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Demographic, clinical, and sociocognitive determinants related to physical activity and dietary intake in patients with ovarian cancer: A cross-sectional study

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HIGHLIGHTS

- Cross-sectional study including 139 patients with ovarian cancer.
- Low levels of physical activity and suboptimal diet reported by patients.
- Gap between current behaviours and the recommended guidelines by the WCRF.
- Limited knowledge regarding WCRF lifestyle guidelines.
- Demographic, clinical and sociocognitive factors associated with physical activity and diet.

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ABSTRACT

Objective. To study physical activity and dietary intake among patients with ovarian cancer and to examine which demographic, clinical, and sociocognitive determinants are associated with these behaviours.

Methods. This cross-sectional study included 139 patients with ovarian cancer scheduled for (neo)adjuvant chemotherapy. Physical activity was measured with the Physical Activity Scale for the Elderly questionnaire (PASE). Dietary intake was measured with a questionnaire assessing energy and protein intake and a questionnaire assessing adherence to the World Cancer Research Fund (WCRF) lifestyle recommendations. Demographic, clinical, and sociocognitive (e.g., self-efficacy) determinants of physical activity and dietary intake were examined using backward linear regression analyses.

Results. Patients reported a median PASE score of 50 (IQR 24–94), a mean ± SD dietary intake of 1831 ± 604 kcal/day and 76 ± 27 g protein/day. Patients adhered to 3 out of 5 WCRF lifestyle recommendations. The absence of comorbidities, lower physical outcome expectations, and higher cancer specific outcome expectations were independently associated with higher physical activity levels. Higher age, lower cancer specific outcome expectations, and higher diet-related self-efficacy were significantly associated with adhering to more WCRF lifestyle recommendations, whilst no variables associated with total caloric or protein intake were identified.

Conclusions. Patients with ovarian cancer have low physical activity levels and a suboptimal diet, particularly low fruit and vegetable consumption and dietary fibre intake. Interventions aiming to improve physical activity

Abbreviations: DHD, Dutch Healthy Diet; FIGO, International Federation of Gynaecology and Obstetrics; IQR, Inter quartile range; MOEES, Multidimensional Outcome Expectations for Exercise Scale; PASE, Physical Activity Scale for the Elderly; QoL, Quality of Life; WCRF, World Cancer Research Fund.

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and dietary intake could focus on increasing self-efficacy and outcome expectations, and should consider age and comorbidity as factors that may impact behaviour.
Trial registration: Netherlands Trial Registry NTR6300.

1. Background

Worldwide, 313,000 women are diagnosed with ovarian cancer every year, making ovarian cancer the eighth most common cancer type among women [1]. The overall 5-year survival rate of ovarian cancer is 30–40% as it is often diagnosed at an advanced stage according to the International Federation of Gynaecology and Obstetrics (FIGO) [2]. Diagnosis and treatment of ovarian cancer often results in reduced physical function, increased levels of fatigue and a decreased Quality of Life (QoL) [3–6]. Studies in patients with cancer, some including patients with ovarian cancer, have shown that exercise and dietary interventions helped to maintain or improve physical fitness and function, reduce fatigue and improve QoL [7–9]. Observational studies in patients with ovarian cancer have shown that meeting physical activity guidelines during and following treatment has been associated with less fatigue and peripheral neuropathy, fewer sleep problems, and reduced symptoms of depression and anxiety [10]. A higher diet quality in patients with ovarian cancer has been associated with a lower all-cause mortality [11]. Sufficient levels of physical activity and a healthy diet may therefore be important for patients with ovarian cancer, and is recommended by the World Cancer Research Fund (WCRF) [12].

Physical activity and dietary interventions based on behaviour change theories have shown to be more effective compared to those not based on behaviour change theories [13]. Behaviour change theories provide insight into why behaviour change may or may not occur and which determinants are associated with this change. A commonly used theory in behaviour change interventions in oncology is Bandura's social cognitive theory [14]. According to this theory, behaviour can be explained by self-efficacy, goal setting, outcome expectations, and socio-structural factors (i.e., barriers and facilitators) [15–19]. Thereby, identification of demographic determinants (e.g., age, education level) can help to identify subgroups that are at risk for unhealthy behaviours. This could help to identify which specific individuals should particularly be targeted for interventions. Hence, insights in which demographic, clinical and sociocognitive determinants are associated with physical activity or dietary intake in patients with ovarian cancer are essential in the design of interventions aiming to improve these behaviours.

