A study on improving cancer-related fatigue and disease-related psychological variables in patients with cervical cancer based on online mindfulness-based stress reduction: a randomized controlled trial

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Abstract

Background The persistent destructive power of cancer-related fatigue (CRF) has been regarded as the biggest influencing factor affecting the postoperative physical and mental health of patients with cervical cancer. During this process, patients might also experience different feelings of disease-related psychological. Therefore, this study aimed to adopt mindfulness-based stress reduction (MBSR) to intervene in patients with cervical cancer, and conducted follow-up for 3 and 6 months to observe the effects of changes in CRF, uncertainty in illness, coping styles, sense of coherence (SOC), and perceived social support (PSS).

Methods A randomized controlled trial was conducted in ShengJing Hospital of China Medical University. A total of 102 patients were selected, and 78 patients completed the whole process, including 40 in the experimental group and 38 in the control group. Data were collected according to Cancer Fatigue Scale, Medical Coping Modes Questionnaire, Multidimensional Scale of Perceived Social Support, and Sense of Coherence-13. The change trend and difference of the two groups of research data were compared by repeated measurement analysis of variance. Bonferroni test was used for multiple tests between groups.

Results The CRF, SOC, and coping styles of the MBSR group showed a decreasing trend ($P < 0.001$) at after MBSR, 3 months follow-up, and 6 months follow-up compared to the before MBSR. However, the uncertainty in illness of the MBSR group showed a decreasing trend ($P < 0.001$) at after MBSR compared to the before MBSR, and it rose in 3 months follow-up and 6 months follow-up.

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Conclusion MBSR can effectively alleviate the fatigue of CRF after treatment, while improving their psychological environment. Medical workers can consider implementing online MBSR for patients with cervical cancer in their daily rehabilitation nursing, which is beneficial for their recovery.

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Keywords A randomized controlled trial, Mindfulness-based stress reduction, Cancer related fatigue, Sense of coherence, Coping styles, Cervical cancer

Background

Since the 1990s, the global incidence rate and mortality of cervical cancer have declined, it is still a major public health problem that threatens women's health and restricts social progress [1]. GLOBAOCAN report showed that in 2020, there were 604,000 new cases of cervical cancer worldwide, and the number of deaths due to cervical cancer reached 342,000[2]. China has a large population base, and as of 2020, new cases and deaths from cancer accounted for 18.2% and 17.3% of the total global cases, respectively, accounting for approximately 1/5 of the global cases [2]. According to GLOBOCAN 2020 cancer estimates and United Nations population projections, in 2022, there would be approximately 111,820 new cases and 61,579 deaths of cervical cancer in China [3].

Radiotherapy and radio-chemotherapy played an important role in the treatment of cervical cancer, and two thirds of patients with cervical cancer required them [4]. However, patients would experience cancer-related fatigue (CRF) at all stages of radiotherapy, chemotherapy, and even palliative treatment [5]. CRF was a subjective, special, and systematic feeling of excessive fatigue, which was closely related to the cancer itself and its therapeutic factors [6]. Related studies have shown that the overall prevalence of CRF among 71,568 patients was 49%, with a high incidence of 62% during treatment and 50.1% within 3 months after treatment, and among survivors, 43% still had varying degrees of fatigue symptoms [7]. A follow-up study on cervical cancer showed that 45.2% and 37.8% of the total population were physically and mentally fatigued, respectively [8]. 60–90% of cancer patients receiving treatment experienced CRF, with symptoms such as physical weakness, silence, and functional impairment [9]. Research has shown that compared to cervical patients without CRF, cervical patients with CRF have relatively poorer quality of life, more prominent symptoms of depression and anxiety, and severe physical and cognitive impairment [10]. The persistent destructive power of CRF has been regarded as the biggest influencing factor affecting the postoperative physical and mental health of patients with cervical cancer [11].

Uncertainty in illness, characterized by cognitive ambiguity and difficulties in predicting disease related symptoms, diagnosis, treatment, and prognosis, was widely recognized as a psychosocial stressor for cancer survivors [12]. The uncertainty of patients with cervical cancer during hospitalization mainly came from unclear symptoms and signs caused by the disease, complex treatment and nursing processes, and a lack of relevant information on the clear diagnosis and severity of the disease [13]. Previous research results have shown that uncertainty in illness was commonly present in patients with cervical cancer during hospitalization, and most patients had high levels of uncertainty in illness [14]. Once patients experienced a sense of uncertainty in illness, it could exacerbate negative emotions such as tension, anxiety, and depression, seriously affecting treatment effectiveness [15].

Coping was defined as the relevant behavioral measures taken by individuals after making cognitive evaluations of stress events that exceed their own burden [16]. Cervical cancer involved issues related to personal privacy, sexual history, life habits, sexual partner behaviour, future fertility and marital relationships. In addition to being affected by traditional Chinese cultural attitudes to these issues, patients with cervical cancer often considered discussion of sexual issues taboo [17]. Therefore, patients with cervical cancer might avoid the disease in a negative way. Previous study has confirmed that patients with cervical cancer were more inclined to adopt negative coping styles, such as avoidance or submission [18]. Positive coping styles helped patients effectively face, adapt to, and recover from the disease, while negative coping styles might affect the disease recovery process of cancer patients, causing negative impacts on their physical and psychological well-being [19].

