ORIGINAL ARTICLE

Moderating effect of sense of coherence on the relationship between symptom distress and health-related quality of life in patients receiving cancer chemotherapy

Kaori Asaba[1] · Akiko Okawa[2]

Abstract

Purpose This study is aimed at examining the buffering effect of sense of coherence (SOC) on symptom distress during cancer drug therapy, which thereby affects health-related quality of life (QoL), and obtaining suggestions for promoting supportive care.
Methods We investigated health-related QoL (SF-8), symptom distress (using the Symptom Distress Scale (SDS)), and SOC (the SOC 13-item Scale) in 66 patients receiving adjuvant chemotherapy for non-small cell lung cancer. We employed descriptive statistics to seek the correlation of each variable; then, a hierarchical multiple regression analysis was conducted with SF-8 score as the dependent variable.
Results Results showed that significant changes in bodily pain showed a buffering effect on the SDS and sense of comprehensibility ($\beta = -0.658$, $p < 0.01$, $\beta = -0.319$, $p < 0.05$), sense of manageability ($\beta = -0.658$, $p < 0.01$, $\beta = 0.398$, $p < 0.01$), and meaningfulness ($\beta = -0.658$, $p < 0.01$, $\beta = -0.257$, $p < 0.05$). Significant changes in general health perception showed a buffering effect on the SDS and sense of manageability ($\beta = -0.406$, $p < 0.01$, $\beta = 0.329$, $p < 0.05$). As a result of the simple inclination test, SOC proved to be effective under high levels of symptom distress; the buffering effect of sense of manageability was reversed regarding bodily pain; and when meaningfulness was lower, it had a positive effect on QoL.
Conclusion This study revealed that SOC exerts a buffering effect in situations where symptoms are highly painful. It also revealed that the effect of SOC was reversed for bodily pain and that a high SOC had a negative effect on QoL.

Keywords Symptom distress · Sense of coherence · Cancer chemotherapy · Cancer patient · Quality of life

Introduction

Advances in chemotherapy mean that cancer patients will live longer; in fact, a study showed that more patients are being able to live owing to pharmacotherapy [1]. However, a recent Japanese report showed that the proportion of adverse reactions, complications, and sequelae of cancer treatment regarding chemotherapy have increased from 19.2% (in 2003) to 44.3% (in 2013) [2]. Supportive therapy is a type of therapy that can ensure enhanced quality of life (QoL) by focusing on how patients experience and perceive symptoms. Since symptoms are

sensations specific to the patients who experience them, supportive therapy may be required for patients during recovery from some treatments, such as chemotherapy.

Moreover, most lung cancer patients experience stress [3, 4] and depression, both of which can reduce their health-related quality of life (HRQoL) and adversely affect the treatment of physical illnesses [5]. Depression and indication disorders have been associated with cancer patients and have shown a high prevalence (i.e., ranging from 9 to 42%), and an association with lower QoL, in this population [6–8]. Accordingly, research have analyzed potential early palliative care interventions to improve depression and QoL in cancer patients [9], albeit the mechanisms of this process are not yet known. Nevertheless, screening and specialized nursing care for distress and adverse reactions are important tasks requiring attention and funding.

Additionally, although we know that patients' subjective perception of chemotherapy-related symptoms differs from that of medical personnel [10–12], the individual characteristics

✉ Kaori Asaba
asaba.kaori@b.mbox.nagoya-u.ac.jp

[1] Department of Nursing, Nagoya University Graduate School of Medicine, Nagoya, Japan

[2] Mie Prefectural College of Nursing, Tsu, Japan

affecting these perceptions remain unclear. The Integrated Approach to Symptom Management (IASM) [13] was developed to ensure the clinical application of the Model of Symptom Management (MSM) [14]. Studies show the effectiveness of patient-centered management based on the IASM vis-à-vis patients' experience of symptoms, mainly because it provides knowledge, skills, and nursing support that are aligned with patients' self-care ability [15–17].

Sense of coherence (SOC) is a personal characteristic related to patients' HRQoL. SOC is a key concept in Antonovsky's health generation theory (salutogenesis), as it is an individual characteristic that affects patients' perception of their symptoms [18]. It refers to people's ability, when exposed to stressful events and situations, to protect their mental and physical health by effectively mobilizing internal and external resources. SOC is an important predictor of QoL because it is effective; studies have shown that patients who had a disease and a high SOC also had a QoL that was considered good [19]. Although we know that SOC is highly associated with anxiety and depression as an indicator of pain in cancer patients [20], the mechanisms have not been clarified.

SOC has both direct and moderating effects [21]; evidence on its direct effect showed that health and well-being vary by SOC level, regardless of the presence of a stressor. Thus, since the buffering effect of SOC on physical and mental health differs by SOC levels when encountering a similar stressor, we can predict that SOC will have different effects on mental and physical health depending on patients' SOC levels for the stressor amid cancer chemotherapy.

