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

Sonia Tucunduva Philippi[1*], Paulo Henrique Guerra[2,3] and Ana Carolina Barco Leme[4]

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

* Correspondence: philippi@usp.br
[1]Department of Nutrition, School of Public Health, University of São Paulo, Av: Dr. Arnaldo, 715 - Cerqueira Cesar, São Paulo CEP 01246-904, Brazil
Full list of author information is available at the end of the article

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
Theory of planned behavior (TPB)									
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 (♀) e 10.3 (♂)]	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, i ntention, 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 Bruijn 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 Bruijn 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, intentions, barriers	Structural equation models using the maximum likelihood analysis

Table 1 Descriptive characteristics of the Var- of studies included and methodological issues *(Continued)*

Berg C. et al. 2000	Sweden (2000)	1739 (11 to 15)	52	CS	Rand	7-day food diary	Milk and high-fiber bread	Attitude, subjective norm, intention, PBC, and behavioral/ normative/control beliefs	Hierarchical linear regression
Social cognitive theory									
Melby E.L. et al. 2016	Norway (2016)	440 (13 to 15)	52	CS	Conv	FFQ	SSB	Perceived parental regulation	Paired samples *t* tests
Lubans D.R. et al. 2012	Australia (2014)	357 (13.2 ± 0.5)	100	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)	49.5	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	0	1	4
Ezendam N.P. et al. 2010	1	1	1	1	1	0	5
Conner M. et al. 2010	1	1	0	1	1	0	4
de Bruijn G-V. et al. 2009	0	0	1	1	0	1	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 K.I. 2004	1	0	1	1	0	1	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?

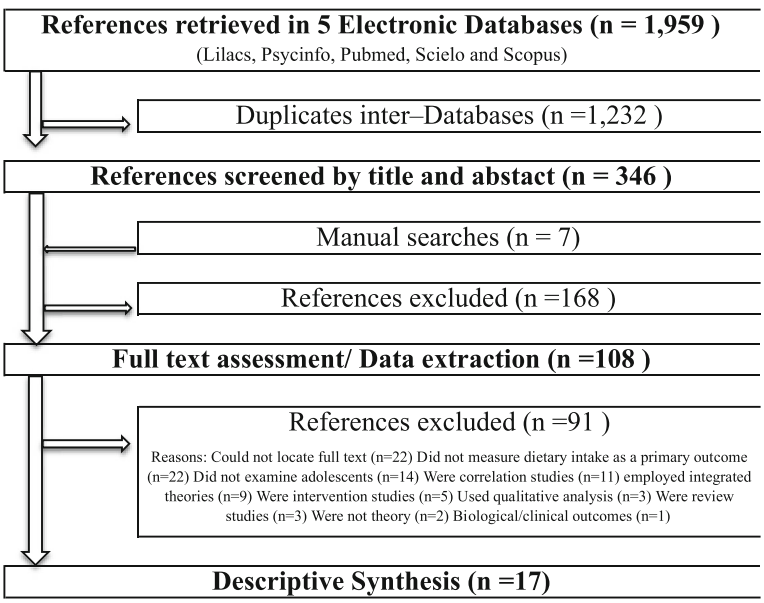

Fig. 1 Systematic review flowchart

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 ß 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 ß 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 ß values were demonstrated in perceived behavioral control for sugar-sweetened beverages [39] and for descriptive norm for fat milk consumption [40], and lowest ß 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

Table 3 Synthesis of the relationships between the variables and dietary intake in adolescents

