DOI: 10.1590/1413-812320202510.34312018

Relationship between sense of coherence and diabetes mellitus: a systematic review

Jesús Humberto Márquez-Palacios (https://orcid.org/0000-0003-2003-9538) [1]
Libia Yanelli Yanez-Peñúñuri (https://orcid.org/0000-0003-4682-5123) [2]
José Guadalupe Salazar-Estrada (https://orcid.org/0000-0002-2199-1275) [3]

Abstract *The aim was to synthesize the best scientific evidence on the effect of sense of coherence in disease development, treatment, and biomedical metabolic control indicators, as well as the complications involved for people at risk of developing diabetes and for diabetics. The systematic review method was implemented. Search and selection efforts of two independent reviewers on Scopus, Web of Science, PubMed, Ebsco, Science Direct, and manuals databases, available until 2017, in Spanish and English, of the population aged 18 and over. From a total of 154 studies, 20 articles were included in the systematic review. Over half of the studies used the SOC-13 version to verify the sense of coherence and the most frequent indicator of metabolic control was glycated hemoglobin. In addition to this, 14 of the 20 studies found a statistically significant relationship between sense of coherence and diabetes. It is concluded that the sense of coherence has a strong correlation with diabetes in the different phases of the disease and is related to the reduction of risk for the development of the disease, a reduction of glycated hemoglobin values, and the appearance of diabetes mellitus-related complications.*

Key words *Chronic disease, Diabetes mellitus, Salutogenesis, Health promotion, Life style*

[1] Programa de post-grado en Psicología con Orientación en Calidad de Vida y Salud, Universidad de Guadalajara. Carretera Guadalajara, Ameca, km 45.5. 46600 Ameca Jalisco México. jsalazar@valles.udg.mx
[2] Departamento de Ciencias Sociales, Universidad de Sonora. H. Caborca Sonora México.
[3] Centro Universitario de los Valles, Universidad de Guadalajara. Ameca Jalisco México.

Introduction

Diabetes mellitus (DM) is a non-transmissible chronic disease that appears when the pancreas does not produce enough insulin or the organism does not use the insulin it produces effectively[1]. In the last few decades, it has become a central public health issue due to its high prevalence. In 2017, 425 million people were diagnosed with DM worldwide, and it is estimated that by 2045 this number will increase to 629 million people[2].

Uncontrolled cases of DM involve acute and chronic complications due to high blood sugar, which causes damage to the body's tissues[3] and enables the development of conditions such as blindness, heart attacks and kidney problems[4]. Blood sugar percentage can serve as an indicator of disease control, and is obtained by means of glycated hemoglobin (A1c)[5]. It has been pointed out that the reduction of at least 1% of the A1c level in DM patients can reduce the likelihood of suffering any of the aforementioned conditions[6-8].

In order to avoid the development and progression of complications, several strategies have been developed to support DM patients, which can be categorized as self-care oriented strategies (SC) for the patient and those aimed at managing the emotions associated with suffering from this disease[9]. In this framework, elements such as timely conflict resolution and healthy coping can be essential to attain control over this pathology[10].

One concept that has been linked to the development of personal skills aimed at coping better with the disease has been the so-called Sense of Coherence (SOC), which stems from the Salutogenesis theory[11]. SOC consists of three dimensions: 1) comprehensibility, which refers to the sensation of understanding what happens when a person is exposed to a stimulation, either pleasant or stressing; 2) manageability, which is the perception of having the necessary and available resources to deal with and resolve the demands involved; and 3) meaningfulness, which is the central element of SOC, as it is the motivational component that leads the person to find the resources he or she needs to deal with the situation[12].

SOC patients are known for perceiving and absorbing the stimuli of their surroundings (internal/external) in an organized manner; they believe that events are structured, predictable and manageable, and that resources (biological, material, cognitive, emotional, sociocultural and educational) are available for them to face the demands posed by these stimuli, which are considered challenges that call for an investment of energy, effort and commitment despite the problems and/or difficulties they might pose[12].

Therefore, SOC represents a new research paradigm that explores health development and maintenance by taking the cultural background of patients into account[13]. This is evidenced by the multiple health studies that have identified SOC as a protective construct that relates to a better quality of life within the context of multiple acute and chronic diseases[14-19].

In the case of DM, studies have not allowed for a clear understanding of the role that SOC plays, given the contradictory nature of the results. It has been reported that a high SOC prevents the development of DM[20], helps reduce the biomarker levels that relate to disease control[21-23] and improves overall lifestyle (LS)[24,25]; however, there is no other research that presents similar findings[23,26,27].

Given the inconsistency of the reported evidence, a systematic review would help to identify and compile all the empirical evidence that meets specific eligibility criteria for the purpose of answering a specific question[28], thus allowing the identification of the scope and limitations, as well as the establishment of a background that could help to look more deeply at certain aspects, on the basis of the best available scientific evidence, in order to aid the decision-making and strategy implementation processes in the field of DM. Therefore, this study has the purpose of describing the effects of SOC on adult DM patients, in terms of disease development, treatment, biomedical metabolic control indicators, and the emergence of complications.

Hence, this study aims at synthesizing the best scientific evidence on the effect of the sense of coherence on disease development, treatment, biomedical metabolic control indicators, and the emergence of complications in people at risk of developing diabetes and in diabetics.

Method

The study used the systematic review method, and prior to the article search in accordance with the statement of the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA), the systematic review protocol was submitted for registration before the Coordination of Research and Graduate Studies at the University where the study was conducted.

Search strategy

The exhaustive search or identification of research studies was conducted by two evaluators who worked independently, as set forth by the guidelines of the PRISMA methodology[29]. The SCOPUS, Web Of Science, PubMed, EBSCO and Science Direct databases were reviewed using the advanced search strategy with the terms "sense of coherence" and "sentido de coherencia", and combining the search through the Boolean operator AND with the term "diabetes"; it is worth mentioning that an initial search was conducted with the combined terms in English and subsequently in Spanish. On SCOPUS and Science Direct, these terms were searched for in the title, abstract and key words of the article; on Web of Science, the search was conducted by topic; on PubMed, the search included the title/abstract, and lastly, on EBSCO, the search included only the title. These searches were not restricted or controlled, only an upper time limit was set: the year 2017. Furthermore, two researchers conducted a manual search on the article reference list in order to identify studies that may have not been included on the databases.