In this study, we included outpatients who were diagnosed with a non-small cell lung cancer in the postoperative stage IA $T_{1b}N_0M_0$ or stage IB, receiving standardized treatment with postoperative adjuvant chemotherapy, and using tegafur/uracil therapy (250 mg/m^2/day, 1–2 years' oral administration) [22, 23].

Purpose

This study is aimed at clarifying the moderating effect of SOC on the relationship between symptom distress and HRQoL in patients during cancer chemotherapy; we hope that these examinations can help stakeholders design a nursing care regime that is more efficient at dealing with the HRQoL of these patients.

Conceptual framework and definition of terms

Conceptual framework (Fig. 1)

Our conceptual model captures the moderating effect of SOC [24]: similar stressors have different effects with different levels of SOC. Figure 1 represents the relationship among pharmacotherapy-induced symptom severity, HRQoL, and SOC.

Definition of terms

Symptom is not an objective index, but individuals' subjective experience of symptoms.

Distress is an unpleasant experience that widens the difference between the ideal state and reality.

Symptom management is the process used by support staff to help patients deal with symptom distress.

HRQoL is individuals' subjective judgments regarding their HRQoL (both mental and physical), including symptom experience factors.

Methods

Study design

This was an exploratory study, which was conducted as a pilot study as there are no prior studies that could be referenced regarding this specific approach. Nonetheless, its reliability and validity were confirmed using a major assessment scale in our examination. Therefore, we calculated the 95% confidence interval at 80% power and set it to 0.5 (Cohen's d medium).

The first author got in touch with the head manager of medical facilities in Japan and asked for their cooperation with this study. Then, the attending physician at those facilities that agreed to participate introduced the first author to potential participants based on our selection. To avoid biases because of differences in treatment time and drugs (e.g., in treatment duration and in the time when side effects were strong owing to different treatment characteristics), we included only patients receiving standardized treatments as study participants.

Participants and period

Study participants were undergoing care at cancer treatment hospitals that were designated by the Ministry of Health, Labour, and Welfare or the prefectural governments in Japan. The following were the inclusion criteria:

1. Diagnosed with non-small cell lung cancer after complete resection; postoperative stage IA $T_{1b}N_0M_0$ or IB; and outpatients currently treated with postoperative adjuvant chemotherapy using tegafur and uracil combination therapy (UFT 250 mg/m^2/day, 1–2 years' oral administration)
2. Aged 20 years or older; understood written Japanese; could complete a 15–20 min survey
3. Started chemotherapy more than 3 months prior to study participation

Fig. 1 Conceptual framework of the present study
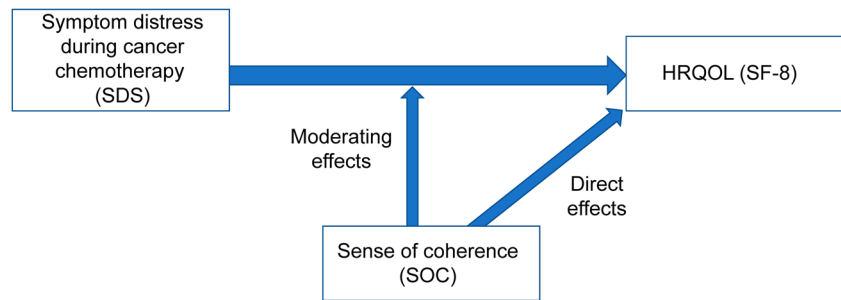
4. Judged by the attending physician to be able to cooperate with the study

The exclusion criteria were having serious mental or severe chronic illnesses.

Survey content and methods

Survey content

We asked participants about their age, gender, family status, occupation, income after treatment, problems during treatment, and sources of information about their illness and treatment from time of diagnosis. The following indices were used:

(a) HRQoL

The Short Form-8 Health Survey, Japanese version (SF-8) [25], an internationally standardized, comprehensive, nonspecific survey with norm-based scoring adapted for Japanese people—and which is interpreted by comparing results with national standards—was used. It has eight items on the following topics: physical functioning (PF), bodily pain (BP), general health perception (GH), vitality (VT), social functioning (SF), role emotional (RE), role physical (RP), and mental health (MH). Each item is rated on either a 5- or 6-point subscale; the higher the score, the better the HRQoL. Results are calculated using a standardized scoring algorithm and two summary scores, the Physical Component Summary (PCS) and Mental Component Summary (MCS) scores are also calculated. Each lower scale is rated out of 100; since previous studies have provided evidence on the standard value and standard deviation of the scores of average Japanese people at the national level, we compared participants' scores with the 2010 national standard value. This also allowed for the examination of the representativeness of our sample. In this study, its Cronbach's alpha was 0.919, indicating stability (Fig. 2).

