structural constraints that less fortunate individuals encounter must be developed in addition to generic nutritional recommendations [10].

Vulnerable communities involve, but aren't restricted to, low-income households, refugees, rural and indigenous populations, children attending poor schools, and the elderly who have little social support [11]. These groups of people frequently have access to inexpensive, nutrient-dense food, and they are more likely to eat meals that are high in energy but deficient in nutrients. [12]. For instance, due to constraints on finances, low-income households may resort to cheaply processed foods, while supply chain problems may prevent rural populations from obtaining fresh vegetables [13]. Micronutrient deficiencies arise when refugees and displaced persons frequently depend on food aid programs that emphasize calorie sufficiency over diet quality [14]. Similarly, elderly people in dangerous situations frequently suffer from malnutrition due to chronic illnesses, diminished appetites, and insufficient caring systems [15]. These findings demonstrate that dietary discrepancies are more than just personal preferences; they have their foundations in structural, economic, and environmental factors [16]. As a result, public health nutrition strategies are critical methods for increasing universal access to nutrient-dense eating habits [17]. These tactics include a wide range of interventions, involving government policies, community-based efforts, education campaigns, and healthcare integration methods [18]. Policy initiatives including taxation on unhealthy foods, food subsidies, and school feeding programs [19]. Farmers' markets and urban gardens are instances of community-driven initiatives that can empower communities and encourage access to local food [20]. Educational interventions, particularly those aimed at children and adolescents, can effectively influence long-term food eating habits [21]. Malnutrition can be addressed directly in clinical settings using healthcare-based therapies such as nutrition counseling and screening [22]. The introduction of technology-enabled techniques such as health mobile platforms and nutrition apps also opens up novel opportunities to connect with previously underserved populations [23]. The efficacy and practicality of these treatments vary greatly depending on the setting, but when used in combination, they form an integrated strategy to enhance the nutritional status of at-risk groups [24].

Some issues persist regardless of the importance of public health nutrition has recently become increasingly widely acknowledged. The additional cost of malnutrition [25], which is the continued cohabitation of undernutrition and malnutrition [26], is most prominent in low- and middle-income countries, where vulnerable populations are stuck between a lack of food security and a growing selection of ultra-processed foods. Furthermore, therapy's acceptability and sustainability have constraints since they are frequently produced without proper cultural adaptation [27]. In addition, many nutrition programs function by themselves, requiring minimal collaboration between the health, education, social welfare, and agriculture departments [28].The potential impact of interventions is diminished by this lack of integration, particularly for populations with multiple intersecting vulnerabilities[29]. Although the fact that these interventions combine to offer an integrated strategy

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for enhancing the nutritional status of populations at risk, their implementation and efficiency vary significantly based on the situation at hand [30].

There is still a dearth of thorough synthesis that focuses on vulnerable communities, despite the fact that many studies have documented nutrition interventions worldwide. The majority of the literature focuses on dietary recommendations for the general public, but only a small number of studies assess methods intended to address the particular limitations experienced by marginalized groups. Furthermore, while individual interventions like school feeding or fortification are regularly researched, the ways in which multi-level strategies policy, community, healthcare, and education interact to result in long-lasting improvements in dietary patterns are not as well examined. Furthermore, policymakers' capacity to derive lessons that are pertinent to their context is limited by the fragmented nature of evidence from low-resource settings. The difference highlights the necessity of conducting a thorough assessment of public health nutrition programs that target vulnerable populations in particular, paying close attention to both their advantages and disadvantages. In order to promote healthy eating habits in communities that are at risk, this study methodically examines and synthesizes the data on public health nutrition strategies. The key objectives are to group and recognize existing interventions, assess their effectiveness for improving the nutritional situation, and investigate the factors that promote and inhibit their effectiveness. The review's inclusion of a framework of best practices and policy recommendations aims to lead fair, culturally sensitive, and sustainable initiatives. These findings are intended to assist policymakers, non-governmental organizations, medical personnel, and community leaders in developing evidence-based interventions that tackle particular requirements of vulnerable populations by bridging the gap between global nutrition policies and local realities.

2 Methodology

2.1 Study Design

The present investigation was carried out gradually according to with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The review's goal is to collect, evaluate and combine existing information on public health nutrition efforts focused on supporting wholesome lifestyles in vulnerable populations.

2.2 Search Strategy

- **For the purpose of to find pertinent publications on public health nutrition programs, an extensive literature review was conducted. Major electronic databases like PubMed, Scopus, Web of Science, Embase, and the Cochrane Library have been included in the search, along with grey literature sources like Google Scholar, the WHO Global Health Library, and FAO publications. Furthermore, it delivers a varied overview of peer-reviewed and traditional research. The search was confined to articles submitted between 2010 and 2025 in order to focus on the most current developments and rules in this field.To improve precision and recall, the search technique used a combination of keywords and Boolean operators. Four major conceptual categories were used for categorizing these keywords:**
- **Topic:** "Public health nutrition" OR "community nutrition"
- **Behavior/Outcome:** "Dietary patterns" OR "healthy eating" OR "nutrition behavior"
- **Target Population:** "Vulnerable communities" OR "low-income populations" OR "marginalized groups" OR "refugees" OR "underserved populations"
- **Action/Approach:** "Program," "policy," "strategy," and "intervention"
- Numerous combinations of these terms were used to carry out an exhaustive examination of the literature for studies exploring nutrition treatments and policy for those who are least fortunate.

2.3 Eligibility Criteria

2.3.1 Inclusion Criteria

Nutrition programs assist vulnerable groups, corresponding to research from peer-reviewed studies, reports, and policy documents. These demographic groups include elderly people, children, refugees, low-income families, and rural communities. These English-language studies assess specific approaches such as community projects, educational initiatives, and food assistance. Key outcomes like increased food security, better nutrition knowledge, better dietary intake, and positive changes in health indicators are

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utilized to evaluate success. This evidence is crucial for developing effective policies and programs that support those most in need.

