Review

Risk Factors for Consumption of Ultra-Processed Foods among Brazilian Adolescents: A Systematic Review

Paulo Henrique Guerra *, Evelyn Helena Corgosinho Ribeiro, Rafael Fagundes Lopes, Laura Maria Balestreri Nunes, Isis Carolina Viali, Brígida da Penha Ferraz, Inaiá Aparecida Almeida, Milena Huber Garzella, Jonas Silveira

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Abstract: Background: Considering its deleterious effects on health, as well as the importance of information to support actions, strategies and public policies, this study was aimed to identify and classify the risk factors for consumption of ultra-processed foods among Brazilian adolescents. Data sources: targeting observational studies involving samples of Brazilian adolescents (11 to 19 years old), which evaluated possible associations between the consumption of ultra-processed foods and individual, interpersonal, environmental and public policies variables, in October 2022, a systematic review was conducted, consulting electronic databases (Lilacs, Pubmed, Scielo, Scopus and Web of Science), Google Scholar and the reference lists of included articles. Data synthesis: The descriptive synthesis consisted of 11 papers, representing nine original studies. In general, the consumption of ultra-processed foods was associated with different individual, interpersonal and environmental variables. More specifically, the following variables can be highlighted: sedentary behavior (specially screen time), studying at a private school, having a higher Body Mass Index and being female. Conclusions: Based on this evidence, it is important to direct actions, strategies and public policies aimed at confronting the consumption of ultra-processed foods for these groups.

Keywords: industrialized foods; epidemiologic factors; adolescent; Brazil; review

1. Introduction

Ultra-processed foods are defined as manufactured industrial formulations obtained from substances extracted or derived from natural food, but which, in fact, have little or none of it in their composition [1]. Besides, they are characterized by low availability of fibers and bioactive compounds [1,2].

Its effects on the dietary pattern of individuals are well described in the literature. Epidemiological studies, conducted with different populations, suggest that as greater the presence of ultra-processed foods in the dietary pattern, increases the energy density of the diet and the concentration of critical nutrients for the development of distinct diseases, in different life cycles [3–6]. Among adolescents, specifically, there is a growing body of evidence indicating that the consumption of ultra-processed foods is a risk factor for increased body fat [7], as well as the development of obesity [4], metabolic diseases [4], asthma [8] and sleep disorders [9,10].

In the Brazilian context, nearly 30% of the total energy consumption, among adolescents and adults, comes from ultra-processed foods [11], which makes it an emerging issue on the public health agenda. Recognizing its deleterious effects on health, there is, in the country, a continuum of institutional actions aimed to face it, within a broader perspective, understanding the problem beyond an individual option.

Thus, a detailed survey investigating the factors associated with the consumption of ultra-processed foods among Brazilian adolescents, in order to formulate actions, strategies and public

health promotion policies, demonstrated that behaviors adopted during adolescence trends to be maintained throughout life. Therefore, the present aimed at identifying and classifying the variables frequently associated with consumption of ultra-processed foods among Brazilian adolescents.

2. Materials and Methods

This systematic review was based on PRISMA checklist. Its registration was previously made on the PROSPERO (CRD42019116609). Throughout the process of developing the study, no modifications were made from the original idea reported in the protocol.

The inclusion criteria were elaborated considering the following structure:

- Participants: Brazilian adolescents aged 11 to 19 years.
- Exposures: Individual, interpersonal, environmental and policy factors, with no restriction.
- Outcome: consumption of ultra-processed foods, measured by instruments that used the NOVA classification.
- Study design: scientific papers published in peer-review journals, which reported observational studies (e.g., case-controls, cohorts or cross-sectional studies).

On the other hand, we defined as exclusion criteria studies with specific clinical populations (e.g., with chronic diseases, disabilities); studies that did not use the NOVA classification, as well as studies that evaluated specific types of ultra-processed foods (e.g., soft drinks, snacks) and other forms of scientific publication, such as abstracts of conference proceedings, dissertations and theses.

