Health behavioral theories used to explain dietary behaviors in adolescents: a systematic review

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Abstract

Background: Health behavior theories are useful to interpret adolescents’ dietary behaviors. Evidences show that theories are influenced by social and psychological determinants. So, the purpose of this study is to systematically review studies that tested social cognitive theories (non-integrated) that predict adolescents’ dietary behaviors.

Methods: A structured electronic search of all publication years (through April 2016) was conducted to identify studies in MEDLINE, SciELO, PsycINFO, Scopus, and LILACS with full text. Included publications were cross-sectional and longitudinal (non-intervention) studies involving adolescents (10 to 18 years) that examined the associations between constructs of social-cognitive theories and dietary behaviors. Related strings in titles, abstracts, and indexing fields were searched.

Results: Theories used to explain dietary intake were the planned behavior and the social cognitive. It was observed evidences of positive associations between the social cognitive constructs and the fruits, the vegetables, the milk groups, and the whole-wheat foods (e.g., bread rich in fiber) and negative associations with sugar-sweetened beverages, soft drinks, snacks high in fat, sugar, and/or sodium, and sweet treats. Theories explained greater proportion of variance for intention to dietary intake. The variance for intention ranged from 3% for pizzas, candy bars, candies, and sugar-sweetened beverages to 68% for whole-wheat food (i.e., bread rich in fiber).

Conclusion: Longitudinal designs are necessary to comprehend the theories and evaluate the behavioral changes. Finally, the use of food groups should be employed in the studies to help the comparisons and present higher reproducibility. Studies always based on objective, systematic, and rigorous evidences.

Keywords: Adolescents, Health behavioral theories, Dietary intake and systematic review

Background

Overweight and obesity among children and adolescents are a great public health worldwide concern [1]. Their development is associated with diverse and complex inter-related factors. While non-modifiable mechanisms (e.g., genetics) are partially to blame, there is a strong evidence for modifiable factors in the genesis of childhood obesity [2]. Among those factors, in individuals between 10 and 18 years of age, diet plays an important role showing a lower intake of energy from the following food groups: fruits; vegetables; and milk, cheese and yogurt; and higher intake in the following groups: fat and oils; and sugar and sweets groups [3–5].

The food pyramid is an orientation tool for the Brazilian population to limit the consumption of the sugar and sweets and oils and fats groups, with a great emphasis on the food items placed in its base, i.e., the group of rice, bread, potato, and cassava; fruits; and vegetables [6]. Similar recommendation exists in Australia [7], Canada [8], and the USA [9]. In spite of extensive evidence supporting the positive effects of healthy eating among youth, inadequate eating occurs among adolescents from high-, middle-, and low-income countries [10–12]. Also, age is a factor for
unhealthy eating behaviors. Adolescents tend to show higher inadequacies compared to children, and the behaviors that are established during this period tend to be consolidated in adulthood [12–14]. Considering several benefits of healthy eating and the amplitude of unhealthy diet consumption among adolescents, there is an urgent need for the comprehension of food behaviors in this population [6, 15].

Some reviews that correlate the diet of the individuals aged 10 to 19 suggest a variety of psychological, behavioral, and social factors associated with healthy eating: families and the friends/peers support, motivations, satisfaction, barriers to healthy eating, and facility access [16–23]. However, there is an evidence gap concerning the testing of specific theories or explaining the variance of specific social cognitive models. Furthermore, little is known about the magnitude of the association between social cognitive constructs and diet ingestion (i.e., individual food items or food groups that are statistically associated with social cognitive constructs).

Health behavioral theories (e.g., social cognitive theory, planned behavioral theory, and self-determination theory) are useful to understand adolescents’ dietary behaviors and to develop and guide intervention strategies. Therefore, studies based on theories are more effective in relation to behavioral changes compared to non-theoretical approaches [24]. There is evidence that theories are influenced by social and psychological determinants and that the approach is based on the self-regulation process and on how different social cognitive aspects are associated to eating behaviors [25]. So, the purpose of this article was to systematically review studies that have tested health behavioral theories to predict adolescents’ dietary behaviors.

Methods
It was a systematic literature review study. The question that guided this review was “What are the aspects of the health behavioral theories used to explain the adolescents’ dietary behaviors?”.