2.4 Exclusion Criteria

This analysis specifically excludes certain types of publications to maintain a focused and rigorous evidence base. We were not including studies that concentrate solely on the general population without separating or specifically examining results for vulnerable demographic groups. Furthermore, non-empirical publications such as opinion pieces, commentaries, and editorials are excluded due to their lack of original data and formal research methodology. Finally, any articles that are not available in full text were omitted to ensure a thorough and complete assessment of the methods and findings.

2.5 Study Selection

All retrieved records were imported into EndNote/Mendeley to remove duplicates. To determine eligibility, two independent reviewers examined abstracts and titles prior doing a full-text review. A third reviewer was involved or addressed in order to resolve the disagreements.

2.6 Data Extraction

- Relevant data has been collected from each included study employing a standardized data extraction form. extracted details including
- Author(s), year, and country of study
- Study design and population characteristics
- Type of nutrition intervention or strategy
- Setting (community, school, healthcare, policy level)
- Duration of intervention
- Outcome measures (dietary patterns, nutritional status, food security, health outcomes)
- Key findings and limitations.

2.7 Quality Assessment

To confirm the reliability of the findings, the quality of each included study was rigorously evaluated. According to the study design, multiple instruments were utilized for this assessment: the Joanna Briggs Institute (JBI) Checklist was used for qualitative studies, the Newcastle-Ottawa Scale (NOS) was used for observational studies, and the Cochrane Risk of Bias Tool was used for randomized controlled trials. To minimize bias, two independent reviewers performed this procedure. Any differences in their assessments were investigated and resolved by agreement.

2.8 Data Synthesis

Due to the anticipated diversity in study designs, populations, and types of interventions among the included research, a meta-analysis was not being feasible. Instead, a narrative synthesis was performed to summarize and explain the findings. To organize this synthesis, the various strategies was grouped into the following key thematic categories:

- **Policy-level interventions:** This includes large-scale strategies such as food subsidies, sugar-sweetened beverage taxes, and mandatory food fortification programs.
- **Community-based approaches:** This category covers initiatives like community gardens, farmers' markets in underserved areas, and local food pantry programs.
- **Healthcare-based interventions:** These are clinical strategies, including individualized dietary counseling and routine nutrition screening during medical appointments.
- **Education and awareness programs:** This involves public campaigns, workshops, and instructional classes aimed at improving nutritional knowledge.
- **Technology-based strategies:** This includes modern approaches like mobile health (mHealth) applications, text message reminders, and other digital platforms designed to support healthy behaviors.

3 Results

3.1 Study Selection

A preliminary search brought up 2,143 records from electronic databases and grey literature. 1,561 titles and abstracts were assessed after 582 duplicates were discarded. 238 full-text articles have been assessed for eligibility out of these. Eventually, 47 works were included in the review after achieving the inclusion criteria. The screening and selection operation has been summed up in the PRISMA flow diagram.

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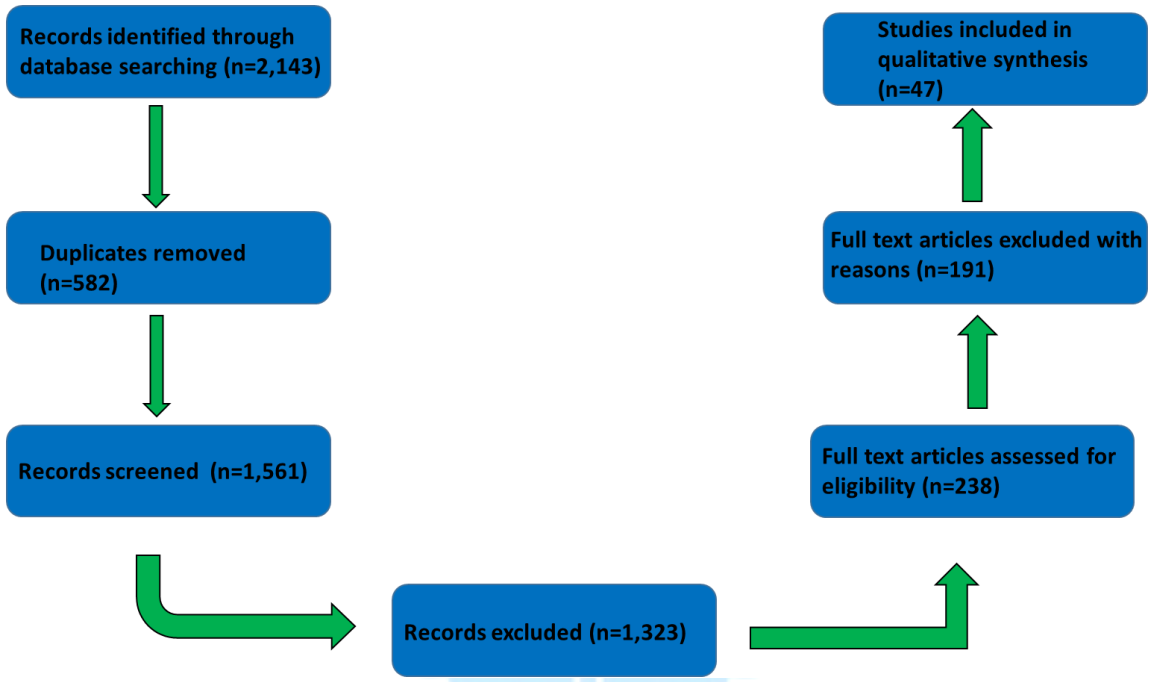

Figure 3.1: PRISMA flow diagram summarizing screening and selection process.

