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## Mapping research associating Brazilian National School Feeding Program and its dietary and socioeconomic outcomes

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### Abstract

The Brazilian National School Feeding Program (PNAE) is a universal free school feeding program that aims to promote healthy nutrition and student health. Since 2009, with the introduction of mandatory procurement from the family farming component, this policy has also aimed to improve family farm livelihoods, which is reflected in the growing number of published studies that have examined both outcomes. This study aims to map and describe the available peer-reviewed literature on the associations between PNAE, and nutritional and socioeconomic outcomes using statistical text analysis to visualize research trends over time and identify gaps. The text analysis was based on articles published up to May 2024 in SciELO, VHL, PubMed, Econlit, Science Direct, Scopus, Web of Science, NBER, and Embase. Results reveal: (i) a rise in the number of published papers addressing food procurement from the family farming component of the PNAE, evincing how changes in legislation have shifted research priorities; (ii) academic production on the PNAE is concentrated in Brazil, primarily in medicine (66%), agricultural sciences (16%) and social sciences (12%), with an emphasis on "nutrition", "food security and nutrition", and "family farming", while fields such as economics, public administration and law remain underrepresented; and (iii) that sustainability is emerging as a new topic. This methodology offers an alternative to meta-analysis for heterogeneous studies, although it does not assess the quality of the included studies or compare their results.

**Keywords:** text mining, school meals, socioeconomic status, diet, family farming, PNAE

### 1. Introduction

The Brazilian National School Feeding Program (Programa Nacional de Alimentação Escolar–PNAE in Portuguese) was launched in the 1950s to offer free meals to public school students. The program stands out for its universal coverage and for being one of the largest school feeding policies worldwide, reaching approximately 40 million students, ranking second only to India in terms of absolute number of beneficiaries. The program is also internationally recognized for its pioneering integration of school feeding with sustainable development policies. From a global perspective, the Brazilian National School Feeding Program (PNAE) aligns closely with SDG 2 (Zero Hunger) and SDG 12 (Responsible Consumption and Production) by ensuring universal access to nutritious food while supporting small-scale producers through public procurement. By prioritizing locally sourced and minimally processed foods, the program demonstrates the potential of large-scale public procurement as a governance tool for advancing sustainable food systems.

Sustainability became an explicit guiding principle of the PNAE in 2009, with the enactment of Law No. 11,947, which introduced incentives for the procurement of locally produced and diversified foodstuffs, prioritizing purchases from family farmers and family-based rural enterprises,

including indigenous peoples and quilombola communities. The law further established that school menus should comply with nutritional guidelines, local eating habits and food cultures, while considering regional agricultural sustainability and diversification and the promotion of healthy and adequate diets. These sustainability-oriented provisions were subsequently reinforced in 2020, with stricter regulations favouring fresh or minimally processed foods and limiting the provision of ultra-processed products.

In 2013, it established minimum amounts of fruits and vegetables, maximum amounts of ingredients, such as salt and sugar, and restrictions on some ultra-processed foods [1]. The guidelines have become more restrictive since 2020, leading to a new PNAE requirement to allocate a minimum of 75% of federal financial resources to *in natura* and minimally processed foods, up to 20% to processed or ultra-processed foods, and up to 5% to culinary ingredients such as salt, oil, and sugar [2]. Concerning public food procurement from family farming, it became mandatory in 2009 [3] that at least 30% of the PNAE federal resources be spent on family farming products. The program prioritizes organic and agroecological products, local production, and products from indigenous, quilombola, and settlement communities.

Studies assessing nutritional and socioeconomic outcomes from the PNAE have multiplied over the years. PNAE is known mainly for (I) promoting healthier diets in schools [4], and as public food procurement from family farming for (II) strengthening and encouraging more sustainable agricultural production, particularly by increasing the income of the farmers involved and fostering local development [5, 6, 7, 8]. Since 2020, dietary regulations for PNAE have been based on the Brazilian Food-based Dietary Guidelines [9].

Evaluation studies on school feeding were conducted and published in the international literature decades earlier than in Brazil. In the United States, consolidated literature reviews have been conducted since the 1970s [10]. Worldwide research on school feeding policies was reported in a 2007 Cochrane review [11, 12], which highlighted the positive effects of the policy on growth and cognitive performance. More recently, a systematic review connected universal school meals to improving diet quality and food security [13]. Jomaa, McDonnell, and Probart [14] published a review focusing on developing countries, identifying reviews focusing on specific countries, such as Ghana [15], reinforcing the positive dietary and health effects of school feeding policy.

Despite the accelerated growth of publications in Brazil, consolidation of knowledge on the national scope is still limited. Studies on PNAE have mainly focused on case studies of individual or small groups of municipalities [16], analyses of the state of public spending on purchases of family farming products [17], and the potential for such purchases by the PNAE [18]. The lack of comparable methods makes systematic review challenging. Available review studies are flexible in their methodology, often focusing on specific topics, such as management quality [19], and are restricted to short periods and/or use limited bibliographic databases. Regarding dietary and socioeconomic outcomes, Pedraza et al. [20] reviewed PNAE research evaluations, while Silva [21] compiled studies on PNAE procurement of family farming products. However, Pedraza's review is restricted to the period from 2010 to 2015, and Silva's review is limited to studies published in the Scientific Periodicals Electronic Library (Spell), Scientific Electronic Library Online (SciELO), and the Institute for Applied Economic Research (IPEA) repository.

In this study, efforts were made to broaden previous reviews to examine whether shifts in the legislation, specifically the mandate for PNAE to source food from family farmers, have reshaped the research landscape. To minimize the risk of excluding relevant studies on dietary and socioeconomic outcomes of PNAE, the available peer-reviewed literature on the subject published up to May 2024 was identified and assessed across Scielo, VHL, PubMed, Econlit, Science Direct, Scopus, Web of Science, NBER and Embase. The large volume of available literature makes systematic review impractical. Text analysis is used as a viable alternative. Text analysis enables mapping of an extensive body of literature. To the best of our knowledge, the existing literature has yet to be evaluated using this method to identify evidence of the dietary and socioeconomic implications of PNAE rules. The novelty of this study lies in its ability to bring emerging themes such as "family farming," "sustainability," and "social policy" to the forefront and expanding beyond its previous focus on nutritional outcomes. The study contributes to the literature by offering an

analytical policy framework that supports a long-term research agenda, identifies well-explored topics, and highlights research gaps in PNAE, particularly regarding its potential to provide nutritious diets for all students and socioeconomic outcomes in society.

