

Factors related to sense of coherence in adult patients with Type 2 diabetes

Yuki Odajima¹ and Naomi Sumi²

¹*School of Nursing, Nagoya City University, Nagoya, Japan*

²*Department of Fundamental Nursing, Faculty of Health Sciences, Hokkaido University, Sapporo, Japan*

ABSTRACT

The influence of a diabetic person's sense of burden and blood sugar control through sense of coherence (SOC) on self-management has yet to be sufficiently clarified. The purpose of this study was to examine the utility of salutogenesis, which has sense of coherence at its core, for the self-management of patients with type 2 diabetes. A total of 258 questionnaires were distributed to patients who were seen at one of three hospitals in an urban area in Japan, after obtaining consent from the patient. They were between 20 and 75 years old and regularly received care. Of the 185 responses, 177 were valid. The responses were analyzed by referring to the framework of salutogenesis, and the relationship between patient characteristics, SOC, the Problem Areas In Diabetes survey (PAID), and glycosylated hemoglobin (HbA1c) were studied with structural equation modeling (SEM). SOC had a main effect on PAID scores and an indirect effect on HbA1c. Moreover, age influenced SOC positively. The SOC of patients with type 2 diabetes in the present study was comparatively high. These observations suggest a direct effect of SOC on reducing the sense of burden from having diabetes and an indirect effect on decreasing HbA1c. This research suggested the possibility that diabetes can be controlled by improving SOC.

Keywords: salutogenesis, self-management, sense of coherence, type 2 diabetes

This is an Open Access article distributed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License. To view the details of this license, please visit (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

INTRODUCTION

Salutogenesis and sense of coherence (SOC)

The concept of salutogenesis advocated by Antonovsky differs concretely from pathogenesis.¹⁾ Pathogenesis focuses on treatment by prevention and on the realities of a specific disease. Additionally, pathogenesis is based on the belief that “a stressor is bad for a person.” On the other hand, salutogenesis regards health as a continuum and emphasizes overall factors for good health rather than specific factors for an illness. Moreover, salutogenesis assumes stressors are unevenly distributed and are characterized by focusing on the entire person and how they deal with stressors. In salutogenesis, “health” can be conceptualized as a “health ease/dis-ease continuum,” and each person falls somewhere between these two extremes.²⁾ The role of stressors is explained by the “sense of coherence” (SOC).¹⁾

Received: May 30, 2017; accepted: October 4, 2017

Corresponding author: Yuki Odajima, RN, PhD

School of Nursing, Nagoya City University, Mizuho-cho, Mizuho-ku, Nagoya 467-8601, Japan

Phone: +81-52-853-8037, Fax: +81-52-852-4641, E-mail: odajima@med.nagoya-cu.ac.jp

Antonovsky defined SOC as “a global orientation that expresses the extent to which one has a pervasive, enduring though dynamic feeling of confidence that (1) the stimuli deriving from one’s internal and external environments in the course of living are structured, predictable, and explicable; (2) the resources are available to one to meet the demands posed by these stimuli; and (3) these demands are challenges, worthy of investment and engagement.”³⁾ Individuals with a strong SOC avoid stressors; that is, they define stimuli as non-stressors or are able to overcome stressors.^{1,2)} Resources used to alleviate stressors are called generalized resistance resources (GRRs). GRRs consistently produce life experiences, provide an underload–overload balance of stimuli, and help shape the outcome of the experiences. Consequently, GRRs and a strong SOC are positively correlated.¹⁾

Numerous works on SOC have examined the local populace as below. Wiesmann and Hannich have reported that SOC is a predictor of health and its relationship to a health condition.⁴⁾ Additionally, SOC is related to social status factors, such as occupation.⁵⁾ Another study found that SOC is related to sleep quality.⁶⁾ SOC has a direct effect, modulating effect, and a mediating effect on health.⁷⁾

A relationship of SOC with self-management of chronic diseases has been reported.⁸⁾ Additionally, a relationship between the SOC and quality of life (QOL) in patients with chronic illness has been reported.^{9,10)} Stressors due to living with an illness easily decrease SOC and QOL.¹¹⁾ In a longitudinal study with patients who had suffered an acute cardiac infection, SOC was reported to influence survival rate through self-rated health, as well as the comprehensibility, manageability, and meaningfulness, which are subordinate concepts of SOC that are related to decreasing vagueness and uncertainty due to disease.¹²⁾ In particular, another study suggested that high SOC was related to a low attack rate of apoplexy following stroke, and that a lack of ability to adapt to stress could be a potential risk factor for apoplexy.¹³⁾