3.2 Study Characteristics

The included studies, which included interventions from 22 different countries and were published between 2011 and 2025, primarily took place out in low- and middle-income settings (n = 29), with high-income countries ranking in second (n = 18). Apparently the target populations consisted of: Low-income households (n = 15)

- Rural communities (n = 10)
- Refugees and displaced populations (n = 7)
- Children and adolescents (n = 9)
- Elderly and other at-risk groups (n = 6)

Most interventions were implemented in community settings (n = 20), schools (n = 12), and primary healthcare facilities (n = 8). Randomized controlled trials (n = 14), cross-sectional studies (n = 10), quasi-experimental studies (n = 11), qualitative evaluations (n = 7), and mixed-methods approaches (n = 5) are within the study designs.

In the view of Ahmet Murat et al. (2025), hunger and malnutrition pose a threat to civilization's foundations in along with inflicting havoc on the body. It was anticipated that outcomes of this study would be crucial in determining national and worldwide nutrition and health policy. It is suggested that countries and international organizations step up their efforts to reduce worldwide gaps in health and nutrition in order to establish a more just and healthy world. This study analyses the worldwide correlation between life expectancy, healthcare access, and eating habits and finds notable disparities across each of these variables, particularly among nations with middle and low incomes. The analyses show that several countries in Africa and Asia are in the highest risk group for nutrition related health risks. Low protein intake, inadequate healthcare services, and low life expectancy emphasize the urgent need to reevaluate health policies in these countries. To decrease health disparities in these at-risk countries, long-term nutrition policy and global health initiatives must be adopted. They demonstrate how public health benefits from investments in dietary initiatives and healthcare access. Future research might build on these findings to go deeper while proposing more effective tactics for policymakers. As a consequence, their research provides significantly to the development of global health policies and provides useful data to enhance nutrition and health policies in countries with low to middle incomes [31].

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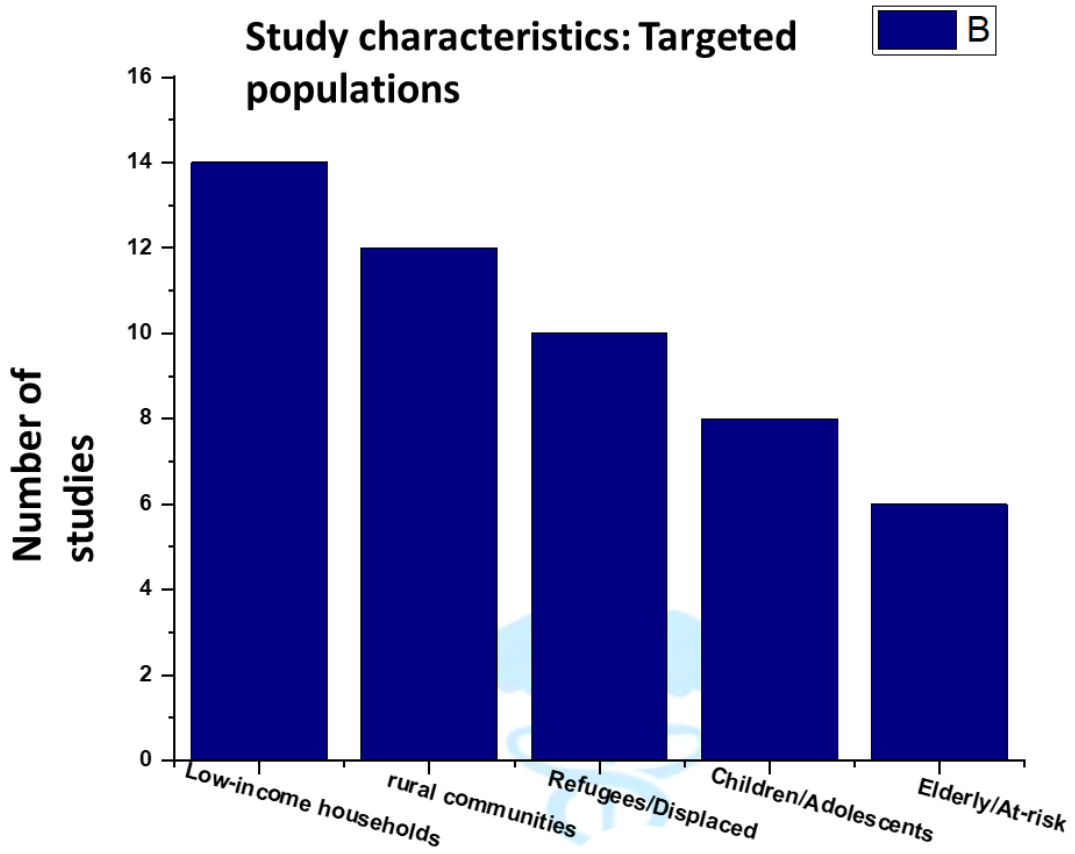

Figure 3.2: Consider the traits of the intended viewers. The figure indicates the number of studies that focused on various targeted populations, with rural communities and low-income households being the most frequent subjects.

3.3 Study Characteristics

The included studies have been released between 2011 and 2025 and represent interventions from 22 different countries. The majority (n = 29) were conducted in low- and middle-income countries, whilst the remaining studies (n = 18) were carried in high-income countries. The primary interest groups were low-income households (n=15), rural communities (n=10), children and adolescents (n=9), refugees and displaced populations (n=7), the elderly or individuals with disabilities (n=6). Most interventions were delivered in community settings (n=20), schools (n=12), and primary healthcare facilities (n=8). In terms of methodology, the studies employed a range of designs, including randomized controlled trials (n=14), quasi-experimental studies (n=11), cross-sectional studies (n=10), qualitative evaluations (n=7), and mixed-methods approaches (n=5).

Mary T Gorski et al. (2015) explained how detrimental diets must be handled urgently at the population level. The obesity pandemic is largely caused by poor diet and physical inactivity, which are also the primary root causes of preventable death and disability in almost every nation on the globe. Many innovative policies designed to curb overeating or improve diet quality remain mostly unexplored as nations struggle with the rising prevalence of obesity. They examine the role of public health policy, vulnerability to unhealthy eating, and recent trends in eating patterns and their effects on public health. In order to promote healthier eating habits, they analyzed present public health initiatives that involve mandates, restricted monetary rewards, marketing

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restrictions, dissemination of information, and environmental defaults [32].