Search strategy
A structured electronic search employing the guide of the “Preferred Reporting Items for Systematic Reviews and Meta-Analyses” (PRISMA) [26, 27] of all publication years (through July of 2016) was conducted using the following five databases: Medical Literature Library of Medicine (MEDLINE), via PubMed; Scientific Electronic Library (SciELO); PsycINFO of the American Psychological Association (APA); Scopus; and Literatura Latino-Americana e do Caribe (Lilacs), via Biblioteca Virtual em Saúde (BVS). Systematic searchers were developed from this model, applied in PubMed: (dietary intake) OR (dietary behavior) OR (eating behavior) OR (fruit and vegetable) OR (fruit) OR (vegetables) OR (sugar sweetened beverages) OR (soft drinks) AND (adolescent) OR (teen) OR (youth) OR (adolescence) OR (children) OR (students) OR (child) OR (young people) OR (girl) OR (boy) AND (theory of planned behavior) OR (theory of reasoned action) OR (social cognitive theory) OR (self-efficacy theory) OR (self-determination theory). When possible, filters were employed in the electronic databases: (i) age, limiting publications to the samples from 10 to 18 years, or an average of the age group and (ii) languages, limiting the review to studies published in the English or Portuguese.

First, titles and abstracts identified in the search process were examined for adequacy, and additional articles known by the authors were examined for possible inclusion. Second, full articles were retrieved and examined for inclusion. Third, reference lists from the full articles retrieved were searched. Finally, relevant article list references (e.g., previous reviews) were examined for additional studies.

Studies selection criteria
The studies that tested specific social cognitive theories to predict healthy eating in pediatric populations were included in this review. Non-interventional studies (including both cross-sectional and longitudinal design) were considered for inclusion. Studies were eligible for inclusion if (1) quantitatively examined food consumption using self-reported methods (e.g., food frequency questionnaire, dietary recalls (habitual or 24-h), and/or food diaries) and (2) included participants aged 10 to 18 years. Studies were excluded if (a) addressed children (<10 years), adults (>18 and <60 years) and elderlies (>60 years); (b) tested integrated theories defined as studies that examined the key constructs of two or more theories. For the aim of this review, integrated theories were those that were specifically indicated to test the key constructs of two or more social cognitive theories, while non-integrated theories included the key constructs from a specific social cognitive theory (i.e., ≥2 theories in the same study) [25]; (c) were intervention studies; (d) did not assess food consumption as a study outcome; or (e) did not assess healthy eating. Congress abstracts, dissertations, thesis, and articles published in journals without peer review were not included in this study review.

The following social cognitive theories: theory of planned behavior, theory of reasoned action and social cognitive theory (self-efficacy or self-determinism) are most frequently cited in researches on health behaviors and health education [28] and/or theories frequently
cited in the eating domain [29–31] and/or commonly cited or theories recently cited in healthy eating domain with children and adolescents. Initially, a single reviewer (AL) assessed articles for eligibility based on the study title. After that, two authors (AL and PG) independently examined the study abstracts in a standard no blinded way. The findings were compared, and the differences were resolved by the third author (SP), when necessary.

Data extraction
The specific characteristics of the identified studies that were extracted included (1) theory used for the study development; (2) method of food consumption assessment; (3) psychosocial constructs examined; (4) associations between eating coefficients paths; and (5) variance explanation. Key characteristics of the identified studies were also extracted, including country of the study, size, and source of the population and design (Table 1).

Risk of bias
Two authors (AL and PG) independently evaluated the risk of bias of the studies that filled the inclusion criteria. The criteria to evaluate the risk of bias were adapted from the Strengthening the Report of Observational Studies in Epidemiology (STROBE) [32] and from the Consolidated Standards of Reporting Trials (CONSORT) [33] statements. The score of the risk of bias for each study was evaluated through a six-point scale assigning a 0 value (absent or insufficiently reported) or 1 (present or clearly described) for each of the questions reported in Table 2. Studies with a score of 0–2 were considered as of high risk of bias; studies with score of 3–4 were classified as of moderate risk of bias; and those with a score >5 were classified as of low-risk of bias. This score was based on previous systematic reviews [25, 34, 35].

