Systematic Review

Salutogenesis, nutritional status and eating behaviour: a systematic review

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Abstract

Objective: To assess the relationship between the sense of coherence (SOC), eating behaviour and nutritional status.
Design: It is a systematic review.
Setting: The following databases were searched: MEDLINE/PubMed, Science Direct/Elsevier, LILACS/Bireme, SciELO and Google Scholar, using the indexed terms 'salutogenesis', 'sense of coherence', 'nutritional status', 'nutrition', 'eating behavior' and 'healthy eating'. The indexed terms were used in Portuguese and English according to the database searched. The data were extracted in a standardised way and the quality of the studies was assessed using the Newcastle–Ottawa Scale.
Participants: Observational studies were included, with no limitations on the date of publication or language.
Results: After reading the titles and abstracts of 1855 articles, 107 full texts were retrieved, of which 27 were included. Of these, twenty-five were cross-sectional and two were longitudinal. The average score for Newcastle–Ottawa studies was 6 and most studies were rated as moderate and low quality. The cumulative sample size of all included studies was 28 981 adults and the elderly, aged between 18 and 81 years. The studies were carried out in fifteen different countries. Fifteen articles assessed eating behaviour/habit and twelve assessed nutritional status. Studies have shown that SOC has a positive relationship with an appropriate eating behaviour/habit. On the other hand, the relationship between SOC and nutritional status was controversial among studies. The heterogeneity of the data resulting from the use of different methods of evaluation of the outcomes of interest (nutritional status and eating behaviour) made it impossible to perform a meta-analysis.
Conclusion: SOC was positively associated with adequate eating behaviour. However, it was not possible to establish a relationship between SOC and nutritional status.

Inadequate eating habits are responsible for more deaths than any other global risk factor, including smoking[1]. National nutritional surveys show that most people do not follow dietary recommendations, which is one of the reasons for the high prevalence of obesity and other chronic diseases[2].

In order to understand eating behaviour contrary to dietary recommendations, it is essential to consider the environment that involves the formation of eating habits – physical, social, emotional and cultural aspects. In this sense, the Salutogenic Theory, which seeks to explain the interaction of the different systems involved in

maintaining full health, has gained more and more followers[3].

Conversely, the traditional biomedical view does not value the psychosocial and sociocultural factors involved in this process and can therefore be considered reductionist. Health professionals generally work within a biomedical paradigm in which taking care of someone's diet is seen as an individual and not a collective responsibility. Diets depend on compliance with national dietary guidelines: not drinking alcohol, reducing the intake of foods containing saturated fats, sugars and salt, and, on the other hand, increase the intake of foods containing unsaturated fat and fibre (fruits, vegetables and grains)[4].

Studying people and the context in a disjointed way, as does the traditional biomedical view, may be easier, but it does not do justice to reality and limits relevance and applicability in everyday eating situations. Aaron Antonovsky's Salutogenic Theory, therefore, has filled the gap left by the traditional biomedical view, by seeking to understand primarily the factors associated with health and well-being, from the biopsychosocial point of view, and to explain what are the necessary resources to guarantee the development of an adequate human diet[3].

The Salutogenic structure adds two features to the current biomedical approach. First, it considers all aspects of health, considering health not only as the absence of disease, but also as a quality of life and well-being. Second, it aims to answer the question of how health arises from active participation in lifelong learning experiences. The use of this guidance to study the dynamic interaction between the individual and the context provides a better understanding of how people themselves create health, thus generating a future basis for changes in quality of life strategies[5].

To assess the interaction between people and their context, Aaron Antonovsky created within his theory the concept of the sense of coherence (SOC). SOC is a global orientation that expresses the penetrating, long-lasting, trusting, predictable and explainable feelings of the individual; the resources that are available to meet the demands placed on stimuli and helps to assess if these demands are challenges worthy of investment and engagement. SOC is considered a source of resilience and guidance to protect the well-being of life. This instrument is easy to apply and operationalise in the dynamic interaction between the three subcomponents of understandability, manageability and significance[6]. One of its limitations is that some studies report respondents' difficulties in understanding some items and the origin of these problems may be cultural differences. To minimise this limitation, cross-cultural adaptations, modifications in some questions of the scale are carried out, and these versions are evaluated and validated[7]. SOC is measured through a questionnaire of twenty-nine questions (full version) or thirteen questions (short version), with seven or five answer options, both formulated by the creator of the theory. A strong SOC is defined as a direction that helps people to perceive life as comprehensive, manageable and meaningful in order to reduce perceived tension[6].

Since salutogenesis guides the study of health as an interaction between physical, mental, social and spiritual factors, portraying the way people experience food and health in their daily lives, research on salutogenic nutrition has the potential to lay the basis for strategies that emphasise resources to maintain a healthy diet[5].

In view of the above, the objective was to systematically review empirical studies to assess the relationship between the SOC, behaviour/eating habits and nutritional status, based on the theoretical and conceptual basis of the Salutogenic Theory.