Background and purpose of research

The number of diabetic persons in Japan has recently been estimated to be about 9.5 million people.¹⁴⁾ Diabetes is related to psychosocial factors such as SOC and medical factors including BMI and family medical history of diabetes.¹⁵⁾ Moreover, two reports have found that a diabetic person’s SOC is related to coping strategy,^{16,17)} while another found that SOC is related to QOL.¹⁸⁾ Blood sugar control is related to SOC through adherence and psychological pain.¹⁹⁾ Additionally, it has been suggested that intentionally improving SOC in daily life is useful for the self-management of patients with complications.²⁰⁾ Moreover, SOC has been assumed to be indirectly related to self-rated health, but no relationship was found with glycosylated hemoglobin (HbA1c) and SOC.²¹⁾ However, there are few reports on the utility of salutogenesis for under diabetic person and the influence of a diabetic person’s sense of burden and blood sugar control via SOC on self-management has yet to be sufficiently clarified.

Hence, examining the factors related to SOC in salutogenesis should be useful. Consequently, this study examines the utility of the salutogenesis with SOC as its core for self-management of type 2 diabetes.

MATERIALS AND METHODS

Research hypothesis

The present study determined three working hypotheses based on the concept of salutogenesis. (1) Patient characteristics are related to SOC, Problem Areas In Diabetes survey (PAID), and HbA1c. (2) SOC is related to PAID. (3) PAID is related to HbA1c. Fig. 1 shows the research framework.

SOC in Type 2 diabetes mellitus

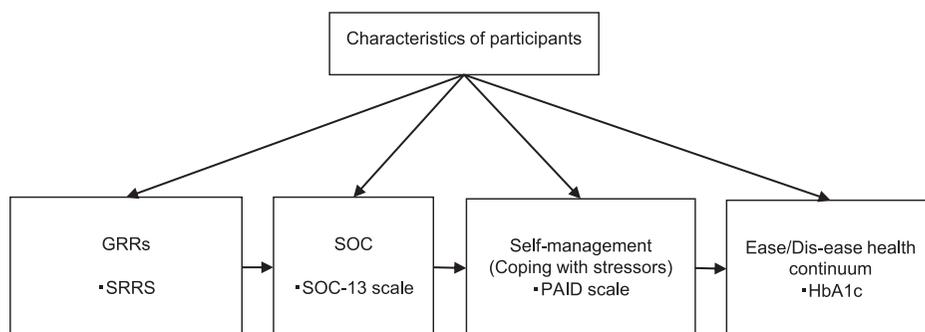


Fig. 1 Self-management model for patients with type 2 diabetes. The study framework was derived from Antonovsky's hypothesis. The operative variables used in this study are also shown.

Design

Data on study variables were collected using a cross-sectional design and questionnaires.

Participants

Participants were outpatients with type 2 diabetes between 20 and 75 years old, who regularly sought care at one of three hospitals in Hokkaido. One hospital is private general hospital. The other two are private hospitals specializing in internal disease. These hospitals were selected to secure an adequate number of participants for the cross-sectional study and to reduce selection bias that would occur when assessing only one facility. Participants with impaired communication abilities due to mental health problems, participants with perceptual disturbances, and those with renal failure or who were pregnant were excluded from participation.

Measurement instruments

Antonovsky created two versions of the SOC instrument, one containing 29 items and one containing 13 items.²²⁾ The reliability and validity of the two versions has been verified.^{23,24)} Additionally, a Japanese version has been validated and a study found a Cronbach's α of 0.81.²⁵⁾ This study employed the 13-item version due to the load on the respondents.²⁶⁾ The 13 items correspond to the three components of SOC: 5 items about comprehensibility, 4 items about manageability, and 4 items about meaningfulness. Participants are asked to respond on a 5-point Likert scale with total scores ranging from 13 to 65. The higher the score, the stronger the sense of coherence is. The questionnaire was used with the permission of the copyright holder.

The reliability and validity of the Problem Areas In Diabetes (PAID) Survey was verified at the Johnson Diabetic Center and Harvard Medical School in the United States.²⁷⁾ Additionally, the reliability of the Japanese version has been verified; Cronbach's α was found to be 0.93.²⁸⁾ Participants are asked to respond on a 5-point Likert scale with total scores ranging from 20 to 100. The higher the score, the higher sense of burden from having diabetes is. The PAID was selected because it reflects multiple factors, including somatization, mental well-being, and a social dimension, as well as comprehensibility, manageability, and meaningfulness in terms of SOC.