In addition to the introduction, a methods section outlines the selection criteria and analytical approach. The results are organized by analytical subperiods, aggregated findings, and thematic areas. The discussion contextualizes these results within recent legislative and institutional developments, and the conclusion summarizes the main contributions and outlines implications for future research and policy.

## **2. Methods**

This review includes papers published up to May 2024 as data sources for text analysis. The process of identifying, screening, selecting, translating, analysing, and writing requires a lengthy three-semester process. The database selection was performed in three steps. The first step was identification (see Appendix I), where four search criteria were defined to search, screen, and select papers, namely, outcome, population, intervention, and type of study. The outcomes were dietary and socioeconomic; the population included public school students and school meal suppliers; the intervention was the Brazilian School Feeding Program (PNAE); and the type of study was original. More details related to the search are available in the Supplementary Material. Papers that met this search criteria were peer-reviewed original studies and were written in English, Spanish, or Portuguese were included in the initial selection.

A total of 1,454 papers were identified, of which 542 were excluded because of automated duplication removal. The second step involved eligibility screening, in which two independent reviewers evaluated the titles and abstracts from the databases and excluded studies that did not meet the eligibility criteria (see details in Appendix I). Any discrepancies or inconsistencies were resolved by a third referee. During this screening process, 549 papers were excluded based on abstract assessments.

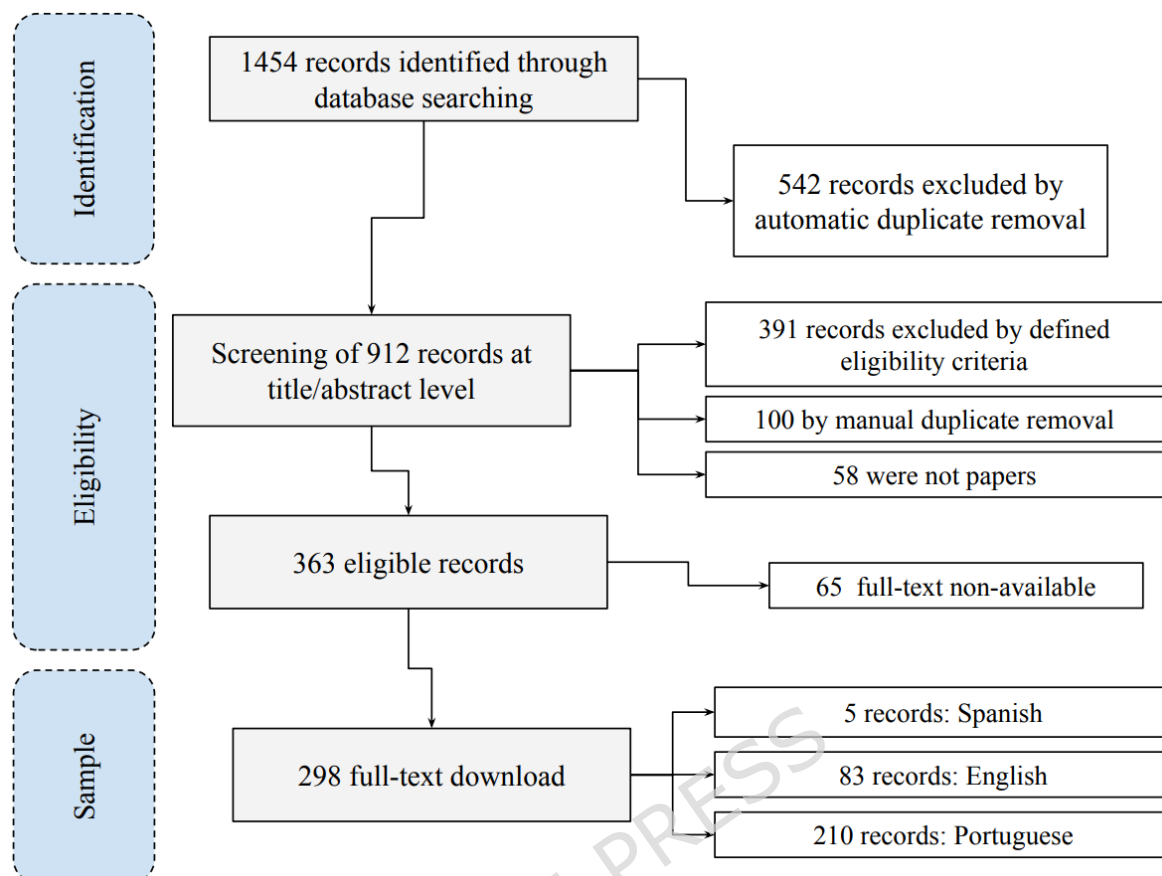


Figure 1: Selection criteria

Abstracts were considered sufficient if they included basic elements such as objectives, methodology, and results, providing sufficient information to determine if the paper met the search criteria. Papers lacking complete or comprehensive information required partial or full-text screening for final decision-making. In the final stage, the selected full texts available were downloaded, and 65 full texts could not be found. The authors accessed full-text articles from Scielo, VHL, PubMed, EconLit, Science Direct, Scopus, Web of Science, NBER, and Embase databases. The inability to retrieve the full text of some articles was due to technical issues with the websites of non-indexed journals. While we acknowledge that not all articles could be retrieved as a limitation, we are confident that the core published literature was captured and that their absence does not undermine the validity of our analysis.

Portuguese and Spanish papers were translated into English. Figure 1 outlines the steps to compose the “full sample” data selection group, which included 298 papers. The sample was divided by period to discuss changes in the research over time. The period cut-offs were defined based on significant changes in the PNAE legislation. The first cut-offs occurred in 2009 (Law no. 11,947, June 16), when the federal government established a mandatory rule to allocate PNAE resources to purchase food from family farms. The second cut-off was 2013 (FNDE Resolution no. June 26 17), which marked the imposition of minimum fruit and vegetable offers and maximum restrictions on ingredients, such as salt, sugar, and some ultra-processed foods. The last year of analysis was 2018 (Law No. 13.666, May 17), when food and nutrition education became part of school curricula. The year 2020 was excluded given the insufficient time for scientific production to incorporate new legislation. According to this legislation, processed and ultra-processed foods are limited to 20% of the budget, and culinary ingredients to at most 5%.