Methods

This is a systematic literature review study, carried out between May and November 2020, in order to answer the following question: 'Is the SOC associated with nutritional status and/or eating behaviour?' The adopted protocol followed the items established by the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols (PRISMAP)[8,9] and was registered in the PROSPERO database (https://www.crd.york.ac.uk/prospero/), through the number CRD42020191179.

Two researchers (GV and BP) independently carried out the searches in the following databases, from inception to November 2020: MEDLINE/PubMed, Science Direct/Elsevier, LILACS/Bireme, SciELO and Google Scholar. For the MEDLINE/PubMed database, indexed terms in the Medical Subject Headings (MeSH) were used and for LILACS/Bireme and Scielo databases, indexed terms in the Health Sciences Descriptors (DeCS) were used. The search terms were related to the Salutogenic Theory, nutritional status and eating behaviour: 'Salutogenesis', 'Sense of coherence', 'Nutritional Science', 'nutritional status', 'feeding behavior' and 'healthy eating'. These terms were used in English and Portuguese languages, according to the database searched. The Boolean operators 'AND' and 'OR' were used to cross search terms and define the search strategy.

Observational studies of the cohort, case–control and cross-sectional design were included, involving the population of adults (age range 18 to 60 years) and the elderly (age range> 60 years) of both sexes and who used SOC as the exposure variable. There was no restriction on language or year of publication for the inclusion of the studies. Duplicate articles in the databases and studies whose population had any mental illness or other associated nature that directly interfered with the SOC were excluded.

The evaluation of the eligibility criteria for inclusion of the studies in the systematic review was carried out by two independent researchers (G.V. and B.P.). First, the studies found in each database were analysed by title and summary to identify potential studies for inclusion.

In case of doubts, an evaluation of the full text was made to ensure proper inclusion or exclusion. The full text of the studies judged to be eligible for inclusion was also read in order to confirm the initial screening. When there was disagreement between the two reviewers, the opinion of two other reviewers was asked.

The systematic review description process followed the recommendations for the items in the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA). The study data were extracted by two researchers independently (LN and JS) and included title of the study, surname of the first author, year of publication, country where the study was carried out, study design, objective, characteristics of the studied population (age, sex and sample), description of the observation performed and the outcomes studied with their respective assessment instruments, cut-off points, data analysis and results. Disagreement cases were resolved by discussion between the reviewers and the opinion of a third reviewer, if necessary. In case of missing data, the authors of the original articles were contacted to provide more detailed information.

Two independent reviewers carried out the methodological quality assessment of the included articles using the Newcastle–Ottawa Quality Assessment Scale (NOS). NOS adapted for cross-sectional studies[10] and NOS for cohort studies[11] were used.

NOS uses a star system for scoring articles, considering specific criteria. Cohort studies could score a maximum of four stars for the selection criteria, two stars for the comparability criteria and three stars for the result criteria, totalling a maximum of nine stars. The authors considered the studies of high quality when they scored ≥7 stars and the moderate quality of 5–6 stars, according to the classification adopted by Xing et al. (2016)[12]. Regarding cross-sectional studies, a maximum of five stars were scored for the selection criteria, three stars for the comparability criteria and two stars for the outcome criteria, totalling a maximum of ten stars. The criteria adopted by Wang et al. (2017)[13] were used to classify cross-sectional studies, which considered low-quality scores as 0–4, moderate-quality scores as 5–6 and high-quality scores as ≥7.

The data were presented according to the nutritional development outcomes: nutritional status and eating behaviour. Eating behaviour was considered as a set of actions related to food, which ranges from the decision to eat, the availability of food, the method of preparation, the utensils used, the schedules and division of meals, and the type of food ingested. Nutritional status, in turn, was considered as the variables related to the energy reserves, usually body fat, and metabolically active mass, usually fat-free mass, of the individuals, being assessed through the assessment of body composition. Body composition may be assessed through a variety of methods, such as anthropometry, the most common, and use of labelled isotopes or bioelectrical impedance, for example.

Results

The initial searches in the databases identified 3080 studies, of which 27 met all the eligibility criteria (Fig. 1).

