

A Web-based self-management exercise and diet intervention for breast cancer survivors: Pilot randomized controlled trial[☆]



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ABSTRACT

Background: Regular exercise and dietary practices have been shown to affect the health-related quality of life (HRQOL) and survival of breast cancer patients.

Objective: The current study aimed to investigate whether the WSEDI was a feasible and primarily effective method for promoting exercise and dietary behaviours for breast cancer patients.

Design: A 12-week randomized, controlled trial.

Setting: Oncology outpatient treatment clinics at 3 university hospitals and 1 National Cancer Center in South Korea.

Participants: Fifty-nine breast cancer patients who had received curative surgery and completed primary cancer treatment within 12 months prior to the study and who had been diagnosed with stage 0–III cancers within 2 years prior to the study were recruited.

Methods: Participants were randomly assigned to either the intervention group, which used a Web-based self-management exercise and diet intervention program incorporating transtheoretical model (TTM)-based strategies ($n = 29$), or to the control group, which used a 50-page educational booklet on exercise and diet ($n = 28$). The intervention efficacy was measured at the baseline and 12 weeks via a Web-based survey that addressed the promotion of exercise and consumption of 5 servings of fruits and vegetables (F&V) per day, dietary quality, HRQOL, anxiety, depression, fatigue, motivational readiness, and self-efficacy.

Results: The proportion of subjects who performed at least moderate-intensity aerobic exercise for at least 150 min per week; ate 5 servings of F&V per day; and had overall improvements in dietary quality, physical functioning and appetite loss (HRQOL), fatigue, and motivational readiness was greater in the intervention group than in the control group. The self-efficacy with respect to exercise and F&V consumption was greater in the

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intervention group than in the control group. A Web-based program that targets changes in exercise and dietary behaviours might be effective for breast cancer survivors if the TTM theory has been used to inform the program strategy, although further research with a larger sample size is required to enable definitive conclusions.

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What is already known about the topic?

- Regular exercise and dietary practices have been demonstrated to affect the health-related quality of life (HRQOL) and survival of breast cancer patients.
- To date, most exercise and dietary interventions that had been developed for cancer survivors required clinic-based face-to-face counselling sessions; however, when the intervention ends and the participants cannot receive feedback from the experts, and the motivation for regular exercise and diet practices decreases, their effects could not be observed or sustained.

What this paper adds

- A Web-based self-management intervention program was developed to target changes in exercise and dietary behaviours using transtheoretical model (TTM)-based strategies. This Web-based program might provide an effective alternative with regards to improving the weekly exercise duration, the daily fruit and vegetable (F&V) intake, overall dietary quality, physical functioning, appetite loss, and fatigue; however, further research with a larger sample size is required.

1. Background

Breast cancer is the most common cancer among women in many countries, but survival rates of breast cancer have steadily improved over the past 30 years (American Cancer Society, 2011). Putting on weight after cancer diagnosis or cancer treatment increases the incidence of chronic disease and re-occurring cancer (Herman et al., 2005). Healthy weight maintenance has been shown to affect both the health-related quality of life (HRQOL) (Demark-Wahnefried et al., 2002; Herman et al., 2005) and survival of breast cancer patients (Calle et al., 2003). For these reasons, retaining a normal weight is a high priority when assessing the needs of cancer survivors (Jones and Demark-Wahnefried, 2006). Regular exercise and a well-balanced diet are prerequisites for the maintenance of a healthy weight.

To date, most exercise and dietary interventions that had been developed for cancer survivors employed intensive clinic-based face-to-face counselling sessions (Courneya et al., 2003; Jones and Demark-Wahnefried, 2006; Pinto et al., 2005). Although the efficacy of such interventions is apparent immediately after delivery, once sufficient time has elapsed, the effects of the intervention cannot be found. The reason is that when the clinic-based face-to-face intervention ends, the participants cannot receive feedback from the experts, and the motivation for regular exercise and diet practices decreases (Daley et al.,

2007). Further, accessibility issues such as the remote location of the clinic, time taken to travel to the clinic, and encountering traffic are considerable barriers to the successful delivery of clinic-based face-to-face interventions (Jones et al., 2007). One suggested method to address the disadvantages of a clinic-based intervention was to employ a Web-based intervention program that could provide both feedback and the motivation to maintain regular exercise and dietary practices.

Several Web-based “cancer management” programs intended to improve breast cancer survivors’ HRQOL have been developed, and their efficacies have been evaluated. Web-based programs for the management of adverse effects (Golant et al., 2003), informational and emotional support and assistance with decision-making regarding cancer treatment-associated survivorship care planning (Gustafson et al., 2001), and improving psychological and emotional coping skills (Owen et al., 2005) were previously developed. All Web-based programs were shown to improve HRQOL (Golant et al., 2003; Gustafson et al., 2001), increase social support (Gustafson et al., 2001), alleviate anxiety and depression (Owen et al., 2005), and encourage patient participation in health management (Gustafson et al., 2001). Regarding exercise and dietary management, several Web-based programs have been developed for patients with gout and diabetes (Kim, 2007; Oh et al., 2011). However, there are few Web-based self-management programs intended to address exercise and dietary practices and improve HRQOL in cancer survivors. Web-based interventions into chronic disease settings for cancer survivors can improve patient empowerment and might subsequently improve the survivors’ health statuses and quality of life and reduce their need for supportive care (Kuijpers et al., 2013).