Searches were carried on in the electronic databases Lilacs, Pubmed, Scielo, Scopus and Web os Science were conducted on October 7, 2022, considering the syntax developed for Pubmed: (((processed[Text Word] OR (ultraprocessed[Text Word]) OR (ultra-processed[Text Word]))) AND (((adolesc*[Text Word]) OR (teen*[Text Word])) OR (youth*[Text Word]))) AND (Brazil*[Text Word]). In Lilacs and Scielo databases, searchers were also performed in Portuguese. The full description of systematic searches is available in Appendix A.

To avoid losing relevant information, complementary searches were carried out on Google Scholar, by reading the initial 200 records, organized by their relevance and in the reference lists of the studies assessed by their full texts.

The records identified in the databases were exported to the Rayyan [12] and the duplicates were initially identified and removed. Trained pairs of researchers screened titles and abstracts (B.F. and I.V.; I.A. and M.G.; L.N. and R.L.), independently, with the support of another reviewer to resolve any doubts and establish consensus (P.G.). This same logic was adopted in the full text assessment, data extraction and elaboration of the descriptive synthesis.

Data extraction was organized in an electronic spreadsheet divided into three tabs: descriptive information (e.g., study location, age group, follow-up process, sample size), methodological information (e.g., study design, instruments used for evaluating food consumption, statistical protocol) and results (e.g., measures of effect, measures of variability and p value). This procedure was also conducted by pairs (B.F. and I.V.; I.A. and M.G.; L.N. and R.L.), with the support of a third researcher (P.G.).

Regarding the extraction of results, specifically, it is important to highlight that articles which used different analysis (e.g., univariate and multivariate analyses), we chose to extract the most adjusted result, presenting or not statistical associations. This was adopted to control confounders in the synthesis. The results were classified as: (i) no statistically significant association ($p > 0.05$); positive (ii) or negative (iii) statistically significant association ($p < 0.05$).

At the end of the data extraction, variables were classified by their nature (individual, interpersonal, environmental or public policy), according to the Socioecological model [13].

The descriptive synthesis was elaborated from the refinement of the data in the extraction spreadsheet. Due to the high number of variables identified among the included studies, it was stipulated that only the variables analyzed by at least three studies would be presented in the synthesis. From the beginning, we sought to elaborate a descriptive synthesis composed of the most frequently evaluated variables among the studies, in order to provide more robust information for decision making.

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The risk of bias in the included studies was assessed using the adapted version of the quality assessment tool for quantitative studies of the Effective Public Health Practice Project (EPHPP) [14]. Adaptations were made considering the inclusion criteria of this research, covering six domains: sample profile; selection bias; report of representativeness; instrument used to assess food consumption; losses and dropouts and statistical analysis.

3. Results

Searches in electronic databases resulted in the identification of 1,444 potential studies (Figure 1). Removing the duplicates, 1,350 were assessed by their titles and abstracts. A total of 68 remained for full-text assessment, among which, 57 were excluded. The main reasons for exclusion were: not grouping ultra-processed foods in the analysis (n = 15); age group (n = 8) and; not using ultra-processed terminology (n = 8). Eleven original articles met the eligibility criteria and had their data extracted for the descriptive synthesis [15–25]. However, three articles used data from the same Survey (the 2015 National School Health Survey) [23–25], and, therefore, the present synthesis was developed from data of nine original studies.