(b) Symptom distress during cancer chemotherapy

The Symptom Distress Scale (SDS) [26], Japanese version [27], was used to evaluate symptom distress (max score range 11–33). It has 11 factors—Nausea (range 1–9), Appetite (range 1–4), Insomnia (range 1–4), Pain (range 1–9), Fatigue (range 1–4), Bowel Patterns (range 1–4), Concentration (range 1–4), Appearance (range 1–4), Breathing (range 1–4), Outlook (range 1–4), and Cough (range 1–4)—and 13 more items, which were evaluated on a 7-point scale. Specifically, the scales of nine of these 13 items ranged from "normal or no distress for a given symptom" (1) to "representing extensive distress" (5), while that of four items (concerning the frequency and intensity of pain and nausea) ranged from "almost never/mild" (1) to "almost constantly/unbearable" (5). The higher the score, the greater the symptom distress. Its Cronbach's alpha was 0.76, denoting that its criterion-related validity was verified. For this study, its Cronbach's alpha was 0.678, indicating stability.

(iii) SOC

SOC capacity was measured using the Japanese version [28] of the 13-item SOC Scale (SOC-13), a shortened version of the SOC-29 [29]. It includes the following three subscales: Sense of Comprehensibility (CO) (range 12–35), Sense of Manageability (MA) (range 10–26), and Meaningfulness (ME) (range 12–24); the subscales are rated on a 7-point scale. The higher the SOC score, the higher the capacity to maintain health conditions (max score range 46–79). Its Cronbach's alpha coefficient for the total scale and its subscales ranged from 0.72–0.89, denoting that its criterion-related validity and predictive validity were verified.

Its three subscales measure the capacity to formulate an explanation for, and comprehend the source of, problems faced in daily life, as well as to project what may happen with those problems. Specifically, MA assesses whether people have sufficient resources to handle problems; ME assesses whether the problems people face are deemed as worthy of attempts to resolve, despite the potential

hardships. In this study, its Cronbach's alpha coefficient was 0.671, indicating stability.

Data collection

The survey was conducted between July 2016 and March 2017 on patients who consented to participate. Anonymous self-administered questionnaires were distributed to participants and received by post.

Analysis method

Descriptive statistics were calculated for each questionnaire item. The Mann–Whitney U test and Spearman's rank correlation coefficient were used to determine participants' characteristics and SF-8. Correlations among variables were examined between the SF-8, SDS, and SOC indices using Spearman's rank correlation coefficient, with each scale item score set as a variable. Thereafter, hierarchical multiple regression analysis was performed to examine the direct and moderating effects of SOC.

Specifically, Step 1 included SF-8 as the dependent variable, and the control variables were age, time from surgery to start of chemotherapy, chemotherapy history, and the number of problems during treatment; in Step 2, symptom distress (i.e., the SDS) during cancer chemotherapy was included; in Step 3, SOC (i.e., the SOC-13) was included; finally, in Step 4, the interaction terms for SDS and SOC were included. A significance test of change in R^2 (ΔR^2) was conducted for each step, and the extent and direction of the effect on HRQoL was confirmed. The analysis used centralized variable scores to avoid multicollinearity between independent variables. Simple slope analysis was performed for significant interaction terms, using mean ± 1SD (standard deviation). SPSS ver. 26 for Windows was used for statistical analysis. Significance was set at $p < 0.05$.

Compliance with ethical standards

The bioethics review committee of each participating hospital approved this study. The survey was conducted at facilities that agreed to cooperate, and approval from the appropriate ethics committees of the target facilities was secured.

Candidates were selected by the attending physician, and after that physician introduced me to the candidate, I explained the purpose, methods, and confidentiality of the study both verbally and in writing. It was explained that the survey would be anonymous and that consent would be deemed granted by voluntary submission of the questionnaire via post. Participants were informed that their completed questionnaires would not be disclosed, that they would not be disadvantaged in any way

regarding their medical treatment and nursing owing to participation, and that no details enabling identification would be released.

Results

Participants' characteristics (Table 1)

The analysis included data from 66 participants (87 questionnaires were distributed, but 21 were not returned) participants who responded to the survey. Mean age was 69.45 ± 8.42 years, with 39 men (59.1%) and 27 women (40.9%; Table 1). Mean time from diagnosis to surgery was 1.97 ± 2.29 months, from surgery to chemotherapy was 1.48 ± 1.77 months, and chemotherapy history was 18.9 ± 8.9 months.

Overall, 57 (86.4%) participants lived with family members, and four (6.1%) reported that their economic situation had changed after their diagnosis. The most common problem during treatment was "burden on the spouse" ($n = 17$; 25.8%), followed by "distress regarding treatment-related symptoms" ($n = 16$; 24.2%), and "treatment and medical expenses" ($n = 15$; 22.7%). The mean number of problems during treatment was 1.70 ± 1.61. The most common source of information about their illness and treatment was "doctors, nurses, and pharmacists" ($n = 55$; 83.3%), followed by "family, friends, and acquaintances" ($n = 25$; 37.9%) and "books and journals" ($n = 23$; 34.8%).