Food items	Association with DI and co-efficients		Variance explained	
	Constructs/exposure variable	Reference	Constructs/exposure variable	Reference
Theory of planned behavior				
SSB	Intention: ß = −0.27; PBC: ß =0.09; subjective norms: ß = −0.10; attitudes: ß = −0.01	Riebl S.K. et al. 2016	Intention 12%	Riebl S.K. et al. 2016
FV	Peer encouragement for healthy eating: ß = 0.097	Stok F.M. et al. 2015	Intention 4%	Stok F.M. et al. 2015
Snacks—pizza, candy bar and candies; SSB	Peer encouragement for healthy eating: ß = −0.063	Stok F.M. et al. 2015	Intention 3%	Stok F.M. et al. 2015
Snacks	Attitude: ß =0.56; PBC: ß = 0.27; subjective norms: ß = 0.19 (for boys) and attitudes: ß =0.04; subjective norms: ß = 0.29; PBC: ß = 0.27 (girls)	Branscum P., Sharma M 2014	Intention 56% (boys) and 39% (girls)	Branscum P., Sharma M 2014
Calorie/dense-nutrient poor snacks	Intention: ß = −0.286 (girls)	Branscum P., Sharma M 2014	Intention 7.2% (girls)	Branscum P., Sharma M 2014
FV	Intention ß = 0.27 (boys and girls)	Branscum P., Sharma M 2014	Intention 6%	Branscum P., Sharma M 2014
High-fiber bread	Instrumental attitude: ß = 0.17; affective attitude: ß = 0.21; injunctive norm: ß = 0.15; descriptive norm: ß = 0.23; perceived confidence: ß = 0.06	Conner M. et al. 2011	Intention 37%	Conner M. et al. 2011
Skimmed milk	Instrumental attitude: ß = 0.23; affective attitude: ß = 0.17; injunctive norm: ß = 0.15; descriptive norm: ß = 0.36; perceived confidence: ß = 0.11	Conner M. et al. 2011	Intention 67%	Conner M. et al. 2011
Soft drink	Attitude: ß = 0.482; intention: ß = 0.539; subjective norm: ß = 0.309	Tak N.I. et al. 2011	Intention 19, 24, and 36.6%	Tak N.I. et al. 2011
SSB	Availability: PBC: ß = −0.61	Ezendam N.P.M. et al. 2010	Intention 28%	Ezendam N.P.M. et al. 2010
FV	Attitude: ß = 0.19; subjective norm: ß = 0.15; PBC: ß = 0.24	Murnagham D.A. et al. 2010	Intention 50%	Murnagham D.A. et al. 2010
Soft drink	PBC: ß = 0.33	Bruijn G.J., Putte B. 2009	Intention 18.6%	Bruijn G.J., Putte B. 2009
FV, treat foods, SSB and takeaways	Intention: ß = 0.41; PBC: ß = 0.21	Hewitt A.M., Stephens C. 2007	Intention 44%	Hewitt A.M., Stephens C. 2007
Soft drink	Attitude: ß = 0.32; subjective norm: ß = 0.22; PBC: ß = 0.16	Bruijn G.J. et al. 2007	Intention 14%	Bruijn G.J. et al. 2007
Soft drink	Attitude: ß = 0.58; subjective norm: ß = 0.14; PBC: ß = 0.24	Kassem N.O. et al. 2003	Intention 28%	Kassem N.O. et al. 2003
FV, %fat and total calories	Attitude: ß = 039; subjective norm: ß = 0.23; PBC: ß = 0.28	Backman D.R. et al. 2002	Intention 42%	Backman D.R. et al. 2002
FV	Attitude: ß = 0.13; subjective norm: ß = 0.34; barriers: ß = 0.33; intentions: ß = 0.11	Lien N. et al. 2002	Intention 31%	Lien N. et al. 2002
High-fiber bread	PBC: ß = 0.05	Berg C. et al. 2000	Intention 68%	Berg C. et al. 2000
Skimmed milk	Injunctive norm: ß = 0.08; PBC: ß = 0.09	Berg C. et al. 2000	Intention 93%	Berg C. et al. 2000
Medium-fat milk	PBC: ß = 0.10	Berg C. et al. 2000	Intention 79%	Berg C. et al. 2000

Table 3 Synthesis of the relationships between the variables and dietary intake in adolescents *(Continued)*