The selected literature was analysed using factor analysis, a text-analysis tool. This approach

was deemed appropriate for conducting an initial assessment of the available literature on this theme [22, 23]. Text analysis enables us to illustrate new avenues of analysis, identify well-researched topics, highlight gaps in the research field, and provide necessary tools to build an analytical policy framework to advance into the PNAE research agenda. Text analysis, or text mining, was significantly developed by the “French School of Data Analysis”, which created tools and software that facilitated the rapid adoption and dissemination of the methods and practices [24]. Text analysis is becoming increasingly popular as a strategy to manage large amounts of information. By 2022, approximately 5,500 publications mentioning “text analysis” or “text mining” were identified in the Pubmed search engine, with 4,500 of these published in the last decade (2013-2022) and about 1,700 published between 2021 and 2022 alone. This analysis technique has become a popular literature review tool in various fields [25, 26]. In addition to its capacity to handle large datasets, it is a versatile approach that facilitates qualitative research, including content analysis [27, 28], research on trending topics and dynamics on social media [29, 30], academic discourse analysis [31], and literature related to food security [32]. It also aids in academic publication mapping [33], which is closely related to the present study. However, school feeding programs have not been examined using this method.

To carry out this analysis, the database had to be pre-processed by standardizing words and organizing data on text segments (TS). The analysis of TS forms the basis of Correspondence Factorial Analysis (CFA). CFA identifies the relational meaning between the units of analysis and provides a graphic representation of words. As CFA follows the characteristics of Principal Component Analysis (PCA), it allows for the identification of different knowledge paths by observing the distance between words and their positions in the plan. It filters words based on their frequencies in a database [34].

Finally, a step beyond CFA is Descending Hierarchical Classification (DHC), which defines sets of classes based on co-occurrence and distribution patterns (typical words and typical text segments). This method helps understand the structure of the content of a text corpus [35]. The analysis was performed on the text segments that made up the articles, meaning that the same article could be present in more than one class. To perform the analysis, a filter was defined to select the relevant fragments. Words with more than 3,000 records in the text were included, which is the default setting in the analysis software used (Iramuteq - Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires). The software documentation suggests increasing the cut-off if there is enough processing power or decreasing it if the amount of text analysed is small. In this study, the cutoff was not increased to maintain clarity in the analysis. Instead, the cutoff was adjusted to 2000 for 2019-2021, 2225 for 2014-2018 and 2500 for 2001-2008 and 2014-2018. The remaining analyses used a standard cutoff of 3000. Regarding the quality of the analysis, the sum of the first two “factors” indicates the percentage of total variance. The analysis of the selected articles showed the following variances: 89.7% for 2001-2008; 90.1% for 2009-2013; 81.1% for 2014-2018; 84.0% for 2019-2021, and 87.5% for the total set.

It is important to emphasize that the entire process is reproducible. Papers were automatically separated into classes using factor analysis, with no researcher influence, except for the definition of the analytical categories (class labelling) based on their expertise. CFA and DHC enabled the mapping of relationships between words and phrases in PNAE-related papers. This approach allowed the study to achieve its central objective of identifying the representational structure and meaning of the research on PNAE.

### 3. Results

Once the papers were identified and qualified, they were analysed in two distinct aggregations. First, according to four periods, up to 2009, 2010-2013, 2014-2020 and 2021-2024, defined by significant changes in PNAE legislation. Second, by thematic area.

### 3.1. Analysis in sub-periods

Figure 2 divides the identified studies into four periods: before 2009, 2010-2013, 2014-2020 and 2021-2024. The first sample analysed included papers published up to 2009, year in which food procurement from family farms became mandatory. In the earliest period, research on PNAE was largely framed within a biomedical and nutrient-based paradigm, with a strong emphasis on specific micronutrients and dietary components. Alongside this dominant approach, an emerging line of inquiry began to examine the program's role in promoting healthy eating practices and decentralized implementation. A third, more incipient strand linked school feeding to rural and socioeconomic dimensions, anticipating later scholarly interest in family farming and local development.

This shift reflects a broader transformation in the scientific understanding of school feeding in Brazil. Over time, the literature has moved from a reductionist focus on individual nutrient deficiencies toward a more systemic conception of food security, one that recognizes the interconnections among health, agriculture, social equity, and governance. Within this framework, school feeding is increasingly understood not merely as a nutritional intervention, but as a component of a broader socio-ecological and policy system [51, 54]. The PNAE exemplifies how this conceptual shift is translated into policy design. Rather than treating outcomes such as childhood anaemia as problems solvable through nutrient supplementation alone, the program operates through a system that (a) ensures diversified local food production (agricultural pillar), (b) guarantees a structured market for family farmers via public procurement (economic and governance pillar), (c) provides culturally appropriate meals (socio-cultural pillar), and (d) promotes education on healthy eating (health pillar).

Between 2010 and 2013, the literature reflects a conceptual broadening of how diet is understood, incorporating dietary patterns and food security alongside nutrient-based concerns. At the same time, increased attention to municipalities and institutional procurement highlights the growing relevance of governance arrangements and policy instruments, particularly the legal requirement to source food from family farming. These developments signal an emerging and clearer connection between school feeding policies, local governance, and rural development.

Taken together with the previous period, this stage confirms a gradual reorientation of PNAE research from a predominantly health-centered approach toward a more integrated food systems perspective. This parallel evolution in research focus directly reinforces the conception of PNAE as an integrated policy, a characterization that is increasingly reflected in the academic narrative. In this literature, PNAE is widely described as a reference case of an integrated school feeding policy, linking food and nutrition security objectives with family farming and local development strategies. The program is frequently cited in international literature as an innovative example of institutional food procurement that brings together social, nutritional, and agricultural policy goals within a single framework [55].