HRQoL, SDS, and SOC indices (Table 1)

In the SF-8 (i.e., the HRQoL scale), the mean score was 48.61 ± 5.22 for the PCS and 49.46 ± 6.58 for the MCS (scores for BP, VT, and MH are listed in Table 1). The mean score for the SDS was 18.29 ± 5.03, with high scores in the Pain (2.48 ± 1.86), Outlook (2.02 ± 0.85), and Appetite (1.88 ± 0.90) subscales. The mean total score for the SOC-13 was 63.28 ± 8.98, and the score for the subscales was 26.90 ± 5.56 for CO, 18.32 ± 3.35 for MA, and 17.83 ± 2.84 for ME.

Correlation between participants' basic attributes and HRQoL (SF-8)

A significant negative correlation was seen between age and PF ($\rho = -0.269$, $p < 0.05$, Supplementary Table 1). Time from surgery to chemotherapy had a significantly negative correlation with PCS scores ($\rho = -0.295$, $p < 0.05$). We also noticed significantly positive correlations of chemotherapy history with BP ($\rho = 0.352$, $p < 0.01$), GH ($\rho = 0.320$, $p < 0.05$), and PCS scores ($\rho = 0.287$, $p < 0.05$). The number of problems during treatment had a significantly negative correlation with GH ($\rho = -0.303$, $p < 0.05$), VT ($\rho = -0.317$, $p < 0.01$), MH

Table 1 Participants' characteristics and their scores for the Sense of Coherence 13-item Scale, Symptom Distress Scale, and Short Form-8 Health Survey

Variables	n	%	Overall (n=66) Mean ± SD	(Range)	Men (n=39) Mean±SD	Women (n=27) Mean±SD	t	χ²	
Age			69.45 ± 8.42	(50~85)	69.36 ± 7.64	69.58 ± 9.64	−0.101		n.s.
Therapeutic course									
Time from diagnosis to surgery (months)			1.97 ± 2.29	(0~16)	1.66 ± 1.40	2.42 ± 3.19	−1.31		n.s.
Time from surgery to chemotherapy (months)			1.48 ± 1.77	(0~12)	1.40 ± 1.27	1.60 ± 2.35	−0.43		n.s.
History of chemotherapy (months)			18.89 ± 8.9	(3~38)	19.91 ± 9.54	17.52 ± 8.08	1.02		n.s.
Cohabitating family									
Yes	57	86.4						36.94	p<0.01
No	8	12.1							
Decline in financial status after falling ill									
Yes	4	6.1						96.03	p<0.01
No	58	67.9							
Problems during treatment (multiple selection)									
Number of problems			1.70 ± 1.61	(0~6)	1.41 ± 1.48	2.15 ± 1.76	−1.84		n.s.
Distress regarding symptoms associated with treatment	16	24.2							
Methods of coping with symptoms associated with treatment	12	18.2							
Whether or not to contact the hospital while at home	5	7.60							
How to explain the symptoms to the attending physician	9	13.6							
Effects and burdens on the spouse	17	25.8							
Effects and burdens on the child(ren)	10	15.2							
Changes in appearance	7	10.6							
Costs of treatment and medical care	15	22.7							
Work-related problems	13	19.7							
Contacts in case of problem	6	9.1							
Other	2	3							
Sources of information about their illness and treatment (multiple selections allowed)									
Number of sources			2.33 ± 1.42		2.26 ± 1.33	2.50 ± 1.56	−0.675		n.s.
Physicians, nurses, and pharmacists	55	83.3							
Cancer consultation support lefts	1	1.5							
Cancer patient salons	1	1.5							
Patients, patient organizations, and patient support organizations	0	0							
Family, friends, and acquaintances	25	37.9							
Television, radio, newspapers, and ads	16	24.2							
Books and magazines	23	34.8							
Internet	18	27.3							
Leaflets and pamphlets issued by hospitals and pharmaceutical companies	15	22.7							
Other	0	0							
Sense of Coherence 13-item Scale (i.e., sense of coherence)		Reliability coefficient (Cronbach's α).671							
Total			63.28 ± 8.98		62.72 ± 9.25	63.90 ± 8.76	−0.474		n.s.
Sense of comprehensibility			26.90 ± 5.56		26.11 ± 5.83	27.91 ± 5.00	−1.20		n.s.
Sense of manageability			18.32 ± 3.35		18.66 ± 3.31	17.63 ± 3.39	1.19		n.s.
Meaningfulness			17.83 ± 2.84		17.92 ± 2.92	17.81 ± 2.77	.16		n.s.
Symptom Distress Scale (i.e., symptom distress during cancer chemotherapy)		Reliability coefficient (Cronbach's α 0.678)							
Total			18.29 ± 5.03		17.76 ± 4.37	19.08 ± 5.87	−1.02		n.s.
Nausea			1.51 ± 1.15		1.76 ± 1.38	1.15 ± .54	2.45		p<0.05

Table 1 (continued)