Social cognitive theory				
Soft drink	Maternal legitimacy regulation: ß = –0.88; maternal overt control: ß = 0.61; paternal legitimacy regulation: ß = –0.89	Melbye E.L. et al. 2016	N/A	Melbye E.L. et al. 2016
Core foods	Self-efficacy: ß = 046; behavioral strategies: ß = 0.55	Lubans D.R. et al. 2012	Intention 45%	Lubans D.R. et al. 2012
Non-core foods	Self-efficacy: ß = –0.46	Lubans D.R. et al. 2012	Intention 48%	Lubans D.R. et al. 2012
FV	Self-efficacy: ß = 0.10; modeling: ß = 0.05; accessibility: ß = 0.27; preferences: ß = 0.26; awareness: ß = 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 underreported [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 e-mail. 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-sectionals and longitudinal (i.e., non-experimental and experimental) studies. Always based on studies with objective, systematic, and rigorous evidences.

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All authors read and approved the final manuscript. ST is a senior researcher of this project, contributed to the study conceptualization and manuscript preparation, and provided critical editorial input of the data. PG contributed to the application of the methods for the references searches, reading, examination, and relevant data abstraction and drafted the manuscript. AL conducted the literature review and the abstraction of study data and drafted the manuscript.

Competing interests

The authors declare they have no competing interests.

Author details

[1]Department of Nutrition, School of Public Health, University of São Paulo, Av: Dr. Arnaldo, 715 - Cerqueira Cesar, São Paulo CEP 01246-904, Brazil. [2]Federal University Fronteira do Sul, Chapecó, Santa Catarina, Brazil. [3]Group of Studies and Research in Physical Activity Epidemiology and Health, São Paulo, Brazil. [4]School of Public Health, University of São Paulo, São Paulo, Brazil.