From 2014 onward, the research agenda stabilizes around an integrated understanding of school feeding that simultaneously addresses diet quality, family farming, and governance. Over time, the emphasis progressively shifts toward consumption patterns and the broader food environment, particularly children's exposure to ultra-processed foods, while sustainability becomes an explicit analytical category [58]. This indicates a move from sector-specific analyses toward a more systemic perspective aligned with broader debates on sustainable food systems. Recent studies increasingly situate the PNAE within wider food systems transformations, linking procurement practices to environmental, social, and territorial sustainability [57]. This indicates a temporal alignment between evolving policy priorities, regulatory developments, and academic engagement with sustainability as an explicit analytical framework.

The trajectory identified in this review highlights a gradual maturation of the scientific literature on the PNAE. As the program incorporated new objectives related to family farming, sustainability, and governance, academic research similarly broadened its analytical lens. This alignment suggests a dynamic relationship in which policy innovation and scholarly production evolve in

tandem, reinforcing the PNAE's position as a reference case in food system transformation.

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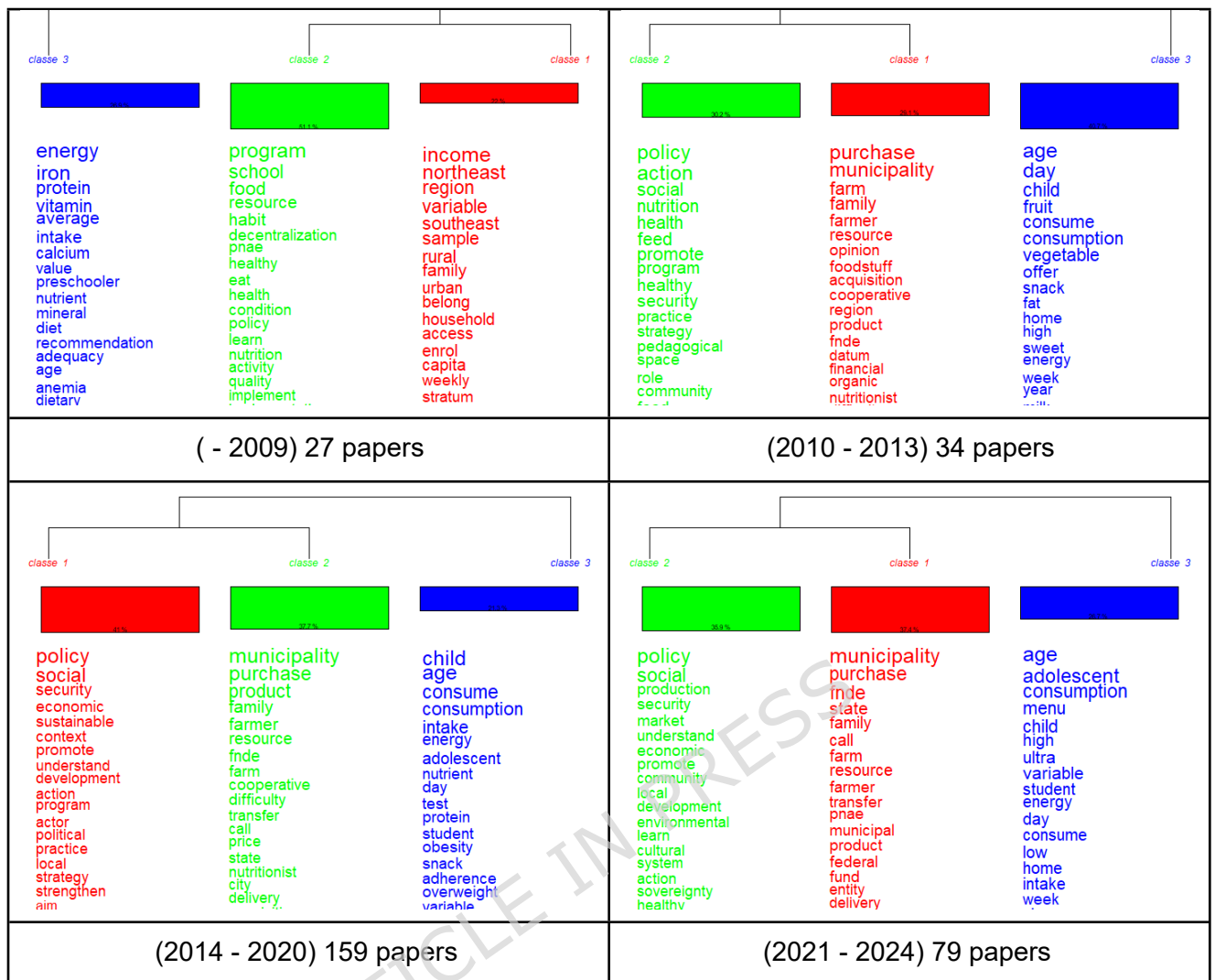


Figure 3: Selection by period dendrograms

### 3.2. Papers by thematic area

The disciplinary distribution of publications offers insight into how the PNAE has been framed within the academic literature over time. Rather than reflecting a fully interdisciplinary field, the research landscape reveals a pronounced concentration in specific domains, shaped by the historical evolution of school feeding research. Analysis of the data over time enabled the identification of groups or classes of papers that could be assigned to specific research areas, highlighting potential gaps in the research agenda that could benefit from interdisciplinary approaches.

To better characterize the structural features of this body of literature, we mapped the origin of the journals and their disciplinary classifications using the classification of the Scimago Journal & Country Rank (JSR) platform. This stage of the analysis aimed to identify and compare the origins of publications on the topic in question, and to identify the dominant themes of this production. Of the 363 eligible records, 134 could not identify the subject area of the journal and 31 could not identify the country of the journal in which the paper was published.