Variables	n	%	Overall (n = 66) Mean ± SD	(Range)	Men (n = 39) Mean ± SD	Women (n = 27) Mean ± SD	t	X²
Appetite			1.88 ± 0.90		1.85 ± .94	1.92 ± .94	−0.33	n.s.
Insomnia (sleeping disorders)			1.64 ± 0.97		1.51 ± .82	1.85 ± 1.16	−1.34	n.s.
Pain			2.48 ± 1.86		2.26 ± 1.41	2.85 ± 2.38	−1.12	n.s.
Fatigue			1.78 ± 0.83		1.67 ± .74	1.96 ± .94	−1.40	n.s.
Bowel pattern			1.44 ± 0.75		1.41 ± .71	1.46 ± .81	−.27	n.s.
Concentration			1.30 ± 0.53		1.33 ± .53	1.27 ± .53	0.48	n.s.
Appearance			1.26 ± 0.66		1.15 ± .49	1.38 ± .85	1.25	n.s.
Breathing			1.33 ± 0.56		1.46 ± .64	1.15 ± .37	2.45	$p<0.05$
Outlook			2.02 ± 0.85		1.87 ± .73	2.27 ± .96	−1.89	n.s.
Cough			1.76 ± 0.58		1.77 ± .63	1.77 ± .51	.00	n.s.
Short Form-8 Health Survey (i.e., health-related quality of life)	Reliability coefficient (Cronbach's α 0.919)							
Summary scores	(National mean)							
Physical component summary	50.85		48.61 ± 5.22		49.08 ± 5.01	47.73 ± 5.52	1.02	n.s.
Mental component summary	50.09		49.46 ± 6.58		49.93 ± 7.14	48.63 ± 5.81	.76	n.s.
Subscales								
Physical functioning	50.65		47.71 ± 6.07		47.97 ± 6.54	47.32 ± 5.54	0.42	n.s.
Role physical	51.42		48.23 ± 6.11		48.96 ± 5.79	46.90 ± 6.48	1.34	n.s.
Bodily pain	50.99		53.78 ± 7.17		54.23 ± 6.20	52.86 ± 8.50	0.75	n.s.
General health perception	51.76		49.80 ± 6.39		50.10 ± 6.42	49.01 ± 6.30	0.67	n.s.
Vitality	50.89		52.07 ± 5.26		52.64 ± 4.69	51.16 ± 6.07	1.06	n.s.
Social functioning	50.96		49.94 ± 7.59		51.17 ± 6.70	47.88 ± 8.58	1.73	n.s.
Role emotional	49.84		48.06 ± 7.07		47.96 ± 7.75	48.22 ± 6.20	−0.14	n.s.
Mental health	50.09		50.84 ± 6.43		51.43 ± 6.71	49.73 ± 5.98	1.05	n.s.

Table 2 Correlations between Sense of Coherence 13-item Scale, Symptom Distress Scale, and the Short Form-8 Health Survey

	Summary scores of the Short Form-8 Health Survey		Subscales of the Short Form-8 Health Survey							
	Physical component summary	Mental component summary	Physical functioning	Role physical	Bodily pain	General health perception	Vitality	Social functioning	Role emotional	Mental health
Symptom Distress Scale	−0.609**	−0.440**	−0.461**	−0.574**	− 0.627**	−0.443**	− ;0.556**	−0.442**	−0.434**	−0.614**
Sense of Coherence 13-item Scale	0.218	0.420**	0.167	0.251	0.162	0.467**	0.324*	0.346**	0.198	0.470**
Sense of comprehensibility	0.150	0.413**	0.065	0.178	0.212	0.451**	0.330*	0.255	0.212	0.441**
Sense of manageability	0.224	0.298*	0.178	0.241	0.141	0.345**	0.196	0.310*	0.089	0.360**
Meaningfulness	0.168	0.330**	0.308*	0.248*	−0.069	0.192	0.273*	0.369**	0.228	0.279*

Spearman's rank correlation coefficient *$p < 0.05$, **$p < 0.01$

($\rho = -0.457$, $p < 0.01$), and MCS scores ($\rho = -0.368$, $p < 0.01$). The number of sources of information about their illness and treatment was not significantly correlated with any scale or subscale. There was also no significant correlation between any SF-8 item and whether the patient was living with family members or whether there was a decline in income after falling ill (Supplementary Table 2).

Correlation between SOC, SDS, and SF-8 (Table 2)

The scores for SDS were found to be strongly and negatively correlated to all SF-8 items. Moreover, the SOC-13 was positively correlated with the following subscales of the SF-8: MCS ($\rho = 0.420$, $p < 0.01$), general health perception ($\rho = 0.467$, $p < 0.01$), VT ($\rho = 0.324$, $p < 0.05$), SF ($\rho = 0.346$, $p < 0.01$), and MH ($\rho = .470$, $p < 0.01$).