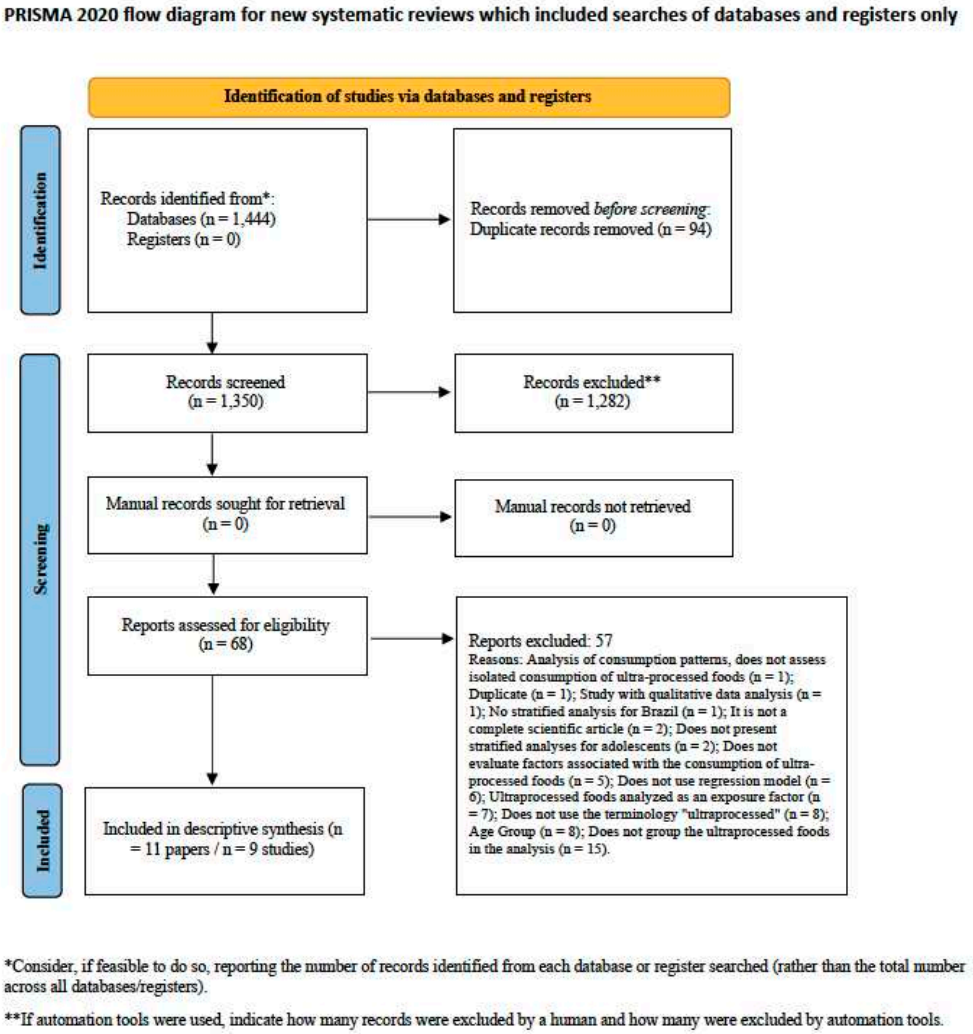

Figure 1.

Table 1 presents descriptive and methodological data of the included studies. Regarding the location / scope of the research, the synthesis gathered data from two national22-25 and seven studies conducted in different Brazilian states [15–21]. Data collection of the included studies took place

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between 2008 [16] and 2019 [21]. The samples ranged from 238 [16] to 102,072 [23,24] participants, mostly female adolescents in seven studies (77.8%)[15–17,19,21–25].

Analyzing the study design, all of them are cross-sectional, with most of the samples being composed of probabilistic methods [15,17,20–25] (Table 2). More specifically, two cross-sectional analyses were based on birth cohorts, one that occurred in Pelotas [18] and the other in São Luís [19]. Even with the high variability between the instruments used to assess food consumption, as well as the periods of observation of the instruments, applications of the Food Frequency Questionnaire [16,18,19] and food recalls [17,20–25] were more frequently (Table 1).

Table 1. Descriptive and methodological characteristics of the included studies.