Selection

As in the search process, the article selection was conducted by two researchers who worked independently and selected and included studies by assessing whether they met the inclusion, exclusion and elimination criteria. This phase included three stages or filters: evaluation, eligibility, and inclusion; after the last stage, the statistical level of agreement was calculated using the Kappa coefficient.

Inclusion criteria

The research studies included had to meet the following criteria: a) scientific publications in the form of articles; b) studies published up to December 31, 2017; c) research conducted on patients with DM in its multiple forms; d) experimental and observational articles that reported empirical findings on the sense of coherence in people at risk of developing DM or who have DM; e) studies that associated SOC with DM; and/or f) articles that associated SOC and DM based on the risk of developing DM, its treatment (pharmaceutical and/or LS treatments), disease control, and complications; g) articles in English and Spanish.

Exclusion and elimination criteria

The articles that were dismissed included: a) studies conducted with a qualitative methodology; b) studies that referred to SOC in caregivers or family members of DM patients; c) summaries, book chapters, books and thesis dissertations; d) articles that addressed SOC in DM patients solely on a descriptive level without any statistical relationship. The only elimination parameter applied to studies that were repeated on the reviewed databases.

Extraction

After selecting the publications, each text was analyzed fully and the most relevant findings were identified. The extraction of information was conducted based on an electronic form that was previously tested by the reviewers, who then extracted the following data: author, year of publication, type of DM, population, type of study, version of the instrument to measure SOC, biomedical indicators, controlled variables, category and main results. It is worth mentioning that the information on the research populations was obtained from the results section; in the case of medical indicators and controlled variables, the information was obtained exclusively from the method section, with consideration given only to information that was explicitly described in this section. With regard to the results of the studies, only information that was relevant to this study was extracted.

Assessment of the quality of the articles

The quality assessment and risk of bias process for the articles included in this review was conducted independently by the article reviewers. Two verification lists were used: AXIS[30] for observational studies, and Downs and Black Checklist[31] for clinical trials. These instruments were chosen based on reports of their previous use in other studies[32,33]. Furthermore, in order to assess the level of agreement, the Kappa index was used.

Results

The selection of studies for this systematic review was determined based on a four-stage filtering process (identification, evaluation, eligibility and inclusion) conducted by two of the authors

The first stage identified 154 publications on the scientific databases. Subsequently, 81 duplicated studies were eliminated. It is worth mentioning that this stage produced a Kappa level of agreement of .93.

The second stage processed 73 publications based on the title and abstract of the studies, and dismissed 34 publications because they were outside the scope of this review. The phase concluded with 39 articles.

The third phase involved eligibility. Both authors read the entire filtered articles, and as a result, 19 studies were dismissed because of the following reasons: a) six studies were published in a language other than Spanish or English; b) two publications were not scientific articles; and c) 11 studies did not make a statistical association between SOC and DM. Finally, the fourth stage included 20 studies published in English. The Kappa index for the level of agreement between the authors involved in the inclusion process was .87. No studies were identified during the manual search (Figure 1).

The studies reviewed included, in total, one random clinical trial and 19 observational studies; 63% were transversal, 15% were cases and controls, 11% were longitudinal, and 11% were cohort studies. With regard to the study population, 35% of the reviewed articles reported on patients with DM1, 35% with DM2, and 20% included combined samples: 1) DM1 and DM2 patients and 2) pre-diabetes and DM2 patients. Furthermore, 10% of the studies did not report DM in the target population. All the articles included adult participants (over 20 years old). 90% of the studies had populations that included both men and women, while 5% included only women and the remaining 5% included only men (Table 1).

Three measurement instruments were defined with regard to the measurement of SOC: SOC-13[12] and SOC-29[12], which were developed by the author of the construct, and a third 3-item version developed by Lundberg and Nyström (SOC-3)[34]. 55% of the publications used SOC-13, while 25% opted for SOC-29 and the remaining 20% used the SOC-3 version.

The measurement of DM was conducted based on biomarkers. Different controls were identified according to the studied population: a) oral glucose tolerance tests (OGTT) and/or the HOMA analysis were used to measure risk of developing DM; b) treatment-related indicators included body mass index (BMI) and/or the Bruce protocol; c) for disease control, reports included A1c, and/or low-density lipoprotein analysis (C-LDL), and/or high-density lipoprotein analysis (C-HDL), and/or triglyceride levels (TL), and/or diastolic blood pressure (DBP), and/or systolic blood pressure (SBP); d) in the cases of participants at risk of developing complications, reports included A1c and/or the albuminuria excretion rate (AER), and/or end-stage kidney disease (ESKD); and/or f) lastly, three studies did not collect biomedical indicators from their samples, as one constituted a prospective study and the other a comparative study.

The results of the studies were grouped into categories; the first consisting of studies on people at risk of developing diabetes, which was identified in 30% of the reviewed articles (Table 2); subsequently, with regard to articles that addressed diabetes patients, the second category consisted of studies on diabetes treatment (5%); the third category included studies on disease control (35%); and the fourth category consisted of studies on the development of diabetes-related complications (10%); it is worth mentioning that other studies combined two of these categories: disease control and diabetes-related complications (10%) and diabetes treatment and disease control (5%) (Table 3).

With regard to the findings on the risk of developing diabetes, some studies reported a negative and significant correlation between SOC and the risk of developing DM, which suggests that people with high SOC levels have less risk of developing the disease[20,35-37]. Similarly, Merakou et al.[38] evaluated SOC in people with and without DM, and found that people with DM are less likely to have a strong SOC, compared to people without DM. On the other hand, Agardth et al.[39] and Eriksson et al.[40] found that SOC levels did not have an impact on the risk of developing diabetes (Table 2).

With regard to the treatment category, there was a notable positive and significant correlation between SOC and non-pharmaceutical treatment for DM. The results of these studies show that a strong SOC relates to good dietary choices in women and to increased physical activity in men[24]. Furthermore, studies found that people with a strong SOC are more likely to change their LS[25] (Table 3).