Regarding SOC-13 subscales, SOC was positively correlated with the following subscales of the SF-8: MCS ($\rho = 0.413$, $p < 0.01$), Overall Sense of Health ($\rho = 0.451$, $p < 0.01$), VT ($\rho = 0.330$, $p < 0.05$), and MH ($\rho = 0.441$, $p < 0.01$). The MA subscale was weakly and positively correlated with the MCS ($\rho = 0.298$, $p < 0.05$), Overall Sense of Health ($\rho = 0.345$, $p < 0.01$), SF ($\rho = 0.310$, $p < 0.05$), and MH ($\rho = 0.360$, $p < 0.01$) subscales. Finally, the ME subscale was weakly and positively correlated with the MCS ($\rho = 0.330$, $p < 0.01$), PF ($\rho = 0.308$, $p < 0.05$), RP ($\rho = 0.248$, $p < 0.05$), VT ($\rho = 0.273$, $p < 0.05$), SF ($\rho = .369$, $p < 0.01$), and MH subscales ($\rho = 0.279$, $p < 0.05$).

Relationship between SDS and SOC with SF-8 (Table 3, 4)

Substantial changes were observed for the GH subscale of SF-8 in Step 1 ($\Delta R^2 = 0.109$, $p < 0.01$), Step 2 ($\Delta R^2 = 0.303$,

$p < 0.01$), Step 3 ($\Delta R^2 = 0.402$, $p < 0.01$), and Step 4 ($\Delta R^2 = 0.496$, $p < 0.01$); these changes had a buffering effect on SDS and the MA subscale of the SOC ($\beta = -0.406$, $p < 0.01$, $\beta = 0.329$, $p < 0.05$). Regarding interactions between the SDS and SOC-13, a simple slope analysis was performed, substituting the following adjusted variable: value ± 1SD.

SOC was effective even when SDS scores were low; however, when SDS scores were high, SOC became higher or else the HRQoL worsened further. For the MA subscale, the effects of SOC were reversed; MA was effective when SDS was high, whereas when SDS was low, the MA became lower and HRQoL became higher. For the ME subscale, SOC was effective even when SDS was low; however, when SDS was high, the ME became higher or else the HRQoL worsened further (Fig. 2).

Discussion

This study showed that the SDS had a strong native correlation with all items of SF-8 and that the SOC exerted a buffering effect in participants with high levels of pain; these results provide in-depth data on the HRQoL of cancer patients. Additionally, this study showed that the effect of SOC was reversed for BP and that high meaningfulness on SOC had a negative effect on HRQoL.

Since study participants were receiving chemotherapy as a postoperative aid and there were no adverse events related to pain owing to drug use, BP was considered chronic post-surgical pain (CPSP). Thus, we inferred that BP was a compound symptom, being associated with the side effects of cancer chemotherapy.

The International Pain Society [30] is defined CPSP as "pain lasting at least 3 months after surgery"; it develops in 10–50%

Table 3 Hierarchical multiple regression analysis on quality of life based on the physical component summary of the Short Form-8 Health Survey

Model	Variables	Physical functioning				Role physical				Bodily pain				General health perception			
		B	β	R^2	ΔR^2	b	β	R^2	ΔR^2	b	β	R^2	ΔR^2	b	β	R^2	ΔR^2
1	Characteristics (control variables)			0.113	0.113			0.135	0.135			0.211	0.211**			0.109	0.109**
	Age	-0.272	-0.249			-0.080	-0.107			-0.090	-0.006			-0.184	-0.140		
	Time from surgery to chemotherapy (months)	-0.109	-0.109			0.092	0.109			0.187	0.146			0.121	0.103		
	History of chemotherapy (months)	-0.008	-0.008			0.043	0.050			0.349	0.294			0.158	0.139		
	Number of problems during treatment	0.089	0.096			0.147	0.159			0.087	0.073			0.025	0.023		
2	Symptom distress during cancer chemotherapy			0.233	0.120*			0.441	0.390**			0.442	0.231**			0.303	0.303**
	SDS[a]	-0.314	-0.380*			-0.678	-0.575**			-0.596	-0.658**			-0.384	-0.406**		
3	Sense of coherence			0.297	0.064*			0.464	0.380**			0.477	0.035**			0.402	0.402**
	Sense of comprehensibility	-0.140	-0.151			-0.150	-0.166			0.169	0.140			-0.335	0.322*		
	Sense of manageability	0.048	0.054			0.085	0.090			-0.196	-0.173			-0.004	-0.004		
	Meaningfulness	0.247	0.236			0.151	0.190			-0.202	-0.147			0.141	0.112		
4	Items with interactions			0.305	0.008			0.508	0.396**			0.586	0.108**			0.496	0.496**
	SDS[a]×Sense of comprehensibility	0.034	0.040			-0.027	-0.027			-0.332	-0.319*			-0.020	-0.020		
	SDS[a]×Sense of manageability	-0.018	-0.022			0.213	0.201			0.386	0.398**			0.299	0.329*		
	SDS[a] × Meaningfulness	-0.096	-0.100			0.057	0.065			-0.305	-0.257*			0.021	0.019		