Reference	Place (Data collection)	Sample size (%F)	Age range (mean)	Sampling	Instrument used to assess food intake	Point prevalence
Correa et al., 2018 [15]	Florianópolis-SC (2012–13)	888 (52)[a]	11–14 (nd)	P	QUADA-3	Previous Day
Gadelha et al., 2019 [16]	Recife-PE (2008–13)	238 (61)	10–16 (11; 15)	nd	FFQ	Previous Month
Monteles et al., 2019 [17]	Teresina-PI (nd)	617 (57)	14–19 (17)	P	Food recall	Previous Day
Costa et al., 2020 [18]	Pelotas-RS (2015)	3.514 (48)	11 (11)	Birth Cohort[b]	IDS and FFQ	Previous Year
Viola et al., 2020 [19]	São Luís-MA (2016)	1.525 (53)	18–19 (nd)	Birth Cohort[c]	FFQ	Previous Year
Leite et al., 2021 [20]	São Paulo-SP (2017)	2.680 (47)	14–15 (15)	P	Food recall[d]	Previous Week
Melo et al., 2021 [21]	Juiz de Fora-MG (2018–19)	804 (58)	14–19 (16)	P	Food recall	Previous Week
Rocha et al., 2021 [22]	Country (2013–14)	71.553 (56)	12–17 (15)	P	Food recall	Previous Day
Costa et al., 2018 [23]						
Noll et al., 2019 [24]	Country (2015)[e]	16.324[f] (nd); 102.072 (53)	14–15 (nd)	P	Food recall	Previous Week
Silva et al., 2021 [25]						

Legends: a: Considers the percentage of girls in the total sample (7–14 years old); b: All children born in Pelotas (2004); c: All children born in 10 maternity hospitals in São Luís (March 1997 - February 1998); d: adapted from the National School Health Survey, 2015; e: Articles generated from data of the National School Health Survey 2015; f: Sample 2 of the National School Health Survey, 2015: %F: percentage of females; FFQ: food frequency questionnaire; IDS: instrument developed for the study; MA: Maranhão; nd: not described; MG: Minas Gerais; P: sample composed by probabilistic method; PE: Pernambuco; PI: Piaui; QUADA-3: Previous Day Food Questionnaire; RS: Rio Grande do Sul; SC: Santa Catarina; SP: São Paulo.

Table 2. Risk of bias assessment of included studies.

Reference	Sample profile	Study Design	Representativeness (level)	instruments used to assess food intake	Losses and / or withdrawals	Statistical analysis
Correa et al., 2018 [15]	Low	CS	Low (city)	Low	Low	Low
Gadelha et al., 2019 [16]	Moderate	CS-CO	nd	Low	nd	Low
Monteles et al., 2019 [17]	Low	CS	nd	Low	nd	Low
Costa et al., 2020 [18]	Low	CS-CO	Low (city)	Low	Low	Low

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Viola et al., 2020 [19]	Low	CS-CO	Low (city)	Low	Low	Low
Leite et al., 2021 [20]	Low	CS	Low (city)	Low	Low	Low
Melo et al., 2021 [21]	Moderate	CS	Low (city)	Low	Low	Low
Rocha et al., 2021 [22]	Low	CS	Low (country)	Low	Moderate	Low
Costa et al., 2018 [23]	Low	CS	Low (country)	Low	Low	Low
Noll et al., 2019 [24]						
Silva et al., 2021 [25]						

Legends: CS: cross sectional study; CS-CO: cross-sectional analysis based on cohort study; nd: not described

In a general perspective, there was a predominance of low risk of bias (Table 2). The moderate risk of bias assessments, observed in the sample profile and losses and/or withdrawals domains, were caused by the specific involvement of adolescents enrolled in public schools (heterogeneous samples were established as low risk of bias) [16,21] and the analysis involving 71% of the initially approached sample (80% was established as the minimum cut-off point for low risk of bias) [22], respectively.

While extracting the original data, 95 analyzes were identified, involving 51 different variables (e.g., using univariate and multivariate models). In general, there was a predominance of variables in the individual domain (n = 38; 74.5%), followed by variables in the environmental domain (n = 7; 13.7%), interpersonal (n = 5; 9, 8%) and public policy (n = 1; 2.0%). The full extraction spreadsheet can be requested from the corresponding author.