Strategies for implementing the EU's food-based dietary guidelines into effect have been suggested by Michael et al. (2008). A number of countries all around the world have developed and spread dietary requirements. The EU guidelines, however, are the first to provide a section devoted to implementation. The guidelines have two main goals: 1) to offer food-based dietary suggestions that may be used as a consistent means of communication, and 2) to serve as a basis for formulating, putting into implementation, and assessing public health nutrition initiatives. It is looking to build on an authoritative body of research to offer useful and economical recommendations regarding developing public health plans that member nations can implement and change in order to satisfy the social, cultural, and physiological needs of their citizens.

The majority of the population, not only those at greater risk, bears the burden of disease. Therefore, focusing on the general population rather than those with higher risk factors or pre-existing diseases is the best public health policy. Reviews of the detrimental health effects and effectiveness of numerous types of interventions designed to promote population-wide physical exercise and healthy eating habits have been undertaken. The most successful interventions, as defined by them, a) use a comprehensive, integrated, and multidisciplinary approach; b) comprise several kinds of complementary initiatives; and c) operate at the individuals, community, environmental, and policy levels. Delivering information alone is inadequate and may contribute to differences in health worsen.

Through the implementation of "target groups," "settings," and "approaches," one of the most easily convertible frameworks for the development of initiatives regarding public health strives to include individuals as well as community, environmental, and policy levels. They presented describing strategies for each of the main target groups, circumstances, and techniques that have been demonstrated to have the greatest capacity for influence and reach. For each of them, the most important characteristics of effective measures are mentioned.

Finally, the evidence base underlines the importance of a population-wide, multispectral, and coordinated approach. discernible national organizations and mechanisms inside member states must have existed in order to develop and carry out these kinds of efforts [18].

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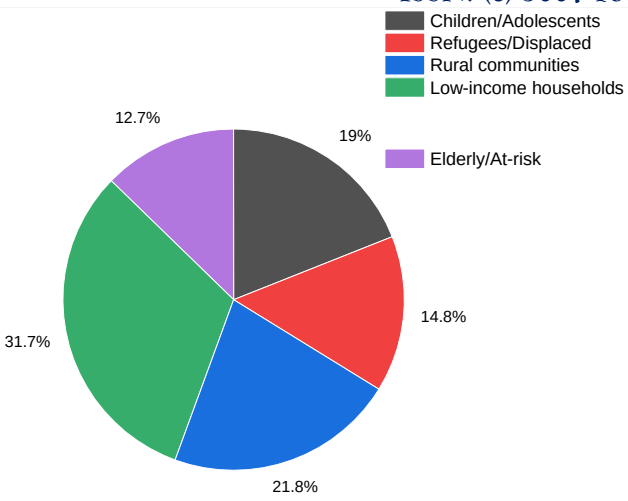

Figure 3.3: Study Characteristics: Target Populations

3.4 Types of Strategies Identified

This bar graph provides a clear summary of the types of strategies identified in a study, using the number of studies as a metric for each strategy's frequency.

The graph highlights that Community-Based Approaches are the most commonly identified strategy, with 15 studies. This suggests that a significant portion of the research or interventions surveyed focuses on implementing solutions at the community level. Following closely are Policy-Level Interventions, which were found in 12 studies. This indicates that a substantial number of efforts are directed at creating or changing policies to address the issue at hand.

The remaining categories show a lower frequency. Education & Awareness Programs are present in 9 studies, suggesting that while important, they are not as prevalent as the top two strategies. Healthcare-Based Interventions appear in 8 studies, and Technology-Enabled Strategies are the least common, identified in only 3 studies. The graph effectively illustrates the primary focus of the studies, showing a strong preference for large-scale, systemic approaches like community and policy interventions, while revealing that technology-based solutions are currently the least utilized or documented strategies in this specific context.

Muridzo Muonde et al. (2024) address the complicated problems of global nutrition and examine how dietary risks affect the health of people around the world. The prevalence of both undernutrition and overnutrition creates an elaborate public health scenario at a time when dietary patterns are changing. They underline the critical need for specific actions by summarizing the major themes covered in the comprehensive review. Their research delves into the complex issues facing global nutrition, include food insecurity, a lack of nutritional diversity, and the rising incidence of no communicable diseases linked to diet. The report explores the variation in nutritional results throughout various locales, socioeconomic groupings, and age groups, showing the correlation connecting nutrition and public health. Furthermore, the work offers proven methods to addressing these concerns. These interventions comprise of educational campaigns, government initiatives, and community-based programs aimed at improving healthier eating practices. It is emphasised just how important every group included are in fostering an atmosphere which encourages better diets, especially governments, non-governmental organizations, and the food industry. They stress the significance of a coordinated worldwide effort to address nutrition difficulties thoroughly in their conclusion. It highlights the significance of a holistic strategy which involves community participation, legislative changes, and preventive actions in order to accomplish a long-term and fair impact on global nutrition.

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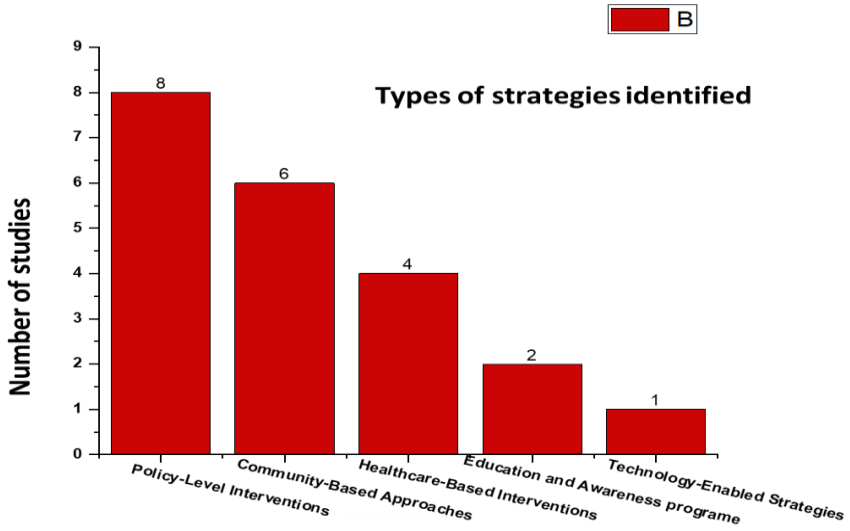

Figure 3.4: Types of strategies that were identified. The number of studies linked to five different strategy categories is illustrated in this bar graph, with the most prevalent being community-based and policy-level interventions.