The results in the category of disease control were diverse. Some authors claim that there is a negative and significant correlation between SOC and the biomarkers, which suggests that people with a strong SOC will have lower triglyceride[24], A1c[21,22,24,41], LDL cholesterol[23] and

Ciência & Saúde Coletiva, 25(10):3955-3967, 2020

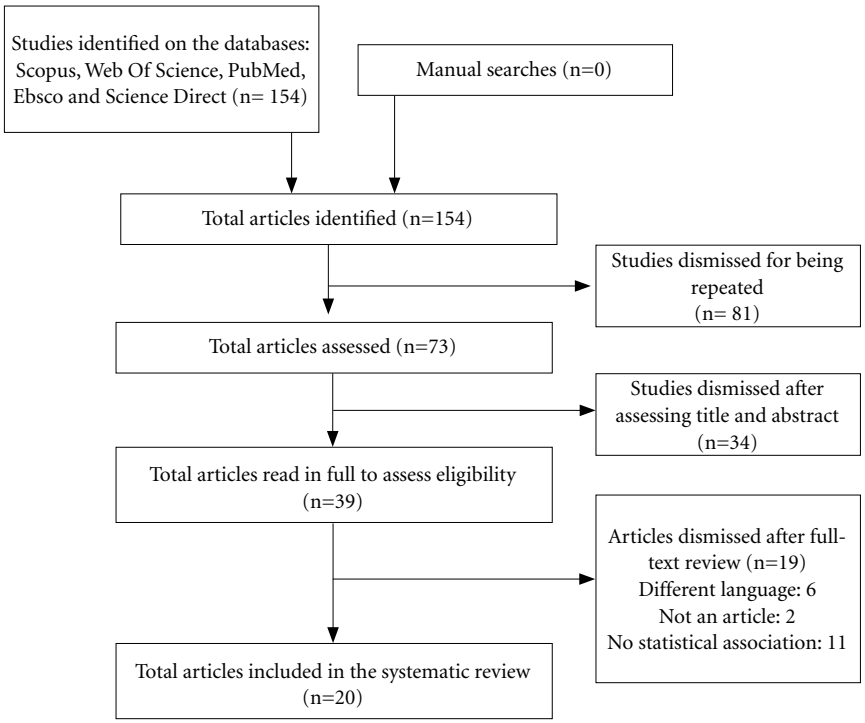

Figure 1. Flow diagram of the four-stage PRISMA methodology.

BMI[22] levels. On the other hand, two studies suggest an indirect association between SOC and A1c, and that this relationship is mediated by health self-assessment[42], AC, and psychopathological symptoms[43]. Only one study referred to a positive and significant correlation between SOC and A1c[44]. Other studies reported no association between SOC and biomarkers such as: A1c[23,26,27], triglyceride levels[23], BMI[21,24], HDL cholesterol[23,24], SBP[23] and DBP[23] (Table 3).

Lastly, with regard to diabetes-related complications, studies found that low scores in SOC relate to DM in men, nephropathy[21] and amputations due to the disease[45]. However, other studies describe that SOC scores do not differ in people with and without DM that developed complications such as carpal tunnel syndrome[46] and severe retinopathy[21] (Table 3).

In order to reduce the risk of showing results that could be influenced by other variables, 45% of the studies[20,22-24,35-37,40,43] chose to control for variables and avoid bias in the inference of results. Different types of controlled variables were found: BMI, waist-to-hip ratio (WHR), fat intake, tobacco use and alcoholism, family history of DM, physical activity and inactivity, disease-related complications and time of diagnosis; biomedical variables such as AER and ESKD; and socio-demographic and psychological variables: stress and health self-assessment. 55% did not report having controlled their results. In all the studies that did control for some variables, the relationship between SOC and DM remained.

Results on the quality and risk of bias of the studies

19 observational studies were evaluated with the AXIS tool, which found that all the studies had clear purposes and an appropriate research method. 94% of the studies justified their sample size; 91% measured the risk factor and the result variables in accordance with the study's objectives; 79% of the studies measured their variables based on instruments that showed evidence of their psychometric properties; 83% considered a sample framework of an appropriate population base and clearly reported values to determine statistical significance and/or accuracy estimations; 64% had the possibility of selecting rep-

Table 1. Description of the general characteristics of the populations included in the studies.

Author and year	Type of study	Instrument	Indicators	DM Type	Population and age average in years
Lundman and Norberg, 1993[26]	CS	SOC-29	A1c	DM1	N = 20, M = N/A, W = N/A Age: N/A
Sandén-Eriksson, 2000[42]	L	SOC-13	A1c	DM2	N = 88, M = 57%, W = 43% Age: $\bar{x}$ = 65 σ = 10 M, $\bar{x}$ = 69 σ = 10 W
Richardson et al., 2001[27]	CS	SOC-29	A1c, CO*	DM1	N = 107, M = 44%, W = 56% Age: $\bar{x}$ = 43 σ = 12
Shiu, 2004[44]	CS	SOC-13	A1c	DM2	N = 72, M = 39%, W = 61%; with Tx of insulin Age: $\bar{x}$ = 52 σ = 12
Agardh et al., 2003[35]	CC	SOC-3	PTOG, HOMA	DM2	N = 4821, M = 0%, W = 100%; with and without DM Age: N/A
Agardh et al., 2004[39]	CS	SOC-3	PTOG, IMC	DM2	N = 7950, M = 39%, W = 61%; with and without DM2 Age: N/A
Cohen and Kanter, 2004[43]	CC	SOC-29	A1c	DM1 and DM2	N = 96, M = 61%, W = 39%; with and without DM Age: $\bar{x}$ = 51 σ = 15 DM1, $\bar{x}$ = 55 σ = 11 DM2, $\bar{x}$ = 51 σ = 13 without DM
Hilding et al., 2006[36]	CS	SOC-3	PTOG	PD and DM2	N = 7949, M = 39%, W = 61% Age: $\bar{x}$ = 47 σ = 5 M with and without FHD, $\bar{x}$ = 47 σ = 5 W with and without FHD
Kouvonen et al., 2008[20]	C	SOC-13	N/D	DM2	N = 5827, M = 100%, W = 0%; with and without CD. Age: $\bar{x}$ = 39 σ = 10
Abdelgadir et al., 2009[45]	CS	SOC-13	N/D	DM	N = 120, M = 52%, W = 48%; with and without LLA Age: $\bar{x}$ = 57 σ = 10, M and W with LLA, $\bar{x}$ = 53 σ = 11, M and W without LLA
Ahola et al., 2010[21]	CS	SOC-13	A1c, IMC, IEA, ERET and PRP*	DM1	N = 1264, M= 45%, W = 55% Age: $\bar{x}$ = 44 σ = 12 GSS, $\bar{x}$ = 45 σ = 12 GSW
Ahola et al., 2012[24]	CS	SOC-13	IMC, PSD, PSS, A1c, c-HDL and NT	DM1	N = 1104, M = 44%, W = 56% Age: $\bar{x}$ = 45 σ = 12
Peer et al., 2012[37]	CS	SOC-13	PTOG	DM	N = 1071, M = 47.5%, W = 52.5%; with and without DM Age: $\bar{x}$ = 43 σ = 13
Merakou et al., 2013[38]	CC	SOC-29	N/D	DM2	N = 202, M = 51%, W = 49%; with and without DM2 Age: $\bar{x}$ = 67 σ = N/A group with DM2, $\bar{x}$ = 71 σ = N/A group without DM2
Eriksson et al, 2013[40]	C	SOC-3	PTOG	PD and DM2	N = 4985, M = 41%, W = 59 with and without NGT Age: W $\bar{x}$ = 47 σ = 5 NGT, $\bar{x}$ = 50 σ = 4 PD, $\bar{x}$ = 49 σ = 4 DM2; M $\bar{x}$ = 46 σ = 5 NGT, $\bar{x}$ = 47 σ = 5 PD, $\bar{x}$ = 47 σ = 5 DM2.
Thomsen et al., 2014[46]	L	SOC-13	A1c	DM1 and DM2	N = 66, M = 38%, W = 62%; with and without DM Age: N/D
Nilsen et al., 2015[25]	RCT	SOC-13	Protocolo de Bruce	DM2	N = 213, M = 50% W = 50%; at DM2 Age: $\bar{x}$ = 46 σ = 11
Linden et al., 2016[41]	CS	SOC-13	A1c	DM1	N = 168, M = 0%, W = 100%; pregnant with DM1 Age: $\bar{x}$ = 31 σ = 5
Olesen et al., 2017[23]	CS	SOC-13	A1c, PSD, PSS, c-LDL c-HDL and NT	DM1	N = 125, M= 42%, W = 58% Age: $\bar{x}$ = 61 σ = 10
Nuccitelli et al., 2017[22]	CS	SOC-29	A1c, IMC and c-LDL	DM1	N = 97, M = 45%, W = 55% with and without MC Age: $\bar{x}$ = 41 σ = 10 with MC, $\bar{x}$ = 41 σ = 11 without MC