However, applying the inclusion of inclusion related to the determining variables for at least three studies, eight variables remained for the composition of the synthesis. They are presented in Table 3, with their respective effect measures and variability. Regarding the assessment in relation to the domains of the Socioecological model, five were classified as individual domain (sedentary behavior; Body Mass Index; age; waist circumference and sex); two as interpersonal domain (maternal education and socioeconomic level) and one as environmental domain (studying at a private school).

Table 3. Descriptive synthesis of the results.

Sedentary Behavior – Individual domain (n = 5)
Costa et al., 2018[23] (sitting and screen time): Linear trend, with dose-response effect
Melo et al., 2021[21] (screen time): β = 0.38 (95%CI = 0.13–0.62)
Rocha et al., 2021[22] (Eating in front of screens): β = 4.2 (95%CI = -3.1–5.3)
Rocha et al., 2021[22] (>2 h/d on screens): β = 4.2 (95%CI = 1.2–4.3)
Silva et al., 2021[25] (Sitting time): PR = 1.13 (95%CI = 1.11–1.16)
Silva et al., 2021[25] (Eating while watching television): PR = 1.09 (95%CI = 1.07–1.10)
Gadelha et al. 2019[16] (screen time): 2008-9: OR = 0.75 (95%CI = 0.22–2.75)
Gadelha et al. 2019[16] (screen time): 2012-13: OR = 1.40 (95%CI = 0.66–2.95)
Administrative dependence of the school – Environmental domain (n = 4)
Noll et al., 2019[24] (private school): PR = 1.29 (95%CI = 1.23–1.35)
Rocha et al., 2021[22] (private school): β = 1.9 (95%CI = 0.8–2.9)
Silva et al., 2021[25] (private school): β = 1.11 (95%CI = 1.02–1.09)
Monteles et al., 2019[17] (private school): β+* = -0.06 (95%CI = -3.50–0.40)
Body Mass Index – Individual domain (n = 4)

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Melo et al., 2021[21]: β = 0.03 (95%CI = 0.05–0.00)
Monteles et al., 2019[17] (≥25.0 kg/m2): β+* = 0.11 (95%CI = 10.9–3.94)
Viola et al., 2020[19]: β = 0.01 (95%CI = 0.03–0.01)
Gadelha et al., 2019[16] (2008–9): OR = 0.70 (95%CI = 0.16–3.10)
Gadelha et al., 2019[16] (2012–13): OR = 1.04 (95%CI = 0.25–4.34)
Maternal schooling – Interpersonal domain (n = 4)
Costa et al., 2020[23]: Inverse dose-response relationship (p = 0.003)
Silva et al., 2021[25] (lack of maternal education): PR = 0.88 (95%CI = 0.83–0.94)
Gadelha et al., 2019[16]: (2008–9): OR = 0.68 (95%CI = 0.04–13.19)
Melo et al., 202121: β = 0.16 (95%CI = -0.07–0.39)
Age – Individual domain (n = 4)
Noll et al., 2019[24] (16–19 years old): PR = 0.89 (95%CI = 0.85–0.93)
Silva et al., 2021[25] (<15 years old): PR = 1.08 (95%CI = 1.06–1.11)
Gadelha et al., 2019[16] (2008–9): β = 0.34 (SE = 0.02)
Gadelha et al., 2019[16] (2012–13): β = 0.15 (SE = 0.06)
Melo et al., 2021[21]: β = -0.31 (95%CI = -0.34–0.96)
Waist circumference – Individual domain (n = 4)
Gadelha et al. 2019[16]: 2012–13: OR = 1.44 (95%CI = 0.02–0.94)
Gadelha et al., 2019[16]: 2008-9: RR = 0,37 (95%CI = 0,06; 2,31)
Viola et al., 2020[17]: β = -0,02 (95%CI = -0,05; 0,01)
Melo et al., 2021[21]: β = -0,04 (95%CI = -0,10; 0,02)
Gender – Individual domain (n = 3)
Monteles et al., 2019[17] (females): β+ = 0.39 (95%CI = 7.3–12.4)
Noll et al., 2019[24] (females): PR = 1.12 (95%CI = 1.10–1.15)
Costa et al., 2020[23]: No differences (p = 0.47)
Socioeconomic level – Individual domain (n = 3)
Melo et al., 2021[21]: β = 0.12 (95%CI = 0.03–0.21)
Monteles et al., 2019[17] (≥ 2 minimum wages): β+ = -0.01 (95%CI = -2.60–2.10)
Costa et al., 2020[23]: No differences (p = 0,93)
Legends: *: compared to adolescents who had Body Mass Index up to 24.9 kg/m2; 95%CI: 95% confidence interval; OR: odds ratio; PR: prevalence ratio; SE: standard error.