Previous studies in patients with cancer types other than ovarian cancer identified that older age [20,21], limited social support [21], and lower education level [22] are associated with lower physical activity levels. Considerably less is known about which determinants influence a healthy diet in patients with cancer. In patients with breast cancer, higher self-efficacy and motivation were associated with a healthier dietary pattern [23]. Due to differences in treatments and disease trajectories, it is not clear whether results from studies focussing on patients with other types of cancer can be generalized to patients with ovarian cancer. Therefore, we aimed to study which demographic, clinical, and sociocognitive determinants were associated with physical activity and dietary intake among patients with ovarian cancer.

2. Methods

2.1. Study design and participants

This study is part of the Physical Activity and Dietary intervention in patients with OVArian cancer (PADOVA) study, registered in the Netherlands Trial Registry (NTR6300) [24]. The study was approved by the medical ethical committees of the Amsterdam UMC and participating hospitals. Patients were recruited from the Center of Gynaecologic Oncology Amsterdam (which is a collaboration of all gynaecological oncologists from Amsterdam UMC, Netherlands Cancer Institute/Antoni van Leeuwenhoek and affiliated referring hospitals), Catharina Hospital Eindhoven, Radboudumc Nijmegen and its collaborating community hospitals in the Netherlands. Patients were eligible for inclusion if they were scheduled to undergo adjuvant or neoadjuvant chemotherapy for ovarian cancer. Patients were excluded if they had a prior cancer diagnosis within 5 years or were not able to perform basic activities of daily living. Other exclusion criteria were a contraindication for exercise (e.g., heart failure), cognitive disorders or severe emotional instability (e.g., schizophrenia, Alzheimer), unable to read and/or write Dutch, and a life expectancy of <3 months. All patients provided written informed consent before participating. Patient inclusion started in February 2018 and finished in March 2022.

Eligible patients who did not wish to participate in the trial were asked to complete a one-time questionnaire, containing the same questions as the baseline questionnaire for trial participants. In both groups the questionnaire was administered just before or directly after the first cycle of chemotherapy. In the case of adjuvant chemotherapy treatment, patients already had their surgery, and the questionnaire was administered as soon as they started chemotherapy. Data from the trial participants questionnaires and the one-time questionnaire were pooled for cross-sectional analyses.

2.2. Variables

To investigate physical activity levels, dietary intake, and their demographic and sociocognitive determinants, questionnaires were used. Questionnaires were completed digitally or on paper, depending on the patient's preference. Clinical determinants were extracted from medical records.

2.3. Dependent variables: physical activity and dietary intake

Physical activity was measured using the Physical Activity Scale for the Elderly (PASE). This questionnaire has been developed and validated to assess physical activity in people aged 65 years and older [25]. In addition, it reports a good to excellent test-retest reliability and good content validity among cancer patients with cancer aged 50 ± 12 years [26]. Patients found this questionnaire particularly favourable to complete, and this questionnaire was used in previous exercise oncology trials in patients with an average age between 50 and 60 [7,27–29]. Assessing physical activity with the PASE allowed us to directly compare physical activity levels to other cancer patient populations. The PASE consists of 13 items, assessing leisure-, domestic-, and occupational physical activities [25]. PASE score is based on the amount of time spent in each activity (hours/week) and the frequency of the activity (never, seldom (1–2 days a week), sometimes (3–4 days a week), or often (5–7 days a week)). The total PASE score was calculated by multiplying the frequency and durations of the activities by the weights of the activity item and summing the scores across all activities [25,30].