Sense of Coherence (SOC) refers to the general, persistent, and dynamic confidence that an individual holds when facing internal and external environmental stimuli [20]. A diagnosis of cancer is a major life stressor that can affect the physiological, psychological and physical state of the person concerned [21]. SOC can strengthen the management of stressors and promote physical and mental health [22, 23]. Previous studies had shown that patients with cervical cancer had a low level of SOC which might lead to symptoms of depression or anxiety in patients [24]. Study also showed that cancer patients with low levels of personal resources (including SOC)

adapted to their disease more poorly than patients with high levels [25].

Perceived social support (PSS) is the personal belief or assessment of the degree to which social networks (e.g., family and friends) provide informational, physical, or psychological support [26]. It was found that PSS played a more important role than received social support, thus receiving more attention [27]. Related studies have shown that patients with cervical cancer have a moderate level of PSS [24]. Higher scores on spirituality and varied types of social support were significantly associated with fewer symptoms in sleep disturbance, pain interference, anxiety, depression, and energy/fatigue among cervical cancer survivors [28]. Therefore, perceiving good spiritual support can cope with the disease and better adapt to changes in themselves and their environment. Compared to the actual material support received, the spiritual support felt by patients may be improved by intervention measures. Therefore, we focus on the intervention effect of PSS.

Mindfulness-based stress reduction (MBSR) is an 8-week standardized group program developed by Kabat-Zinn [29]. MBSR was rooted in the ancient Buddhist meditation tradition, emphasizing the deliberate concentration of consciousness on one's current experiences in a non judgmental and non reactive manner. It required attention to the present, curiosity, openness, and acceptance [29]. The 8-week course typically included formal exercises (body scan meditation, sit meditation, hatha yoga, and walking meditation) and informal exercises (awareness of happy/unpleasant daily events, interpersonal communication, repetitive thoughts/emotions, and their connection to bodily sensations) [29]. MBSR helped cancer patients develop the ability to accept and observe. By allowing patients to feel their current emotions and face themselves with an open mind, acceptance, and non critical attitude, it enhanced patients' confidence in disease prognosis, understanding themselves and the surrounding environment, and objective evaluation, which can improve their physical and mental health. MBSR has been widely applied to different cancer patients and has achieved good results in improving mental health [30–32].

Based on the above descriptions, we found that patients with cervical cancer generally experienced CRF, uncertainty in illness, negative coping styles, low SOC, and moderate levels of PSS. MBSR could effectively improve the physical and mental health of cancer patients. However, there was relatively little research on patients with cervical cancer and no follow-up has been conducted on patients, making it difficult to determine the long-term intervention effect. Therefore, this study aimed to adopt MBSR to intervene in patients with cervical cancer, and conducted follow-up for 3 and 6 months to observe the

effects of changes in CRF, uncertainty in illness, coping styles, SOC, and PSS.

Methods
Trial design
This study was a randomized controlled trial which completed the registration of the China Clinical Trial Registration Center (ChiCTR2000040122), and was approved by the Ethics Committee of China Medical University.

Participants
Sample selection
The samples for this study were all patients with cervical cancer from a tertiary hospital affiliated with China Medical University. Inclusion criteria: patients with primary cervical cancer confirmed by pathology; aged over 18; communicate independently and fill in questionnaires; know the illness of themselves; volunteer to participate in the investigation and sign the informed consent. Exclusion criteria for study subjects: patients with other malignant tumors at the same time; patients with a history of psychiatric diseases or mental retardation; patients who have received psychotherapy or intervention within one year. Rejection criteria: no outcome indicators of patients were measured at any two time points. Abscission criteria: voluntary withdrawal from the study; interruption of treatment or death.

Interventions
The experimental group received MBSR, and the control group received routine nursing intervention. After completing a 6-month follow-up, the control group also received MBSR. The contents of routine nursing included admission nursing, comfortable nursing, maintaining a good nurse patient relationship, health education, clinical observation and discharge nursing. The contents of MBSR on intervention group are shown in Table 1.

Outcomes
Primary outcome measures
Cancer-related fatigue: The Cancer Fatigue Scale (CFS) was designed by Okuyama and validated by 307 cancer patients, including 15 items [33]. CFS used a scoring method for 0–4, with a total score ranging of 0-60points. Higher score indicated a higher level of CRF. The Cronbach' α of the scale in two group were greater than 0.8 at four periods. The KMO values of the scale in two group were between 0.7 and 0.8 at at four periods.

Secondary outcome measures
Uncertainty in illness: The Medical Uncertainty in Illness Scale (MUIS) was developed by Michel and Braden under the guidance of the theory of medical uncertainty to assess the uncertainty level of adult patients, including