The participants provided information on the following items to assess characteristics of patients who go to hospital: sex, age, height, weight, duration of diabetes, employment status, family structure, frequency of hospital trips, and HbA1c. The patients provided information on the following items as variables representative their current medical history: diabetic complica-

tions (retinopathy, nephropathy, and peripheral neuropathy), pharmacotherapy of diabetes (internal medicine and insulin injection), and if they have been hospitalized due to diabetic complications. HbA1c is an index that shows the average amount of sugar in person's blood during the preceding one to two months. It is used to monitor the effectiveness of diabetic treatment. Additionally, the Social Readjustment Rating Scale (SRRS) was administered as life events are believed to be related to SOC.²⁹⁾ The questionnaire inquired about life events in the preceding three months, including major positive or negative changes in financial status, living conditions, and other life events. HbA1c was used as a marker for where participants fall in terms of the health ease/dis-ease continuum.

Data collection

The author individually explained the research purpose to each patient who visited each hospital outpatient clinic, and requested participation from patients who met the inclusion criteria. Patients who consented to participate were then recruited and asked to sign an informed consent form. The participants received the questionnaires and an envelope for returning the completed questionnaire by mail.

Sample size

The sample size was not calculated statistically as this study included not only hypothesis testing but was also exploratory.

Statistical analysis

The self-management of patients with type 2 diabetes was analyzed using structural equation modeling (SEM). SEM is useful for splitting the influences of one variable on another into total, direct, and indirect effects.^{30,31)} Recently, SEM has come to be used as a method of analysis in medical research.^{32,33)} We used SEM to quantify the relationships that are mediated by patient characteristics, SOC, the PAID, and HbA1c. In addition, Spearman's correlations were used to determine the relationships between SOC, the PAID, HbA1c, and characteristics of patients. Variables that correlated positively with SOC was assumed to be an element of GRRs. Binary variables in terms of the participants' characteristics were analyzed using Mann–Whitney tests between SOC, PAID, HbA1c, and variables considered to be GRRs. Only significant variables were assumed to be a variable of the SEM, and an arrow was drawn based on the hypothesis (Fig. 1). The significance level was set at $p < .05$. Statistical analysis was carried out using the Japanese version of IBM SPSS Statistics version 22 and the software AMOS version 22 (IBM, Armonk, NY, USA).

Ethical considerations

Participants received a verbal and written explanation of the study objectives and methods. Upon agreeing to participate, participants signed the consent form and kept a copy thereof for their reference. The study complied with the Declaration of Helsinki with regard to confidentiality and data management.³⁴⁾ Participants were also informed that they could withdraw from the study at any time without penalty. The clinical research review committee of Hokkaido University approved of the study (No. 10–02–1).

RESULTS

Study participants & baseline characteristics

Table 1 shows the participant characteristics. One hundred and seven respondents (60.5%) were men. The average age of men and women combined was 57.9 ± 10.9 years old. One hundred and sixty-three respondents (92.1%) were 40 years old or older. The SOC score was 45.8 ± 8.9 , which is similar to the score of 44.1 ± 8.8 found in a survey of 1095 adult men and women in Japan.²⁵⁾ Cronbach's alpha for this scale was 0.87. The PAID score was 43.2 ± 16.0 with a Cronbach's alpha of 0.95. The average HbA1c value was $6.8 \pm 1.3\%$, and the average duration of diabetes was 9.0 ± 8.6 years. Twenty-six people (14.7%) were single, and 93 respondents (52.5%) were employed. One hundred and fifty-eight individuals (89.3%) received pharmacotherapy for diabetes. One hundred and fifty-three respondents (86.4%) went to the hospital at least once a month. Additionally, 23 (19.3%) reported major changes in their financial status, 22 (18.5%) indicated major changes in living conditions, and 74 people (62.2%) reported other major life events.

Table 1 Characteristics of participants ($n = 177$)

Item	Breakdown	
Sex	Male	107 (60.5%)
	Female	70 (39.5%)
Age (mean \pm SD)		57.9 ± 10.9
Height (mean \pm SD)		162.6 ± 9.0
Weight (mean \pm SD)		66.2 ± 11.9
BMI (mean \pm SD)		25.2 ± 4.0
SOC (mean \pm SD)		45.8 ± 8.9
PAID (mean \pm SD)		43.2 ± 16.0
HbA1c (mean \pm SD)		6.8 ± 1.3
Duration of diabetes (mean \pm SD)		9.0 ± 8.6
Family structure	Living alone	26 (14.7%)
	Living with more persons	151 (85.3%)
Employed	Yes	93 (52.5%)
	No	84 (47.5%)
Presence of diabetes complications	Yes	41 (23.2%)
	No	136 (76.8%)
Pharmacotherapy for diabetes	Yes	158 (89.3%)
	No	19 (10.7%)
Presence of hospitalization for diabetes	Yes	88 (50.3%)
	No	89 (49.7%)
Frequency of hospital trips	Once a month	153 (86.4%)
	One every two months	24 (13.6%)
Life events ^a		
Major changes in financial status		23 (19.3%)
Major changes in living conditions		22 (18.5%)
Other life events		74 (62.2%)