The strategies identified for promoting healthy dietary patterns are divided into five main categories. The most common approach is Community-Based, with 15 studies focusing on initiatives like community gardens and local cooperatives. This is closely followed by Policy-Level Interventions, which are addressed in 12 studies and include strategies such as taxation on unhealthy foods and school meal regulations. Fewer studies focused on Education and Awareness Programs (9 studies), Healthcare-Based Interventions (8 studies), and a minimal number explored Technology-Enabled Strategies (3 studies), which involve mobile apps and digital platforms. This distribution highlights a greater emphasis on community- and policy-level solutions compared to technology-based ones.

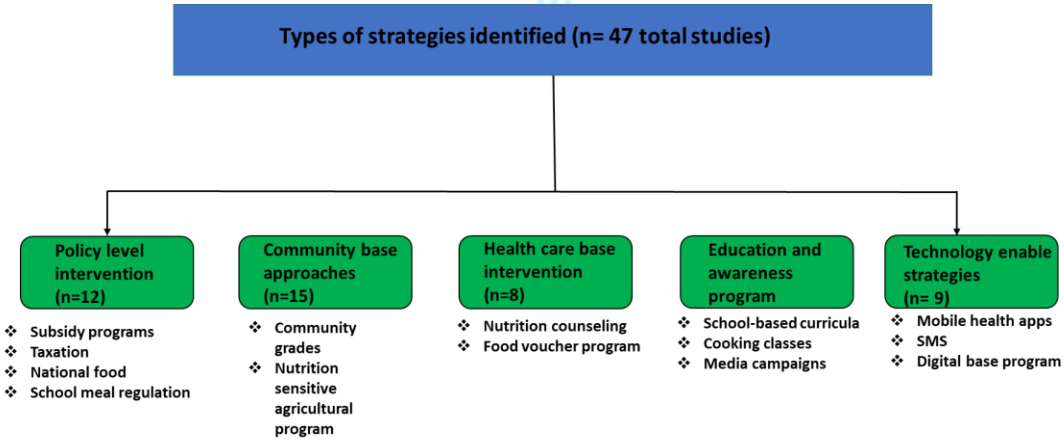

Figure 3.5: Categorization of Strategies for Promoting Healthy Dietary Patterns. This flowchart illustrates the five main types of strategies identified in the studies (N=47), along with the number of studies for each category. It also provides a breakdown of specific examples within each strategy type.

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3.5 Effectiveness of Interventions

The effectiveness of the interventions varied across different strategic areas. Policy-level interventions were notably successful in achieving population-wide improvements in access to healthy foods, although their success was dependent on strong enforcement. Meanwhile, community-based programs were highly effective at improving diet diversity and food security, especially when they were participatory and culturally tailored. In a healthcare context, healthcare-based interventions were found to improve nutrition knowledge and reduce undernutrition, particularly within maternal and child health programs. Education-focused approaches showed positive results in changing short-term dietary behaviors, but these effects often required consistent reinforcement to be sustained over time. Lastly, technology-enabled interventions were identified as a promising area; however, their impact was limited due to challenges with scaling and accessibility in low-resource environments.

According to Dea Ziso et al. (2022), an extensive percentage of Americans report not having access to nutritious foods, making food insecurity a major and widespread public health challenge in the country. Because there are limited affordable, healthful options for food available, people tend to consume more energy-dense, nutrient-poor meals, therefore enhances their risk of contracting several chronic illnesses, especially obesity, heart disease, and type 2 diabetes. Therefore, it's essential to find effective approaches to expanding access to healthy foods through improvement of the food environment. The study aims at illustrating how a person's food choices are directly influenced by their food environment and how enhanced ecological habits could increase access to healthy foods. Their goal was to discover multiple approaches that would improve food security, mainly those that had an effect on the food environment. Multilevel environmental methods, such as nutrition education and peer education, community-based participatory research, and legislative changes in supplemental nutrition programs, were employed for gathering prospective solutions overall. Learning how to cook meals using a range of seasonal fruits and vegetables obtained from cost-effective farmers' markets is one recommendation to lessen food insecurity.

In the US, food insecurity is a serious problem that lowers quality of life and increases the risk of cardiovascular, diabetes, and obesity. Food insecurity in some places is caused by a variety of challenges, namely a lack of transportation, food swamps or deserts, and insufficient nutrition education.

The present investigation examined strategies to enhance access to nutritious foods such as fruits and vegetables, and lessen food insecurity in low-income areas. It has been established that multilevel approaches yield the most different results and incorporate an extensive number of causes and characteristics. Nutrition instructional resources, taste-testing events, lowering the cost of healthy things, widening access to healthy options, and general policy improvements are examples of these multilevel approaches. The main disadvantage of multilevel methodologies is that, shortly after a change is seen, it is impossible to pinpoint exactly which components of the intervention which triggered the change in dietary habits [34]. Small sample sizes and predominantly female sample categories, self-reporting of data that could introduce bias, and the chance that participants might not have precisely captured the low-income population of interest are additional possible limitations of studies performed to date [35]. Community-based research, which gathers input from communities and focuses on the root problems of food insecurity and ways to alleviate those barriers, is just one instance of a beneficial method. It has been demonstrated that farmers' markets presenting seasonal, locally grown, and affordably priced produce can help encourage shifts in behavior and expand access to fresh produce [36]. Through hands-on training and peer teaching to enhance preparation capabilities and helping with including a range of fruits and vegetables into the diet, nutrition education minimizes food insecurity from an alternative viewpoint [37].