Sedentary behavior was the most frequently assessed variable. In five papers [16,21–23,25], eight analyzes were identified, which mostly represent measures of screen time. In six of these analyzes [21–23,25], it was observed risk associations of screen time and higher consumption of ultra-processed foods (75%) (Table 3).

Subsequently, other variables could also be highlighted: studying in a private school (n = 4 articles; n = 4 analyses; 3 associations; 75%) [17,22,24,25], having higher scores of Body Mass Index (n = 4 articles; n = 5 analyses; 3 associations; 60%) [16,17,19,21] and female sex (n = 3 articles; n = 3 analyses; 2 associations; 66%) [17,23,24]. The variable maternal schooling showed discrepant associations, observing risks in relation to the highest [25] and lowest [23] levels of schooling. Complementarily, the variables age [16,21,24,25], waist circumference [16,17,21] and socioeconomic level [17,21,23] presented higher frequencies of statistically null results.

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4. Discussion

Based on eleven papers, which represent data from nine different studies conducted in Brazil, the synthesis of this review highlights and classifies the main variables related with consumption of ultra-processed foods among adolescents.

The available evidence reinforces the understanding that the consumption of ultra-processed foods among Brazilian adolescents is not only related to individual issues, considering the risk associations with the studying in a private school [22,24,25] which are part of the environmental domain.

Sedentary behavior, highlighting screen time (e.g., computer, television and / or videogame), was the variable most frequently analyzed and associated with higher consumption of ultra-processed foods [21–23,25]. It is worth mentioning that sedentary behavior is also an emerging theme in the scientific literature [26], due to its – often unavoidable – high frequency in the contemporary modus of life and deleterious effects on health, in different stages of life [27–29].

Exposure and convenience justify the relationship between screen time and higher consumption of ultra-processed foods. Regarding the exposure, there is the premise that the longer the screens are used, greater the adolescent's exposure to the advertising strategies of the food industries, which, in some way, can increase interest in certain products.

The food industry has specific lines and products aimed at this age group, using a strong visual appeal and a persuasive communication strategy [30]. Considering the high television advertising of ultra-processed foods in the country (≅60%) [31] and the habit of buying food products advertised on television increases the consumption of ultra-processed foods [32], regulation of their advertising and insertion of warning messages about the degree of processing (e.g., labeling of products) [33] are configured as necessary strategies.

However, it should be noted that these strategies are not simple or quick-to-implement, since the food industry – which is based on agribusiness and large transnational conglomerates – is highly representative in the Brazilian economy [34]. The interests of the industry often have repercussions on the weakening of governance structures aimed at preventing or controlling obesity and other chronic non-transmissible diseases in children and adolescents, limiting the States to implement its own actions, strategies and/or public policies, such as regulating and reducing access and/or availability of these products.

Anyway, confrontation actions also permeate the family environment, where the regulation of food, sharing of meals with parents and television time could occur [35,36], and schools, which could support the training, debate and implementation of health promotion actions among children and adolescents. Thus, the effects of school-based educational interventions conducted in Latin American countries on the reduction of screen time during leisure time among adolescents are relevant [37].