Table 1 Contents of MBSR

Contents	Practice
Week 1 Understanding mindfulness Mindfulness Breathing Push a video about the origin, concept, and core content of mindfulness, which was based on "Mindfulness Meditation" of Kabat-Zinn; Distribute an electronic exercise manual to guide patients on proper mindfulness breathing.	Formal practice: Watch the video repeatedly to gain a preliminary understanding of mindfulness; Mindfulness breathing (10 min/day). Informal practice: Based on personal understanding of mindfulness, cultivate mindfulness in daily life.
Week 2 Body scan Mindfulness breathing Push a body scan operation video, with mindfulness decompression experts guiding patients on how to perform body scans.	Formal practice: The patient slowly moved their attention from various parts of the body in sequence and performed a body scan (45 min/day); Mindfulness breathing (10 min/day). Informal practice: Ask family members to help with body scans; Embrace your families.
Week 3 Mindfulness Yoga Mindfulness Breathing Push 16 basic yoga poses 'renderings'.	Formal practice: Yoga practice poses (20 min/day); Mindfulness breathing (10 min/day). Informal practice: Daily awareness of an event that pleases oneself and recording of thoughts.
Week 4 Sitting meditation Mindfulness yoga Mindfulness breathing Push a video on how to operate sitting meditation.	Formal practice: Adopt the correct sitting posture for meditation practice, combined with mindfulness yoga, and alternate between these two (45 min/day); Mindfulness breathing (10 min/day). Informal practice: Identify an unpleasant event every day, choose to respond in a positive way, and record your thoughts.
Week 5 Sitting meditation Body scan Push mindfulness related videos, as well as disease related videos (disease treatment, prognosis, etc.).	Formal practice: Take the correct sitting posture for meditation practice, combined with body scans, and alternate between the two (45 min/day). Informal practice: Quietly reflect on the most touching things your family did during your illness every day and record them.
Week 6 Mindfulness walking Sitting meditation The operation method for pushing mindfulness walking.	Formal practice: Alternate mindfulness walking and sitting meditation (45 min /day), with patients with difficulty walking undergoing sitting meditation (10–20 min /day). Informal practice: Watch a video of Ba Duan Jin and learn from it.
Week 7 Mindfulness combination exercise Push mindfulness related videos	Formal practice: Patients were free to choose which combination of exercises to do 45 min a day without listening to the instructions. Informal practice: Patients combine themselves and make notes.
Week 8 Open mindfulness life Push the entire process of mindfulness reduction	Formal exercise: Patients was free to choose which exercise they want (45 min/day) and continue the exercise. Informal practice: Provide feedback on the learning content of the first seven weeks and write down your thoughts.

25 items [34]. MUIS used a scoring method for 1–5, with a total score ranging of 25–125 points. Higher score indicated a higher level of uncertainty in illness. The Cronbach' α of the scale in two group were greater than 0.7 at four periods. The KMO values of the scale in two group were between 0.7 and 0.8 at at four periods.

Coping modes: The Medical Coping Modes Questionnaire (MCMQ) was developed by Feifel and was applicable to patients with various diseases [35]. There were 20 items and three dimensions: facing, avoiding and yielding. MCMQ used a scoring method for 1–4, with a total score ranging of 20–80 points. The higher the score, the more inclined the individual was to adopt this coping style. The Cronbach' α of the scale in two group were greater than 0.7 at four periods. The KMO values of the scale in two group were grater than 0.7 at at four periods.

Perceived social support: The Multidimensional Scale of Perceived Social Support (MSPSS) developed by Zimet was used, including 12 items [36]. MSPSS used a scoring method for 1–7, with a total score ranging of 12–84 points. Higher score indicated a higher level of PSS. The Cronbach' α of the scale in two group were greater than 0.8 at four periods. The KMO values of the scale in two group were between 0.6 and 0.8 at four periods.

Sense of coherence: The Sense of Coherence-13 (SOC-13) was a simplified version of SOC-29 by Antonovsky [37]. Compared with SOC-29, the simplified version of SOC-13 was more widely used [38]. SOC-13 used a scoring method for 1–7, with a total score ranging of 13–91 points. Higher score indicated a higher level of SOC. The Cronbach' α of the scale in two group were greater than 0.7 at four periods. The KMO values of the scale in two group were between 0.7 and 0.8 at at four periods.

Demographic and clinical characteristics measures

The self-made general situation questionnaire was used, including demographic information (age, body mass index, marital status, education level, occupation, monthly income, passive smoking, exercise, dietary characteristics, and so on) and clinical information (menopause, diagnosis type, tumor stage, treatment, and so on).

Sample size

Estimate the sample size according to the formula: $n = 2(\mu_\alpha + \mu_\beta)^2 \sigma^2 / \delta^2$. μ_α is the U value corresponding to the probability of type I error. Take the test level α=0.05 (both sides), and the significance level is 5%. μ_β is the U value corresponding to the probability of type II error. β is 0.1, and the degree of grasp 1-β=0.9. δ is the expected effect quantity, that is, the absolute value of the difference between the two groups' means. σ^2 is the overall variance, which can be estimated by the sample variance, that is, the mean value of the two groups' variances. Refer to the relevant literature, δ and σ are taken as 4.5 and 6.5 respectively [39]. According to the sample ratio of 1:1 and the calculation formula of sample size, each group needs 44 samples. A total of 102 patients were selected. Finally, 78 patients completed the whole process, including 40 in the experimental group and 30 in the control group.

Randomisation

The patients were randomly assigned to the experimental group and the control group at a ratio of 1:1 by the investigator. Through an online random number generator, 102 random number sequences were generated from 1999 numbers, and the generated random numbers were written on paper strips and sealed in envelopes. Patients with odd numbers were assigned to MBSR group, while patients with even numbers were assigned to the control group.