According to the transtheoretical model (TTM) (Prochaska and DiClemente, 1983), increasing the stage of change (Frith et al., 2010), enhancing self-efficacy (Frith et al., 2010; Luszczynska et al., 2011), and encouraging the process of change (Pollak et al., 1998) can create behavioural changes that consequently lead to improvements in the HRQOL (Courneya et al., 2003; Daley et al., 2007; Voskuil et al., 2010), depression (Daley et al., 2007; Eyigor et al., 2010; Pinto et al., 2005), anxiety (Pinto et al., 2005), and fatigue (Courneya et al., 2003; Pinto et al., 2005). To date, previous studies have identified the possibility that the TTM theory could be applied to a Web-based intervention by showing that the programs had effects on healthy behaviour changes (Huang et al., 2009; Kim and Kang, 2006). Within the background described above, we previously developed a Web-based self-management exercise and diet intervention program (WSEDI) that applied TTM-based strategies (Lee et al., 2013).

2. Objective

The current study aimed to investigate whether the WSEDI was a feasible and primarily effective method for promoting exercise and dietary behaviours and dietary quality and a secondarily effective method for addressing HRQOL, anxiety, depression, fatigue, motivational readiness, and self-efficacy in breast cancer patients.

3. Methods

3.1. Study participants

The study was conducted from October 1, 2011, through February 28, 2012, at 3 university hospitals (1500, 2700, and 930 beds) and 1 National Cancer Center (550 beds). A pool of breast cancer patients who had undergone curative surgery and completed primary cancer treatment within the 12 months prior to the study and who had been diagnosed with stage 0–III cancers within the 2 years prior to the study were identified from 4 hospital cancer registries; these patients were sent invitation letters and brief questionnaires from oncology care physicians at each involved hospital. The brief questionnaire asked whether the patient undertook at least moderate exercise for at least 150 min per week, consumed 5 servings of fruits and vegetables (F&V) per day, and for what duration each behaviour had been practiced. Next, oncologists screened the breast cancer patients who responded to the invitation letters for conditions that would hinder unsupervised exercise (congestive heart failure or angina, recent myocardial infarction, breathing difficulties requiring oxygen use or hospitalization, walker or wheelchair use, or planned hip or knee replacement surgery) or ingestion of a diet with high content of F&V without supervision (kidney failure or chronic warfarin use); and for the absence of a progressive cancer or an additional primary tumour. Participants were subsequently screened based on following inclusion criteria; age of 20 years or older; serum haemoglobin ≥ 10 g/dl; had not met at least 1 of the 2 behavioural goals (performing at least moderate exercise for at least 150 min per week and consuming 5 servings of F&V per day); ability to use the computer; home internet access; and mobile phone user. However, those who met the following exclusion criteria were removed from the study; currently receiving any cancer treatment; a serious psychological disorder; an infectious condition; and visual or motor dysfunction. The required clinical data to assess the inclusion and exclusion criteria were collected by the research nurse from electronic medical records within the previous month. The fifty-nine breast cancer patients who met the eligibility criteria and who provided written informed consent were enrolled by a research nurse (Fig. 1).

3.2. Randomization

The efficacy of WSEDI was evaluated by a randomized controlled trial with a control group. Participants who signed a written informed consent form were randomly assigned to either the intervention or the control group

using a computerized random number generator (SAS 9.2; Proc plan). The randomization is controlled centrally in National Cancer Center. An independent statistician at the National Cancer Center generated a random allocation sequence. Block randomization into four strata defined by disease stage ($\leq$ IIa/ $\geq$ IIb) and the number of goal behaviours practiced (of the 2 goal behaviours: energy expenditure achieved by performing at least moderate exercise for at least 150 min/week and an intake of ≥ 5 servings of F&V per day) at study entry (zero/one) was performed by the independent statistician. No participants were formally informed of their assignment to either the intervention or the control group. However, some may have deduced that the WSEDI was the test modality.

After randomization, brief training (<30 min) was routinely scheduled during the study enrolment week. The training addressed how to use WSEDI was offered to the intervention group members. Trainers did not explain or address any of the WSEDI contents. The intervention group was also provided with a manual describing the intended use of WSEDI.