The results reveal a clear temporal evolution in the literature. Early work is tightly clustered around health and nutrition outcomes, reflecting a predominantly public health framing of school feeding. From the mid-2010s onward, the literature becomes more diversified, incorporating

socioeconomic, governance, and food systems perspectives, with a marked expansion in thematic breadth in the most recent period. In the 2020s, the share of publications from Medicine and Nursing declined, although the area remains the dominant contributor to school feeding research, accounting for 66% of publications across the study period. Research from Agricultural and Biological Sciences and Social Sciences becomes more visible from the 2010s onward, with Social Sciences representing 16% of publications and Agricultural and Biological Sciences represented 12% over the full period. The continued dominance of medical and nutrition sciences indicates that school feeding has largely been framed as a public health intervention, while broader perspectives related to food systems, production, and socioeconomic dynamics have gained prominence only more recently.

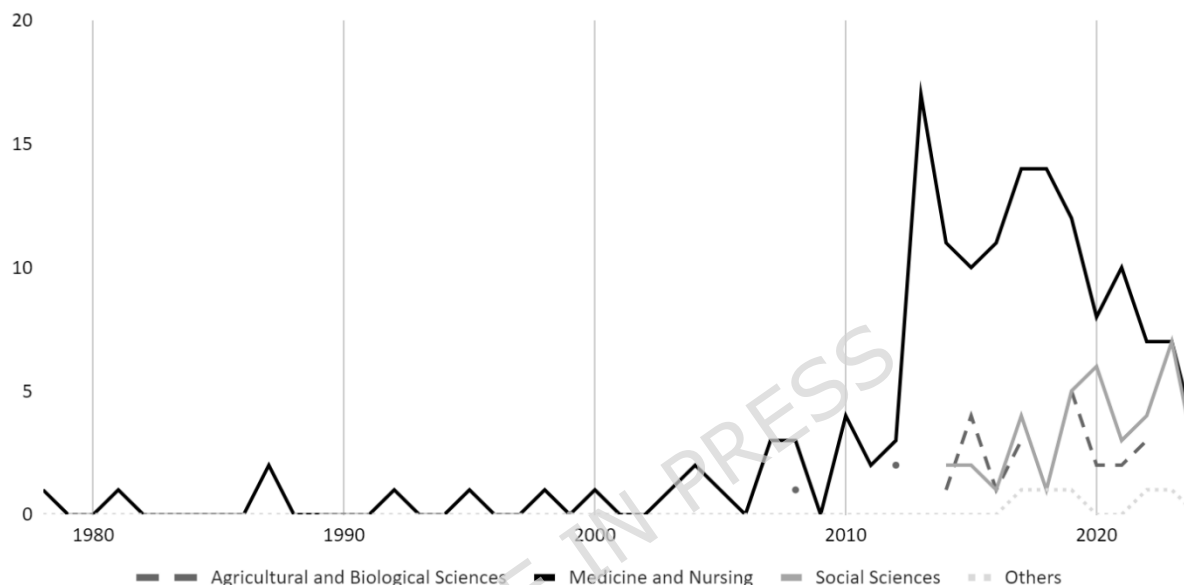


Figure 4. Records by thematic area

Source: Authors based on Scimago Journal & Country Rank (JSR)

The geographical distribution of publications reflects the predominantly national orientation of research on the PNAE. Most articles (78.5%) were published in Brazilian journals, with a smaller share (21.5%) appearing in international journals. The countries with the highest publication rates on this subject during the analysed period, in descending order, were Brazil (78.5%), the United Kingdom (6.1%), the United States (4.5%), Switzerland (4.2%), Venezuela (1.8%), Portugal (0.9%), Colombia (0.9%), Spain (0.9), Chile (0.6%), Argentina (0.6%), Belgium (0.3%), the Netherlands (0.3%), and Germany (0.3%). While this concentration is expected given the Brazilian origin of the policy, it points to opportunities to further situate the PNAE within comparative and international research agendas on school feeding and sustainable food systems.

Taken together, the thematic and geographical distribution of publications indicates that, although PNAE research has expanded in scope, this expansion has not been matched by a proportional increase in disciplinary or international diversity. Contributions from disciplines closely related to governance, such as economics, public administration, and law, are comparatively less visible. This imbalance helps frame the strengths and limitations of the existing evidence base and highlights the potential benefits of greater interdisciplinary and international engagement.

#### 4. Discussion

To our knowledge, this is the first investigation to discuss PNAE by jointly considering its two main outcomes, as stipulated in the program's legislation: dietary impacts and socioeconomic

dimensions related to family farming. The findings suggest that changes in legislation governing how PNAE food procurement have been associated with shifts in the program's research focus over time. In particular, the introduction of the legal requirement for PNAE to purchase food from family farmers coincides with the growing prominence of themes such as "family farming", "sustainability" and "social policy" in the literature over the last decade. Earlier research, by contrast, was largely concentrated on nutritional outcomes.

The literature on school feeding globally and in Brazil is more consolidated regarding dietary outcomes, as evidenced by the significant number of published articles in general and the use of comparable methodologies, thereby enabling systematic literature reviews. Systematic reviews of the global school feeding literature often emphasize diet outcomes, with less attention being given to psychosocial and behavioural outcomes [13, 11], a trend echoed in the findings of this study. In Brazil, systematic reviews on this topic are scarce, particularly those focusing on PNAE's dietary and socioeconomic outcomes or covering time frames, similar to Pedraza et al. [20]. Nevertheless, the thematic division observed by Pedraza et al. closely aligns with that found in this study, which presents studies from a period marked by increased research on family farming while maintaining the focus on dietary outcomes.

The study conducted by Silva [21] provides valuable insights that correlate with our findings. Silva conducted an extensive bibliometric survey spanning 1974 to 2019, identifying 79 scientific publications focusing on topics such as state public policies, school feeding, and family farming in Brazil. The study aimed to compare publications before and after the enactment of Law 11.947/2009, using search criteria like "school feeding", and "PNAE", and selecting only indexed, peer-reviewed journals. Our study employs similar search criteria and methodologies, leading to comparable results in terms of thematic evolution across a set of scientific publications over time.

Specifically, both studies identified three main thematic classes: nutrition, purchases of family farming products by PNAE, characterized as a public procurement policy, and food security and nutrition, reflecting public food policies and the human right to adequate food. These themes closely aligned with the main research subjects identified in Silva's bibliometric survey. Notably, public procurement emerged as the most extensively studied theme in both analyses, indicating a significant increase in research interest. This heightened attention can be attributed to the dynamics for executing entities in meeting the requirements established by Law 11947/2009 of sourcing at least 30% of PNAE food purchases from family farming. Silva [21] noted that all texts on family farming purchases were published after 2013, exploring issues such as national compliance with the minimum purchase norms for family farming [17, 36, 37, 42], municipal performance in specific states [38, 39], public calls [40], and perspectives of stakeholders involved in the implementation of PNAE [41].