Implementation

The study included an intervention implementer, who is an experienced obstetrician and gynecologist, as well as a medical doctor specializing in social and psychological factors and health, and a data analyst. The process of selecting participants was carried out in hospitals, where patients came for treatment and their attending physician (the implementer of this study) explained the purpose and process of this project to them. Then intervention would be carried out online. Mobile phone-Wechat-Public account was adopted. The implementer created Wechat groups to let participants pay attention to the Wechat public account of MBSR in mobile medicine. The implementer of the intervention released videos or articles every Wednesday, and reminded participants to enter the official account every week and click "popular science" to watch. After completing a course every week, participants would give a feedback in the form of text or voice in the group. After MBSR, 3 months and 6 months, the effect of the intervention group and the control group were measured by Wechat electronic questionnaire. The data collected were used by the intervention implementer and data analyst.

Blinding

This study adopted single blind. Participants were not aware of their group type.

Statistical methods

We used IBM SPSS Statistics 26 for statistics and analysis. The independent sample t-test was used to compare the data of different variables between the control group and MBSR group. The change trend and difference of the research data in same group were compared by repeated measurement analysis of variance. Bonferroni test was used for multiple tests between same groups. This study used bilateral testing, and $P < 0.05$ indicated statistically significant results.

Results

Follow-up process of the study subjects

A total of 116 patients with cervical cancer were included in this study, of which 102 met the standard. There were 51 cases in MBSR group and 51 cases in control group. The effective sample size for the follow-up survey was 78 cases, with 40 cases in MBSR group and 38 cases in control group. The specific follow-up process was shown in Fig. 1. By comparing the general data of the lost sample and the completed study sample, it was found that there were no statistically significant differences in general demographic, clinical, and psychological characteristics.

Baseline data distribution between MBSR group and control group

The results in Table 2 indicated that there was no statistical difference ($P > 0.05$) between MBSR group and control group in terms of demographic and clinical related characteristics.

Analysis of the effect of MBSR on CRF

The simple effect between the control group and the MBSR group was significant ($P < 0.001$) at after MBSR, 3-month follow-up, and 6-month follow-up. In MBSR group, the simple effect of test times was significant ($P < 0.001$). Bonferroni paired test showed that the CRF of the MBSR group showed a decreasing trend ($P < 0.001$) at after MBSR, 3 months follow-up, and 6 months follow-up compared to the before MBSR. The specific results were shown in Table 3.

Fig. 1 Flow diagram

Analysis of the effect of MBSR on SOC

The simple effect between the control group and the MBSR group was significant ($P<0.001$) at after MBSR, 3-month follow-up, and 6-month follow-up. In MBSR group, the simple effect of test times was significant ($P<0.001$). Bonferroni paired test showed that the SOC of the MBSR group showed a upward trend ($P<0.001$) at after MBSR, 3 months follow-up, and 6 months follow-up compared to the before MBSR. The specific results were shown in Table 4.
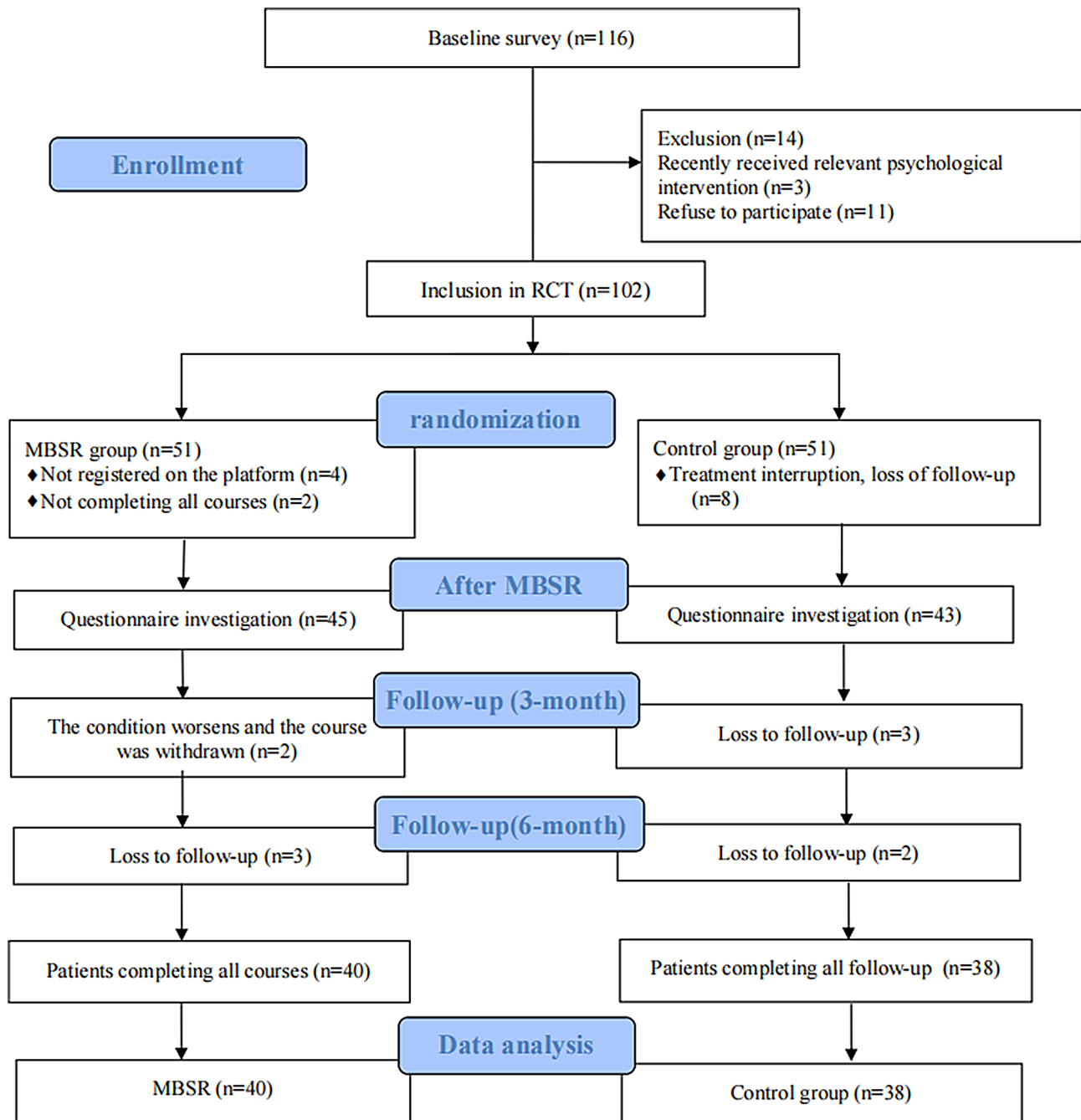
Analysis of the effect of MBSR on the method of facing