Results
Overview of the studies
The systematic searches retrieved 1959 potential studies (Fig. 1). Of these were identified 17 studies that assessed the usefulness of health behavioral theories that explained adolescents’ dietary ingestion (Table 1). In terms of theory used in the methods of studies, 14 studies evaluated the planned behavioral theory [36–49] and three evaluated the social cognitive theory (self-efficacy/self-determinant theory) [50–52]. No study employing the “Theory of Reasoned Action” met the inclusion criteria, so these theories were not examined. The majority of the studies (14/17, 82.4%) employed cross-sectional design, whereas two were longitudinal studies (non-experimental) [43, 45]. Most of the studies (14/17, 82.4%) selected adolescents from regular fundamental and high schools [37–40, 42, 44–52], 1 (5.9%) from vocational schools [41], from family practice center [43], and other from a convenience sample through e-mail lists, community newspapers, flyers, and word-of-mouth dissemination [36]. The sample size varied from 100 [36] to 2746 [37]. The majority of the studies were conducted in the USA (5/17) [36, 44, 45, 47, 49] followed by The Netherlands (4/17) [39, 41, 43, 48], representing 52.9% of the total. Other countries represented in the descriptive synthesis were in Norway [40, 46], Sweden [50, 52], Australia [51], Canada [38], and New Zealand [42]. One study was multi-center and assessed the cultural differences in four European regions (Poland, Portugal, The Netherlands, and the UK) [37] (Table 1).

Food consumption assessment
Of the 17 studies, the majority (52.9%) examined sugar sweetened beverages intake (e.g., artificial juices—powder and nectar, sport energy drinks, soft drinks, and flavored milk) [36, 37, 39, 41–44, 48], followed by fruit and vegetables intake (47.1%) (i.e., fresh, frozen, and/or canned) [37, 38, 42, 45, 47, 49, 50], four examined the consumption of sugar, fat, and/or sodium-rich snacks (e.g., cookies, fish and chips* [typical dish from Australia, New Zealand, and the UK], fried chicken, fried snacks [i.e., nuts, corn, and potato chips], pastries [e.g., tarts, baked snacks, cakes], hamburgers, pizza, sweets, and candies) [37, 42, 47, 51], and only two (11.1%) examined breakfast items food intake (i.e., milk and bread [e.g., skim-, low-medium-, and full-fat milk, and high-fiber bread]) [40, 46]. It is important to highlight that four studies divided the food/beverages items into two categories: healthy/core foods and unhealthy/non-core foods [37, 42, 45, 51].

Data was collected using a diversity of self-reported methods; the most used one was the food frequency questionnaire (FFQ) (13/17, 76.5%) [37–39, 41–45, 48–52], two studies employed habitual or 24-h dietary recalls [36, 47] and a 7-day food diary [40, 46].

Risk of bias
Findings from the assessment of the study risk of bias are described in Table 2. Five studies were considered low risk of bias [36, 39, 43, 48, 51], 10 studies were classified as moderated risk of bias [37, 38, 40, 41, 49, 52], and 2 as being high risk of bias [42, 46].

Only two studies did not report the tool reproducibility for the food consumption assessment [46] (item 3) and one [46] the validity/reproducibility for the social cognitive measurements (item 4). Seven studies reported the power sample size calculation [36, 37, 39, 40, 43, 48, 51] (item 5), and 10 studies reported the number of adolescents who completed each different measurement [36, 38, 41, 43–45, 47–50] (item 6). The risk of bias was used to guide the level of evidence of
Table 1: Descriptive characteristics of the Var- of studies included and methodological issues