3.3. Intervention

The intervention group was exposed to a 12-week, WSEDI aimed at enhancing exercise and dietary behaviours tailored according to the principal constructs of the TTM theory such as the stage of change, process of change, decisional balance, or self-efficacy. No intervention-related interactions (i.e., exercise and diet behaviour) between the intervention group and the research nurse or among intervention group members occurred while processing the intervention. The intervention group members were encouraged to use WSEDI regularly (at least twice weekly) through automated SMS messages. The WSEDI contained four portions including assessment, education (tailored information provision), action planning (goal setting, scheduling, keeping a diary), and automatic feedback. The educational content were as follows; enhancing exercise and dietary behaviour in cancer survivors; the importance of normal weight management; barriers to sustainability of exercise and diet behaviour; considerations when planning exercise and diet; a consequences such as QOL and survival of the regular exercise and a balanced diet; and exercise and dietary guidelines for cancer survivors. The educational contents were arranged based on TTM theory. Thus, the educational portion was subdivided into five modules that were based on each patient's current stage of change (e.g., pre-contemplation, contemplation, preparation, action, maintenance). The action-planning portion began at the preparation stage. Each participant was recommended to plan their exercise behaviour in line with ACS guidelines (Doyle et al., 2006). However, the type, intensity, duration, and frequency of aerobic exercise could be self-adjusted as necessary according to individual preferences (Jones and Demark-Wahnefried, 2006; WHO, 2002). In the dietary planning portion, each patient was recommended to plan their optimal number of units per recommended food group in order to achieve a balanced diet (Oh et al., 2003). Dietary recommendation was based on daily caloric requirements

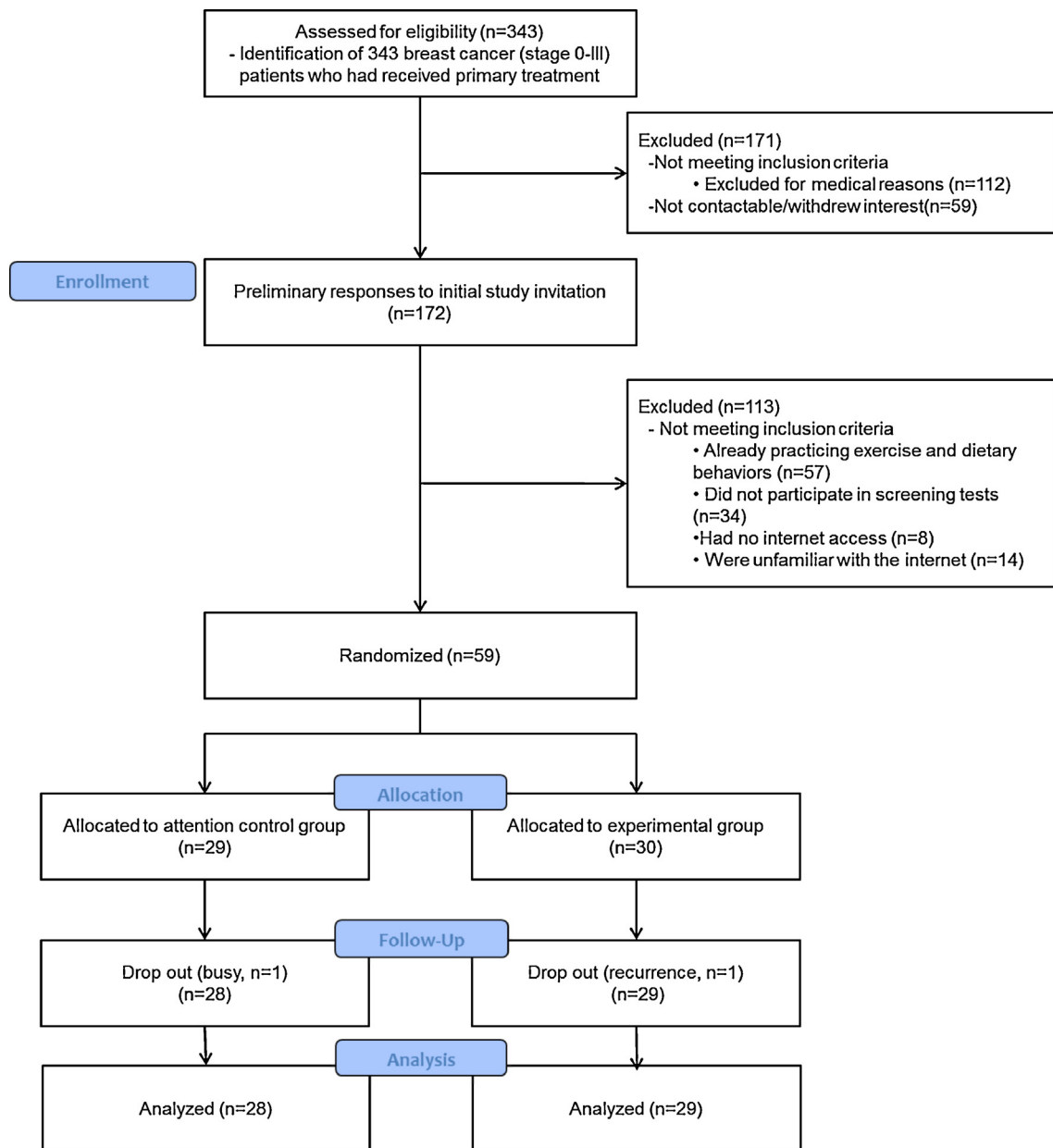


Fig. 1. Consort diagram: recruitment and eligibility screening, randomization, follow-up, and analysis.