Twenty-five articles were cross-sectional studies and two were cohort studies. The studies were carried out mainly with adults (n 17); a minority included both adults and elderly (n 10). The cumulative sample size of all included studies was 28 981 adults and elderly, aged between 18 and 81 years. The studies were developed in different countries: Japan, Sweden, Germany, USA, Poland, Brazil, Finland, Romania, Australia, Austria, South Korea, Turkey, Hungary, Slovakia and the Netherlands. Most of the articles were in English, being only one in Japanese.
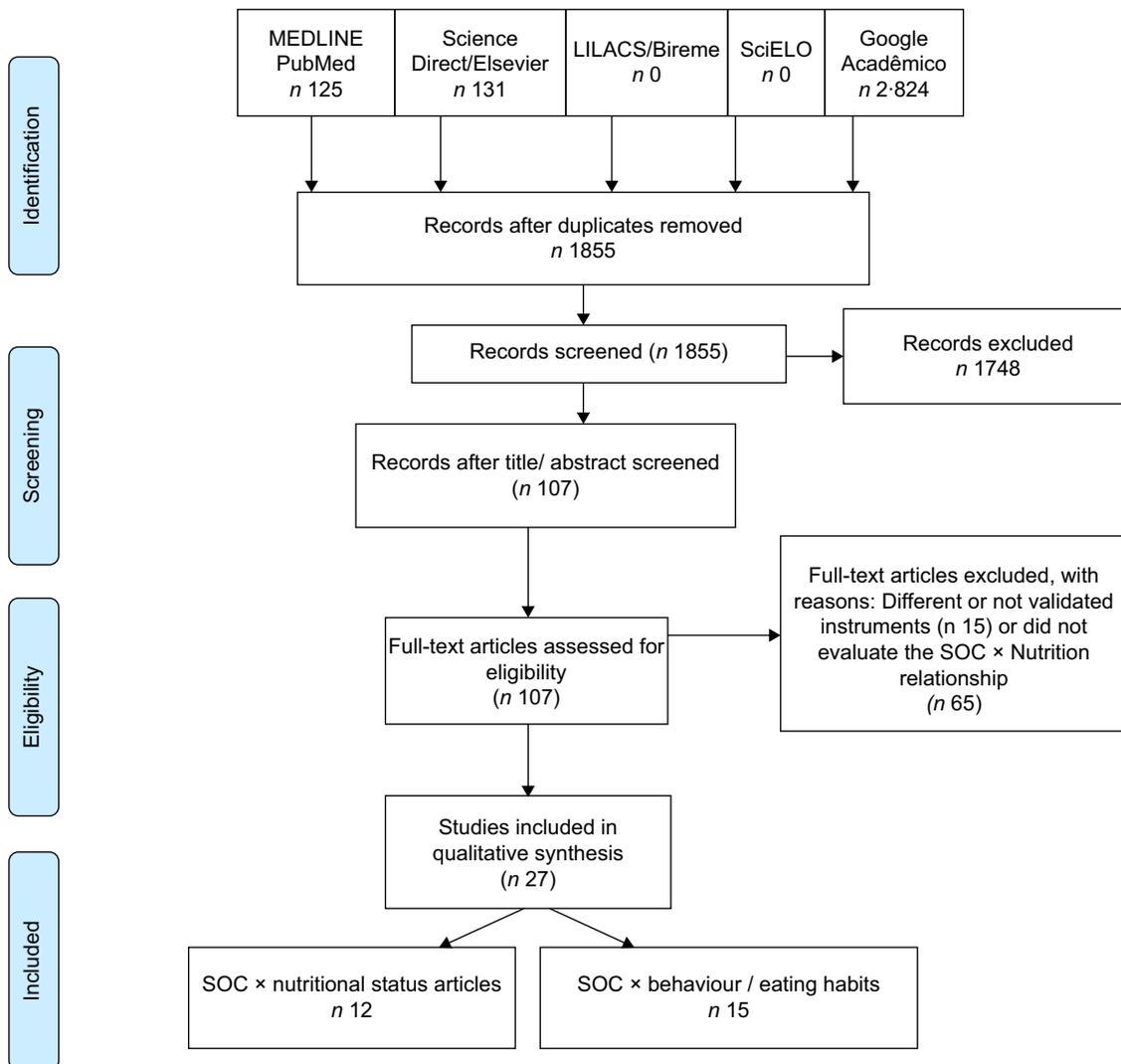
Fifteen studies had eating behaviour/habit as an outcome; twelve had nutritional status. The information presented by the studies analysed was heterogeneous, since they varied in relation to which scale had been adopted to measure the SOC: 71 % used the summary scale with thirteen items and 29 % used the scale with twenty-nine items. The studies also varied in the methods used to assess nutritional status and eating behaviour. Ways of assessing nutritional status varied between Mini Nutritional Assessment in the short form (MNA) and BMI. Eating behaviour/habit was assessed through concepts of adequate nutrition determined by the authors within a pro-health behaviour, consumption of fruits and vegetables, self-perception of a healthy diet, self-reported semi-quantitative food record, consumption of breakfast, sugar consumption between meals, FFQ and dietary scores, based on various indexes. The heterogeneity of the data resulting from these different evaluating methods of the outcomes of interest (nutritional status and eating behaviour) made it impossible to carry out a meta-analysis of the results.

Sense of coherence v. eating behaviour/habit

Among the fifteen articles whose outcome was eating behaviour/habit, eleven demonstrated that SOC positively predicts adequate eating behavior/habit and four indicated that a weak SOC is related to an increase in fast eating, an irregular diet and an excess of food at night supper. Therefore, all articles by different means reported the same relationship: SOC influences eating behaviour/habit (Table 1).

Sense of coherence v. nutritional status

Of the twelve articles that assessed the relationship between SOC and nutritional status, two used MNA as a tool and stated that SOC was weaker in malnourished individuals. A similar positive correlation was found by another article that used BMI as a parameter to assess nutritional status[14]. Another six articles showed that SOC and BMI are negatively correlated, that is, the weaker the SOC, the

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLos Med 6(7): e1000097 doi:10.1371/journal.pmed1000097

Fig. 1 (colour online) Flowchart of the systematic review steps. SOC, sense of coherence

higher the BMI[15–20]. On the other hand, three articles found no association between BMI and SOC[21–23] (Table 2).