^aMultiple answer options

Relationship between SOC and other variables

The relationships between SOC, age, BMI, and duration of diabetes were examined with Spearman's rank correlation coefficient. Age and SOC were positively correlated ($r = .319$, $p < .01$). Therefore, age is a factor to improve SOC. Additionally, the relationships between age, SOC, PAID, and HbA1c were examined using Spearman's rank correlation coefficient. Consequently, it was found that SOC was positively correlated with age ($r = .319$, $p < .001$) and negatively with PAID ($r = -.473$, $p < .001$). Additionally, HbA1c was positively correlated with PAID ($r = .190$, $p < .05$) and BMI ($r = .180$, $p < .016$).

Mann-Whitney tests were conducted with sex, family structure, employment status, presence of diabetic complications, pharmacotherapy for diabetes, presence of hospitalization for diabetes, frequency of hospital trips, and life events for age, SOC, PAID, and HbA1c. In terms of age, a significant difference was observed for employment status ($p < .001$) and major changes in living conditions ($p < .05$). In terms of SOC, a significant difference was seen in major changes in financial status ($p < .05$). In terms of the PAID scores, no significant differences were seen in these variables. In terms of HbA1c, significant differences were seen for family structure ($p < .05$), pharmacotherapy for diabetes ($p < .01$), frequency of hospital trips ($p < .05$), and major changes in living conditions ($p < .05$).

The relationships of each were examined by adding items that displayed significant differences as variables in the research frame using SEM based on the working hypothesis. Table 2 shows the analysis process where non-significant standardized coefficients in the covariance structure analysis were excluded at a 5% significance level. Upon repeating the analysis, standardized coefficients remained significant at the 5% level. The significant standardized coefficients remaining due to the first analysis were as follows. For age, employment status ($p < .001$) and major changes in living conditions ($p < .05$) remained, while for SOC, age ($p < .001$) and major changes in financial status remained ($p < .01$). Only SOC ($p < .001$) remained for PAID scores, while pharmacotherapy for diabetes ($p < .01$), family structure ($p < .001$), the PAID ($p < .01$), and major changes in living conditions ($p < .01$) remained for HbA1c. As a result, frequency of hospital trips ($p > .05$) was excluded. The significant standardized coefficients after the second analysis were as follows. For age, employment status ($p < .001$), and major changes in living

Table 2 Process of SEM

Cause variable	Direction of path coefficient	Result variable	Estimated value (First)	Estimated value (Second)
Age	←	Employed	-.368***	-.368***
Age	←	Major changes in living conditions	-.151*	-.151*
SOC	←	Age	.288***	.288***
SOC	←	Major changes in financial status	-.189**	-.189**
PAID	←	SOC	-.488***	-.488***
HbA1c	←	PAID	.184**	.184**
HbA1c	←	BMI	.051	
HbA1c	←	Pharmacotherapy	.267**	.204**
HbA1c	←	Family structure	.259***	.228**
HbA1c	←	Frequency of hospital trips	.007	
HbA1c	←	Major changes in living conditions	.213**	.202**