The simple effect between the control group and the MBSR group was significant ($P<0.001$) at after MBSR, 3-month follow-up, and 6-month follow-up. In MBSR group, the simple effect of test times was significant ($P<0.001$). Bonferroni paired test showed that the **the method of facing** of the MBSR group showed a upward trend ($P<0.001$) at after MBSR, 3 months follow-up, and 6 months follow-up compared to the before MBSR. The specific results were shown in Table 5.

Table 2 Comparison of baseline data between MBSR group and control group (N,%)

Variables	MBSR group ($n=51$)	Control group ($n=51$)	χ^2/adjustχ^2	*P*
Age (Years)			3.615	0.164
≤45	11(21.5)	6(11.8)		
46–55	21(41.2)	17(33.3)		
>55	19(31.3)	28(54.9)		
Marital status			3.169	0.075
Unmarried/Divorced/Widowed	13(25.5)	6(11.8)		
Married	38(74.5)	45(88.2)		
Education level			0.001	0.999
Junior high school and below	40(78.4)	40(78.4)		
High school and above	11(21.6)	11(21.6)		
Occupation			4.703	0.346
Retired personnel	30(58.8)	31(60.8)		
State and public institutions	2(4)	0(0)		
Staff and workers of enterprise	7(13.7)	3(6)		
Self-employed personnel	3(6)	3(6)		
Unemployed personnel	9(17.5)	14(27.2)		
Per capita monthly income			0.131	0.899
≤2000 CNY	21(41.2)	23(45.1)		
2001–5000 CNY	20(39.2)	20(39.2)		
>5000 CNY	10(19.6)	8(15.75)		
Place of residence			0.453	0.501
City	36(70.6)	39(76.5)		
Countryside	15(29.4)	12(23.5)		
BMI			2.925	0.260
<18	1(2.0)	5(9.8)		
18~24	33(54.7)	29(56.9)		
>24	17(33.3)	17(33.3)		
Long term passive smoking			0.206	0.650
No	37(72.5)	39(76.5)		
Yes	14(27.5)	12(23.5)		
Physical exercise			2.791	0.268
Never	26(51.0)	33(64.7)		
Once/week	9(17.6)	9(17.6)		
≥2–3 times/week	16(31.4)	9(17.6)		
Diagnostic type			1.186	0.276
New diagnosis	41(80.4)	45(88.2)		
Recrudescence	10(19.6)	6(11.8)		
Cancer stage			0.311	0.856
I	9(17.6)	7(13.7)		
II	32(62.7)	34(66.7)		
III+IV	10(19.6)	10(19.6)		

Analysis of the effect of MBSR on the method of yielding

The simple effect between the control group and the MBSR group was significant (*P*<0.001) at after MBSR, 3-month follow-up, and 6-month follow-up. In MBSR group, the simple effect of test times was significant (*P*<0.001). Bonferroni paired test showed that **the method of yielding** of the MBSR group showed a decreasing trend (*P*<0.001) at after MBSR, 3 months follow-up, and 6 months follow-up compared to the before MBSR. The specific results were shown in Table 6.

Analysis of the effect of MBSR on uncertainty in illness

The simple effect between the control group and the MBSR group was significant (*P*<0.01) at after MBSR, 3-month follow-up, and 6-month follow-up. In MBSR group, the simple effect of test times was significant (*P*<0.001). Bonferroni paired test showed that the uncertainty in illness of the MBSR group showed a decreasing trend (*P*<0.001) at after MBSR compared to the before MBSR, and it rose in 3 months follow-up and 6 months follow-up. The specific results were shown in Table 7.