Methodological quality assessment

All sixteen articles whose outcome was eating behaviour/habit had moderate (*n* 10) or high (*n* 6) methodological quality, with scores ranging from 5 to 9 points. The main deficiencies were related to comparability (Table 3). Regarding the twelve articles whose outcome was nutritional status, two articles had low methodological quality[20,22] and the other ten had moderate (*n* 6) and high quality (*n* 4). The main deficiencies were also related to comparability (Table 4).

Discussion

When analysing the selected articles, fifteen studies asserted that the SOC positively influences eating behaviour, where a strong SOC was associated with several healthy eating patterns. On the other hand, the results of the twelve studies that assessed the relationship between the SOC and nutritional status were controversial.

Research on salutogenic nutrition, the theoretical basis of the SOC, has the potential to bring new insights on health promotion. Salutogenic nutrition guides the study of the dynamics between people and their environment with respect to how health develops from this interaction[2]. Evidence shows that a strong SOC is associated with a number of behaviours related to a healthy lifestyle,

Table 1 Articles that correlate the SOC and eating behaviour/habit

Author, year	Country	Population (type/n)	Types of SOC	Evaluation of food behaviour	Criteria	Study design	Results
Ahola et al., 2012	Finland	1104 adults: 486 men and 618 women	SOC-13	Usual self-administered structured diet questionnaire and whether received guidance.	Added the frequency of consumption with a range from 0 to 22 points and grouped in tertiles (the higher the score, the greater the tendency to comply).	Cross-sectional	SOC correlated positively with diet score ($r = 0.20$, $P < 0.001$). First SOC tertile had the lowest dietary scores: 10 (8–13), while those in the third tertile had the highest: 13 (10–15). Woman: SOC associated with diet score after adjusting age, socioeconomic status and dietary orientation.
Binkowska-Bury et al., 2016	Poland	668 adults: 356 women and 312 men	SOC-29	Juczyński Health Behaviours Inventory (IZZ) – adequate eating habits (types of food and well-balanced diet).	Eating habits adequacy level score: 1–4: low level; 5–6: medium Level; 7–10: high level.	Cross-sectional	Higher level of pro-health behaviours, including healthy eating habits, was associated with a strong SOC (coefficient in the regression model = 0.18; $P < 0.001$).
Greimel et al., 2016	Japan and Australia	881 young adults: 440 women and 441 men	SOC-13	Self-reported DEBQ	DEBQ consists of thirty-three items comprising three subscales: (a) emotional eating (thirteen items); (b) external eating (ten items) and (c) restraint eating (ten items). Translations are available in German and Japanese. Respondents indicate their agreement with each item on a five-point response scale from disagree strongly (1) to agree strongly (5). Continuous score scale.	Cross-sectional	SOC was negatively correlated with dietary restriction. ($\beta = -0.20$; $P < 0.001$)
Horiguchi et al., 2016	Japan	334 young adults: 191 men and 143 women	SOC-13	EBS	EBS for Japanese young adults consists of eleven items that are rated on a four-point scale (1= never, 2 = very rarely, 3 = sometimes and 4 = very often). Factor 1 (extrinsic eating) includes six items, factor 2 (eating quickly) includes three items, and factor 3 (strong taste) includes two items. Factor scores for each subscale are calculated as the mean of the item scores, and the overall score on the EBS is determined by the mean value of the three subscales.	Cross-sectional	Higher EBS scores indicate eating behaviour that is more harmful to health, so negative and significant correlations were found between the EBS and SOC scores for men and negative and non-significant correlations between the EBS and SOC scores for women. Men (SOC v. general EBS: $r = -0.23$; $P = < 0.01$; SOC v. extrinsic eating: $r = -0.29$; $P = < 0.01$; SOC v. eating fast: $r = 0.00$ $P = < 0.01$). Women (SOC v. general EBS: $r = -0.03$; SOC v. extrinsic eating: $r = -0.13$; SOC x fast eating: $r = -0.03$).
Kato et al., 2019	Japan and Austria	769 young adults: 387 men and 382 women	SOC-13	DEBQ	DEBQ consists of thirty-three items comprising three subscales: (a) Emotional Eating (thirteen items); (b) External Eating (ten items) and (c) Restraint Eating (ten items). Respondents indicate their agreement with each item on a five-point response scale from disagree strongly (1) to agree strongly (5). Continuous score scale.	Cross-sectional	SOC negatively affected the three types of eating in Austrians (men: $\beta = -0.227$ to -0.215; women: $\beta = -0.262$ to -0.214) In Japanese students, SOC negatively affected eating in both sexes and emotional eating in men (men: $\beta = -0.150$; women: $\beta = -0.198$) and emotional eating as a whole ($\beta = -0.187$)