in accordance with individual BMI values, normal body weights, and daily level of activity. In a diary, participants recorded daily exercise behaviour (type, intensity, and duration) and the daily number of units of each food group consumed. The data on actual behaviours and what were recommended were compared visually on the Web screen. This information was used to give daily feedback on goal achievement as part of the automatic feedback portion (SMS module) of the intervention. A brief summary of the interventional goal, principal strategies, educational theme, and technical functions used for delivering interventions at each stage of change is shown in the Appendix 1 (Lee et al., 2013).

The control group received a 50-page educational booklet on exercise and diet. The basic content of the booklet was same as that of the WSEDI. The booklet did not incorporate the core constructs of the TTM (Appendix 2). The protocol was approved by the Institutional Review Boards of the four study hospitals.

3.4. Outcome measures

All members of both the control and experimental groups were registered on the website (using IDs and passwords); the baseline and 12-week follow-up measurements were collected via self-reported Web-based

surveys. SMS messages reminded study members of upcoming assessment points and invited those members to access the web program.

3.4.1. Primary outcomes

1. Exercise and intake of F&V: Based on the 7-day exercise diaries, exercise was measured in minutes per week of at least moderate aerobic exercise that consumed at least 4 metabolic equivalents (3.5 ml O₂/kg/min) (Jones and Demark-Wahnefried, 2006; Brown et al., 2003; Warburton et al., 2006). The number of F&V servings consumed per day was assessed and averaged using a 3-day dietary recall. Participants were asked to recall all food and beverages consumed on three non-consecutive days (two weekdays and one weekend day).
2. Dietary quality: Initial food intake was assessed based on 3-day dietary recall. Dietary quality was measured using the diet quality index (DQI) (Patterson et al., 1994), as revised for use with Korean populations (Oh et al., 2003). The DQI contains eight questions exploring nutrition; these are the proportions of energy derived from fat and saturated fatty acids; cholesterol intake (mg/day); the proportion of energy derived from carbohydrates; the intake of F&V (servings/day); protein intake (as a % of the recommended daily allowance (RDA)); calcium intake (as a % of the RDA); and sodium intake (mg/day). All nutrient intake data were estimated using the Korean Nutrition Society computer-assisted nutritional analysis program (CAN Pro 4.0) and were scored with reference to the RDA by a dietician. Each of the 8 categories was scored from 0 to 2, and the scores of the 8 categories were summed; the score range thus lay between 0 and 16, where a higher score was indicative of better dietary quality (Wayne et al., 2006). The dietician telephoned each participant to assure that the food records were maintained properly for nutritional analysis in terms of data accuracy and completeness.

3.4.2. Secondary outcomes

1. HRQOL: The European Organization for Research and Treatment of Cancer (EORTC) QLQ-C30 is a 30-item cancer-specific questionnaire that assesses the general QOL of cancer patients (Aronson et al., 1993). The questionnaire addresses five functional domains (physical, role, cognitive, emotional, and social); has two symptom scales (for pain and nausea and vomiting); contains global health and overall QOL scales; addresses several single items associated with symptoms reported by cancer patients (insomnia, dyspnoea, appetite loss, constipation, and diarrhoea); and also measures the perceived financial impact of disease and treatment. On scales evaluating global health and functioning (overall QOL), a higher score represents a greater level of function and health. On scales evaluating symptoms, a higher score indicates the existence of more problems and a greater magnitude of existing symptoms. The

Korean version of the EORTC QLQ-C30 has previously been validated (Yun et al., 2004).