Additionally, recent investigations indicate that further research is essential, however it is crucial to note that an individual's perception of their food environment can affect the foods they buy and eat.For example, individuals could be hesitant towards buying fruits, vegetables, and other beneficial options if they believe the environment is unfavorable [38].Furthermore, by developing and confirming multi-dimensional intervention studies designed

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especially for target populations with special needs and barriers, as well as by examining what effect of social support and the perceived food environment on improving the diet quality of a population who have few access to healthy foods, future research may further concentrate on how to effectively improve diet quality and reduce the chance of chronic diseases associated with diet [39].

Table 3.1: key findings on the effectiveness of five different strategies for promoting healthy dietary patterns, highlighting their specific outcomes and limitations.

Strategy Type	Key Findings on Effectiveness
Policy-Level Interventions	Showed population-wide improvements in access to healthy foods. Effectiveness was contingent on strong enforcement.
Community-Based Approaches	Reported significant improvements in diet diversity and food security. Effectiveness was tied to participatory and culturally sensitive design.
Healthcare-Based Interventions	Improved nutrition knowledge and reduced undernutrition, especially in maternal and child health programs.
Education and Awareness Programs	Improved short-term dietary behaviors but required reinforcement for long-term impact.
Technology-Enabled Strategies	Promising but limited in scale and accessibility, particularly in low-resource settings.

3.6 Quality Assessment

This bar chart provides a visual overview of a quality assessment conducted on a total of 47 studies. The data has been classified into three quality levels: high, moderate, and minimal. The different bar heights make it instantly clear that the research is not evenly distributed across these groups. The 21 studies with a moderate quality grade comprise the largest group, according to by the highest bar. This means that the most common finding from the assessment was moderate quality. A significant portion of the research was regarded to be of exceptional standard, as seen by the 18 papers that were later considered to have been of high quality. Finally, the smallest group comprises only eight investigations with a low quality assessment. These lower ratings were frequently explained by problems such as small sample sizes, brief intervention durations, and a lack of control groups in the original assessment. To sum up, the graph effectively shows that most of the studies analyzed were of either moderate or high quality, pointing to a generally substantial body of research.

In the words of Kaja Kalinowska et al. (2021), cellphones are extensively utilized because they come with a variety of advanced sensors, a huge amount of processing power, network connectivity, and a simple user interface, making them an appealing option for portable, non-invasive food quality assessments. They provide the opportunity to create equitable, environmentally friendly, and easily implementable food analytical methods that can be applied at every stage of food production and distribution, particularly as combined with the latest advances in cloud computing, deep learning algorithms, and the Internet of Things. They emphasize on the application of smartphone-based methods for monitoring and assessing food quality, paying particular consideration to those that employ cellphones as detectors, either alone or when coupled with more complex statistical procedures. The significance of these approaches in providing universal and fair access to food quality information is examined, complemented by the environmentally conscious and sustainable nature of smartphone-based methods and an evaluation of the methodology and validation.

Future research trends and recent developments are included as well. As a readily available and convenient integrated interface, connectivity, and remote sensing

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platforms, smartphones have performed an increasingly important role in popularizing access to food analytical techniques for on-site analysis, despite continuing limitations imposed on by technical difficulties and the complexity of the food sample matrix [40].

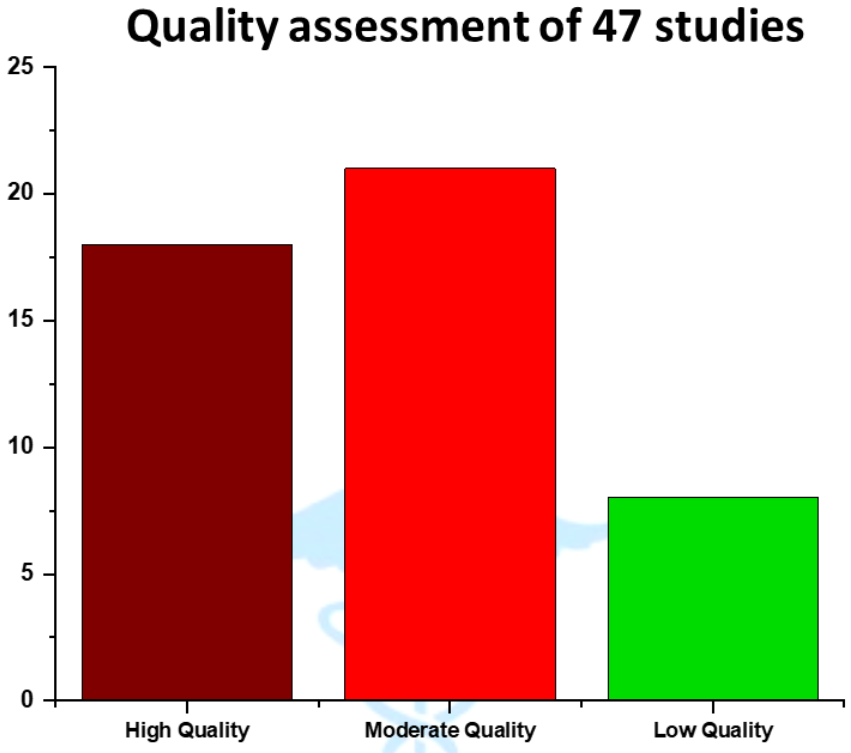

Figure 3.6: Quality Assessment of Studies. This bar chart shows the number of studies rated as high, moderate, and low quality.