Table 3 Analysis of the effect of MBSR on CRF (Mean±SD)

Group	Before MBSR	After MBSR	3-month follow-up	6-month follow-up	F	P	partial η²
Control group	36.74±4.21*	36.53±4.24	33.74±4.18*	36.79±4.98	9.670	<0.001	0.282
MBSR group	37.70±2.70*	31.25±1.59*	31.00±3.40*	31.25±2.52*	34.389	<0.001	0.582
t	1.462	53.899	10.091	38.982			
P	0.230	<0.001	0.002	<0.001			
partial η²	0.019	0.415	0.117	0.339			
Group main effect					48.452	<0.001	0.389
Main effect of test times					26.788	<0.001	0.261
Group*Test Times					14.666	<0.001	0.162

Note*Bonferroni Multiple Comparison Results. Control group:3-month follow-up VS Before MBSR(P=0.002); MBSR group: After MBSR VS Before MBSR(P<0.001);3-month follow-up VS Before MBSR(P<0.001);6-month follow-up VS Before MBSR(P<0.001)

Table 4 Analysis of the effect of MBSR on SOC (Mean ± SD)

Group	Before MBSR	After MBSR	3-month follow-up	6-month follow-up	F	P	partial η²
Control group	53.68±6.94*	56.97±5.45*	56.57±4.94	56.34±4.61	10.759	<0.001	0.304
MBSR group	55.07±3.70*	59.95±3.58*	64.20±10.58*	64.17±10.58*	30.843	<0.001	0.556
t	1.236	8.185	16.299	17.629			
P	0.270	0.005	<0.001	<0.001			
partial η²	0.016	0.097	0.177	0.188			
Group main effect					17.564	<0.001	0.188
Main effect of test times					23.009	<0.001	0.232
Group*Test Times					7.810	0.004	0.093

Note*Bonferroni Multiple Comparison Results. Control group: After MBSR VS Before MBSR(P<0.001); MBSR group: After MBSR VS Before MBSR(P<0.001);3-month follow-up VS Before MBSR(P<0.001);3-month follow-up VS Before MBSR(P<0.001)

Table 5 Analysis of the effect of MBSR on **the method of facing** (Mean ± SD)

Group	Before MBSR	After MBSR	3-month follow-up	6-month follow-up	F	P	partial η²
Control group	19.78±1.37	19.89±1.39	19.57±3.12	19.58±3.13	0.243	0.866	0.010
MBSR group	19.20±2.61*	21.15±2.38*	21.10±2.07*	20.95±2.08*	25.563	<0.001	0.509
t	1.528	7.973	6.479	5.241			
P	0.220	0.006	0.013	0.025			
partial η²	0.020	0.095	0.079	0.065			
Group main effect					4.289	0.042	0.053
Main effect of test times					6.124	0.009	0.075
Group*Test Times					7.326	0.004	0.088

Notes*Bonferroni Multiple Comparison Results. MBSR group: After MBSR VS Before MBSR(P<0.001);3-month follow-up VS Before MBSR(P<0.001);3-month follow-up VS Before MBSR(P<0.001)

Table 6 Analysis of the effect of MBSR on **the method of yielding** (Mean ± SD)

Group	Before MBSR	After MBSR	3-month follow-up	6-month follow-up	F	P	partial η²
Control group	10.26±1.88	10.13±1.71	10.53±1.70	10.58±1.73	0.961	0.416	0.038
MBSR group	12.10±0.95*	10.85±1.07*	9.05±1.62*	8.90±1.61*	41.262	<0.001	0.626
t	29.928	4.982	15.417	19.613			
P	<0.001	0.029	<0.001	<0.001			
partial η²	0.283	0.062	0.169	0.205			
Group main effect					0.279	0.599	0.004
Main effect of test times					31.083	<0.001	0.290
Group*Test Times					49.196	<0.001	0.393

Notes*Bonferroni Multiple Comparison Results: MBSR group: After MBSR VS Before MBSR(P<0.001);3-month follow-up VS Before MBSR(P<0.001);6-month follow-up VS Before MBSR(P<0.001)

Table 7 Analysis of the effect of MBSR on uncertainty in illness (Mean ± SD)

Group	Before MBSR	After MBSR	3-month follow-up	6-month follow-up	F	P	partial η²
Control group	79.55±8.18[*a]	73.23±7.19[*]	72.78±6.37[ab]	76.50±5.11[b]	23.411	<0.001	0.487
MBSR group	78.30±4.54[*]	66.83±5.83[*ab]	77.27±9.04[a]	77.38±9.17[b]	46.809	<0.001	0.655
t	0.708	18.766	6.353	0.267			
P	0.403	<0.001	0.014	0.607			
partial *η²*	0.09	0.198	0.077	0.003			
Group main effect					0.237	0.628	0.003
Main effect of test times					36.110	<0.001	0.322
Group*Test Times					12.873	<0.001	0.145

Notes[ab*]Bonferroni Multiple Comparison Results. Control group: After MBSR VS Before MBSR($P<0.001$);3-month follow-up VS Before MBSR($P<0.001$);6-month follow-upVS3-month follow-up($P<0.001$); MBSR group: After MBSR VS Before MBSR($P<0.001$);3-month follow-up VS After MBSR($P<0.001$);6-month follow-up VS After MBSR($P<0.001$)

Table 8 Analysis of the effect of MBSR on PSS (Mean ± SD)

Group	Before MBSR	After MBSR	3-month follow-up	6-month follow-up	F	P	partial η²
Control group	68.66±2.52	69.13±2.92	69.42±8.74	69.42±8.74	0.511	0.676	0.020
MBSR group	68.60±10.81	68.90±10.29	69.00±8.63	69.47±8.98	1.680	0.179	0.064
t	0.001	0.018	0.046	0.001			
P	0.974	0.894	0.831	0.979			
partial *η²*	0.000	0.001	0.000	0.000			
Group main effect					0.009	0.924	0.000
Main effect of test times					0.582	0.482	0.008
Group*Test Times					0.052	0.869	0.001

Analysis of the effect of MBSR on PSS

The simple effect between the control group and the MBSR group was not significant ($P>0.05$) at after MBSR, 3-month follow-up, and 6-month follow-up. In MBSR group, the simple effect of test times was not significant ($P>0.05$). The specific results were shown in Table 8.