* $p < .05$ ** $p < .01$ *** $p < .001$

SOC in Type 2 diabetes mellitus

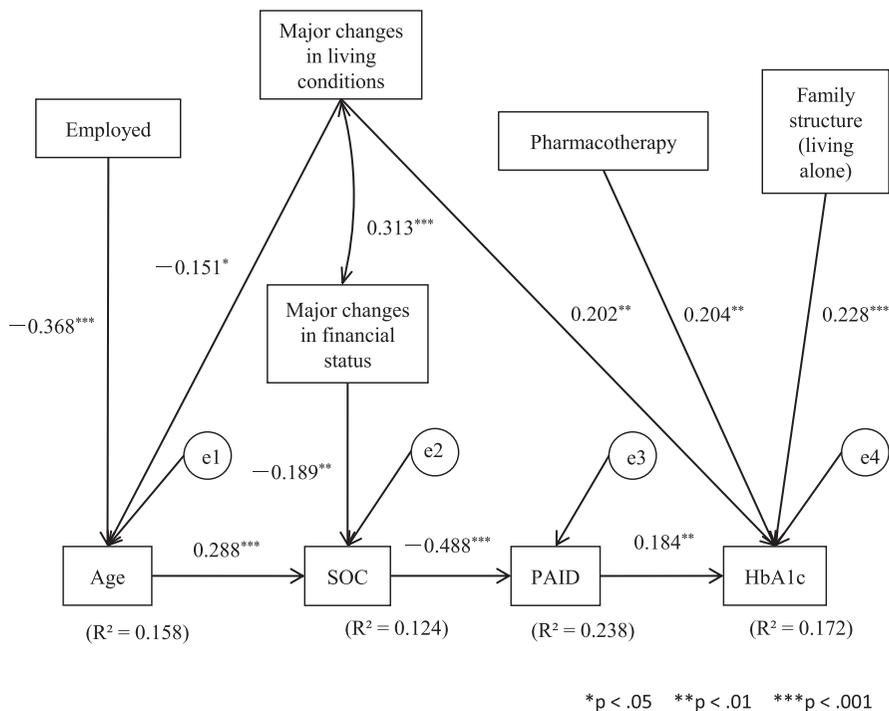


Fig. 2 Result of SEM. Based on Figure 1, we performed exploratory analysis to observe the direct and indirect effects of SOC.

conditions ($p < .05$) remained, while age ($p < .001$) and major changes in financial status ($p < .01$) remained for SOC. PAID scores were only influenced by SOC ($p < .001$). However, for HbA1c, pharmacotherapy for diabetes ($p < .01$), family structure ($p < .01$), PAID scores ($p < .01$), and major changes in living conditions ($p < .01$) remained significant.

Fig. 2 shows the significant standard coefficients identified through the analyses and a model chart with the coefficient of determination. In Fig. 2, e1, e2, e3, and e4 show the error variables. Employment status (a binary variable) was negatively related to age ($p < .001$). Age positively influenced SOC ($p < .001$). SOC negatively influenced PAID scores ($p < .001$). Major changes in financial status negatively impacted SOC ($p < .01$), but had an indirect positive effect on PAID scores. PAID scores ($p < .01$), major changes in living conditions ($p < .01$), pharmacotherapy for diabetes ($p < .01$), and living alone ($p < .001$) positively impacted HbA1c. Moreover, major changes in financial status and major changes in living conditions were correlated in the SEM ($r = .313$, $p < .001$). The coefficient of determination for age, SOC, PAID scores, and HbA1c were .158, .124, .238, and .172, respectively. The goodness-of-fit of this model was GFI = .971, AGFI = .950, CFI = 1.000, and RMSEA = .000.

The age range in this study was quite wide (20–75 years old) and the distribution may have been skewed. Therefore, an additional analysis for a subgroup which excludes young participants (< 40 years old) was conducted. The result of this analysis provided a glimpse that the path from major changes in living conditions to age had become insignificant, and the Fig. 2 model was maintained. The goodness-of-fit of this model was GFI = 1.00, AGFI = .938, CFI = 1.000, and RMSEA = .017.

DISCUSSION

Participant characteristics

More men (60.5%) completed the questionnaire than women. More than half of the diabetic persons were employed (52.5%) and there were a many middle-aged and elderly persons (92.1%). Therefore, we speculate that the main desire of the study participants is to manage their diabetes adequately to be able to fulfill their responsibilities at work and at home. The mean value of HbA1c was relatively good (6.8). The percentage of those receiving pharmacotherapy for diabetes was 89.3%, and just over half had been hospitalized due to diabetes. However, the percentage of diabetic complications was relatively low (23.2%). Many of people went to hospital once a month (86.4%). The frequency of hospital trips in Japan is reported to be higher than that of another country.³⁵⁾ Therefore, the target group might be reflecting the distinctiveness of Japan's healthcare system. The responses indicated that the diabetic symptoms were well controlled and most had a low sense of burden due to diabetes. However, the percentage of diabetic persons who had either major changes in financial status or major changes in living conditions were 19.3% and 18.5% respectively. Therefore, these factors are thought to influence the self-management of diabetes greatly.

Relationship between age, SOC, PAID scores, and HbA1c from the perspective of salutogenesis

The relationship between age, SOC, PAID scores, and HbA1c was determined from the perspective of salutogenesis. Antonovsky felt the influence of age on SOC stabilized around 30 years of age²²⁾ and one study found that SOC did not relate to age.³⁶⁾ However, a different study found that SOC tended to increase with age, that is, the influence of age did not stabilize, as per Antonovsky's hypothesis.²³⁾ The present study is consistent with the report where SOC increased with age. Moreover, SOC had a strong, negative influence on PAID scores, but PAID scores had a positive influence on HbA1c. Hence, SOC did not directly influence HbA1c, but indirectly affected HbA1c due to the impact of SOC on PAID. This result supports the framework of salutogenesis.