2. Anxiety and depression: The Hospital Anxiety and Depression Scale (HADS) is a self-report measurement tool designed for use in medical settings. This scale contains 14 items, and of these, seven assess anxiety (HADS-A) and seven assess depression (HADS-D) (Zigmond and Snaith, 1983). Each subscale was scored from 0 to 21; higher scores indicate greater levels of distress. The Korean version of the HADS (Oh et al., 1999) has been validated. In the present study, Cronbach's alpha values for the HADS-A and HADS-D were 0.81 and 0.84, respectively.
3. Fatigue: The Brief Fatigue Inventory (BFI) was used to measure fatigue. This inventory is a one-page measurement tool that includes nine items, each rated on a 0–10 scale, that reflect the severity of fatigue. The Brief Fatigue Inventory contains subscales assessing the severity of fatigue and the extent to which fatigue has interfered with various aspects of life (Mendoza et al., 1999). We used subscales assessing the severity of fatigue. The Korean version of the Brief Fatigue Inventory (BFI-K) has previously been validated (Yun et al., 2005). In the present study, Cronbach's alpha value for the BFI-K was 0.95.
4. Stage of change: Staging items derived from TTM theory were domain-specific, and explored goal behaviour. Staging items were developed and adopted by previous study (Demark-Wahnefried et al., 2003). Stage of change was defined as motivational readiness (Prochaska and DiClemente, 1983). Participants were asked: "On average, do you exercise at least 30 min a day, 5 days a week (Brown et al., 2003; Warburton et al., 2006); do you eat at least five servings of fruit and vegetables a day (Demark-Wahnefried et al., 2003; Djuric et al., 2002)?" If a response was affirmative, the following questions were posed: "How long have you been exercising at least 30 min a day, 5 days a week; eating at least five servings of V&F a day?" The responses included: "less than six months" (interpreted as the action stage) and "6 months or longer" (interpreted as the maintenance stage). If a patient responded negatively or replied "I don't know", that patient was asked: "Are you seriously thinking about (exercising at least 30 min a day, 5 days a week; eating at least five servings of V&F a day) within the next 6 months?" The responses included: "No" or "don't know" (interpreted as the precontemplation stage), and "yes". Those responding affirmatively were next asked: "Are you planning to start (exercising at least 30 min a day, 5 days a week; eating at least five servings of V&F a day) within the next 30 days?" Those responding affirmatively were classified as being in the preparation stage; those responding negatively or those who did not know were classified as being in the contemplation stage.
5. Perceived self-efficacy: Because self-efficacy is domain-specific, participants were asked, in terms of each goal behaviour: "How sure are you that you could (exercise at least 30 min a day at least 5 days a week; eat at least five servings of V&F per day)?" The answers were: Very sure, sure, somewhat sure, unsure, and very unsure.

Prior to questioning, exercise, and F&V servings were described. For example: “Examples of exercise are brisk walking, cycling, swimming, mountain climbing, or another form of exercise that makes your heart pound, or makes you break out in a sweat, and is not part of your normal job activity”. Also: “One serving of vegetables is equal to 1/2 cup of cooked (or parboiled) vegetables or one cup of greens, and one serving of fruit is equal to one piece of fruit, 1/2 cup of canned fruit, 1/4 cup of dried fruit, or 3/4 cup of 100% juice.”

3.5. Statistical analyses

The trial design ensured that 29 patients per group (the number indicate the initially planned number of subjects to be randomized) would afford a power of 81% (two-sided alpha; 0.05) to detect a difference of 5% in the control group (the estimated Hawthorne effect) (Braunholtz et al., 2001) compared to a difference in primary outcome of 34% in the intervention group (Demark-Wahnefried et al., 2007). The primary outcome used to calculate the sample size was the proportion of participants that exercised at a moderate intensity for at least 150 min per week.

The characteristics of the intervention and control groups were described using frequencies and means, standard deviations, and ranges, for all variables. The *t*-test for continuous variables and the Chi-square test for categorical variables were utilized to explore the homogeneity of baseline characteristics between the two groups. Between-group differences from baseline to 12-week point of the test – in terms of the stage of change, the level of self-efficacy, the categorized protein intake (i.e., poor, fair, good) and the categorized calcium intake (i.e., poor, fair,

good) – were explored using an ordinal logistic regression model, adjusting for baseline values. Group difference in the percentage of patients attaining goal behaviour, such as exercising at moderate intensity for at least 150 min a week and eating five servings of F&V a day, was tested with the logistic regression model. Between-group differences from baseline to 12-week point in HRQOL, the levels of fatigue, anxiety, depression, and the continuous variables of DQI (Total calories from fat, SFA, and carbohydrate, and Cholesterol) were explored using an analysis of covariance (ANCOVA) after adjustment for baseline scores.

SAS version 9.2 (SAS Institute, Cary, NC) was used in all statistical analyses. Two-sided *p* values are reported and a *p* value of <0.05 was considered to be statistically significant.

4. Results

4.1. Characteristics of study participants

Of the 343 identified patients, 171 were excluded from the first medical screening or for not expressing an interest in participating. A total of 172 (50%) patients enrolled in the study and submitted consent forms along with the second screening survey. Of those, the authors excluded 113 patients (66%). The leading reasons for exclusion were healthy exercise and dietary behaviours or failure to complete the second screening survey (see Fig. 1). The remaining 59 women were randomly assigned to either the intervention (*n* = 30) or control (*n* = 29) group. During the study, 2 women (3%) dropped out and were lost to follow-up. The reasons for drop out included busyness (*n* = 1) and breast cancer recurrence (*n* = 1). The reasons for

Table 1
Characteristics of study participants.