The simple effect results of the group

The results of simple effects in the group of CRF, SOC, PSS, the method of facing and yielding, and uncertainty in illness were shown in Fig. 2.

Discussion

The results showed that after MBSR intervention the symptoms of CRF were significantly improved, and maintained the effect for 6 months. Witek Janusek et al. [40] conducted a MBSR study on patients with early breast cancer, and measured them before, during and at the end of the intervention, as well as one month and six months after the end of the intervention. The results showed that patients in intervention group showed a downward trend in fatigue, consistent with the results of this study. Similarly, Schell et al. [41] included many relevant studies on mental intervention of MBSR for breast cancer patients. The research results showed that the beneficial effect on fatigue was obvious at the end of the intervention, but it did not appear until six months later. CRF was the subjective experience and state of cancer patients, which could not be alleviated through rest and was closely related to the treatment itself and psychological status. MBSR could effectively improve the patient's mental health level, self-confidence, and coping ability, thus effectively improving the patient's CRF symptoms, and the intervention effect can be maintained in the short term.

The results showed that MBSR effectively improved the SOC of patients, and the best effect was achieved at 3 month. Kenne et al. [42] took MBSR on 62 patients with breast cancer and followed up for 3 months. The results showed that MBSR improved the SOC of patients, which was consistent with the results of this study. SOC emphasized the positive psychological resilience and efficacy of patients. In research both domestically and internationally, MBSR had achieved good results in promoting SOC. Victorson et al. [43] took online MBSR for 36 breast cancer patients, and also found that patients' positive psychology improved significantly from the intervention to 4 months. When patients faced difficulties, stress, or levels of loss beyond their ability, they redefined or constructed stress events, showing positive emotions to achieve inner balance. In summary, MBSR had a positive effect on the SOC of cervical cancer patients, which effectively promoted their positive psychological level and lasted for up to 6 months.

The results regarding the patient's coping style showed that the patient's positive coping style significantly improved, and remained unchanged at 6 months. At the
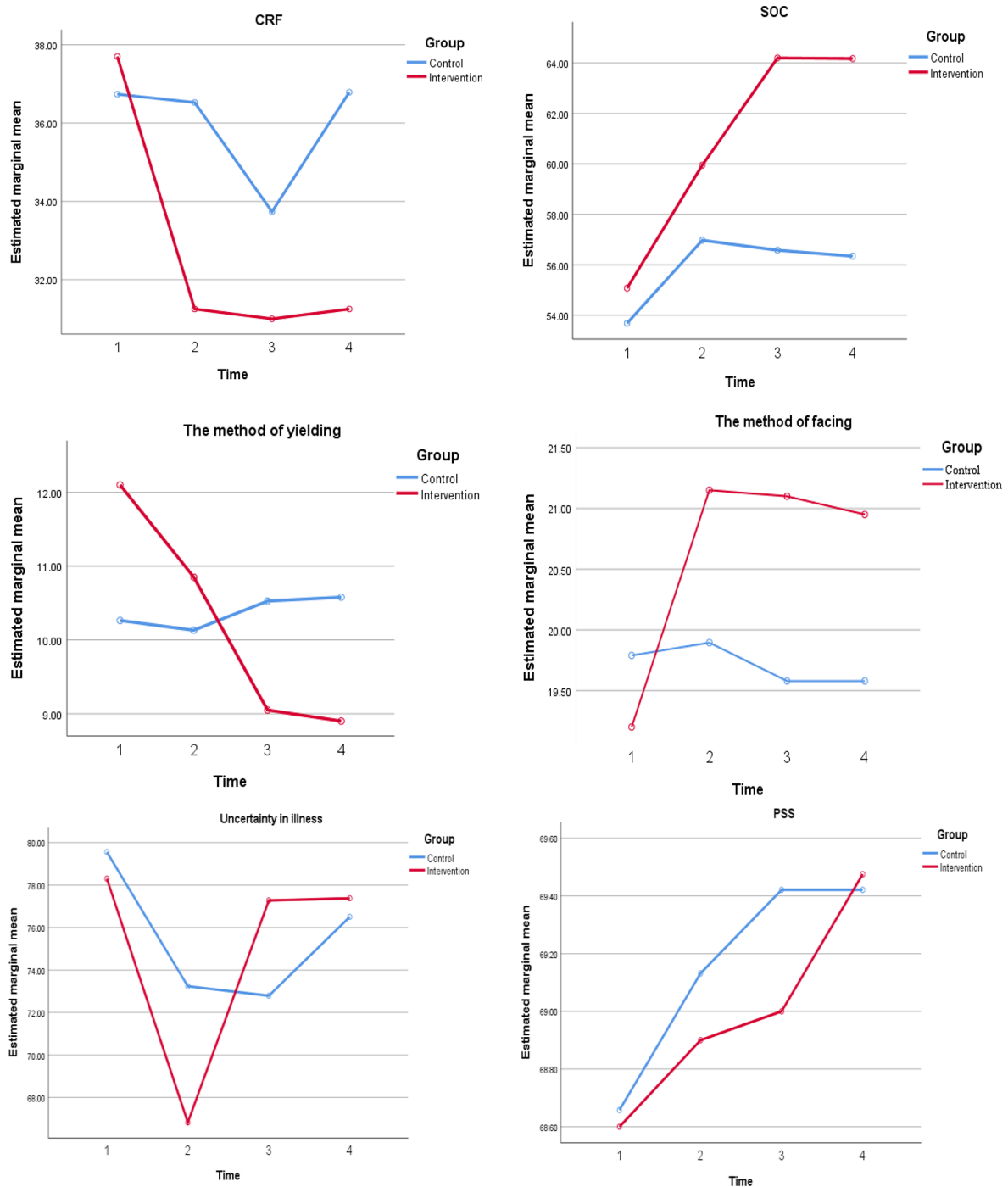
Fig. 2 The interaction between groups and measurement times