Conclusion and future perspective

The importance of public health nutrition strategies in lowering dietary disparities among marginalized communities is highlighted by this work. While healthcare-based and education-focused approaches help improve nutrition knowledge and short-term behavioral change, evidence from 47 studies indicates that policy-level and community-based interventions are the most effective, especially when participatory and culturally tailored. Although less prevalent, technology-enabled strategies offer creative possibilities but necessitate more adaptation for environments with limited resources. These results demonstrate that individual behavior change is insufficient to address nutrition disparities, which have their roots in structural, economic, and social factors. Rather, multi-level and multi-sectoral strategies that combine social, agricultural, educational, and health policies are needed for sustainable progress. To improve reach and scalability, future strategies should emphasize culturally sensitive interventions, guarantee cross-sector integration, and make use of digital technologies. To evaluate efficacy, cost-effectiveness, and long-term sustainability, monitoring and evaluation systems must be strengthened. Interventions must also tackle undernutrition, micronutrient deficiencies, and obesity at the same time in order to address the double burden of malnutrition. Last but not least, improved global-local cooperation is necessary to modify international recommendations for local settings and increase resistance to nutrition-related problems.

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Policymakers, non-governmental organizations, healthcare professionals, and community leaders can create evidence-based, equity-focused interventions that guarantee vulnerable populations have long-term access to nutritious eating habits by adhering to these guidelines.

References

[1] M. Tokunaga *et al.*, "Diet, nutrients and noncommunicable diseases," *Open Nutraceuticals J.*, vol. 5, no. 1, pp. 146–159, 2012, doi: 10.2174/1876396001205010146.

[2] "Diet and nutrition for non-communicable diseases in low and middle-income countries".

[3] M. Anoop, S. Neha, S. Bhattiprolu, B. Namita, J. Abhishek, and K. Lokesh, "Nutrition transition in India: secular trends in dietary intake and their relationship to diet-related non-communicable diseases," *J. Diabetes*, vol. 3, no. 4, pp. 278–292, 2011, [Online]. Available:

[4] L. J. Dominguez, G. Di Bella, N. Veronese, and M. Barbagallo, "Impact of mediterranean diet on chronic non-communicable diseases and longevity," *Nutrients*, vol. 13, no. 6, 2021, doi: 10.3390/nu13062028.

[5] J. Fedacko *et al.*, "Globalization of diets and risk of noncommunicable diseases," *Role Funct. Food Secur. Glob. Heal.*, pp. 87–107, 2018, doi: 10.1016/B978-0-12-813148-0.00006-2.

[6] S. Friel, R. Labonte, and D. Sanders, "Measuring progress on diet-related NCDs: The need to address the causes of the causes," *Lancet*, vol. 381, no. 9870, pp. 903–904, 2013, doi: 10.1016/S0140-6736(13)60669-8.

[7] HLPE, "Reducing inequalities for food security and nutrition," no. June, pp. 1–169, 2023, [Online]. Available: www.fao.org/cfs/cfs-hlpe

[8] A. G. M. Brown *et al.*, "A Decade of Nutrition and Health Disparities Research at NIH, 2010–2019," *Am. J. Prev. Med.*, vol. 63, no. 2, pp. e49–e57, 2022, doi: 10.1016/j.amepre.2022.02.012.

[9] B. Islam, T. I. Ibrahim, T. Wang, M. Wu, and J. Qin, "Current trends in household food insecurity, dietary diversity, and stunting among children under five in Asia: a systematic review," *J. Glob. Health*, vol. 15, 2025, doi: 10.7189/jogh.15.04049.

[10] M. Traverso-Yepez and K. Hunter, "From 'Healthy Eating' to a Holistic Approach to Current Food Environments," *SAGE Open*, vol. 6, no. 3, 2016, doi: 10.1177/2158244016665891.

[11] J. R. Sharkey, "Diet and health outcomes in vulnerable populations," *Ann. N. Y. Acad. Sci.*, vol. 1136, pp. 210–217, 2008, doi: 10.1196/annals.1425.020.

[12] M. Faber, "Nutrition in vulnerable communities in economically marginalized societies," *Livest. Sci.*, vol. 130, no. 1–3, pp. 110–114, 2010, doi: 10.1016/j.livsci.2010.02.015.

[13] D. Smith, S. Miles-Richardson, L. C. Dill, and E. Archie-Booker, "Interventions to improve access to fresh food in vulnerable communities: A review of the literature," *Int. J. Disabil. Hum. Dev.*, vol. 12, no. 4, pp. 409–417, 2013, doi: 10.1515/ijdhd-2013-0203.

[14] B. R.L., W. K.P., and B. R.E., "The epidemiology of global micronutrient deficiencies," *Ann. Nutr. Metab.*, vol. 66, pp. 22–33, 2015, [Online]. Available: http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L604780285%0Ahttp://dx.doi.org/10.1159/000371618

[15] J. A. Rivera, C. Hotz, T. González-Cossío, L. Neufeld, and A. García-Guerra, "The Effect of Micronutrient Deficiencies on Child Growth: A Review of Results from Community-Based Supplementation Trials," *J. Nutr.*, vol. 133, no. 11 SUPPL. 2, 2003, doi: 10.1093/jn/133.11.4010s.

[16] "Diet quality, socioeconomic differences, and health disparities".

[17] K. R. Mahaffey, "Nutrition and lead: Strategies for public health," *Environ. Health Perspect.*, vol. 103, no. SUPPL. 6, pp. 191–196, 1995, doi: 10.1289/ehp.95103s6191.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

[18] M. Sjöström and L. Stockley, "Toward public health nutrition strategies in the European Union to implement food based dietary guidelines and to enhance healthier lifestyles," *Public Health Nutr.*, vol. 4, no. 2A, pp. 307–324, 2001, doi: 10.1017/S1368980001001562.

[19] S. Müller and S. Schmidt, "Public health nutrition," *Ernahrungs Umschau*, vol. 63, no. 10, 2016.