Note: A1c = Glycated hemoglobin, AER = Albuminuria extraction rate, BMI = Body mass index, C = Cohort, CC = Cases and controls, CD = Chronic diseases, CM = Metabolic Control, CO = Complications, CS = Cross Sectional, C-HDL = High-density lipoproteins, C-LDL = Low-density lipoproteins, DM = Diabetes mellitus, DBP = Diastolic blood pressure, DM1 = Type 1 diabetes mellitus, DM2 = Type 2 diabetes mellitus, ESKD = End-stage kidney disease, FHD = Family history of diabetes, GSS = Group with SOC strong, GWS = Group with SOC weak, HOMA = Insulin resistance index, L = Longitudinal, LLA = Lower limb amputation, M = Men, N = Sample size, NGT = Normal glucose tolerance, N/A = Not available, OGTT = Oral glucose tolerance test, PD = Pre-diabetes, PRP = Presence of retinopathy, RCT = Randomized clinical trial, SBP = Systolic blood pressure, SOC = Sense of Coherence, TL = Triglyceride level, Tx = Treatment, W = Women, $\bar{x}$ = Mean, σ = Standard deviation. * = Obtained from medical file.

Chart 1. Characteristics and main results in studies of people at risk of developing diabetes.

Author and year	Category	Controlled variables	Main results
Agardh et al., 2003[35]	RDDM	BMI, WHR, PA, smoking and FHD.	Weak SOC associated with RDDM and risk of insulin resistance.
Agardh et al., 2004[39]	RDDM	N/A	The SOC modified the relative risk of developing DM2
Hilding et al., 2006[36]	RDDM	BMI, PA and smoking.	Weak SOC increased the risk of DM2
Kouvonen et al., 2008[20]	RDDM	Socio-demographic variables, PS, HSA, smoking, alcohol consumption and PA.	People over the age of 50 with weak SOC are more at RDDM at a rate of up to 46%
Peer et al., 2012[37]	RDDM	PI, fat intake, BMI, WHR, FHD, age, sex and urbanization	Weak SOC was significantly associated to a greater RDDM.
Eriksson et al., 2013[40]	RDDM	FHD, BMI, smoking, PA, schooling and PS	No association between weak SOC and DM2 in M or W.

Note: BMI = Bodily mass index, DM2 = Diabetes mellitus type 2, FHD = Family history of diabetes, HSA = Health self-assessment, M = Men, N/A = Not available, PA = Physical activity, PI = Physical inactivity, PS = Psychological stress, RDDM = Risk of developing diabetes mellitus, SOC = Sense of coherence, W = Women, WHR = Weight-to-hip ratio.

Chart 2. Características y resultados principales de estudios en personas con diabetes.

Author and year	Category	Controlled variables	Main results
Nilsen et al., 2015[25]	TTO	N/A	Patients with strong SOC are 14 times more likely to change their LS
Ahola et al., 2012[24]	TTO and DC	Age, socioeconomic status, AER and ESKD	Patients with strong SOC have a lower triglyceride concentration and A1c. Strong SOC is associated with good dietary choices, in W and greater PA in M.
Lundman and Norberg, 1993[26]	DC	N/A	No significant correlation between the SOC and A1c measurements.
Sandén-Eriksson, 2000[42]	DC	N/A	SOC is indirectly related to A1c through HAS
Shiu, 2004[44]	DC	N/A	Positive and significant correlation between SOC and A1c.
Cohen and Kanter, 2004[43]	DC	Socio-demographic variables, duration of DM, complications and BMI.	SOC is indirectly related to A1c through the adherence to SC conducts and psychopathological symptoms.
Linden et al., 2016[41]	DC	N/A	SOC was associated with GC. W with GC scored higher on the scale of understandability in SOC.
Olesen et al., 2017[23]	DC	Sex, age and duration of diabetes	Negative non-linear association between strong SOC and C-LDL.
Nuccitelli et al., 2017[22]	DC	Does not describe the variables used	SOC associated negatively with BMI and A1c.
Richardson et al., 2001[27]	DC and DRC	N/A	No significant correlation between SOC and A1c. Strong SOC reported in people without complications or one complication.
Ahola et al., 2010[21]	DC and DRC	N/A	Weak SOC is associated with the worst result of A1c. Patients with strong SOC reached an A1c level below 7,5% more frequently. In M, weak SOC was associated with nephropathy. No differences in SOC measurements in retinopathy.
Abdelgadir et al., 2009[45]	DRC	N/A	SOC had a negative correlation in diabetic patients with amputations.
Thomsen et al., 2014[46]	DRC	N/A	No evidence of any differences in SOC among the groups of patients.