| Reference | Location (year) | Sample (age) | %F | Type | Selection | Assessment tool | Food item | Constructs analyzed | Equation model/effect measure |
|-----------|-----------------|--------------|----|------|-----------|-----------------|-----------|----------------------|--------------------------------|
| Riebl S.K. et al. 2016 | USA (2016) | 102 (14.0 ± 0.2) | 48 | CS | Conv | 24-h recall | SSB | Attitude, subjective norm, intention, and PBC | Bias corrected bootstrapping of confidence interval |
| Stok F.M. et al. 2015 | Poland, Portugal, The UK and The Netherlands (2015) | 2764 (13.2 ± 1.9) | 49.1 | CS | Conv | FFQ | FV, snacks and SSB | Subjective norm and intention | Hierarchical linear regression |
| Branscum, P., Sharma, M. 2014 | USA (2014) | 167 [10.5 (%2) ± 10.3 (%3)] | 58.7 | CS | Conv | 24-h recall | Calorie dense-nutrient-poor snacks and FV | Attitude, subjective norm, intention, and PBC | Hierarchical linear regression |
| Tak N.I. et al. 2011 | The Netherlands (2011) | 187 (14.1 ± 1.2) | 46 | CS | Rand | FFQ | SSB | Attitude, subjective norm, intention, and PBC | Hierarchical linear regression |
| Murnaghan D.A. et al. 2010 | Canada (2010) | 287 (13 to 14) | 51 | CS | Conv | FFQ | FV | Attitude, subjective norm, intention, PBC, and behavioral/normative/control beliefs | Structural equation models using the maximum likelihood analysis |
| Ezendam N.P. et al. 2010 | The Netherlands (2010) | 348 (12.6 ± 0.5) | 52.3 | CS | Rand | FFQ | SSB | Attitude, subjective norm, intention, and PBC | Multilevel logistic regression models and product-of-coefficient test |
| Conner M. et al. 2010 | Sweden (2010) | 1735 (11 to 15) | NA | CS | Conv | 7-day food diary | High-fiber bread and low-fat milk | Attitude, subjective norm, intention, PBC, and behavioral/normative/control beliefs | Hierarchical linear regression |
| de Brujin G.V. et al. 2009 | The Netherlands (2009) | 312 (14.6 ± 1.3) | 65.3 | CS | Conv | FFQ | Soft drinks | Attitude, subjective norm, intention, and PBC | Structural equation models using the maximum likelihood analysis |
| Hewitt A.M., Stephens C. 2007 | New Zealand (2007) | 261 (11.4) | 52.9 | CS | Conv | FFQ | FV, treats food, fizzy drinks and takeaway foods | Attitude, subjective norm, intention, PBC, and behavioral/normative/control beliefs | Hierarchical linear regression |
| de Brujin G.J. et al. 2007 | The Netherlands (2007) | 208 (15.2 ± 1.9) | 61.5 | L | Conv | FFQ | SSB | Attitude, subjective norm, intention, and PBC | Hierarchical linear regression |
| Kassem N.O. et al. 2003 | USA (2003) | 707 (13 to 18) | 100 | CS | Conv | FFQ | Soft drinks | Attitudes, subjective norm, intention, and PBC | Hierarchical linear regression |
| Backman D.R. et al. 2002 | USA (2002) | 735 (14 to 19) | 55.9 | L | Rand | FFQ | FV | Attitude, subjective norm, intention, PBC, and behavioral/normative/control beliefs | Hierarchical linear regression |
| Lien N. et al. 2002 | USA (1998 – 1999) | 1406 (N/A) | 47.8 | L | Rand | FFQ | FV | Attitude, subjective norm, intention, barriers | Structural equation models using the maximum likelihood analysis |
| Study Authors          | Country (Year) | Sample Size | Type  | Methodology | Measure                          | Analysis | Theory/Model                   |
|-----------------------|----------------|-------------|-------|-------------|----------------------------------|----------|--------------------------------|
| Berg C. et al. 2000    | Sweden (2000)  | 1739        | CS    | Rand        | 7-day food diary                 | Milk and high-fiber bread                  | Attitude, subjective norm, intention, PBC, and behavioral/normative/control beliefs | Hierarchical linear regression |
| Melby E.L. et al. 2016 | Norway (2016)  | 440         | CS    | Conv        | FFQ                             | SSB      | Perceived parental regulation  | Paired samples t tests         |
| Lubans D.R. et al. 2012 | Australia (2014) | 357         | CS    | Rand        | FFQ                             | Core and non-core foods                  | Self-efficacy, intentions, behavioral strategies, family support, situations, outcome expectations, and expectancies | Structural equation models using the maximum likelihood analysis |
| Bere E., Klepp K.I. 2004 | Norway (2004)  | 1950 (11.8) | CS    | Rand        | FFQ                             | FV                                | Self-efficacy, intentions, behavioral strategies, family support, situations, outcome expectations | Hierarchical linear regression |