Dietary intake was assessed by two different questionnaires. The first is a brief food frequency questionnaire used to assess adherence to the WCRF lifestyle recommendations and Dutch guidelines for a healthy diet [31]. It consists of 25 questions to assess intake of fruits

(gram/day), vegetables (gram/day), red meat (gram/week), processed meat (gram/week), sugary drinks that promote weight gain (drinks/day), dietary fibre intake (gram/day), alcoholic drinks (number of drinks/day) [32]. Component scores were computed based on the 2007 operationalization of the WCRF lifestyle recommendations for five dietary recommendations (i.e., sugar-sweetened drinks, fruit and vegetables, dietary fibre, red and processed meat, and alcohol intake), explained in detail in Table 1. This resulted in a sum score representing participants that fully adhered, partially adhered or did not adhere to 2007 WCRF dietary recommendations. In addition, component scores were computed for the Dutch Healthy Diet (DHD)-index, resulting in a continuous sum score with a range of 0–80 [26]. For both the WCRF lifestyle adherence score and the DHD-index a higher value reflected a healthier diet. The second dietary questionnaire, which is used in clinical practice, assessed total energy and protein intake per day using a table with 49 often consumed dietary products. Participants were asked to record the food portions they consumed in a typical day from the previous week in the table. The Dutch Food Composition Database (NEVO) [33] was used to determine from these portions the kilocalories and protein intake per day. The total intake per day was corrected for under- and over-reporting using cut-off values for minimum and maximum daily calorie intake (500–3500 kcal/day) [34]. Values below 500 and above 3500 kcal/day were removed from the analyses.

2.4. Independent variables

Stage of behaviour change regarding physical activity, body weight, protein intake and WCRF dietary recommendations (i.e., sugary drinks, fruit and vegetable intake, dietary fibre intake, red and processed meat intake and alcohol consumption) was assessed using questions based on the stage of change constructs proposed by the transtheoretical model of health behavioural change of Prochasca et al. [35]. It evaluates if people are motivated or have the intention to change their behaviour. Questions (e.g., Do you currently eat enough vegetables?) were scored with “yes, I do this >6months” (maintenance phase), “yes, I do this <6 months” (action phase), “no, but I intent to do this within the next month” (preparation phase), and “no, and I don't intent to do this within 6 months” (contemplation phase).

2.4.1. Demographic determinants

Participants were asked about demographic variables, including age, ethnicity, living situation (i.e., alone/together with partner/other), smoking status (yes/no) and education level (i.e., low: primary or prevocational secondary education, intermediate: senior general, pre-university, or vocational education, and high: higher or university education).

2.4.2. Clinical determinants

Cancer stage and treatment were categorised into neoadjuvant treatment vs adjuvant treatment for low stage cancer vs adjuvant treatment for high stage cancer. Comorbidities were assessed using the Charlson Comorbidity Index [36], dichotomised into none versus ≥1, with exclusion of the primary malignancy.

2.4.3. Sociocognitive determinants

Knowledge on the WCRF dietary recommendations and some additional dietary factors (e.g., protein and artificial sweeteners) that received special attention during the dietary consultation were questioned using 11 multiple-choice items that have been used in a previous study [37], including vegetables and fruits, red meat, cured/ processed meats, physical activity, overweight, alcohol, sweeteners, use of food supplements, sodium intake, and protein intake. Answers were scored with 1 (correct) or 0 (incorrect), resulting in a knowledge score from 0 to 11. Internal consistency of the knowledge questions was determined by Cronbach's alpha, revealing $\alpha = 0.743$.

Table 1
Patient characteristics.