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References

1. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, Mullany EC, Biryukov S, Abbafati C, Abera SF, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2014;384(9945):766–81.
2. Han JC, Lawlor DA, Kimm SY. Childhood obesity. Lancet. 2010;375(9727):1737–48.
3. Ochola S, Masibo PK. Dietary intake of schoolchildren and adolescents in developing countries. Ann Nutr Metab. 2014;64 Suppl 2:24–40.
4. Enes CC, Slater B. Dietary intake of adolescents compared with the Brazilian Food Guide and their differences according to anthropometric data and physical activity. Rev Bras Epidemiol. 2015;18(4):798–808.
5. Ha K, Chung S, Lee HS, Kim CI, Joung H, Paik HY, Song Y. Association of dietary sugars and sugar-sweetened beverage intake with obesity in Korean children and adolescents. Nutrients. 2016;8(1):E31.
6. Philippi ST, Barco Leme AC. Dietary intake and meal frequency of Brazilian girls attending a school-based randomized controlled trial. Nutrition & Food Science. 2015;45(6):954–68.
7. Australia. Eat for health—Australian Dietary Guidelines providing the scientific evidence for healthier Australian diets. In: National Health and Medical Research Council, Department of Health and Aging. 2013.
8. Katamay SW, Esslinger KA, Vigneault M, Johnston JL, Junkins BA, Robbins LG, Sirois IV, Jones-Mclean EM, Kennedy AF, Bush MA, et al. Eating well with Canada's Food Guide (2007): development of the food intake pattern. Nutr Rev. 2007;65(4):155–66.
9. USDA. 2015–2020 Dietary Guidelines for Americans. United States: U.S. Department of Health and Human Services and U.S. Department of Agriculture; December 2015
10. Zhang Z, Gillespie C, Welsh JA, Hu FB, Yang Q. Usual intake of added sugars and lipid profiles among the U.S. adolescents: National Health and Nutrition Examination Survey, 2005–2010. J Adolesc Health. 2015;56(3):352–9.
11. Louzada ML, Baraldi LG, Steele EM, Martins AP, Canella DS, Moubarac JC, Levy RB, Cannon G, Afshin A, Imamura F, et al. Consumption of ultra-processed foods and obesity in Brazilian adolescents and adults. Prev Med. 2015;81:9–15.
12. Stephens LD, McNaughton SA, Crawford D, Ball K. Predictors of high-energy foods and beverages: a longitudinal study among socio-economically disadvantaged adolescents. Public Health Nutr. 2014;17(2):324–37.
13. Bucher Della Torre S, Keller A, Laure Depeyre J, Kruseman M. Sugar-sweetened beverages and obesity risk in children and adolescents: a systematic analysis on how methodological quality may influence conclusions. J Acad Nutr Diet. 2016;116(4):638–59.
14. Al Junaibi A, Abdulle A, Sabri S, Hag-Ali M, Nagelkerke N. The prevalence and potential determinants of obesity among school children and adolescents in Abu Dhabi, United Arab Emirates. Int J Obes (Lond). 2013; 37(1):68–74.
15. Leme ACB, Philippi ST, Toassa EC. O que os adolescentes preferem: os alimentos da escola ou os alimentos competitivos? Saúde e Sociedade. 2013;22(2):456–67.
16. Van Lippevelde W, Verloigne M, De Bourdeaudhuij I, Brug J, Bjelland M, Lien N, Maes L. Does parental involvement make a difference in school-based nutrition and physical activity interventions? A systematic review of randomized controlled trials. Int J Public Health. 2012;57(4):673–8.
17. Fletcher A, Bonell C, Sorhaindo A. You are what your friends eat: systematic review of social network analyses of young people's eating behaviours and bodyweight. J Epidemiol Community Health. 2011;65(6):548–55.
18. Pearson N, Biddle SJ, Gorely T. Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review. Public Health Nutr. 2009;12(2):267–83.
19. Pearson N, Biddle SJ, Gorely T. Family correlates of breakfast consumption among children and adolescents. A systematic review. Appetite. 2009;52(1):1–7.
20. Woodruff SJ, Hanning RM. A review of family meal influence on adolescents' dietary intake. Can J Diet Pract Res. 2008;69(1):14–22.
21. McLean N, Griffin S, Toney K, Hardeman W. Family involvement in weight control, weight maintenance and weight-loss interventions: a systematic review of randomised trials. Int J Obes Relat Metab Disord. 2003;27(9):987–1005.
22. Barbosa Filho VC, de Campos W, Lopes Ada S. Epidemiology of physical inactivity, sedentary behaviors, and unhealthy eating habits among Brazilian adolescents: a systematic review. Cien Saude Colet. 2014;19(1):173–93.
23. Akbari F, Azadbakht L. A systematic review on diet quality among Iranian youth: focusing on reports from Tehran and Isfahan. Arch Iran Med. 2014; 17(8):574–84.
24. Cerin E, Barnett A, Baranowski T. Testing theories of dietary behavior change in youth using the mediating variable model with intervention programs. J Nutr Educ Behav. 2009;41(5):309–18.
25. Plotnikoff RC, Costigan SA, Karunamuni N, Lubans DR. Social cognitive theories used to explain physical activity behavior in adolescents: a systematic review and meta-analysis. Prev Med. 2013;56(5):245–53.
26. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ. 2009;339:b2535.
27. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009;6(7):e1000097.
28. Conner M, Norman P, editors. Predicting health behavior: research and practice with social cognition models. 2nd ed. Buckingham: Open University Press; 2005.