%F percentage of girls in the sample, CS cross-sectional, Conv convenience, FFQ food frequency questionnaire, FV fruit and vegetables, L longitudinal, NA not available, Rand randomization, PBC perceived behavior control, SCT social cognitive theory, SDT self-determination theory, SSB sugar-sweetened beverages, TPB theory of planned behavior.
Table 2  Risk of bias of studies included in this review

| Study                        | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Total (risk of bias) |
|------------------------------|----|----|----|----|----|----|----------------------|
| Riebl S.K. et al. 2016       | 1  | 1  | 1  | 1  | 1  | 1  | 6                    |
| Melby E.L. et al. 2016       | 1  | 0  | 1  | 1  | 0  | 0  | 3                    |
| Stok F.M. et al. 2015        | 1  | 0  | 1  | 1  | 1  | 0  | 4                    |
| Branscum P., Sharma M. 2014 | 1  | 0  | 1  | 1  | 0  | 1  | 4                    |
| Lubans D.R. et al. 2012      | 1  | 1  | 1  | 1  | 1  | 0  | 5                    |
| Tak N.I. et al. 2011         | 1  | 0  | 1  | 1  | 1  | 1  | 5                    |
| Murnaghan D.A. et al. 2010   | 1  | 0  | 1  | 1  | 1  | 0  | 4                    |
| Ezendam N.P. et al. 2010     | 1  | 1  | 1  | 1  | 1  | 0  | 5                    |
| Conner M. et al. 2010        | 1  | 1  | 1  | 1  | 1  | 1  | 4                    |
| de Bruijn G-V. et al. 2009   | 0  | 0  | 1  | 1  | 1  | 0  | 3                    |
| Hewitt A.M., Stephens C. 2007| 0  | 0  | 1  | 1  | 0  | 0  | 2                    |
| de Bruijn G.J. et al. 2007   | 1  | 0  | 1  | 1  | 1  | 1  | 5                    |
| Bere E., Klepp KI. 2004      | 1  | 0  | 1  | 1  | 1  | 0  | 4                    |
| Kassem N.O. et al. 2003      | 1  | 0  | 1  | 1  | 0  | 1  | 4                    |
| Backman D.R. et al. 2002     | 1  | 0  | 1  | 1  | 0  | 1  | 4                    |
| Lien N. et al. 2002          | 1  | 0  | 1  | 1  | 0  | 1  | 4                    |
| Berg C. et al. 2000          | 1  | 0  | 0  | 0  | 0  | 0  | 1                    |

(1) Did the study describe the participant eligibility criteria? (2) Were the participants randomly selected? (3) Did the study report the sources and details of dietary intake assessment and did the instruments have acceptable reliability for the specific age group? (4) Did the study report the sources and details of assessment of social cognitive aspects outcomes and did all of the methods have acceptable reliability? (5) Did the study report a power calculation and was the study adequately powered to detect hypothesized relationships? (6) Did the study report the numbers of individuals who completed each of the different measures and did participants complete at least 80% of dietary intake measures?

Fig. 1 Systematic review flowchart
the available studies. The differences among the studies with moderate- and high-risk of bias and low-risk of bias were related to (i) type of sample selection (i.e., convenience vs. random sample); (ii) report power calculation and were adequately powered to detect hypothesized relationships; (iii) report the number of adolescents who completed each of the different measures and were able to complete at least 80% of the dietary measures. All discrepancies between reviewers in relation to data extraction were solved via consensus.

Overview of the evidence
The cross-sectional data presented the intention variance explained ranging from 3% for food items from the snacks group (i.e., pizza, candy bar, and candies and sugar-sweetened beverages) [37] and 93% for skimmed milk [46]. In general, the intention variance for most of the cross-sectional data was on the range of 31 to 56% for the following food items: (snacks—calorie/dense-nutrient poor snacks), sugar-sweetened beverages (including the soft drinks), treats and takeaways, high-fiber bread, and FV [37, 40, 42, 45, 47–49]. Moreover, higher β values (i.e., positive association) were observed in relation to the association between attitudes for soft drink intake [44], attitudes for snacks [i.e., included all types of food items that can be eaten in in-between meals such as cookies, candy, fried potato chips, and fruits and vegetables (including fresh, frozen, and canned)] [47], behavioral strategies and self-efficacy for the core foods [51]. The core foods included the following food groups: breads and cereals, fruits, vegetables, milk, and meats. Those items, also, pertained to the smart food concept, which is to choose food items with better nutrition values: (i) reduced in fat, sugar, and sodium, and (ii) high in vitamins, minerals, and fiber, such fruits and vegetables and whole-wheat foods (e.g., breads, rice, pasta, and cookies) [6]. A negative association (i.e., lowest β values) was observed for intention and perceived behavioral control for soft drink consumption [36, 39] and calorie/dense nutrient poor food items only for the girls [47].