A previous work on SOC in regard to health suggested that SOC was influenced by a main effect, modulator effect, and effect of mediation.⁷⁾ A different report found that high SOC was related to maintaining high blood sugar levels.³⁷⁾ A reason for this is that among the respondents with high SOC were people who did not comply with the treatment regimen and simply lead their normal lifestyle, thus maintaining high blood sugar levels.³⁷⁾ Additionally, Antonovsky claims that respondents with rigid SOC were regarded as having no problems.²²⁾ SOC had a main effect on PAID scores and an indirect effect on HbA1c, though a direct relationship between SOC and HbA1c was not found in the present study. It is speculated that the respondents reported few subjective symptoms because 136 people (76.8%) had no diabetic complications. Therefore, it is possible that these respondents included people who may have strong SOC, but had a poor awareness of diabetes and did not comply with the treatment regimen, simply leading their normal lifestyle.

Some previous reports have found that PAID and HbA1c were positively related,³⁸⁻⁴⁰⁾ while others did not.^{41,42)} The present study is consistent with previous works that suggest that they are related.

From the SEM analysis, these effects appear to imply causal relationships based on the hypotheses derived from the salutogenesis theory. The goodness-of-fit was adequate. However, the examination of the causal relationships is insufficient as the present study is cross-sectional. Therefore, it will be necessary to examine the causal relationships with a longitudinal study in the future.

This self-management model in clinical settings suggests that it is essential to focus on SOC as a supporting factor for self-management behavior rather than focusing on self-management behavior as a factor related to HbA1c. The advantage of this model is that the SOC of patients with type 2 diabetes is related to self-management, so it may be possible to improve the patients' self-management by ascertaining and working on their SOC. However, various factors affect HbA1c, including physical activity, smoking, psychological stress, depression, and hypertension⁴³. This study has not clarified whether GRRs are influenced by these factors. It is also essential to focus on factors other than SOC, which could not be included in this model.

Relationship between the SOC of patients with type 2 diabetes and relevant factors

Major changes in financial status were related to lower SOC. It has previously been reported that changes in social and economic positions, including occupation and employment status, are related to SOC.⁵⁾ Our results suggested that major financial changes created instability and decreased SOC. Furthermore, HbA1c was positively impacted by major changes in the living conditions, pharmacotherapy for diabetes, and living alone. Major changes in living conditions likely involves changes in eating habits and exercise, and thus is connected to controlling blood sugar. Similarly, living with one or more persons may ease the burden of maintaining a healthy lifestyle, which would improve controlling blood sugar. Age was negatively impacted by major changes in living conditions. Many of the older respondents might have had difficulty changing their lifestyle because they were employed. Therefore, it might be necessary that the medical staff provide appropriate support after understanding changes in patients' financial status and living conditions as these conditions relate to HbA1c directly and indirectly through SOC.

Limitations

As these data were collected from only three hospitals in one area, generalizability of the study findings is limited. This study is a cross-sectional study; therefore, a causal relationship between SOC and other variables was not assessed. Another limitation of the present study is that it was a self-report questionnaire investigation. Additionally, 153 of the respondents (86.4%) visit the hospital regularly. Therefore, it is highly likely that the participants selected in this study were people who are willing go to hospital, and it cannot be ruled out that this may have affected the outcome of this study.

CONCLUSION

The SOC of patients with type 2 diabetes in the present study tended to rise with age, contrary to Antonovsky's hypothesis. Moreover, a high SOC was related to a low PAID score and to having HbA1c under control. These observations suggest a direct effect of SOC on reducing the sense of burden from having diabetes and an indirect effect on decreasing HbA1c. Our findings imply that improving SOC in type 2 diabetes persons via outpatient care reduced the sense of burden from having diabetes and helped to reduce HbA1c. For diabetic outpatients, it is important to provide supports that suit the patient's lifestyle and personal traits such as age and financial status. This research suggests the possibility that the diabetic person's sense of burden can be controlled well by improving SOC. Therefore, it is necessary to examine the causal relationships through a longitudinal study.

ACKNOWLEDGEMENTS

We are grateful to all the participants of the study.

AUTHOR DISCLOSURE STATEMENT

None of the authors have conflicts of interest to declare.