Thus, our results indicate that concepts related to family farming began to gain prominence in the post-2009 period. The DHC and graphs show that terms such as "purchase", "call", "acquisition", "market", "farm", "family", "municipality" and "FNDE", among others linked to public procurement, only gained significant attention in scientific literature starting from 2009-2013. This finding corroborates the bibliometric survey conducted by Silva [21]. Consequently, academic research on school feeding faced a strong thematic shift toward family farming, with the focus on this area increasing from 10.7% before 2009 to 33.0% between 2010 and 2019.

We examined the organizational arrangements and local development focusing on texts discussing various forms of local development articulations related to the implementation of the PNAE. This is addressed based on the integration of family farming into the dynamics of the local economy via public policies [41]; relationships between consumption, production, food policies, and consolidation of agri-food systems aimed at territorial development [43, 44]; the connection between the trajectory of family farmers' collective organizations, their functioning, access to public policies, and compliance with the local direct purchase rule mandated by PNAE [50]; the joint socio-economic benefits resulting from the link between institutional markets and family farming [51]; operational challenges such as low participation, inefficient communication, lack of farmers documentation, and marketing ceilings, among others [45]; and finally, evaluation of socioeconomic effects arising from local marketing dynamics of PNAE implementation [46].

Similarly, the thematic category ‘organizational arrangements and local development’ and its associated terms reinforce these findings by highlighting a shift on how PNAE has been examined over time. From the 2009-2013 period, and more clearly from 2014-2018 onward, the increased frequency of terms referring to organizational arrangements such as “action”, “municipality”, “context”, “difficulty”, “price”, “cooperation”, and “external” indicates growing scholarly attention to the practical, institutional, and territorial dimensions of program implementation. This pattern suggests a gradual move away from purely outcome-oriented analyses toward a closer examination of governance structures, coordination challenges, and local-level constraints shaping the program’s operation and its developments impacts.

The thematic categories “agroecological production and sustainability” and “cooperative and associativism” further illustrate how the literature has expanded to address production practices and collective organization within PNAE. Studies on these categories examine organic and agroecological food production processes and their integration into school feeding programs [47, 48, 49, 50, 51], as well as the constitutionality of farmers’ organizations aiming to access PNAE [4, 52, 53, 37]. Consistent with this shift, the statistical text analysis shows that terms such as “cooperative”, “sustainability”, “organic,” and “environmental” become more prominent from the 2014-2018 period onward. These findings suggest increasing recognition that school feeding policies must reconcile nutritional goals with environmental sustainability, aligning with the bibliometric survey in question [21] and reflecting emerging attention to planetary boundaries and food system impacts [60].

The Brazilian experience explicitly positioned in connection with international policy frameworks and debates on sustainable food systems, as seen in the growing literature on these themes. The discussion details how the PNAE operationalizes the provision of healthy food alongside support for small-scale producers (linking to SDGs 2 and 12) by leveraging public procurement to foster local, diverse, and sustainable food production.

Thus, the classes developed in this study (“nutrition”, “family farming”, and “food security and nutrition”) and their respective descriptions, dendrograms and observed frequencies, especially in the latter two, are consistent with recent academic production on PNAE reported by Silva [21]. This correspondence means that scientific research has evolved in close dialogue with the legal and regulatory framework of the program because academic interests, reflected in the prominence of these themes, tend to align with policy and legislative developments shaping school feeding [48, 49, 50]. The final dendrogram produced in our analysis further demonstrates this alignment, notably through the emergence of terms such as “right”, “security,” and “healthy”, which have not previously featured as central elements in the literature.

## 5. Conclusions

This study aimed to map the available studies on the PNAE (National School Feeding Programme) and its main outcomes (diet and socioeconomic status) using statistical tools (text mining). This approach proved effective for synthesizing a heterogeneous corpus where traditional systematic review was challenging, highlighting strategic gaps and emerging trends. By doing so, the study provides a macroscopic analysis of policy's thematic evolution and interdisciplinary engagement, highlighting gaps and potential areas for future studies.

Overall, the key findings of this study suggest that:

- (i) Changes in legislation significantly influence the direction of research. PNAE was initially studied within health disciplines, focusing on diet and food and nutrition security, and gradually garnered attention from social sciences, highlighting the procurement of family agriculture products over time. The focus on family farming comes from the compulsory purchase of family farming products by law. This demonstrates a virtuous feedback loop: policy change generates a new research field (school feeding, family farming, and territorial development), whose accumulating evidence builds “political innovation capital” that further consolidates and advocates for the policy;
- (ii) The topic of school feeding has attracted a more diverse range of disciplines over time in the social, agricultural, and biological sciences. However, despite being a public purchasing

mechanism endowed with legal innovations and public resource management implications, it remains understudied in fields such as economics, public administration, and law.

(iii) the most recent period alludes to terms like “sustainable” and “environment”, indicating these topics as emerging trends. Public procurement is increasingly recognized for its potential to develop local, inclusive, healthy, and sustainable food systems, linking rural productive inclusion with the promotion of food and nutrition security. Brazil has developed agro-ecological transition and biodiversity conservation initiatives through public procurement practices that are regarded as scalable and exportable to other regions and countries. Understanding the relationship between public procurement and the effective transformation of food systems requires increased involvement from additional research fields, including agricultural and biological sciences, law, specific fields like logistics and economics, and transdisciplinary studies.

From a global perspective, the PNAE operationalizes the integrated agenda of the UN Sustainable Development Goals. It directly contributes to SDG 2 (Zero Hunger) by ensuring food security and supporting smallholders, and to SDG 12 (Responsible Consumption and Production) by steering institutional demand towards local, diverse, and healthy food. The program exemplifies how public procurement can be a governance instrument for systemic transformation.