Longitudinal data presented variance explained 67% of the intention for fat milk reduction intake [40] and 41% for intention of FV intake [38]. The highest β values were demonstrated in perceived behavioral control for sugar-sweetened beverages [39] and for descriptive norm for fat milk consumption [40], and lowest β values for attitudes (i.e., negative) for soft drink intake [43] and perceived confidence for whole-wheat bread (i.e., whole wheat food items), attitudes and subjective norms for fruits and vegetables consumption [38] (Table 3).

Discussion
The aim of this review was to evaluate the explanatory power of the main health behavioral theories to identify the social cognitive theories of the adolescents’ eating behaviors. Seventeen eligible studies were identified and the majority showed moderate to low risk of bias. All the studies demonstrated adequate reliability to the social cognitive measures, and the majority reported adequate reliability for the assessment of food consumption. Both measures used self-reported questionnaires. The good reliability might have influenced the way to predict the ability of the social cognitive measures and food consumption through the studies of this review [25].

There were differences in the theoretical approach, in the population (i.e., age and sex), in the food consumption outcomes (e.g., sugar-sweetened beverages, soft drinks, fruits and vegetables, and energy-dense poor nutrient food items), in the food surveys (e.g., food frequency questionnaire and recalls), and in the construct methods of behavioral mediators. Differences also occurred within the same study in regard to the social economic variables (e.g., sex and local). Therefore, it is difficult to draw a conclusion with respect to this issue [24].

Furthermore, there might be limitations due to the non-examination of all constructs detailed in the health behavioral theories and also because the majority of the review studies presented cross-sectional design. However, it is worth noting that there were no integrated theories in the studies, and that some constructs from one theory are equivalent to the constructs of another theory. For example, “self-efficacy”, the key construct of the social cognitive theory (SCT) is similar to “perceived behavioral control” (PBC) of the theory of planned behavior (TPB). Moreover, attitudes in the TPB are comparable to the expectations of the SCT, which is related to physical and cognitive beliefs about healthy eating (e.g., healthy eating can help weight control) [53].

Taking into account the social cognitive constructs with and/or within studies, a certain consistency level was observed for intention, perceived behavioral control/self-efficacy, subjective norms, attitudes/expectations, and availability, as being positively related to eating behavior. These constructs also presented an important correlation with children and adolescents in cross-sectional and longitudinal (i.e., non-experimental) designs [15, 54–58]. Although this review presented some studies with longitudinal design, the majority of them were cross-sectional, making it difficult to provide enough support to predict the construct validity [24].