Characteristic	Control group (<i>n</i> = 29)	WSEDI intervention group (<i>n</i> = 30)	<i>p</i>
Age, years, mean (SD)	43.2 (5.1)	41.5 (6.3)	0.256
Educational level, <i>n</i> (%)			
High school	9 (31.0)	7 (23.3)	0.506
College or beyond	19 (69.0)	24 (76.7)	
Marital status, <i>n</i> (%)			
Married	24 (82.8)	27 (90.0)	0.318
Not married	5 (17.2)	3 (10.0)	
Time elapsed since treatment, days			
Mean (SD)	156.6 (102.8)	161.6 (107.8)	0.857
Body mass index, <i>n</i> (%)			
≥18.5 kg/m ² , <23 kg/m ²	16 (55.2)	20 (66.7)	0.231
<18.5 kg/m ² , ≥23 kg/m ²	13 (45.7)	10 (33.3)	
Surgery type, <i>n</i> (%)			
Breast-conserving	23 (79.3)	20 (66.7)	0.239
Mastectomy	6 (20.7)	10 (33.3)	
Receiving chemotherapy, <i>n</i> (%)			
No	6 (20.7)	4 (13.3)	0.452
Yes	23 (79.3)	26 (86.7)	
Receiving radiotherapy, <i>n</i> (%)			
No	4 (13.8)	3 (10.0)	0.652
Yes	25 (86.2)	27 (90.0)	
Clinical stage, <i>n</i> (%)			
Stage 0	0 (0.0)	2 (6.7)	0.538
Stage I	11 (37.9)	12 (40.0)	
Stage II	15 (51.7)	13 (43.3)	
Stage III	3 (10.3)	3 (10.0)	

SD = standard deviation; WSEDI = Web-based self-management exercise and diet intervention program.

Table 2

Group differences of primary outcomes compared between the control and the intervention groups at 12 weeks.

	Control group		WSEDI intervention group		Adjusted p^a
	Baseline	12 weeks	Baseline	12 weeks	
	$n = 29$	$n = 28$	$n = 30$	$n = 29$	
Behavioural outcome					
Moderate-intensity aerobic exercise, ≥ 150 min/week, n (%)	10 (34.5)	10 (35.7)	10 (33.3)	19 (65.5)	<0.0001
Daily intake of F&V, ≥ 5 servings of F&V, n (%)	14 (48.3)	9 (32.1)	13 (43.3)	16 (55.2)	0.001
Diet quality					
Diet Quality Index (DQI) total	10.3	9.6	9.7	11.1	0.001
Total % calories from fat	22.2	19.3	20.8	17.3	0.492
Total % calories from SFA	3.5	3.3	3.7	3.5	0.399
Cholesterol, mg/day	285.6	272.1	288.0	256.4	0.248
Total % calories from carbohydrate	60.8	62.8	61.2	64	0.707
Sodium, mg/day	3.708	3.427	3.738	3.218	0.399
Protein, % RDA, n (%)					
Poor (<75 , >150)	12 (41.4)	13 (46.4)	20 (66.7)	12 (41.3)	0.016
Fair (>125 , ≤ 150)	6 (20.7)	8 (28.6)	5 (16.7)	9 (31.0)	
Good (≥ 75 , ≤ 125)	11 (37.9)	7 (25.0)	5 (16.7)	7 (24.1)	
Calcium, % RDA, n (%)					
Poor (<75 , >150)	15 (51.7)	17 (60.7)	22 (73.3)	14 (48.3)	0.003
Fair (>125 , ≤ 150)	3 (10.3)	3 (10.7)	1 (3.3)	0 (0.0)	
Good (≥ 75 , ≤ 125)	11 (37.9)	8 (28.6)	7 (23.3)	14 (48.3)	

SFA = saturated fatty acids; F&V = fruit and vegetables; RDA = recommended daily allowances; WSEDI = Web-based self-management exercise and diet.

^a Group differences at 12 weeks adjusted for baseline values.

drop out were not related to the intervention. The 12-week intervention course and follow-up were completed by 29 (96.7%) participants in the intervention group and 28 (96.6%) in the control group (Fig. 1). The baseline characteristics of the 59 participants who underwent randomization were shown in Table 1. No significant difference between the two study groups was evident in terms of any sociodemographic or clinical characteristics.

4.2. Effect of Web-based self-management program

4.2.1. Primary outcomes

Table 2 summarized the primary outcomes from baseline to 12 weeks in the two groups. Moderate intensity aerobic exercise for at least 150 min per week ($p < 0.0001$) and eating five servings of F&V per day ($p = 0.001$) significantly increased in the intervention group compared to controls. The intervention group also showed a greater improvement in overall diet quality than did controls ($p = 0.001$). The proportion of patients in whom protein intake met the RDA was also significantly higher in the intervention group than in controls ($p = 0.016$). The proportion of patients in whom calcium intake met the RDA was significantly higher in the intervention group than in controls ($p = 0.003$).