29. Franko DL, Cousineau TM, Rodgers RF, Roehrig JP, Hoffman JA. Social-cognitive correlates of fruit and vegetable consumption in minority and non-minority youth. J Nutr Educ Behav. 2013;45(2):96–101.
30. Luszczynska A, Horodyska K, Zarychta K, Liszewska N, Knoll N, Scholz U. Planning and self-efficacy interventions encouraging replacing energy-dense foods intake with fruit and vegetable: a longitudinal experimental study. Psychol Health. 2016;31(1):40–64.
31. Richards R, Smith C, Eggett DL. Correlates of energy intake and body mass index among homeless children in Minnesota. Child Obes. 2013;9(3):240–51.
32. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP, Initiative S. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453–7.
33. Moher D, Hopewell S, Schulz KF, Montori V, Gotzsche PC, Devereaux PJ, Elbourne D, Egger M, Altman DG. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. BMJ. 2010;340:c869.
34. Costigan SA, Barnett L, Plotnikoff RC, Lubans DR. The health indicators associated with screen-based sedentary behavior among adolescent girls: a systematic review. J Adolesc Health. 2013;52(4):382–92.
35. Lubans DR, Morgan PJ, Cliff DP, Barnett LM, Okely AD. Fundamental movement skills in children and adolescents: review of associated health benefits. Sports Med. 2010;40(12):1019–35.
36. Riebl SK, MacDougal C, Hill C, Estabrooks PA, Dunsmore JC, Savla J, Frisard MI, Dietrich AM, Davy BM. Beverage choices of adolescents and their parents using the theory of planned behavior: a mixed methods analysis. J Acad Nutr Diet. 2016;116(2):226–39. e221.
37. Stok FM, de Vet E, de Wit JB, Luszczynska A, Safron M, de Ridder DT. The proof is in the eating: subjective peer norms are associated with adolescents' eating behaviour. Public Health Nutr. 2015;18(6):1044–51.
38. Murnaghan DA, Blanchard CM, Rodgers WM, LaRosa JN, MacQuarrie CR, MacLellan DL, Gray BJ. Predictors of physical activity, healthy eating and being smoke-free in teens: a theory of planned behaviour approach. Psychol Health. 2010;25(8):925–41.
39. Ezendam NP, Evans AE, Stigler MH, Brug J, Oenema A. Cognitive and home environmental predictors of change in sugar-sweetened beverage consumption among adolescents. Br J Nutr. 2010;103(5):768–74.
40. Conner M, Hugh-Jones S, Berg C. Using the two-factor theory of planned behaviour to predict adolescent breakfast choices. Educational and Child Psychology. 2010;28(4):37–50.
41. de Bruijn GJ, van den Putte B. Adolescent soft drink consumption, television viewing and habit strength. Investigating clustering effects in the theory of planned behaviour. Appetite. 2009;53(1):66–75.
42. Hewitt AM, Stephens C. Healthy eating among 10–13-year-old New Zealand children: understanding choice using the theory of planned behaviour and the role of parental influence. Psychol Health Med. 2007;12(5):526–35.
43. de Bruijn GJ, Kremers SP, de Vries H, van Mechelen W, Brug J. Associations of social-environmental and individual-level factors with adolescent soft drink consumption: results from the SMILE study. Health Educ Res. 2007; 22(2):227–37.
44. Kassem NO, Lee JW, Modeste NN, Johnston PK. Understanding soft drink consumption among female adolescents using the theory of planned behavior. Health Educ Res. 2003;18(3):278–91.
45. Backman DR, Haddad EH, Lee JW, Johnston PK, Hodgkin GE. Psychosocial predictors of healthful dietary behavior in adolescents. J Nutr Educ Behav. 2002;34(4):184–93.
46. Berg C, Jonsson I, Conner M. Understanding choice of milk and bread for breakfast among Swedish children aged 11–15 years: an application of the theory of planned behaviour. Appetite. 2000;34(1):5–19.
47. Branscum P, Sharma M. Comparing the utility of the theory of planned behavior between boys and girls for predicting snack food consumption: implications for practice. Health Promot Pract. 2014;15(1):134–40.