Consequently, this article’s central contribution is to highlight a critical impediment to the PNAE’s transformative potential: the persistent underrepresentation of Economics, Public Administration, and Law in its scholarship. This gap has direct consequences, as it limits the analysis of the program’s core operational pillars—normative innovation and socioeconomic impact. Engagement from these fields is therefore not a mere academic option but a practical necessity. More in-depth analyses are essential to address the specific legal constraints, budgetary challenges, and monitoring deficits that hinder the program’s full feasibility. Research focused on these issues can directly enable the scaling-up of the PNAE’s inclusiveness, sustainability, and health-promoting potential. Ultimately, bridging this disciplinary divide is fundamental. It is the key to solidifying the PNAE’s role not just as a nutrition intervention, but as a robust governance instrument for sustainable food systems, ensuring its longevity and maximizing its impact as a global policy innovation. PNAE is positioned not merely as a national program but as a compelling case study that demonstrates the potential of large-scale public procurement to serve as an effective governance instrument for systemic food system transformation.

Future studies could apply this methodology to further investigate emerging research areas related to PNAE, their contributions to policy advancements, and persistent research gaps. A limitation of this study and the statistical tool used is its inability to assess the quality of the methods used in the analysed studies or to compare their findings.

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### **Data availability**

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### **Ethical approval**

Not applicable.

### **Contributors**

**LPE:** Conceptualisation, Methodology, Data curation, Formal analysis, Writing – original draft, Writing - Review & Editing, Visualization. **FJM:** Methodology, Data curation, Formal analysis, Writing - Review & Editing. **TDO:** Conceptualisation, Methodology, Writing – original draft, Writing - Review & Editing.

### **Declaration of Competing Interest**

We declare no competing interests.

**Consent to Participate**

Not applicable.

**Consent for Publication**

Not applicable.

**Clinical Trial Number**

Not applicable.

**Declaration of generative AI and AI-assisted technologies in the writing process**

During the preparation of this work the authors used ChatGPT in order to review grammar, cohesion and clarity of the text. After using this tool/service, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the publication.

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### Referências bibliográficas

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## Appendix I

### Search criteria

Supplementary file: Search criteria

Criteria	Key element
Outcome	Qualitative and quantitative outcomes will include analysis and measures of students, farmers, and their communities' outcomes related to (1) food security and nutrition (2) and socioeconomic indicators. - Dietary outcomes; - Socioeconomic outcomes.
Participants/population	Students attending Brazilian public schools; Brazilian School Feeding Program supply chain and its localities. Local: Brazil. — Kindergarten, elementary and high school, family and non-family farmers and other food suppliers.
Intervention/Exposure	Brazilian School Feeding Program (PNAE).
Study	Original Studies.

### Data extraction (selection and coding)

Search in all fields - when available.

((("agricultura familiar" OR "agricultores familiares" OR "agricultor familiar" OR "fornecedor" OR "fornecedores" OR "estudante" OR "estudantes" OR "crianca" OR "crianças" OR "aluno" OR "alunos") AND ("merenda escolar" OR "alimentação escolar" OR "programa nacional de alimentação escolar" OR "PNAE") AND ("dieta" OR "dietas" OR "nutrição" OR "alimentação" OR "renda" OR "socioeconômico" OR "economico" OR "desenvolvimento" OR "meio de vida"))) OR (((("family farming" OR "family farmers" OR "peasant" OR "family farmer" OR "supplier" OR "suppliers" OR "student" OR "students" OR "child") AND ("school lunch" OR "school feeding" OR "national school feeding program" OR "PNAE") AND ("food" OR "diet" OR "nutrition" OR "livelihood" OR "economic" OR "economics" OR "development" OR "income" OR "socioeconomic" OR "socioeconomics"))) OR ((("agricultura familiar" OR "agricultores familiares" OR "campesino" OR "campesinos" OR "agricultor familiar" OR "proveedor" OR "estudiantes" OR "niño" OR "estudiante") AND ("almuerzo escolar" OR "alimentación escolar" OR "programa de alimentación escolar" OR "PNAE") AND ("dieta" OR "dietas" OR "nutrición" OR "alimentación" OR "medios de vida" OR "economía" OR "desarrollo" OR "ingreso" OR "ingresos" OR "socioeconómico" OR "socioeconómicos")))))