REFERENCES

- 1) Antonovsky A. The sense of coherence as a determinant of health. In: *Behavioral Health: A Handbook of Health Enhancement and Disease Prevention*, edited by Matarazzo JD, Weiss SM, Herd, JA, Miller ME, Weiss SM. pp.114–129, 1984, John Wiley, New York.
- 2) Antonovsky A. Health, stress, coping: New perspective on mental and physical well-being. pp.38–69, 1979, Jossey-Bass Publishers, San Francisco, London.
- 3) Antonovsky A. Unraveling the mystery of health: How people manage stress and stay well. p.19, 1987, Jossey-Bass Publishers, San Francisco, London.
- 4) Wiesmann U, Hannich H. A salutogenic analysis of healthy aging in active elderly persons. *Res Aging*, 2010; 32: 349–371.
- 5) Togari T, Yamazaki Y. The socioeconomic gradient of sense of coherence from a representative sample survey of 4800 Japanese people aged 20 to 40. *Bull Soc Med*, 2009; 26: 45–52.
- 6) Nasermoaddeli A, Sekine M, Hamanishi S, Kagamimori S. Job strain and sleep quality in Japanese civil servants with special reference to sense of coherence. *J Occup Health*, 2002; 44: 337–342.
- 7) Eriksson M, Lindström B. Antonovsky's sense of coherence scale and the relation with health: a systematic review. *J Epidemiol Community Health*, 2006; 60: 376–381.
- 8) Gallagher R, Donoghue J, Chenoweth L, Stein-Parbury J. Self-management in older patients with chronic illness. *Int J Nurs Pract*, 2008; 14: 373–382.
- 9) Kristofferzon ML, Lindqvist R, Nilsson A. Relationships between coping, coping resources and quality of life in patients with chronic illness: a pilot study. *Scand J Caring Sci*, 2011; 25: 476–483.
- 10) Jakobsson L. Indwelling catheter treatment and health-related quality of life in men with prostate cancer in comparison with men with benign prostatic hyperplasia. *Scand J Caring Sci*, 2002; 16: 264–271.
- 11) Delgado C. Sense of coherence, spirituality, stress and quality of life in chronic illness. *J Nurs Scholarsh*, 2007; 39: 229–234.
- 12) Gerber Y, Benyamini Y, Goldbourt U, Drory Y; Israel Study Group on First Acute Myocardial Infarction. Prognostic importance and long-term determinants of self-rated health after initial acute myocardial infarction. *Med Care*, 2009; 47: 342–349.
- 13) Surtees PG, Wainwright NW, Luben RL, Wareham NJ, Bingham SA, Khaw KT. Adaptation to social adversity is associated with stroke incidence: evidence from the EPIC-Norfolk prospective cohort study. *Stroke*, 2007; 38: 1447–1453.
- 14) Health and Nutrition Information Study Group, Ministry of Health, Labour and Welfare. *The notional health and nutrition examination survey in Japan*, 2012; Retrieved from <http://www.mhlw.go.jp/bunya/kenkou/eiyoudl/h24-houkoku.pdf> (in Japanese)
- 15) Agardh EE, Ahlbom A, Andersson T, Efendic S, Grill V, Hallqvist J, et al. Explanations of socioeconomic differences in excess risk of type 2 diabetes in Swedish men and women. *Diabetes Care*, 2004; 27: 716–721.
- 16) Li S, Shiu AT. Sense of coherence and diabetes psychosocial self-efficacy of members of a peer-led organisation in Hong Kong. *J Clin Nurs*, 2008; 17: 1526–1528.
- 17) 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: 381–386.
- 18) 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: 45–50.
- 19) Cohen M, Kanter Y. Relation between sense of coherence and glycemic control in type 1 and type 2 diabetes. *Behav Med*, 2004; 29: 175–183.
- 20) Leksell JK, Wikblad KF, Sandberg GE. Sense of coherence and power among people with blindness caused by diabetes. *Diabetes Res Clin Pract*, 2005; 67: 124–129.