Table 1 Continued

Author, year	Country	Population (type/n)	Types of SOC	Evaluation of food behaviour	Criteria	Study design	Results
Koponen et al., 2019	Finland	5167 adults: 2962 men and 22 205 women	SOC-13	Fruits and vegetables intake (FVBI)	FVBI was the sum of intake of fruits, fresh vegetables, cooked vegetables and berries during the last regarded acceptable (>0·70) or excellent (>0·80).	Cross-sectional	SOC correlated more strongly with FVBI ($r = 0·18$, $P < 0·001$). Social support, a SOC and competence for self-care correlated positively with the FVBI. Positive female sex associations, autonomous motivation, social support and a SOC with the FVBI remained significant even after the effects of other central life context factors were controlled.
Kye & Park, 2012	South Korea	1530 adults and elderly: 841 women and 689 men	SOC-13	Consumption of a diversified and well-balanced diet that included sufficient amounts of fruits and vegetables	Perceived dietary behaviour was assessed with one binary yes/no question by asking participants to indicate whether they consumed a diverse, well-balanced diet that included sufficient amounts of fruits and vegetables.	Cross-sectional	Relationship between the self-perception of consumption of a healthy diet and SOC; Low SOC: reference; Moderate SOC: OR 1·15; $P < 0·001$; High SOC: OR 1·45; $P < 0·001$.
Lindmark et al., 2005	Sweden	4·991 adults and elderly: 2·446 men and 2·545 women	SOC-13	Self-administered semi-quantitative food register	Frequencies of consumption of eight-four food items were reported on an increasing, nine-level scale, including never, maximum once a month, 1–3 times/month, once a week, 2–3 times a week, 4–6 times a week, once a day, 2–3 times a day, and 4 or more times a day. The reported frequencies of consumption were converted to number of intakes per d, and energy and nutrient intakes were calculated by multiplying these frequencies by portion size and energy or nutrient content from a food composition database from the Swedish National Food Administration.	Cross-sectional	Energy, total and saturated fat, ascorbic acid, sucrose and portions of fruits, vegetables, cereals and sweets correlated with the SOC of women. Total and saturated fat, ascorbic acid, fibre, alcohol and portions of fruits, vegetables, bread and cereals, fish and potatoes correlated with a strong SOC of men. All classified as strong SOC had a higher average vegetable intake than those in the lowest quartiles. The correlations were positive and negative, varying according to the type of food, models presented that supported that the low SOC coincides with a less health-promoting dietary preference and vice versa. The calculated measure of effect was VIP having been presented for each food group and listed for the model with values $\geq 1·2$
Nishiyama et al., 2013	Japan	92 young adults: 57 men and 35 women	SOC-29	Breakfast consumption	The breakfast eaters were defined as those students who skipped breakfast no more than once per week, and the breakfast skippers were defined as those students who skipped breakfast two or more times per week. They did the annual average to classify	Cohort	SOC associated with skipping breakfast. Breakfast eaters showed a stronger SOC. Effect measure not reported.

Table 1 *Continued*

Author, year	Country	Population (type/n)	Types of SOC	Evaluation of food behaviour	Criteria	Study design	Results
Peker *et al.*, 2012	Turkey	566 young adults: 295 women and 271 men	SOC-13	Health practices (daily frequency of sugar intake between meals)	Daily between-meals frequency of sugar intake were dichotomised for: twice or more and none to once	Cross-sectional	Students with a strong SOC reported lower sugar consumption between meals (OR = 0·67, 95 % CI 0·44, 0·99; P = 0·009).
Pusztai *et al.*, 2019	Hungary	241 young adults	SOC-13	Characteristics of the diet	Subjective health status and characteristics of their diet were measured by a five-point Likert scale (from bad = 1 to excellent = 5)	Cross-sectional	There was a relationship between strong SOC and healthy diet. Students whose weight has not changed since their arrival in Hungary reported a stronger SOC (F = 3·78; p = 0·024; *post hoc* test: P = 0·030 and P = 0·008)
Ray *et al.*, 2009	Finland	268 adults responsible for children aged 10 and 11 years	SOC-13	Standard meal questionnaire and food frequency intake and dietary patterns	The foods were scored according to how often they were eaten during 1 week; never = 0, less than once a week = 0·5, once a week = 1, 2–4 times/week = 3, 5–6 times/week =5·5, once a day = 7 and several times a day = 14.	Cross-sectional	Weak SOC was associated with parents who maintain an irregular meal pattern (OR = 0·96 95 % CI 0·94, 0·99; P = 0·004), frequent intake of energy-rich foods (β = 20·11 95 % CI 20·18, 0·04; P = 0·002) and less frequent intake of nutrient-rich foods (β = 0·10 95 % CI 0·00, 0·19; P = 0·051). Mediating factors (availability and accessibility of fruits and vegetables at home, parental fruit and vegetable intake and irregular dietary pattern) explained the strong SOC association and intake of nutrient-rich foods.
Silarova *et al.*, 2013	Slovakia	298 adults: 164 men and 134 women	SOC-13	Semi-structured FFQ	The sum total score was calculated and divided into three groups defined as poor, medium and good food intake using the first and third quartiles as the cut-off points.	Cross-sectional	Strong baseline SOC predicted healthy nutritional behaviour among patients with percutaneous coronary intervention (OR 1·08, 95 % CI 1·01, 1·15).
Swan *et al.*, 2015	The Netherlands	703 adults: 359 women and 344 men	SOC-13	Dietary score	Based on the distribution of scores, participants' dietary scores were stratified into either low dietary score (≤14) or high dietary score (15 or higher) for the analysis.	Cross-sectional	Five factors contributed significantly to the high dietary score, among them, strong SOC. Multivariable logistic regression. High dietary score x strong SOC: OR 1·66 (95 % CI 1·15, 2·36) P = 0·007
Swan *et al.*, 2016	The Netherlands	781 adults: 414 women and 367 men	SOC-13	Satisfaction with weight; Nutritional knowledge; Flexible eating restriction; Situational self-efficacy for healthy eating.	The nutrition knowledge scale used for this study asked participants to respond with either true or false on statements regarding consumption of different food items and its impact on physical health sum of nine items true/false;	Cross-sectional	Strong SOC was associated with a superior satisfaction with weight, greater self-efficacy for healthy eating, less social discouragement for healthy eating, and greater accessibility and availability of healthy foods;