### Themes that required discussion among the researchers:

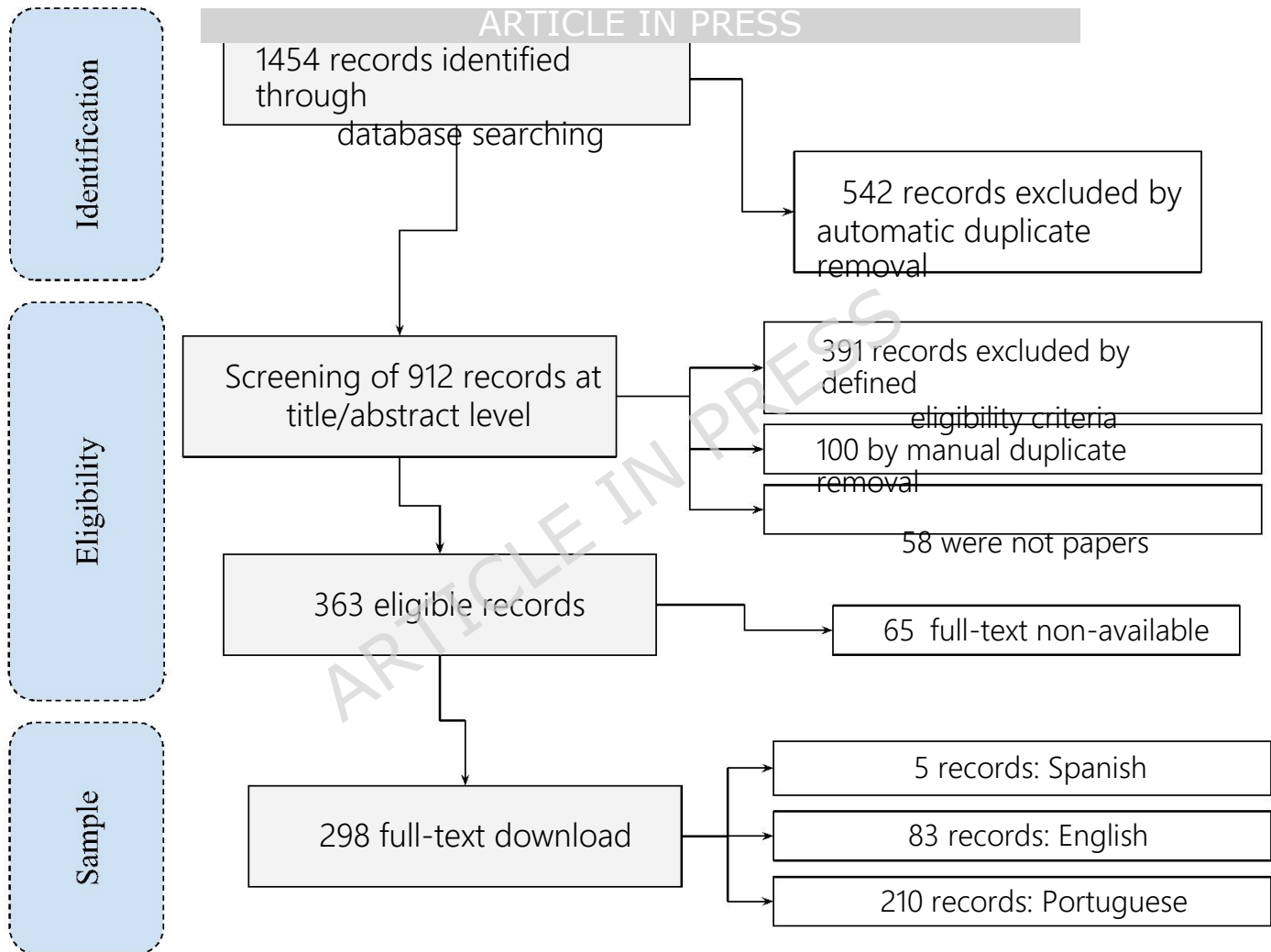
#### Excluded:

- School diets that do not discuss school feeding;
- Cariogenic potential of school meals;
- Nutritional status;

- Food allergies;
- Food Intoxication;
- School Canteens;
- Extensive studies on school feeding which include Brazil only tangentially;
- Hygienic sanitation (sanitary status, food safety, etc.);
- Papers about CAE, cooks and other PNAE agents;
- Validation of the questionnaire: when the object is the questionnaire and there is no explicit mention of the results of the research interest.
- Nutrition education when not related to PNAE;
- PAA and other public purchases.
- Artigos cujo foco não é PNAE (menciona PNAE, mas não investiga o programa...)

**Included:**

- Evaluation of salt, iron, etc. microbiological quality, and other diet-related elements
- Sensorial analysis;
- Perceptions of nutritionists, cooks, parents, etc. on school meals when related to diet and socioeconomic outcomes
- PNAE management when related to diet and socioeconomic outcomes.



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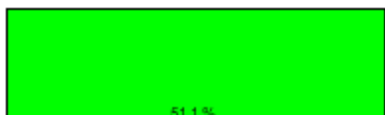
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classe 3



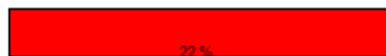
energy  
iron  
protein  
vitamin  
average  
intake  
calcium  
value  
preschooler  
nutrient  
mineral  
diet  
recommendation  
adequacy  
age  
anemia  
dietary

classe 2



program  
school  
food  
resource  
habit  
decentralization  
pnae  
healthy  
eat  
health  
condition  
policy  
learn  
nutrition  
activity  
quality  
implement

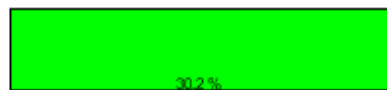
classe 1



income  
northeast  
region  
variable  
southeast  
sample  
rural  
family  
urban  
belong  
household  
access  
enrol  
capita  
weekly  
stratum

ARTICLE IN PRESS

classe 2



30.2%

policy  
action  
social  
nutrition  
health  
feed  
promote  
program  
healthy  
security  
practice  
strategy  
pedagogical  
space  
role  
community  
food

classe 1



29.1%

purchase  
municipality  
farm  
family  
farmer  
resource  
opinion  
foodstuff  
acquisition  
cooperative  
region  
product  
fnde  
datum  
financial  
organic  
nutritionist

classe 3

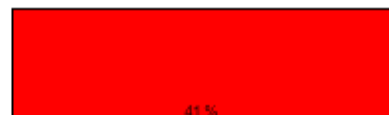


40.7%

age  
day  
child  
fruit  
consume  
consumption  
vegetable  
offer  
snack  
fat  
home  
high  
sweet  
energy  
week  
year  
milk

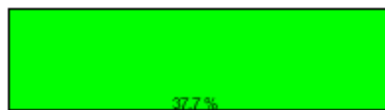
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classe 1



policy  
social  
security  
economic  
sustainable  
context  
promote  
understand  
development  
action  
program  
actor  
political  
practice  
local  
strategy  
strengthen  
aim

classe 2



municipality  
purchase  
product  
family  
farmer  
resource  
fnde  
farm  
cooperative  
difficulty  
transfer  
call  
price  
state  
nutritionist  
city  
delivery

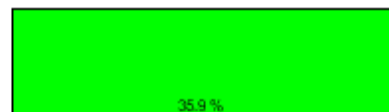
classe 3



child  
age  
consume  
consumption  
intake  
energy  
adolescent  
nutrient  
day  
test  
protein  
student  
obesity  
snack  
adherence  
overweight  
variable

## ARTICLE IN PRESS

classe 2



35.9%

policy  
social  
production  
security  
market  
understand  
economic  
promote  
community  
local  
development  
environmental  
learn  
cultural  
system  
action  
sovereignty  
healthy

classe 1



37.4%

municipality  
purchase  
fnde  
state  
family  
call  
farm  
resource  
farmer  
transfer  
pnae  
municipal  
product  
federal  
fund  
entity  
delivery

classe 3



26.7%

age  
adolescent  
consumption  
menu  
child  
high  
ultra  
variable  
student  
energy  
day  
consume  
low  
home  
intake  
week

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