However, few of the longitudinal studies presented might be useful to explain that intentions, attitudes, subjective norms, availability, and self-efficacy/self-control are potential determinants for food intake. Corroborating with previous studies, subjective norms, intentions, and control presented non-significant findings related to food consumption [24]. From the evidence provided by
| Food items | Association with DI and co-efficients | Variance explained |
|------------|-------------------------------------|--------------------|
| SSB        | Intention: $\beta = -0.27$; PBC: $\beta = 0.09$; subjective norms: $\beta = -0.10$; attitudes: $\beta = -0.01$ | Intention 12% |
| FV         | Peer encouragement for healthy eating: $\beta = 0.097$ | Intention 4% |
| Snacks     | Peer encouragement for healthy eating: $\beta = -0.063$ | Intention 3% |
| Calorie/dense-nutrient poor snacks | Intention: $\beta = -0.286$ (girls) | Intention 7.2% (girls) |
| FV         | Intention $\beta = 0.27$ (boys and girls) | Intention 6% |
| High-fiber bread | Instrumental attitude: $\beta = 0.17$; affective attitude: $\beta = 0.21$; injunctive norm: $\beta = 0.15$; descriptive norm: $\beta = 0.23$; perceived confidence: $\beta = 0.06$ | Intention 37% |
| Skimmed milk | Instrumental attitude: $\beta = 0.23$; affective attitude: $\beta = 0.17$; injunctive norm: $\beta = 0.13$; descriptive norm: $\beta = 0.36$; perceived confidence: $\beta = 0.11$ | Intention 67% |
| Soft drink | Attitude: $\beta = 0.482$; intention: $\beta = 0.539$; subjective norm: $\beta = 0.309$ | Intention 19, 24, and 36.6% |
| SSB        | Availability: PBC: $\beta = -0.61$ | Intention 28% |
| FV         | Attitude: $\beta = 0.19$; subjective norm $\beta = 0.15$; PBC: $\beta = 0.24$ | Intention 50% |
| Soft drink | PBC: $\beta = 0.33$ | Intention 18.6% |
| FV, treat foods, SSB and takeaways | Intention: $\beta = 0.41$; PBC: $\beta = 0.21$ | Intention 44% |
| Soft drink | Attitude: $\beta = 0.32$; subjective norm $\beta = 0.22$; PBC: $\beta = 0.16$ | Intention 14% |
| Soft drink | Attitude: $\beta = 0.58$; subjective norm $\beta = 0.14$; PBC: $\beta = 0.24$ | Intention 28% |
| FV, %fat and total calories | Attitude: $\beta = 0.39$; subjective norm $\beta = 0.23$; PBC: $\beta = 0.28$ | Intention 42% |
| FV         | Attitude: $\beta = 0.13$; subjective norm $\beta = 0.34$; barriers: $\beta = 0.33$; intentions: $\beta = 0.11$ | Intention 31% |
| High-fiber bread | PBC: $\beta = 0.05$ | Intention 68% |
| Skimmed milk | Injunctive norm: $\beta = 0.08$; PBC: $\beta = 0.09$ | Intention 93% |
| Medium-fat milk | PBC: $\beta = 0.10$ | Intention 79% |
### Table 3: Synthesis of the relationships between the variables and dietary intake in adolescents (Continued)

| Social cognitive theory | Maternal legitimacy regulation: $\beta = -0.88$; maternal overt control: $\beta = 0.61$; paternal legitimacy regulation: $\beta = -0.89$ | Melbye E.L. et al. 2016 | N/A | Melbye E.L. et al. 2016 |
|-------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------|-----|-------------------------|
| Soft drink              |                                                                                                                 |                         |     |                         |
| Core foods              | Self-efficacy: $\beta = 0.46$; behavioral strategies: $\beta = 0.55$                                           | Lubans D.R. et al. 2012 | Intention 45% | Lubans D.R. et al. 2012 |
| Non-core foods          | Self-efficacy: $\beta = -0.46$                                                                                | Lubans D.R. et al. 2012 | Intention 48% | Lubans D.R. et al. 2012 |
| FV                      | Self-efficacy: $\beta = 0.10$; modeling: $\beta = 0.05$; accessibility: $\beta = 0.27$; preferences: $\beta = 0.26$; awareness: $\beta = 0.12$. | Bere E., Klepp K-I. 2004 | Intention 31% | Bere E., Klepp K-I. 2004 |

DI: dietary intake, FV: fruits and vegetables, N/A: not available, PBC: perceived behavioral control, SSB: sugar-sweetened beverages
cross-sectional and longitudinal (non-experimental) designs, it might be suggested that social cognitive constructs are useful to explain certain eating behaviors and to guide future intervention strategies to improve dietary behavior. As consequence, they might prevent diet-related diseases (e.g., obesity and non-communicable diseases). Those strategies should always be based on health behavior theories, being the social cognitive and planned behavioral theories the most used ones in the nutrition area.

As noted in Table 1, the variability of the social cognitive constructs presented in the theories demonstrated the strength of those theories to predict dietary ingestion. However, due to the fact that the food consumption data was self-reported, it should be interpreted with caution, because adolescents, mainly those classified as overweight/obese can misreport the consumption of some food items. For example, those related to fruits and vegetables might be over-reported and those related from the sugars and sweets and the oils and fats groups might be under-reported [59]. On the other hand, subjective measurements to assess food consumption might present some problems: (1) low percentage of individuals meeting the food guideline recommendations; (2) high-cost benefits to use those methods, such as, the double-labeled water [60–62]. Those methods are adequate for the use in laboratory and clinical research, but very complicated to be used in the real world setting (displacement to the communities, especially schools and residences) [6, 63]. The majority of the variance in eating consumption is little explained in the studies presented in this review, so future research should integrate models that include psychosocial predictors, dietary determinants, and ecological multi-levels, i.e., social, community, policies, and environment [25].