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Table 1 Continued

Author, year	Country	Population (type/n)	Types of SOC	Evaluation of food behaviour	Criteria	Study design	Results
					0 = incorrect, 1 = correct; Flexible restraint of eating is defined as a balanced and sensible approach to dietary intake that includes flexible restraint behaviours such as eating slowly and taking small helpings. Situational self-efficacy for healthy eating measures one's confidence in carrying out healthy eating under a variety of circumstances.		SOC and linear regression: self-efficacy for healthy eating $\beta = 0.068$; 95 % low CI = 0·050 95 % high CI = 0·085; $\beta = 0.259$; $P = <0.0001$; SOC and logistic regression for self-efficacy for healthy eating: weak SOC: OR = 0·994 (95 % CI 0·990, 0·998) $P = 0.005$; Strong SOC: OR = 1·01 (95 % CI 1002, 1·01) $P = 0.005$.

SOC, sense of coherence; SOC-13, sense of coherence summarised with 13 questions; SOC-29, sense of coherence with 29 questions; DEBQ, Dutch Eating Behaviour Questionnaire; EBS, Eating Behavior Scale.

including, among others, healthier eating patterns, physical activity, better oral health behaviours and not smoking[5,24,25].

Hence, it is worth noting that a healthy diet goes beyond a nutrient-balanced diet, also encompassing the structure and regularity of the eating habit, the way of preparing food and the psychosocial well-being. Thus, having a fixed number of meals at fixed or routine times and enjoying food with the family, for example, are aspects related to healthy eating[26,27].

Based on this concept, it is already known that stressful situations contribute to abnormal diet patterns. According to Kye & Park (2012)[28], SOC plays a significant role in the perception of a healthy diet. Thus, when the food was evaluated according to emotional, external and food restriction scales, a lesser SOC and more restricted food were predictors of emotional tension. Therefore, it is possible to claim that people who cannot cope with stress tend to have an emotional eating behaviour, eating quickly and with food restriction, that will generate excessive consumption[29–31]. People who resist the negative effects of stress tend to eat healthy diets.

Eating is highly contextual, and personal interpretations of healthy eating are complex and diverse, as they reflect personal, social, cultural and environmental experiences[27]. Eating practices are also inserted in a temporal context. Past experiences guide how people make food choices in the future[32]. Thus, a weak SOC is related to the development of inappropriate eating behaviours/habits over time. From another point of view, studies concluded that the SOC contributes independently to explain the variations in the intake of vegetables and fruits and in the intake of saturated fat, sucrose and sweets[25,33,34]. Mediating factors such as the availability and accessibility of fruits and vegetables at home, nutrition and intake of fruits and vegetables, and irregular eating patterns explain the SOC association and intake of nutrient-rich foods[35].

Hence, people with a strong SOC have an orientation towards healthier lifestyle behaviours, which includes a healthier diet, corroborating the findings of studies that evaluated the relationship between SOC and eating behaviour[5,15,25,28–31,33–41].

If a strong SOC influences a balanced and healthy diet, it would be also expected to be correlated with an adequate nutritional status. The articles that correlated SOC with nutritional status, however, showed conflicting results. The mechanisms involved in the regulation of body weight in humans include genetic, physiological and behavioural factors. These factors can contribute to a positive energy balance, leading to body weight gain. It has been reported that SOC is strongly related to aspects of negative emotionality, and negative emotionality, in turn, is associated with a higher BMI and weight gain. Based on this correlation, some of the selected studies showed a relationship between a higher BMI and a weak SOC, portraying the