4.2.2. Secondary outcomes

Table 3 summarized the secondary outcomes from baseline to 12 weeks in the two groups. In terms of the HRQOL, the physical functioning ($p = 0.023$) and appetite loss ($p = 0.034$) scores, as measured according to the EORTC QLQ-C30, improved to a significantly greater degree in the intervention group than in the control group. The severity of fatigue, as measured using the BFI, improved to a significantly greater extent in the intervention group than in the control group ($p = 0.032$). The stage of change for

exercise ($p < 0.0001$) and F&V consumption ($p = 0.029$) were significantly higher in the intervention group than in controls. There was a significant between-groups difference in self-efficacy for exercise management ($p = 0.024$). A significant between-group difference was also evident in terms of self-efficacy to increase F&V intake ($p = 0.023$).

The WSEDI was both feasible and acceptable among breast cancer survivors. Eighty-nine per cent of the patients consistently participated in this program during the interventional period. The intervention group participants significantly adhered to the final exercise and dietary goals. The participants also provided positive evaluations of the contents, the IT-supported delivery method, and the system's usefulness.

5. Discussion

5.1. Summary of the evidence

The present study suggests that the WSEDI effectively increased the duration of weekly exercise, the daily intake of F&V, overall dietary quality, physical functioning, appetite loss (measured by the HRQOL), and fatigue (assessed using the BFI). The WSEDI appears to be an appropriate alternative method for improving the exercise and dietary behaviours of breast cancer patients. However, further research with a larger sample size is required to make conclusive statements.

The WSEDI does include several notable features that explain why the program positively affected these outcomes. The reason why this program was effective may be the high rate of utilization due to most participants' preparation stage, and due to the strategies of daily feedback and action planning. The diagnosis of cancer also provides a teachable moment when the patients' motivation for lifestyle change is especially high (Hewitt et al.,

Table 3

Group differences of secondary outcomes, comparing data from the control and intervention groups at 12 weeks.

	Control group		WSEDI intervention group		Adjusted p^a
	Baseline	12 weeks	Baseline	12 weeks	
	$n = 29$	$n = 28$	$n = 30$	$n = 29$	
EORTC QLQ-C30, Ls mean					
Functioning					
Physical functioning	75.5	75.9	75.4	83.6	0.023
Role functioning	69.2	76.1	70.5	74.7	0.19
Emotional functioning	70.8	69.6	68.3	71.1	0.551
Cognitive functioning	74.3	71.7	74.2	71.7	0.658
Social functioning	73.6	74.4	73	77.4	0.294
Global quality-of-life	52.6	53.1	53.1	56.4	0.369
Symptom					
Nausea/vomiting	8.7	9.4	6.8	5.8	0.479
Insomnia	27.2	31.9	29.3	26.1	0.423
Pain	20.3	25.2	21.4	21.5	0.825
Dyspnoea	13.8	15.2	13.6	10.4	0.969
Appetite loss	12.3	24.4	14	9.6	0.034
Constipation	23	15.8	21	18.6	0.366
Diarrheal	7	4.7	13.2	4.1	0.212
Financial difficulties	18.1	17.5	19.3	17.9	0.414
Hospital Anxiety Depression Scale, Ls mean					
Anxiety	6.3	7.8	6.7	6.6	0.142
Depression	6.4	8	6.5	7.3	0.271
Brief Fatigue Inventory, Ls mean					
Fatigue severity	16.7	15.3	16.9	13.5	0.032
Stage of change, n (%)					
Stage of change for exercise					
Precontemplation	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Contemplation	3 (10.3)	4 (14.3)	2 (6.67)	0 (0.0)	
Preparation	15 (51.7)	13 (46.4)	19 (63.3)	1 (3.4)	
Action	11 (37.9)	7 (25.0)	8 (26.7)	22 (75.9)	
Maintenance	0 (0.0)	4 (14.3)	1 (3.33)	6 (20.7)	<0.0001
Stage of change to increase F&V intake					
Precontemplation	0 (0.0)	0 (0.0)	2 (6.7)	1 (3.4)	
Contemplation	7 (24.1)	6 (21.4)	10 (33.3)	3 (10.3)	
Preparation	20 (69.0)	13 (46.4)	18 (60.0)	11 (37.9)	
Action	0 (0.0)	8 (28.6)	0 (0.0)	13 (44.8)	
Maintenance	2 (6.9)	1 (3.6)	0 (0.0)	0 (0.0)	0.029
Self-efficacy, n (%)					
Self-efficacy for exercise management					
Not at all sure	1 (3.5)	0 (0.0)	1 (3.3)	0 (0.0)	
A little sure	3 (10.3)	11 (39.3)	7 (23.3)	2 (6.9)	
Somewhat sure	10 (34.5)	6 (21.4)	7 (23.3)	6 (20.7)	
Very sure	10 (34.5)	9 (32.1)	7 (23.3)	17 (58.6)	
Extremely sure	5 (17.2)	2 (7.1)	8 (26.7)	3 (10.3)	0.024
Self-efficacy to increase F&V intake					
Not at all sure	0 (0.0)	0 (0.0)	1 (3.3)	0 (0.0)	
A little sure	6 (20.7)	7 (25.0)	8 (26.7)	6 (20.7)	
Somewhat sure	13 (44.8)	10 (35.7)	15 (50.0)	11 (37.9)	
Very sure	8 (27.6)	10 (35.7)	5 (16.7)	10 (34.5)	
Extremely sure	2 (6.9)	1 (3.6)	1 (3.3)	1 (3.4)	0.023

LS mean = least squares mean; WSEDI = Web-based self-management exercise and diet.