Evidence indicates that girls reported a higher ingestion of foods, such as packaged snacks, fried snacks, processed meats, cookies, and candies/sweets comparing to boys [64]. Hence, the comprehension of dietary behaviors and differences between sexes might be necessary. Among the studies that assessed differences between sexes, Riebl et al. [36] verified that girls drink less soft drinks than boys, being that there was a variation of 16% for this behavior. Similarly, Stock et al. [37] observed a higher consumption of unhealthy snacks and soft drinks among boys, and Ezendam et al. [39] a lower ingestion of soft drinks in the girls group. Conner et al. [40] verified that girls have higher intentions to consume food items rich in fiber, i.e., whole-wheat bread.

The study of Lubans et al. [51], on the contrary, was the only one that presented a sample exclusively with female adolescents and observed 51% of intention and 13% of intake of saturated fat energy; 48% of intention and 18% of intake of energy-dense rich nutrient food items. The reviewed model explained 45 and 20% of intention variation and behaviors, respectively. The comprehension of intention and eating behavior variation and differences between sexes can be useful in the development of behavior change strategies, once these strategies can be a proxy for the implementation of more robust intentions resulting in the use of more accurate measurements. Moreover, other measurements should be presented to examine dietary determinants, i.e., psychological, social, and environmental. For instance, the quality of food items available in schools and neighborhood characteristics. Both have been identified as adolescents’ dietary determinants. Health behavior social-ecological models that include significant environmental characteristics (e.g., closeness and quantity of outlets that have fast-foods and/or food items rich in fat, sugar, and salt) and policies (e.g., changes in the school-canteen—less energy-dense poor nutrient and more energy-dense rich nutrient food items) can be considered in the future research examining adolescents dietary behaviors [51], specially verifying differences between sexes.

Future studies should investigate the usefulness of the health behavioral theories in providing complementary explanation about adolescents’ eating behaviors. Also, future research that integrates theories is clearly needed. The component for the advance of theories is to test the improvement of models with additional behavior constructs [25], i.e., diets. This can support the integration of theories in the case where specific constructs are designed and tested as mediators. Furthermore, this approach offers accuracy to the original model, in case these additional constructs do not explain the behavior variance.

This systematic review filled the gap in the scientific literature because it explores the power of the social cognitive theories in the description of adolescents’ eating behaviors. However, some limitations should be noted. First, the exclusion of published articles in languages that were not English and Portuguese, because it was difficult to identify, retrieve, and translate. Moher et al. [65] observed that despite the strengths of some studies published in other languages (not English), the language restriction was not a source of bias to estimate the studies effectiveness. Second, 22 studies were excluded on behalf of incomplete data to perform this systematic review. Studies were published in the last decades and so it was the difficult to find full texts and to contact authors by email. Third, the studies assessed were limited to the inclusion of specific health behavioral theories (i.e., theory of planned behavior, theory of reasoned action, social cognitive/self-efficacy theory), so the complete spectrum of the theories was not included. Finally, theories were not equally represented (i.e., number of studies represented in each theory). That might limit the interpretations in
relation to the contributions of the adolescents’ eating behaviors.

Conclusions
The systematic review demonstrated that social cognitive and planned behavioral theories were the most used ones to predict adolescents’ dietary behaviors. Future studies employing low risk bias methodologies are needed. New studies with longitudinal design are necessary to improve the understanding about these theories and assess behavior change.

Therefore, it is recommended that the social cognitive constructs are useful to explain certain eating behaviors and to guide future intervention strategies to improve dietary behavior as well as the use of food groups to allow the comparison and reproducibility in future cross-sectional and longitudinal (i.e., non-experimental and experimental) studies. Always based on studies with objective, systematic, and rigorous evidences.

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Competing interests
The authors declare they have no competing interests.

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