Regarding the convenience factor, it is important to highlight that, generally, due to their ready-made or pre-ready condition, ultra-processed foods tend not to affect attention so much, or even to break the pleasure related to the use of screens. This is an advantage in relation to fresh or minimally processed foods, which, as a rule, require more time to prepare.

About the second main result of the review, which indicates the risk of studying in a private school and presenting a higher consumption of ultra-processed foods [22,24,25], some reflections are also necessary. This finding converges with previous research [38], where it is suggested that the environment of private schools is more obesogenic in terms of access, offer, sale and advertising of industrialized products compared to the environment of public schools.

In addition to socioeconomic rhetoric, the Brazilian political perspective may exert influence on such evidence, since public schools are directly impacted by the actions of the (I) National School Feeding Program [24], which advocates school feeding and education actions food and nutrition aligned with the principles of adequate and healthy food indicated by the "Food Guide for the Brazilian population" [39] to all students throughout basic education and (II) of the School Health Program, a policy intersectoral that aims at strengthening knowledge and health practices among children and adolescents in the public school system. Paradoxically, it should be noted that adherence

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to the PNAE is negatively influenced by the presence of canteens and external food vendors, as well as the conditions of distribution and space for consuming meals [40].

Another point of discussion is the regulation of school canteens, which seems to have more impact on public schools, based on guidance [41] and surveillance by the PNAE. The literature suggests that the presence of canteens is associated with the consumption of ultra-processed foods [20] and this seems to be a problem that goes beyond the adolescents' option, since, when considering that cafeterias / canteens are usually rented space in schools, it is important its reflection in the economic field: the search for not having economic losses, on the part of the landlords, would culminate in the expansion of the supply of ultra-processed foods, which, in turn, have great appeal among adolescents.

Concerning the Body Mass Index, the observed associations may represent reverse causality, it means that the consumption of ultra-processed foods is probably associated with overweight and obesity. In any case, by recognizing the interactions of the obesogenic potential of interactions between screen time and the consumption of ultra-processed foods, as well as the complexity of the relationships between these and other variables [42,43], the importance of multicomponent actions, strategies and public policies is reinforced, which, somehow, they can also involve the family environment and surroundings.

Regarding the relationships between female gender and the consumption of ultra-processed foods, found in two studies [17,24], two points can be reflected: 1) it can be justified by the lack of knowledge about ultra-processed foods, ranging from their composition to the effects of consumption; 2) the possibility of a greater impact of marketing strategies among adolescents, which gives rise to the need for educational strategies, indicating aspects ranging from composition to the multidimensional effects of consumption of ultra-processed foods.

For a better interpretation and generalization of this synthesis findings, its necessary to share some considerations. Given the characteristics of the studies, the available evidence is more related to the reality of adolescents living in the urban contexts of Brazilian state capitals. Only two studies were concluded in cities that are not state capitals (Pelotas and Juiz de Fora), but they are urbanized and have more than 300 thousand inhabitants.

Complementarily, as the synthesis was elaborated from data available among the studies developed in the country, it is suggested that future researches investigating also conducting research that also the possible associations between interpersonal, environmental and political variables and the consumption of ultra-processed foods among Brazilian adolescents, understanding the multidimensional effects of behavior.

Furthermore, it should be noted that this summary offers a more general approach to the group of ultra-processed foods, based on the NOVA classification – to the detriment of specific types, such as snacks and sugary drinks, which may have more specific associated / determinant factors. Somehow, given the reinforcement of care with the standardization of the term and selection of studies, the knowledge synthesized in this review can support actions, strategies and public policies aimed at confronting the consumption of ultra-processed foods among Brazilian adolescents.

5. Conclusions

Finally, based on the available literature, the variables sedentary behavior – with emphasis on screen time –, studying at a private school, having a higher Body Mass Index and being female presented more frequent risk associations with the consumption of ultra-processed foods in Brazilian adolescents. It is important to target actions, strategies and public policies aimed at confronting the consumption of ultra-processed foods for these groups.

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Appendix A

The full description of systematic searches used in electronic databases.

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