- 21) Sandén-Eriksson B. Coping with type-2 diabetes: The role of sense of coherence compared with active management. *J Adv Nurs*, 2000; 31: 1393–1397.
- 22) Antonovsky A. Unraveling the mystery of health: How people manage stress and stay well. pp.189–194, 119–123, 24–27, 1987, Jossey-Bass Publishers, San Francisco, London.
- 23) Eriksson M, Lindström B. Validity of Antonovsky's sense of coherence scale: a systematic review. *J Epidemiol Community Health*, 2005; 59: 460–466.
- 24) Feldt T, Lintula H, Suominen S, Koskenvuo M, Vahtera J, Kivimäki M. Structural validity and temporal stability of the 13-item sense of coherence scale: prospective evidence from the population-based HeSSup study. *Qual Life Res*, 2007; 16: 483–493.
- 25) Togari T, Yamazaki Y. Examination of the reliability and factor validity of 13-item five-point version Sense of Coherence Scale. *Jpn J Health Human Ecol*, 2005; 71: 168–182.
- 26) Antonovsky A. Unraveling the Mystery of Health: How People Manage Stress and Stay Well [Kenko-no-nazo-wo-toku] Trans Yamazaki Y, Yoshii K., 1987, Yushindo Kobunsha, Tokyo.
- 27) Polonsky WH, Anderson BJ, Lohrer PA, Welch G, Jacobson AM, Aponte JE, et al. Assessment of diabetes-related distress. *Diabetes Care*, 1995; 18: 754–760.
- 28) Ishii H, Welch G, Jacobson A, Goto M, Okazaki K, Yamamoto T, et al. The Japanese version of Problem Area in Diabetes Scale: a clinical and research tool for the assessment of emotional functioning among diabetic patients. *Diabetes*, 1999; 48: A319.
- 29) Holmes TH, Rahe RH. The social readjustment rating scale. *J Psychosom Res*, 1967; 11: 213–218.
- 30) Bollen KA. Total, direct, and indirect effects in structural equation models. In: *Sociological Methodology*, edited by Clogg CC. pp.37–69, 1987, American Sociological Association, Washington, D.C.
- 31) Oshio A. Structural equation modeling for beginners: Path analysis by Amos. pp.87–119, 2008, TokyoTosho, Tokyo. (in Japanese)
- 32) Shao Y, Liang L, Shi L, Wan C, Yu S. The effect of social support on glycemic control in patients with type 2 diabetes mellitus: the mediating roles of self-efficacy and adherence. *J Diabetes Res*, 2017; 2017: Article 2804178.
- 33) Conti C, Di Francesco G, Fontanella L, Carrozzino D, Patierno C, Vitacolonna E, et al. Negative affectivity predicts lower quality of life and metabolic control in type 2 diabetes patients: a structural equation modeling approach. *Front Psychol*, 2017; 8: Article 831.
- 34) World Medical Association. *WMA Declaration of Helsinki: Ethical principles for medical research involving human subjects*, 2013; Retrieved from <https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/>
- 35) OECD. *Health Care Utilisation*, 2013; Retrieved from http://stats.oecd.org/index.aspx?DataSetCode=HEALTH_STAT
- 36) Bergsten Brucefors A, Hjelte L, Hochwälder J. Mental health and sense of coherence among Swedish adults with cystic fibrosis. *Scand J Caring Sci*, 2011; 25: 365–372.
- 37) Shiu AT. Sense of coherence amongst Hong Kong Chinese adults with insulin-treated type 2 diabetes. *Int J Nurs Stud*, 2004; 41: 387–396.
- 38) Nichols GA, Hillier TA, Javor K, Brown JB. Predictors of glycemic control in insulin-using adults with type 2 diabetes. *Diabetes Care*, 2000; 23: 273–277.
- 39) Nozaki T, Morita C, Matsubayashi S, Ishido K, Yokoyama H, Kawai K, et al. Relation between psychosocial variables and the glycemic control of patients with type 2 diabetes: a cross-sectional and prospective study. *Biopsychosoc Med*, 2009; 3: 4.
- 40) Snoek FJ, Pouwer F, Welch GW, Polonsky WH. Diabetes-related emotional distress in Dutch and U.S. diabetic patients: cross-cultural validity of the problem areas in diabetes scale. *Diabetes Care*, 2000; 23: 1305–1309.
- 41) Gross CC, Scain SF, Scheffel R, Gross JL, Hutz CS. Brazilian version of the Problem Areas in Diabetes Scale (B-PAID): validation and identification of individuals at high risk for emotional distress. *Diabetes Res Clin Pract*, 2007; 76: 455–459.
- 42) Papelbaum M, Lemos HM, Duchesne M, Kupfer R, Moreira RO, Coutinho WF. The association between quality of life, depressive symptoms and glycemic control in a group of type 2 diabetes patients. *Diabetes Res Clin Pract*, 2010; 89: 227–230.
- 43) The Japan Diabetes Society. The Japan diabetes specialist training guidebook version 4: The Japan diabetes society essential training guide for becoming a specialist. pp.33–35, 2009, Shindan to Chiryō Sha, Tokyo. (in Japanese)