Note: A1c = Glycated hemoglobin, AER = Albuminuria extraction rate, BMI = Body mass index, C-LDL = Low-density lipoproteins, DC = Disease control, DM = Diabetes mellitus, DRC = Diabetes-related complications, ESKD = End-stage kidney disease, GC = Glucose control, HSA = Health self-assessment, LS = Lifestyle, M = Men, N/A = Not available, PA = Physical activity, SC = Self-care, SOC = Sense of coherence, TTO = Treatment W = Women.

resentative individuals of the target population and, finally, no studies implemented measures to address and categorize the people that did not respond.

With regard to the results reported in the articles, all of the studies described their basic results appropriately, and included a description of the results from the aforementioned analyses in the method section; 97% of the results were internally consistent; 97% did not describe information of the people who did not respond. With regard to the discussion, 97% justified their analysis and conclusions based on the results and 90% addressed the study's limitations; the assessment also included whether an ethics committee had approved the study or there was informed consent involved, to which 78% responded affirmatively; the entire quality and risk-of-bias assessment process obtained a level of agreement of .76 among the authors for the observational studies.

Concerning the randomized clinical trial conducted by Nilsen et al.[25], which was the only study we evaluated with the Downs and Black Checklist[31] tool, we found that it had a clear objective, the measured results were clearly described, as well as the patients' characteristics, the intervention, main findings, and the characteristics of the patients who were lost. We found that the distributions of the main confusion factors in the groups of patients were not clearly described, nor were they informed of the potential negative effects of the intervention; with regard to the participants, they were representative of the entire population.

Regarding the results, the analyses were adjusted to the different follow-up timeframes of the patients; statistical testing was used to evaluate the main results and the result measurements were accurate, hence the intervention's execution was deemed reliable; lastly, it was impossible to establish whether the patients from the different intervention groups were recruited from the same population or during a single time period, and no information was found on the assignment of patients into groups or whether the patients and health staff knew about this assignment process. This evaluation had a level of agreement among authors of .92 according to the Kappa coefficient.

Discussion

The systematic review identified 20 studies that evaluated the SOC of people with DM, and it was possible to relate these variables (SOC and DM) at four different stages of the pathology: people at risk, treatment, disease control and complications.

With regard to studies that evaluated the relationship between SOC and the risk of developing DM, we found that: one prospective study[20] claims that after giving an 18-year follow-up to men who were initially healthy, those who were over 50 years old and had a weak SOC were at a higher risk of developing DM, which is consistent with the results reported in other studies[35-37]. However, Agardh et al.[39] and Eriksson et al.[40] concluded that a weak SOC does not predict DM, and it is possible that this inconsistency originated from methodological issues. For instance, Agardh et al.[39] do not consider the possible influence of confounding variables on the measured result; it is important, especially for research in the area of epidemiology, to consider variables that may be confounding in order to avoid spurious conclusions[47]. Furthermore, the measurement of SOC in both of the previously cited studies[39,40] was not performed with either of the versions that have shown the most evidence of validity (SOC-13 and SOC-29).

Respecting to treatment category, two studies[24,25] showed that people with a strong SOC have healthier behaviors and are more likely to change their LS. These results are consistent with studies that have stressed the importance of SOC in the dietary choices of people, therefore concluding that people with a strong SOC make healthier dietary choices, do more physical activity and have a lower alcohol and tobacco consumption[48-52], as well as a lower BMI[53]. There were no studies that related SOC with pharmaceutical treatment. The treatment category was the only one (out of the four proposed categories) where no contradictory results were found.

The evaluation of SOC and disease control produced mixed results. Several studies[21-24,41] infer that SOC helps reduce the levels of biomarkers such as A1c, triglycerides, LDL cholesterol and BMI. These findings could result from the fact that people with a strong SOC consume healthy foods, are physically active and generally have a better LS[24,25,48-52,54]; several studies have documented that some healthy LS behaviors, such as: healthy dietary choices, increased physical activity, and lower tobacco consumption, reduce the level of several biomarkers that relate to this metabolic syndrome[55-57].

Two studies had a different point of view regarding the relationship between these variables,

and concluded that there is an indirect relationship between SOC and A1c, which is mediated by health self-assessment[42], AC behaviors and psychopathological symptoms[43]; there are no further studies that support this hypothesis. According to Holmbeck[58], there are two approaches to calculating indirect effects with mediation models: the regression approach and the structural equation model approach. However, this review found that only one of the studies[43] used the proper approach to evaluate indirect effects through the regression approach.

It is noteworthy that most studies that relate SOC and medical indicators report a negative relationship between the variables; however, Shiu[44] does mention a positive association between SOC and A1c, which means that SOC increases the levels of A1c. Unfortunately, the author does not discuss why these results contradict those reported in the literature, and the reasons behind this result are unknown; however, it is possible that the SOC was not measured with a valid and reliable instrument, as the SOC-13 version she used showed a low Cronbach alpha coefficient[44]. This could be an aspect worthy of consideration.

On the other hand, some studies did not show any association between biomarkers[21,23,24,26,27]; however, we identified a few methodological limitations that could explain these results. In the studies conducted by Olesen et al.[23] and Lundman and Norberg[26], the main limitation was the sample size and a low statistical power, which compromises the veracity of their results[59]. In the case of Ahola et al.[21,24] and Richardson et al.[27] their studies do not specify the time period between the biomarker measurements and the SOC measurements, which could generate bias, as the level of the indicators could be modified overtime due to dietary and LS changes[60,61], among other factors. Therefore, it is possible the results do not report a correlation due to this situation.

In the category of complications, which relates to disease treatment and control, we found that a strong SOC mitigates the appearance of complications[27], while a weak SOC is associated with nephropathy[21]; these results are plausible for the time being, as a strong SOC relates to a better LS, which means that people with a strong SOC will have lower measurements in biomarkers that relate to disease control and, consequently, there will be a lower incidence of complications, as they appear due to the lack of control of the disease[62] caused by a loose adherence to the treatment[63]. The study conducted by Ahola et al.[21] concluded that SOC measurements do not influence the development of retinopathy; however, these findings must be processed taking the limitations described above into consideration.