^a Group differences at 12 weeks adjusted for baseline values.

2003; McBride et al., 2008). The maintenance of healthy behaviours is facilitated by timely feedback regarding desired consequences (Frenzel et al., 2010), enhancement of self-efficacy (Koring et al., 2011; Luszczynska et al., 2011), motivation (Frith et al., 2010), and action planning (Conner et al., 2010; Lippke et al., 2009). Action planning promotes the initiation and maintenance of healthy behaviours by identifying and addressing intention-behaviour gaps (Conner et al., 2010; Lippke et al., 2009; Reuter et al., 2009). The tailored feedback might stimulate self-regulatory behaviour through making self-judgments on progress towards desired exercise and diet behaviour

(Bandura, 1989). In addition, the patients' needs were reflected in this program through interviews with the patients. The identified user requirements were combined with technologies to improve user accessibility. The TTM could incorporate facilitating strategies such as timely feedback, enhancement of self-efficacy, motivation, and action planning for the maintenance of healthy behaviours because it contains the core constructs of process of change, self-efficacy, and stage of change (Prochaska and DiClemente, 1983). The WSEDI is a self-management program that harmonizes proper strategies, technologies, and theory in order to maintain healthy behaviours.

The WSEDI significantly affected the scores in specific HRQOL domains, including physical functioning and appetite loss; these findings are consistent with those of previous studies of subjects who participated in exercise programs (Brown et al., 2003; Courneya et al., 2003) and those of a report on women who underwent and recovered from breast cancer treatment and adopted changes in dietary quality (Wayne et al., 2006). The WSEDI also improved motivational readiness and perceived self-efficacy in terms of exercise and F&V consumption. Self-regulation strategies, including diary keeping, an emphasis on goal-setting, and feedback on progress, may increase motivation and perceived self-efficacy (Wing et al., 2006).

The finding that the WSEDI led to reduced fatigue is consistent with those of several reports showing that off-line exercise training can help to mediate fatigue in cancer survivors (Courneya et al., 2003; Pinto et al., 2005; Segal et al., 2003). An earlier work showed that consumption of a low-protein diet was associated with fatigue (Trabal et al., 2006). In our present study, the observed reduction in fatigue may be associated with protein intake that was increased to levels close to that of the recommended daily allowance.

This theory and IT-based self-management program, which features action planning and tailored feedback and education in order to consistently affect motivation and self-efficacy, might contribute to intervention outcomes. Most healthcare providers in busy clinical settings rarely find the time to counsel patients about health management. Accessibility issues such as distance, time, and traffic are considerable barriers to successful health management. The Internet is a promising medium with which to improve these issues. In this self-management program, IT might play a role in the provision of easily accessible, up-to-date, and timely information and feedback tailored to each patient's stage.

Given the current and future circumstances in which the number of cancer survivors is increasing continuously as well as the potential role that this theory and IT-based self-management program could play in improving regular exercise and balanced dietary habits and the fact that the Internet can improve user accessibility, a Web-based intervention could potentially achieve positive and widespread public health outcomes.

5.2. Limitations

Our study had several limitations. First, this study raised the issue in generalizability of findings. The study sample was not representative of the GP of breast cancer patients. The recruitment of elderly patients and those with low educational attainment levels was challenging because such patients cannot easily use a Web-based program. Indeed, the proportions of elderly patients and those with lower educational attainment levels were lower in our study group than in the general population. Given the small sample size, the test results should be interpreted cautiously and with regard to the generalizability of the findings. Nevertheless, the statistical power

might have been adequate to detect the benefits of the intervention program. The actual study power values were 89% and 82%, based on the exercise and dietary outcomes, respectively, and these results are similar to Cohen's recommendation that the power of a well-designed study should range 80–85% (Cohen, 1988). Second, the follow-up duration was only 12 weeks. Further studies are needed to determine if a continuation of a Web-based program, featuring TTM strategies, would effectively maintain long-term practice of desired dietary and exercise behaviours.

6. Conclusions

The WSEDI, which targets changes in exercise and dietary behaviours, might be an effective alternative method for improving the weekly exercise duration, daily F&V intake, overall dietary quality, physical functioning, appetite loss, and fatigue if the TTM theory has been used to inform the program strategy. However, further research with a larger sample size is required to make conclusive claims.

7. Implication for nursing

Web- and theory-based approaches to self-management lifestyle interventions might lead to subsequent healthy behaviours in cancer survivors and promote accessibility to nursing interventions in a primary care setting.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.ijnurstu.2014.04.012>.

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