[a] Symptom Distress Scale

b (partial correlation coefficient) and β (standard partial regression coefficient) indicate values in the final step (Model 4)

*p < 0.05

**p < 0.01

n = 66

Table 4 Hierarchical multiple regression analysis on quality of life based on the mental component summary of the Short Form-8 Health Survey

Model	Variables	Vitality (VT)				Social functioning (SF)				Role emotional (RE)				Mental health (MH)			
		b	β	R^2	ΔR^2	b	β	R^2	ΔR^2	b	β	R^2	ΔR^2	b	β	R^2	ΔR^2
1	Characteristics (control variables)			0.115	0.115			0.079	0.079			0.060	0.060			0.200	0.200**
	Age	−0.280	−0.246			−0.280	−0.246			−0.218	−0.210			0.075	0.060		
	Time from surgery to chemotherapy (months)	0.030	0.028			0.030	0.028			0.082	0.087			0.110	0.099		
	History of chemotherapy (months)	−0.070	−0.069			−0.070	−0.069			−0.065	−0.071			0.117	−0.109		
	Number of problems during treatment	−0.010	−0.011			−0.010	−0.011			−0.068	−0.079			−0.240	−0.241		
2	Distress of symptoms during chemotherapy			0.340	0.225**			0.238	0.159**			0.180	0.120*			0.360	0.160**
	SDS[a]	−0.308	−0.355*			−0.308	−0.355*			−0.306	−0.393*			−0.361	−0.401**		
3	Sense of coherence			0.405	0.065**			0.316	0.078**			0.205	0.026			0.408	0.048**
	Sense of comprehensibility	0.023	0.024			0.023	0.024			0.069	0.079			0.187	0.182		
	Sense of manageability	0.077	0.082			0.077	0.082			−0.111	−0.133			−0.124	−0.127		
	Meaningfulness	0.302	0.279*			0.302	0.279*			0.134	0.133			0.229	0.196		
4	Items with interactions			0.423	0.018**			0.365	0.049**			0.029	0.004			0.434	0.026**
	SDS[a] × Sense of comprehensibility	0.165	0.188			0.165	0.188			0.064	0.081			−0.072	−0.076		
	SDS[a] × Sense of manageability	0.057	0.067			0.057	0.067			−0.053	−0.070			0.196	0.222		
	SDS[a] × Meaningfulness	−0.137	−0.138			−0.137	−0.138			−0.031	−0.034			−0.100	−0.094		

[a] Symptom Distress Scale

b (partial correlation coefficient) and β (standard partial regression coefficient) indicate values in the final step (Model 4)

*p < 0.05

**p < 0.01

n = 66
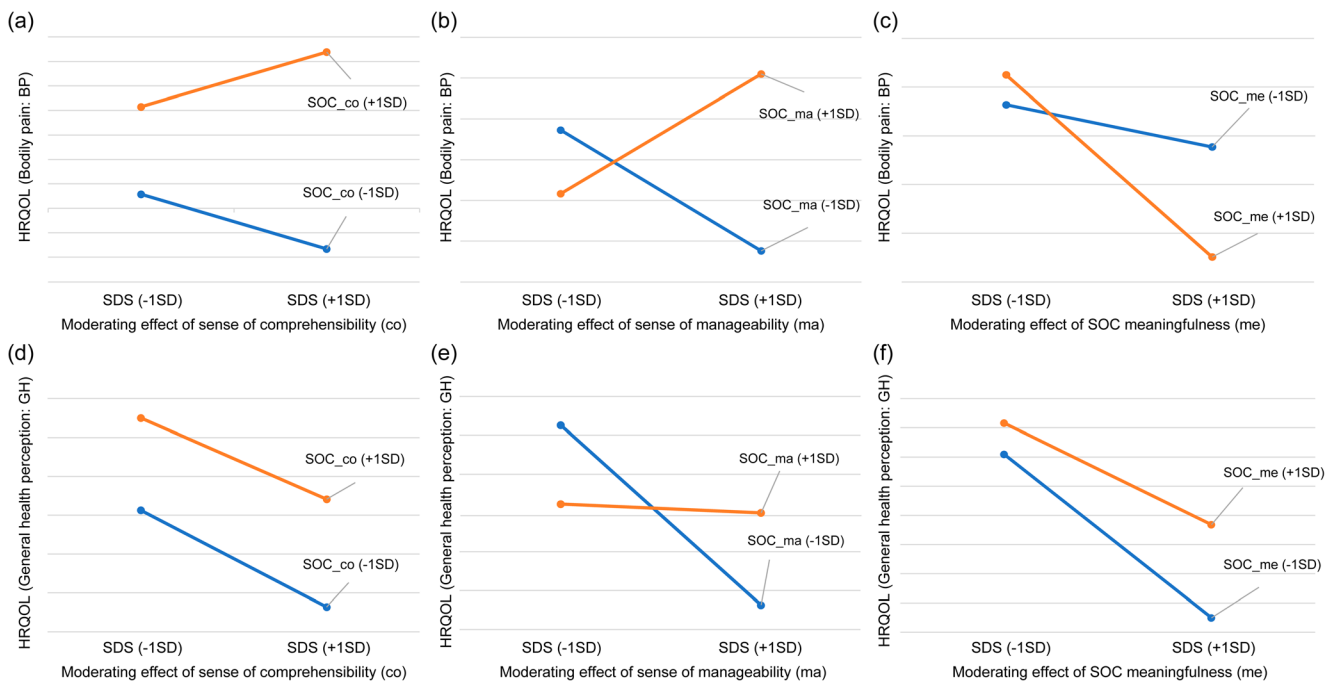
Fig. 2 **a–c** Buffering effect of sense of coherence on quality of life (i.e., bodily pain) on the Symptom Distress Scale. **d–f** Buffering effect of sense of coherence on quality of life (i.e., general health) on the Symptom Distress Scale