Table 2 Articles that relate a SOC and nutritional status

Author, year	Country	Population (type/n)	Types of SOC	Evaluation of the nutritional status	Criteria	Study design	Results
Dewake et al., 2014	Japan	66 elderly: 20 men and 40 women	SOC-13	MNA (Mini – Short-Form Nutritional Assessment), six items	Total score of 14 points: 12–14 points for 'good nutrition' and 8–11 points for 'nutritional risk'; 'Exists' and 0–7 points for 'Malnutrition'.	Cross-sectional	SOC significantly related to MNA ($P = 0.02$) and appetite ($P = <0.001$); Multiple regression: significance between SOC and MNA ($\beta = 0.251$; $P = 0.028$) was maintained even after adjustment for confounding factors. Weak SOC was related to a state of malnutrition
Dewake et al. 2017	Japan	53 elderly: 17 men and 36 women	SOC-13	MNA, six items	Total score of 14 points: 12–14 points for 'good nutrition' and 8–11 points for 'nutritional risk'; 'Exists' and 0–7 points for 'Malnutrition'.	Cross-sectional	49·1 %: normal; 50·9 %: malnourished/risk of malnutrition; Normal participants in the MNA-SF had lower levels of need for care and higher SOC scores compared to malnourished: malnourished/risk = 52·00 (41·00–59·00); normal = 59·00 (53·00–75·25); $P = 0.031$;
Sagara et al., 2009	Japan	110 men adults	SOC-29	BMI	<18·5 kg/m^2 malnutrition; >18·5 kg/m^2 <25 kg/m^2 eutrophic; >25 kg/m^2 overweight; >30 kg/m^2 obesity.	Cohort	Weak SOC was significantly associated with weight gain (regression coefficient = −0·12, SE = 0·042, OR = 0·886; 95 % CI 0·81, 0 960; $P = 0.004$).
Eli et al., 2016	Sweden	867 women	SOC-13	Baseline quest. (BMI)	<18·5 kg/m^2 malnutrition; >18·5 kg/m^2 <25 kg/m^2 eutrophic; >25 kg/m^2 overweight; >30 kg/m^2 obesity.	Cross-sectional	SOC showed a negative correlation with women's BMI ($\beta = −0.19$, $P < 0.001$)
Lengerke et al., 2007	Germany and EUA	947 adults and elderly: 483 women and 464 men	SOC-13	BMI	<25 kg/m^2 eutrophic; >25 kg/m^2 overweight; >30 kg/m^2 obesity.	Cross-sectional	No association between BMI classification v. SOC and no interaction with sex.
Morita et al., 2014	Japan	167 adults and elderly: 130 men and 37 women	SOC-29	BMI	<25 kg/m^2 eutrophic; >25 kg/m^2 overweight.	Cross-sectional	Those with the strongest SOC had a significantly lower chance of being overweight (OR = 0·31; 95 % CI 0·11, 0·81)
Olszak et al., 2018	Poland	131 women adults	SOC-29	Self-questionnaire (BMI)	<25 kg/m^2 eutrophic; >25 kg/m^2 overweight; >30 kg/m^2 obesity.	Cross-sectional	Negative and significant relationship between SOC and BMI ($P < 0.05$). Effect measure was not reported

Table 2 *Continued*

Author, year	Country	Population (type/*n*)	Types of SOC	Evaluation of the nutritional status	Criteria	Study design	Results
Redin *et al.*, 2019	Brazil	1100 adults: 554 men and 546 women	SOC-13	Asked if overweight by CVDRF (BMI > 25) and made a new BMI (self-reported)	<25 kg/m² eutrophic; >25 kg/m² over-weight.	Cross-sectional	There was no significant relationship between SOC and BMI; BMI > 25: SOC med 57·8 (0·5); BMI < 25: SOC med 58·8 (0·5).
Sares-Jäske *et al.*, 2019	Finland	4525 adults and elderly: 2147 men and 2378 women	SOC-13	BMI	<25 kg/m² eutrophic; >25 kg/m² over-weight; >30 kg/m² obesity.	Cross-sectional	Lower BMI was correlated with a weak SOC (OR = 1·45, 95 % CI 1·15, 1·82 $P < 0.0001$)
Skär *et al.*, 2014	Sweden	157 obese adults: 80 women and 77 men	SOC-29	BMI	>30 kg/m² ⩽34·9 kg/m² obesity; ⩾35 kg/m² morbid obesity.	Cross-sectional	Women with a high BMI had a higher prevalence of weak SOC (⩽34·9, 58·2 % and ⩾35·0, 64·5 %) than men (⩽34·9, 34 % and ⩾35·0, 50 %), that is, the female sex correlated with a weak SOC and showed a significant association with high BMI (Pearson's $X^2 = 0.176$ $P \le 0.05$)
Terelak & Budka, 2014	Poland	63 adults and elderly: 30 women and 33 men	SOC-29	BMI	<25 kg/m² eutrophic; >25 kg/m² over-weight; >30 kg/m² obesity.	Cross-sectional	People with a higher BMI are less oriented towards actively solve problems, that is, they have a weak SOC. Spearman's rho correlation coefficient between BMI and SOC components: understanding = −0·029; management = −0·183 and meaning = −0·140.
Zugravu, 2012	Romania	970 adults: 533 women and 437 men	SOC-13	BMI	<18·5 kg/m² malnu-trition; >18·5 kg/m² <25 kg/m² eutrophic; >25 kg/m² over-weight; >30 kg/m² obesity.	Cross-sectional	The linear regression model shows that the BMI is a positive determinant of the SOC score ($\beta = 0.051$; $P = 0.0021$).