same time, the patient's negative coping style decreased. This fully demonstrated that MBSR could effectively improve the coping style of cervical cancer patients, and the intervention effect lasts until 6 months. The results of this study showed that the avoidance dimension was not statistically significant ($P > 0.05$). Ren Xuan et al. [44] conducted a MBSR study on breast cancer patients and followed up for 6 months. The results showed that the score of yielding and avoidance was lower than that before the intervention, and the score of facing was higher than that before the intervention. The score of yielding and avoidance in the intervention group was lower than that in the control group, and the score of facing was higher than that in the control group, consistent with the results of this study. The meta-analysis results of Li et al. [45] also showed that MBSR could effectively improve the coping

style of colorectal cancer patients. When patients faced stress events that exceeded their own burden, they would take corresponding measures to face the disease after making cognitive evaluations of the stress events. Positive coping styles helped patients effectively face, adapt to, and recover from the disease. Negative coping styles affected the recovery process of cancer patients and had negative impacts on their physiology and psychology. MBSR effectively enhanced patients' ability to accept and respond to diseases, effectively improved the attitude of cervical cancer patients when facing diseases, and the intervention effect lasted for up to 6 months.

The effect of MBSR on uncertainty in illness of patients was only significantly at the end of the intervention, and showed an upward trend at 3 months and 6 months follow-up. Lu et al. [46] conducted a MBSR study on breast cancer patients showed that the total score of the uncertainty in illness in the intervention group was lower than that in the control group after intervention, which was consistent with the results of this study, but the study was not followed up, and the duration of the intervention effect could not be known. Uncertainty in illness referred to the inability of patients to accurately assess disease related progression and the difficulty in predicting disease related symptoms, diagnosis, treatment, and prognosis. It was a common subjective experience of cancer patients, and this feeling usually changed over time and generally did not completely disappear. Patients undergoing MBSR communicated with doctors and provided feedback on a weekly basis during the intervention period, during which they could fully understand the progress of the disease. Therefore, there was a significant decrease in uncertainty in illness at the end of the intervention. After the intervention, concerns and speculations about the disease continued to rise, resulting in a continuous increase in uncertainty in illness. The results of this study also showed that MBSR had no significant effect on the intervention of PSS in cervical cancer patients. PSS typically emphasized the emotions and assistance provided by an individual's social network, with a bias towards external factors. As an internal resource, MBSR required the subject to actively explore and develop, utilizing their internal physical and mental strength, so it had no significant intervention effect on PSS.

Advantages and limitations

The advantages of this study are as follows. First, we recruited participants in hospitals, and the attending physician explained the purpose and process of the project, ensuring good compliance. Second, the formal intervention will be conducted online, through weekly online push of articles and videos, and requiring patients to provide feedback, and collected follow-up data by sending questionnaires online after intervention, which saved patient time and ensured participation. Third, our project implementer is an experienced obstetrician and gynecologist who specializes in researching social and psychological factors as well as health, and maintains good relationships with patients, which ensures the good quality of this study. There are also some limitations. First, the sample loss rate in this study is relatively high, resulting in a small sample size and insufficient representativeness of the research subjects. Second, this study requires a significant amount of manpower, resources, and time, resulting in high costs and limiting the promotion and application of the research. Last, this study focuses on short-term treatment outcomes, while there may be a lack of sufficient evidence to support long-term outcomes.

Conclusion

This study demonstrated that MBSR could effectively improve the CRF, SOC, coping style, and uncertainty in illness of cervical cancer patients. Compared with the control group subjects, the MBSR group showed significantly better psychological levels during the 3-month and 6-month follow-up after the intervention, and the positive effects of the intervention lasted until 6 months. The above quantitative research results indicated that 8-week MBSR was an effective intervention method to improve the positive psychological level and alleviate negative emotions of cervical cancer patients, and the positive effects of the intervention still existed in the short term.

Abbreviations
CRF   Cancer-Related Fatigue
MBSR   Mindfulness-Based Stress Reduction
ANOVA   Analysis of Variance
SOC   Sense Of Coherence
PSS   Perceived Social Support

Declarations

Ethics approval and consent to participate
The study design was approved by the Committee on Human Experimentation of China Medical University. All methods were carried out in accordance with Declaration of Helsinki. An informed consent was scanned and signed by each participant before participating. Personal privacy was protected when handling personal data, and we kept individual records completely secret.

Consent for publication
Not Applicable.

Competing interests
The authors declare no competing interests.

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