Lastly, the study also explored whether the presence of DM affected SOC measurements, and the findings show that people without DM had higher SOC measurements[38,45], which suggests that DM affects SOC negatively, while another study does not report similar findings, as it concludes that SOC does not differ among people with and without DM[46]; however, the authors of the latter study mentioned that the reduced sample size could limit the detection of the differences between the groups of patients.

It is worth mentioning that DM has multiple causes; DM1 and DM2 can appear due to genetic and environmental factors[64]. In both cases, it is essential to maintain disease control by adhering to the treatment (pharmaceutical and non-pharmaceutical) in order to stop the complications from developing and progressing. The nature of this disease calls for multidisciplinary strategies[65] that can influence its development, control and treatment, which is why this study explored one of these influencing factors; however, it is important to remember that DM is a phenomenon with many factors involved.

With regard to the measurement of SOC, we must consider that the SOC-3 version has been referred to by Olsson et al.[66] as a non-reliable instrument. Furthermore, Schumann et al.[67] point out that the SOC-3 is not suitable to measure SOC; hence the results of studies that used this version to measure SOC should be interpreted with this limitation in mind.

The forecasts on the prevalence of DM in the next 30 years predict an exponential increase[2], which highlights the need for the implementation of multidisciplinary strategies[65] to prevent and control this disease. Similarly, 12 of the 20 studies were conducted within the last 10 years, which could serve as an indicator of an emerging field of study for the implementation of health promotion and development strategies[68,69] for people with DM.

The quality and risk-of-bias assessment used the AXIS and Downs and Black Checklist[31] tools, as there are no instruments that can help to assess these properties in the field of psychology[70] and the AXIS tool was used to evaluate successful studies in the field of psychology[33]; most of the scales and verification lists are used in epidemiological studies or aim at evaluating clinical trials[32,71].

With regard to the limitations of this study, this review was conducted on five databases

only, which is why future studies could consider broadening the searches and including other languages and databases, as well as including qualitative studies and findings reported in thesis dissertations, book chapters or books.

For future studies, the recommendation is to relate SOC with gestational DM and the pharmaceutical treatment of the disease. For studies that evaluate SOC and biomarkers, one suggestion could be to conduct the measurement of the medical indicators and SOC simultaneously. More studies on the relationship between SOC and DM are needed in order to reaffirm the role of SOC in the different proposed categories of this study. It would be helpful to take a deeper look into the SOC and LS relationship, as several studies claim that SOC relates to healthy behaviors that improve LS, which could explain the lower incidence of DM in people with a strong SOC and lower scores on the biomarkers that relate to metabolic control, as well as a lower incidence in complications.

Collaborations

JH Márquez-Palacios participated in the conception, design, search and selection of articles, the quality and risk-of-bias assessment, as well as in the writing and reviewing the final version of this article. LY Yanez-Peñúñuri participated in the search and selection of articles, the quality and risk-of-bias assessment, and in the writing and reviewing the final version of this article. JG Salazar-Estrada participated in the conception, critical review, and final review of this article.

Acknowledgments

To CONACYT for the support given to this study. To Alfonso Urzúa Morales PhD for his revision and suggestions to improve this study. To Soraya Santana Cárdenas PhD for her support in correcting the writing of the manuscript.

References

1. Fronzo RAD, Ferrannini E, Keen H, Zimmet P. *International Textbook of Diabetes Mellitus*. New Jersey: John Wiley & Sons; 2004.
2. International Diabetes Federation. *Atlas de la Diabetes de la FID* [Internet]. 2017. Disponible en: http://www.diabetesatlas.org/resources/2017-atlas.html
3. American Diabetes Association. 6. Glycemic Targets: Standards of Medical Care in Diabetes—2018. *Stand Med Care Diabetes* 2018; 41:S55-S64.
4. Siddiqui AA, Siddiqui SA, Ahmad S, Siddiqui S, Ahsan I, Sahu K. Diabetes: Mechanism, Pathophysiology and Management-A Review. *Int J Drug Dev Res* 2013; 5(2):1-23.
5. Pereira P, Palay M, Rodríguez A, Neyra R, Chia M. Hemoglobina glucosilada en pacientes con diabetes mellitus. *MEDISAN* 2015; 19(4):555-561.
6. Diabetes Control and Complications Trial Research Group. The Effect of Intensive Treatment of Diabetes on the Development and Progression of Long-Term Complications in Insulin-Dependent Diabetes Mellitus. *N Engl J Med* 1993; 329(14):977-986.
7. UK Prospective Diabetes Study Group. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34). UK Prospective Diabetes Study (UKPDS) Group. *Lancet Lond Engl* 1998; 352(9131):854-865.
8. UK Prospective Diabetes Study Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). UK Prospective Diabetes Study (UKPDS) Group. *Lancet Lond Engl* 1998; 352(9131):837-853.
9. Peyrot M, Rubin RR. Behavioral and Psychosocial Interventions in Diabetes: A conceptual review. *Diabetes Care* 2007; 30(10):2433-2340.
10. Powers MA, Bardsley J, Cypress M, Duker P, Funnell MM, Fischl AH, Maryniuk MD, Siminerio L, Vivian E. Diabetes self-management education and support in type 2 diabetes: a joint position statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. *Diabetes Educ* 2015; 41(4):417-430.
11. Antonovsky A. *Health, Stress, and Coping*. New Jersey: Jossey-Bass; 1979.
12. Antonovsky A. *Unraveling the mystery of health: how people manage stress and stay well*. New Jersey: Jossey-Bass; 1987.
13. Chittem M, Lindström B, Byrapaneni R, Espnes GA. Sense of coherence and chronic illnesses: Scope for research in India. *J Soc Health Diabetes* 2015; 3(2):79-83.
14. Chumbler NR, Kroenke K, Outcalt S, Bair MJ, Krebs E, Wu J, Yu Z. Association between sense of coherence and health-related quality of life among primary care patients with chronic musculoskeletal pain. *Health Qual Life Outcomes* 2013; 11:216.
15. Ekman I, Fagerberg B, Lundman B. Health-related quality of life and sense of coherence among elderly patients with severe chronic heart failure in comparison with healthy controls. *Heart Lung J Crit Care* 2002; 31(2):94-101.