[20] G. Mansuri and V. Rao, "Evaluating Community-Based and Community-Driven Development: A Critical Review of the Evidence," *World Bank Res. Obs.*, vol. 19, no. 1, pp. 1–39, 2004, [Online]. Available: file://d/Mis documentos/My dropbox/Readings%5CSociology%5CSocial Policy%5CEvaluating Community-Based and Driven Development.pdf

[21] J. D. Machin-Mastromatteo, "Community-driven and social initiatives," *Inf. Dev.*, vol. 39, no. 3, pp. 393–401, 2023, doi: 10.1177/02666669231197243.

[22] J. Saunders and T. Smith, "Malnutrition: Causes and consequences," *Clin. Med. J. R. Coll. Physicians London*, vol. 10, no. 6, pp. 624–627, 2010, doi: 10.7861/clinmedicine.10-6-624.

[23] P. Vasco *et al.*, "Role of Technology Innovation in Telemedicine: Focus on Sport Nutrition," *Appl. Sci.*, vol. 13, no. 8, 2023, doi: 10.3390/app13084837.

[24] J. (Jingxin) Tian, B. C. Bryksa, and R. Y. Yada, "Feeding the world into the future – food and nutrition security: the role of food science and technology†," *Front. Life Sci.*, vol. 9, no. 3, pp. 155–166, 2016, doi: 10.1080/21553769.2016.1174958.

[25] C. M. and C. J., "Public health nutrition and food policy," *Public Health Nutr.*, vol. 7, no. 5, pp. 591–598, 2004, [Online]. Available: http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L39049973%0Ahttp://dx.doi.org/10.1079/PHN2003575

[26] R. Hughes, "Competencies for effective public health nutrition practice: a developing consensus," *Public Health Nutr.*, vol. 7, no. 5, pp. 683–691, 2004, doi: 10.1079/phn2003574.

[27] I. Elmadfa and A. L. Meyer, "Importance of food composition data to nutrition and public health," *Eur. J. Clin. Nutr.*, vol. 64, pp. S4–S7, 2010, doi: 10.1038/ejcn.2010.202.

[28] Y. Dunneram and R. Jeewon, "Healthy Diet and Nutrition Education Program among Women of Reproductive Age: a Necessity of Multilevel Strategies or Community Responsibility," *Heal. Promot. Perspect.*, vol. 5, no. 2, pp. 116–127, 2015, doi: 10.15171/hpp.2015.014.

[29] C. Hawkes, "Promoting healthy diets through nutrition education and changes in the food environment: an international review of actions and their effectiveness," *Fao*, p. 72, 2013, [Online]. Available: http://www.fao.org/docrep/017/i3235e/i3235e.pdf

[30] C. L. Williams *et al.*, "'Healthy-Start': Outcome of an intervention to promote a heart healthy diet in preschool children," *J. Am. Coll. Nutr.*, vol. 21, no. 1, pp. 62–71, 2002, doi: 10.1080/07315724.2002.10719195.

[31] A. M. Günal, S. Yılmaz, and S. Arslan, "Most vulnerable diet and health profiles: identifying countries at risk through a three-theme clustering," *Front. Public Heal.*, vol. 13, 2025, doi: 10.3389/fpubh.2025.1569755.

[32] Mary T Gorski and Christina A Roberto, "Public health policies to encourage healthy eating habits: recent perspectives," *J. Healthc. Leadersh.*, pp. 81–90, 2015, [Online]. Available: https://www.dovepress.com/getfile.php

[33] Muridzo Muonde, Tolulope O Olorunsogo, Jane Osareme Ogugua, Chinedu Paschal Maduka, and Olufunke Omotayo, "Global nutrition challenges: A public health review of dietary risks and interventions," *World J. Adv. Res. Rev.*, vol. 21, no. 1, pp. 1467–1478, 2024, doi: 10.30574/wjarr.2024.21.1.0177.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

[34] "Monsivais, P.; Drewnowski, A. The Rising Cost of Low-Energy-Density Foods. J. Am. Diet. Assoc. 2007, 107, 2071–2076. [Google Scholar] [CrossRef]".

[35] "Hammons, A.J.; Hannon, B.; Teran-Garcia, M.; Barragan, M.; Villegas, E.; Wiley, A.; Fiese, B. Effects of Culturally Tailored Nutrition Education on Dietary Quality of Hispanic Mothers: A Randomized Control Trial. J. Nutr. Educ. Behav. 2019, 51, 1168–1176.".

[36] "Kaur, J.; Lamb, M.M.; Ogden, C.L. The Association between Food Insecurity and Obesity in Children—The National Health and Nutrition Examination Survey. J. Acad. Nutr. Diet. 2015, 115, 751–758. [Google Scholar] [CrossRef]".

[37] "Leung, C.; Tester, J.; Laraia, B. Household Food Insecurity and Ideal Cardiovascular Health Factors in US Adults. JAMA Intern. Med. 2017, 177, 730–732. [Google Scholar] [CrossRef] [PubMed] [Green Version]".

[38] "Barnes, T.L.; Lenk, K.; Caspi, C.E.; Erickson, D.J.; Laska, M.N. Perceptions of a Healthier Neighborhood Food Environment Linked to Greater Fruit and Vegetable Purchases at Small and Non-Traditional Food Stores. J. Hunger Environ. Nutr. 2018, 14, 741–761.".

[39] D. Ziso, O. K. Chun, and M. J. Puglisi, "Increasing Access to Healthy Foods through Improving Food Environment: A Review of Mixed Methods Intervention Studies with Residents of Low-Income Communities," *Nutrients*, vol. 14, no. 11, 2022, doi: 10.3390/nu14112278.

[40] K. Kalinowska, W. Wojnowski, and M. Tobiszewski, "Smartphones as tools for equitable food quality assessment," *Trends Food Sci. Technol.*, vol. 111, pp. 271–279, 2021, doi: 10.1016/j.tifs.2021.02.068.