48. Tak NI, Te Velde SJ, Oenema A, Van der Horst K, Timperio A, Crawford D, Brug J. The association between home environmental variables and soft drink consumption among adolescents. Exploration of mediation by individual cognitions and habit strength. Appetite. 2011;56(2):503–10.
49. Lien N, Lytle LA, Komro KA. Applying theory of planned behavior to fruit and vegetable consumption of young adolescents. Am J Health Promot. 2002;16(4):189–97.
50. Bere E, Klepp KI. Correlates of fruit and vegetable intake among Norwegian schoolchildren: parental and self-reports. Public Health Nutr. 2004;7(8):991–8.
51. Lubans DR, Plotnikoff RC, Morgan PJ, Dewar D, Costigan S, Collins CE. Explaining dietary intake in adolescent girls from disadvantaged secondary schools. A test of social cognitive theory. Appetite. 2012;58(2):517–24.
52. Melbye EL, Bergh IH, Hausken SE, Sleddens EF, Glavin K, Lien N, Bjelland M. Adolescent impulsivity and soft drink consumption: the role of parental regulation. Appetite. 2016;96:432–42.
53. Leme ACB, Philippi ST. Cultural adaptation and psychometric properties of social cognitive scales related to adolescent dietary behaviors. Cadernos Saúde Coletiva. 2014;22(3):252–9.
54. Loth KA, MacLehose RF, Larson N, Berge JM, Neumark-Sztainer D. Food availability, modeling and restriction: how are these different aspects of the family eating environment related to adolescent dietary intake? Appetite. 2016;96:80–6.
55. Girelli L, Hagger M, Mallia L, Lucidi F. From perceived autonomy support to intentional behaviour: testing an integrated model in three healthy-eating behaviours. Appetite. 2016;96:280–92.
56. Stok FM, de Vet E, de Wit JB, Renner B, de Ridder DT. Communicating eating-related rules. Suggestions are more effective than restrictions. Appetite. 2015;86:45–53.
57. Pedersen S, Gronhoj A, Thogersen J. Following family or friends. Social norms in adolescent healthy eating. Appetite. 2015;86:54–60.
58. Leme ACB, Philippi ST, Silva ECT. Association of Brazilian adolescents with healthy eating: knowledge, perceptions and food choices. Food Nutr Sci. 2011;02(09):1036–42.
59. Leme AC, Toassa EC, Philippi ST. Padrões dietéticos de adolescentes do sexo feminino matriculadas em escolas técnicas públicas do município de São Paulo destacam as diferenças entre status de peso corporal. Rev Paul Pediatr. Under review.
60. Scagliusi FB, Ferriolli E, Pfrimer K, Laureano C, Cunha CS, Gualano B, Lourenco BH, Lancha Jr AH. Characteristics of women who frequently under report their energy intake: a doubly labelled water study. Eur J Clin Nutr. 2009;63(10):1192–9.
61. Scagliusi FB, Ferriolli E, Pfrimer K, Laureano C, Cunha CS, Gualano B, Lourenco BH, Lancha Jr AH. Underreporting of energy intake in Brazilian women varies according to dietary assessment: a cross-sectional study using doubly labeled water. J Am Diet Assoc. 2008;108(12):2031–40.
62. Collins CE, Watson J, Burrows T. Measuring dietary intake in children and adolescents in the context of overweight and obesity. Int J Obes (Lond). 2010;34(7):1103–15.
63. Rangan A, Allman-Farinelli M, Donohoe E, Gill T. Misreporting of energy intake in the 2007 Australian Children's Survey: differences in the reporting of food types between plausible, under- and over-reporters of energy intake. J Hum Nutr Diet. 2014;27(5):450–8.
64. Azeredo CM, de Rezende LF, Canella DS, Moreira Claro R, de Castro IR, Luiz OD, Levy RB. Dietary intake of Brazilian adolescents. Public Health Nutr. 2014;18(7):1–10
65. Moher D, Pham B, Lawson ML, Klassen TP. The inclusion of reports of randomised trials published in languages other than English in systematic reviews. Health Technol Assess. 2003;7(41):1–90.