of surgical patients and interferes in the daily life activities of 2–10% [31]; these surgical complications, thereby, cause the loss of QoL in many patients. The cause may relate to patients' complex disease states, in which surgery-related factors (e.g., the type and degree of surgical invasion) associate with patient-related factors (e.g., mental and psychological factors and individual differences). In fact, many cancer patients who received active treatment have also experienced multiple symptoms, and the occurrence of multiple symptoms is associated with functional conditions and poor QoL [32]. A study examining the relationship between symptomatic experiences and QoL in patients undergoing outpatient chemotherapy has shown that the more surgeries patients undergo, the stronger their symptoms are [33]; another reported the importance of considering pain, malaise, and depression symptoms as being interrelated, not separated [34]. In addition to chemotherapy-specific symptoms, study participants seemed to recognize symptom experiences that reflected treatment history.

Significant interactions between SDS and SOC on BP and overall health were also observed, with SOC subscales exerting buffering effects under high SDS conditions. Specifically, the effect of people's assessment on the manage-ability of a condition (i.e., the MA subscale) was reversed for body pain, and a lower meaningfulness for SOC had a positive effect on HRQoL. Since the sense of meaning (i.e., in this study, the ME subscale) is internally oriented and less susceptible to external environmental factors [35], it may affect people's use of surrounding resources to deal with BP. During people's cancer chemotherapy, people's CPSP is not one of

the side effects that often subjected to evaluation, so they may often not be a subject approached by medical care. Although SOC is considered a force to mobilize surrounding resources and cope well, it is possible that the pain does not improve and the QoL is low because patients cannot cope without the concern of medical personnel.

A previous study also revealed the symptom experience of, and the strategies used by, patients who experience chemotherapy-induced peripheral neuropathy; the authors reported that, although patients may not be able to respond to mental stress, they are prone to mental stress owing to the characteristics of the symptoms (i.e., they have no effective solution, as the symptoms cannot be easily relieved) [36]. This cited study further remarked the need for appropriate stress management interventions by medical personnel for cancer patients undergoing chemotherapy. In this regard, a study in patients with metastatic lung cancer showed that early pallia-tive care intervention regarding coping and communication support may be the key to effective interventions [37]; another study found that patients with advanced cancer who received early palliative care showed a better coping approach and QoL and reported reduced depression [38]. These studies also remarked that medical personnel needed to be able to recog-nize grade 1–2 side effects of cancer chemotherapy, to note that there is no care solution that is effective at relieving such symptoms and to thereby ensure that proper supportive thera-pies (e.g., stress management, coping, and communication support) are provided to these patients. Thus, our results and prior research highlight that medical personnel could improve

the accuracy of their future pain screenings by adding patients' characteristics (i.e., patients' SOC and HRQoL) into the assessment, alongside the evaluations regarding the side effects of cancer chemotherapy.

Limitations of the study and future directions

The first limitation is that this was a cross-sectional study; thus, the causal relationship between SOC and HRQoL has not been elucidated. Generally, a person's SOC stabilizes around the age of 30 [39]; however, it can change through life experiences, and it is possible that patients' experiences since the onset of cancer therapy increase their SOC. Second, study participants were patients who continued their therapy; thus, the SOC of patients who had to discontinue their therapy was not investigated. Hence, future longitudinal surveys are warranted to explore the relationship between cancer patients' HRQoL and SOC, and the SOC characteristics of patients who discontinue their treatment; investigations regarding the relationship between HRQoL and SOC in patients undergoing cancer treatment with larger samples are also warranted.

Conclusions

We identified a moderating effect of SOC on the relationship between patients' symptom distress and HRQoL during cancer chemotherapy. Thus, patients with low SOC need interactions with medical personnel that promote their SOC, as this may support their symptom management; moreover, medical staff should proactively engage with patients with high ME and provide them with social support accordingly. Since the method of approaching such patients has not been clarified in this study or past research, this topic is left for future examination.

Declarations

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