SOC, sense of coherence; SOC-13, sense of coherence summarized with 13 questions; SOC-29, sense of coherence with 29 questions.

Table 3 Evaluation of the methodological quality of the articles whose outcome was the eating behavior/habit with the Newcastle–Ottawa Scale for cross-sectional and cohort studies

Author (year)	Study design	Selection				Comparability	Output			Total	Classification
		1	2	3	4	5	6	7	8†		
Ahola et al., 2012	Cross-sectional				**	*	**	*		6	Mod
Binkowska-Bury et al., 2016	Cross-sectional	*	*	*	**		**	*		8	High
Greimal et al., 2016	Cross-sectional				**	*	**	*		6	Mod
Horiguchi et al., 2016	Cross-sectional				**		**	*		5	Mod
Kato et al., 2019	Cross-sectional				**	*	**	*		6	Mod
Koponen et al., 2019	Cross-sectional	*	*		**		**	*		7	High
Kye & Park, 2012	Cross-sectional	*	*	*	**	*	**	*		9	High
Lindmark et al., 2005	Cross-sectional	*	*	*	**		**	*		8	High
Nishiyama et al., 2013	Cross-sectional				**	*	**	*		6	Mod
Peker et al., 2012	Cross-sectional				**		**	*		5	Mod
Pusztai et al., 2019	Cross-sectional				**		**	*		5	Mod
Ray et al., 2009	Cross-sectional				**	*	**	*		6	Mod
Silarova et al., 2014	Cohort		*	*	*	*	*	*	*	7	High
Swan et al., 2015	Cross-sectional			*	**		**	*		6	Mod
Swan et al., 2016	Cross-sectional	*	*	*	**		**	*		8	High

*, ** stars for NOS classification.
†Only in the case of cohorts.

Table 4 Evaluation of the methodological quality of the articles whose outcome was nutritional status using the Newcastle–Ottawa Scale for cross-sectional and cohort studies

Author (year)	Study design	Selection				Comparability	Output			Total	Classification
		1	2	3	4	5	6	7	8†		
Dewake et al., 2014	Cross-sectional				**		**	*		5	Mod
Dewake et al., 2017	Cross-sectional				**		**	*		5	Mod
Eli et al., 2016	Cross-sectional	*	*	*	**		**	*		8	High
Lengerke et al., 2007	Cross-sectional	*	*	*	**	*	**	*		9	High
Morita et al., 2014	Cross-sectional		*		**	*	**	*		7	High
Olszak et al., 2018	Cross-sectional				*					1	Low
Redin et al., 2019	Cross-sectional	*	*		**			*		5	Mod
Sagara et al., 2009	Cohort		*	*	*		*	*	*	6	Mod
Sares-Jäske et al., 2019	Cross-sectional	*	*		**	*	**	*		8	High
Skär et al., 2014	Cross-sectional		*		**		**	*		6	Mod
Terelak and Budka, 2014	Cross-sectional				**		**			4	Low
Zugravu, 2012	Cross-sectional				**		**	*		5	Mod

*, ** stars for NOS classification.
†Only in the case of cohorts.

reduction of stress resilience as a potential important factor of obesity[15,17–20]. Contrary to this point of view, Zugravu (2012)[16] observed that higher levels of BMI were associated with a high SOC score. This result, which is not in line with the literature, was seen by the author as a limitation inherent to the design of a cross-sectional study.

Another three studies associated a lower SOC with a lower BMI and even malnutrition[14,42,43]. Another three studies found no association between SOC and BMI, stating that SOC, that is, the ability to deal with stresses and to solve problems, does not influence nutritional status[21–23]. Many of these studies with contradictory results did not have this association as the main objective to be studied and others had a very small number of participants. Perhaps for these reasons, due attention and explanation of these findings were not given.

Thus, it can be observed that the relationship between SOC and nutritional status was different in the various studies, even being absent in some studies. Possibly, this could be because studies carried out to date have had a cross-sectional design, which limits some conclusions, or their line of thinking was not adequate, which can be noted by the low and moderate methodological quality of most of these articles.

Limitations

The heterogeneity both in the way of evaluating the nutritional data and in the data brought by the selected articles was an important limitation, which made it impossible to carry out a meta-analysis. The methodological quality of the articles, mostly moderate and low, also proved to be a limitation of the review, demonstrating the need for more studies with better quality that portray this association.

Conclusion

SOC had a positive relationship with several healthy eating behaviours. Based on these findings, it would be interesting to use SOC for the early detection of protective factors for healthy eating habits (by identifying a strong SOC), thus adopting the instrument as a screening in public health care, enabling early and targeted interventions. Therefore, research institutions should develop interventions that strengthen people's SOC as a means of improving eating behaviours. On the other hand, intervention studies for follow-up over a longer time and in different cultures should be developed in order to better establish the relationship between SOC and nutritional status, which was inconsistent among the studies.

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Supplementary material

For supplementary material accompanying this paper visit https://doi.org/10.1017/S1368980021004444

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