16. Eriksson M, Lindström B. Antonovsky's sense of coherence scale and its relation with quality of life: a systematic review. *J Epidemiol Community Health* 2007; 61(11):938-944.
17. Rohani C, Abedi H-A, Omranipour R, Langius-Eklöf A. Health-related quality of life and the predictive role of sense of coherence, spirituality and religious coping in a sample of Iranian women with breast cancer: a prospective study with comparative design. *Health Qual Life Outcomes* 2015; 13:40.
18. Rohani C, Abedi H-A, Sundberg K, Langius-Eklöf A. Sense of coherence as a mediator of health-related quality of life dimensions in patients with breast cancer: a longitudinal study with prospective design. *Health Qual Life Outcomes* 2015; 13:195.
19. Shor V, Grinstein-Cohen O, Reinshtein J, Liberman O, Delbar V. Health-related quality of life and sense of coherence among partners of women with breast cancer in Israel. *Eur J Oncol Nurs Off J Eur Oncol Nurs Soc* 2015; 19(1):18-22.
20. Kouvonen AM, Väänänen A, Woods SA, Heponiemi T, Koskinen A, Toppinen-Tanner S. Sense of coherence and diabetes: A prospective occupational cohort study. *BMC Public Health* 2008; 8:46.
21. Ahola AJ, Saraheimo M, Forsblom C, Hietala K, Groop P-H, FinnDiane Study Group. The cross-sectional associations between sense of coherence and diabetic microvascular complications, glycaemic control, and patients' conceptions of type 1 diabetes. *Health Qual Life Outcomes* 2010; 8:142.
22. Nuccitelli C, Valentini A, Caletti MT, Caselli C, Mazzella N, Forlani G, Marchesini G. Sense of coherence, self-esteem, and health locus of control in subjects with type 1 diabetes mellitus with/without satisfactory metabolic control. *J Endocrinol Invest* 2017; 41(3):307-314.
23. Olesen K, Jensen TM, Diaz LJ, Møller ACL, Willaing I, Lyssenko V. Sense of Coherence is associated with LDL-cholesterol in patients with type 1 diabetes – The PROLONG-Steno study. *J Clin Transl Endocrinol* 2017; 8:1-5.
24. Ahola AJ, Mikkilä V, Saraheimo M, Wadén J, Mäkimattila S, Forsblom C, Freese R, Groop P-H, FinnDiane Study Group. Sense of coherence, food selection and leisure time physical activity in type 1 diabetes. *Scand J Public Health* 2012; 40(7):621-628.
25. Nilsen V, Bakke PS, Rohde G, Gallefoss F. Is sense of coherence a predictor of lifestyle changes in subjects at risk for type 2 diabetes? *Public Health* 2015; 129(2):155-161.
26. Lundman B, Norberg A. The significance of a sense of coherence for subjective health in persons with insulin-dependent diabetes. *J Adv Nurs* 1993; 18(3):381-386.
27. Richardson A, Adner N, Nordström G. Persons with insulin-dependent diabetes mellitus: acceptance and coping ability. *J Adv Nurs* 2001; 33(6):758-763.
28. Green S, Higgins JP, Alderson P, Clarke M, Mulrow CD, Oxman AD. Introduction. *Cochrane Handbook for Systematic Reviews of Interventions*. New Jersey: Wiley-Blackwell; 2008.
29. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, Clarke M, Devereaux PJ, Kleijnen J, Moher D. The PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration. *PLoS Med* 2009; 6(7):e1000100.
30. Downes MJ, Brennan ML, Williams HC, Dean RS. Development of a critical appraisal tool to assess the quality of cross-sectional studies (AXIS). *BMJ Open* 2016; 6(12):e011458.
31. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health* 1998; 52(6):377-384.
32. Cascaes F, Valdivia BA, Rosa R, Barbosa PJ, Silva R. Escalas y listas de evaluación de la calidad de estudios científicos. *Rev Cuba Inf En Cien Salud* 2013; 24(3):295-312.
33. Chávez-Flores YV, Hidalgo Rasmussen C, Yanez Peñúñuri L. Assessment tools of non-suicidal self-injury in adolescents 1990-2016: A systematic review. *Cien Saúde Colet* 2019; 24(8):2871-2882.
34. Lundberg O, Nyström M. A simplified way of measuring sense of coherenceExperiences from a population survey in Sweden. *Eur J Public Health* 1995; 5(1):56-59.
35. Agardh EE, Ahlbom A, Andersson T, Efendic S, Grill V, Hallqvist J, Norman A, Ostenson C-G. Work stress and low sense of coherence is associated with type 2 diabetes in middle-aged Swedish women. *Diabetes Care* 2003; 26(3):719-724.
36. Hilding A, Eriksson A-K, Agardh EE, Grill V, Ahlbom A, Efendic S, Ostenson C-G. The impact of family history of diabetes and lifestyle factors on abnormal glucose regulation in middle-aged Swedish men and women. *Diabetologia* 2006; 49(11):2589-2598.
37. Peer N, Steyn K, Lombard C, Lambert EV, Vythilingum B, Levitt NS. Rising diabetes prevalence among urban-dwelling black South Africans. *PloS One* 2012; 7(9):e43336.
38. Merakou K, Koutsouri A, Antoniadou E, Barbouni A, Bertsias A, Karageorgos G, Lionis C. Sense of coherence in people with and without type 2 diabetes mellitus: an observational study from Greece. *Ment Health Fam Med* 2013; 10(1):3-13.
39. Agardh EE, Ahlbom A, Andersson T, Efendic S, Grill V, Hallqvist J, Ostenson C-G. Explanations of socioeconomic differences in excess risk of type 2 diabetes in Swedish men and women. *Diabetes Care* 2004; 27(3):716-721.
40. Eriksson A-K, van den Donk M, Hilding A, Östenson C-G. Work stress, sense of coherence, and risk of type 2 diabetes in a prospective study of middle-aged Swedish men and women. *Diabetes Care* 2013; 36(9):2683-2689.
41. Linden K, Sparud-Lundin C, Adolfsson A, Berg M. Well-Being and Diabetes Management in Early Pregnant Women with Type 1 Diabetes Mellitus. *Int J Environ Res Public Health* 2016; 13(8):836.
42. Sandén-Eriksson B. Coping with type-2 diabetes: the role of sense of coherence compared with active management. *J Adv Nurs* 2000; 31(6):1393-1397.

43. Cohen M, Kanter Y. Relation between sense of coherence and glycemic control in type 1 and type 2 diabetes. *Behav Med Wash DC* 2004; 29(4):175-183.
44. Shiu AT-Y. Sense of coherence amongst Hong Kong Chinese adults with insulin-treated type 2 diabetes. *Int J Nurs Stud* 2004; 41(4):387-396.
45. Abdelgadir M, Shebeika W, Eltom M, Berne C, Wikblad K. Health related quality of life and sense of coherence in Sudanese diabetic subjects with lower limb amputation. *Tohoku J Exp Med* 2009; 217(1):45-50.
46. Thomsen NOB, Björk J, Cederlund RI. Health-related quality of life 5 years after carpal tunnel release among patients with diabetes: a prospective study with matched controls. *BMC Endocr Disord* 2014; 14:85.
47. Hernández-Avila M, Garrido F, Salazar-Martínez E. Sesgos en estudios epidemiológicos. *Salud Pública México* 2000; 42:438-446.
48. Wainwright NWJ, Surtees PG, Welch AA, Luben RN, Khaw K, Bingham SA. Healthy lifestyle choices: could sense of coherence aid health promotion? *J Epidemiol Community Health* 2007; 61(10):871-876.
49. Wainwright NWJ, Surtees PG, Welch AA, Luben RN, Khaw K-T, Bingham SA. Sense of coherence, lifestyle choices and mortality. *J Epidemiol Community Health* 2008; 62(9):829-831.
50. Lindmark U, Stegmayr B, Nilsson B, Lindahl B, Johansson I. Food selection associated with sense of coherence in adults. *Nutr J* 2005; 4:9.
51. Binkowska-Bury M, Iwanowicz-Palus G, Kruk W, Perenc L, Mazur A, Filip R, Januszewicz P. Pro-health behaviours - a sense of coherence as the key to a healthy lifestyle in rural areas? *Ann Agric Environ Med AAEM* 2016; 23(2):345-349.
52. Hill R, Tinning R, McCuaig L, Quennerstedt M. Physical Activity and Sense of Coherence in Older Australians. *J Aging Phys Act* 2016; 24(Supl.):S111-S112.
53. Zugravu C. Sense of coherence and its connections with BMI and weight-related beliefs and attitudes. *Int J Collab Res Intern Med Public Health* 2012; 4:1131.
54. Lindfors P, Lundberg O, Lundberg U. Sense of coherence and biomarkers of health in 43-year-old women. *Int J Behav Med* 2005; 12(2):98-102.
55. Saboya PP, Bodanese LC, Zimmermann PR, Gustavo AS, Macagnan FE, Feoli AP, Oliveira MS. Lifestyle Intervention on Metabolic Syndrome and its Impact on Quality of Life: A Randomized Controlled Trial. *Arq Bras Cardiol* 2017; 108(1):60-69.
56. VanWormer JJ, Boucher JL, Sidebottom AC, Sillah A, Knickelbine T. Lifestyle changes and prevention of metabolic syndrome in the Heart of New Ulm Project. *Prev Med Rep* 2017; 6:242-245.
57. Orchard TJ, Temprosa M, Goldberg R, Haffner S, Ratner R, Marcovina S, Fowler S, Diabetes Prevention Program Research Group. The effect of metformin and intensive lifestyle intervention on the metabolic syndrome: the Diabetes Prevention Program randomized trial. *Ann Intern Med* 2005; 142(8):611-619.
58. Holmbeck GN. Toward terminological, conceptual, and statistical clarity in the study of mediators and moderators: examples from the child-clinical and pediatric psychology literatures. *J Consult Clin Psychol* 1997; 65(4):599-610.
59. Cohen J. A power primer. *Psychol Bull* 1992; 112(1):155-159.
60. Xu X, Byles J, Shi Z, McElduff P, Hall J. Dietary pattern transitions, and the associations with BMI, waist circumference, weight and hypertension in a 7-year follow-up among the older Chinese population: a longitudinal study. *BMC Public Health* 2016; 16:743.
61. Siri-Tarino PW. Effects of diet on high-density lipoprotein cholesterol. *Curr Atheroscler Rep* 2011; 13(6):453-460.
62. Nathan DM, Group for the DR. The Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Study at 30 Years: Overview. *Diabetes Care* 2014; 37(1):9-16.
63. Fukuda H, Mizobe M. Impact of nonadherence on complication risks and healthcare costs in patients newly-diagnosed with diabetes. *Diabetes Res Clin Pract* 2017; 123:55-62.
64. American Diabetes Association. 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes - 2018. *Stand Med Care Diabetes* 2018; 41:S13-S27.
65. American Diabetes Association. 1. Improving Care and Promoting Health in Populations: Standards of Medical Care in Diabetes - 2018. *Stand Med Care Diabetes* 2018; 41(Sup. 1):S7-S12.
66. Olsson M, Gassne J, Hansson K. Do different scales measure the same construct? Three Sense of Coherence scales. *J Epidemiol Community Health* 2009; 63(2):166-167.
67. Schumann A, Hapke U, Meyer C, Rumpf H-J, John U. Measuring sense of coherence with only three items: a useful tool for population surveys. *Br J Health Psychol* 2003; 8(Pt 4):409-421.
68. Eriksson M, Lindström B. A salutogenic interpretation of the Ottawa Charter. *Health Promot Int* 2008; 23(2):190-199.
69. Antonovsky A. The salutogenic model as a theory to guide health promotion. *Health Promot Int* 1996; 11(1):11-18.
70. Yanez-Peñúñuri L, Hidalgo-Rasmussen C, Chávez-Flores YV. Revisión sistemática de instrumentos de violencia en el noviazgo en Iberoamérica y evaluación de sus propiedades de medida. *Cien Saude Colet* 2019; 24(6):2249-2262.
71. Sanderson S, Tatt ID, Higgins JP. Tools for assessing quality and susceptibility to bias in observational studies in epidemiology: a systematic review and annotated bibliography. *Int J Epidemiol* 2007; 36(3):666-676.

Article submitted 26/05/2018
Approved 08/01/2019
Final version submitted 10/01/2019

This is an Open Access article distributed under the terms of the Creative Commons Attribution License