Patient characteristics	Total ($n = 139$)
Demographic determinants	
Age (years), mean ± SD	59 ± 11
Smoking, %	
Yes	5.8
No	94.2
Education, %	
Low (primary, prevocational secondary education)	22.3
Intermediate (senior general, pre-university, or vocational education)	33.8
High (higher or university education)	43.9
Marital status, %	
Single	15.1
Married or living together with a partner	72.7
Other	12.2
Clinical	
Charlson comorbidity elevated (≥1, primary malignance excluded), %	7.2
Cancer stage and treatment, %	
Neo-adjuvant	41.0
Adjuvant, low FIGO stage	28.1
Adjuvant, high FIGO stage	30.9
Sociocognitive determinants	
Knowledge, median (IQR; 0–11 range)	4 (2–6)
Barriers for physical activity (15–75 range)	28 (21–36)
Facilitators for physical activity (5–25 range)	10 (8–15)
Barriers for diet (10–50 range)	18 (14–23)
Facilitators for diet (5–25 range)	11 (8–15)
Outcome expectations for physical activity	
Physical (6–30 range)	24 (23–27)
Social (4–20 range)	12 (9–14)
Self-evaluative (5–25 range)	19 (17–20)
Cancer specific (5–25 range)	20 (18–21)
Outcome expectations for diet	
Physical (6–30 range)	24 (22–25)
Social (4–20 range)	12 (10–14)
Self-evaluative (5–25 range)	17 (15–19)
Cancer specific (5–25 range)	18 (17–20)
Self-efficacy	
Self-efficacy physical activity (1–5 range)	4 (4–5)
Self-efficacy diet (7–35 range)	29 (27–32)
Self-efficacy weight (1–5 range)	4 (3–4)
Behaviour	
Physical activity scores, median (IQR)	
PASE total	50 (24–94)
PASE leisure time	15 (9–33)
PASE household	32 (11–53)
PASE occupational	0 (0–0)
Dietary intake, mean ± SD	
Daily energy intake (kcal/day)	1831 ± 604
Protein intake (g/day)	76 ± 27
Dutch Healthy Diet-index total score (0–80 range)	50.9 ± 10.0
WCRF score (0–5 range)	3.4 ± 0.7
WCRF sugary drinks, %	
>250 g/d	15.8
>0 ≤250 g/d	24.5
0 g/d	59.7
WCRF fruit and vegetable, %	
<200 g/d	22.3
200– <400 g/d	66.9
≥400 g/d	10.8
WCRF dietary fibre, %	
<8.5 g/d	12.9
>8.5– <17 g/d	70.5
≥17 g/d	16.5
WCRF red and processed meat, %	
Red meat >500 g/w or processed meat ≥50 g/d	7.2
Red meat <500 g/w or processed meat 2– <50 g/d	63.3
Red meat <500 g/w or processed meat <3 g/d	29.5
WCRF alcohol, %	
>2 drinks	1.4
1–2 drinks	2.2
≤1 drink	96.4

Table 1 (*continued*)

Patient characteristics	Total ($n = 139$)
Stage of behaviour change	
Physical activity %	
Action/maintenance	64.6
Contemplation/preparation	35.4
Body weight %	
Action/maintenance	61.2
Contemplation/preparation	38.8
Protein intake %	
Action/maintenance	83.5
Contemplation/preparation	16.5
Sugar-sweetened drinks %	
Action/maintenance	75.4
Contemplation/preparation	24.6
Fruit intake %	
Action/maintenance	82.8
Contemplation/preparation	17.2
Vegetable intake %	
Action/maintenance	88.2
Contemplation/preparation	11.8
Dietary fibre intake %	
Action/maintenance	86.8
Contemplation/preparation	13.2
Red and processed meat %	
Action/maintenance	75.0
Contemplation/preparation	25.0
Alcohol intake %	
Action/maintenance	93.8
Contemplation/preparation	6.2

Self-efficacy for physical activity and a healthy diet was measured with a self-composed questionnaire including one question about physical activity-related self-efficacy and 7 questions on self-efficacy for a healthy dietary intake, based on the different components of the WCRF dietary recommendations. The questions were formulated as follows [24,38,39]: "I am confident that I will be able to…", which was followed by different statements, e.g., "to exercise at moderate intensity for at least 30 minutes per day", or "eat at least 200 grams vegetables per day". Answers were reported using a 5-point Likert scale ranging from 1 ("I certainly cannot") to 5 ("I certainly can"). For diet-related questions, individual item scores were summed, resulting in self-efficacy scores for physical activity and diet respectively, with a higher score representing a higher self-efficacy.

Outcome expectations for physical activity were assessed using the Multidimensional Outcome Expectations for Exercise Scale (MOEES) [40]. The MOEES questionnaire uses the question "Changing my physical activity pattern will…" followed by 15 statements to assess various expectations. All questions were answered using a 5-point Likert-scale, with 1 = strongly disagree, 5 = strongly agree. Items were summed, resulting in 3 subscales, i.e., physical, social, and self-evaluative outcome expectations. In addition, a total score was derived by summing all item scores, with a higher score indicating a more positive outcome expectation. In addition to the standard items in the MOEES, we added a few cancer-specific items related to outcome expectations, including "...improve my recovery from treatments" or "…allow me to be more in control of my life". These cancer-specific items were summed and analysed as a separate subscale, where a higher score indicated a more positive outcome expectation. To measure outcome expectations for dietary intake, the MOEES questionnaire was adjusted to diet-specific questions (i.e., "Changing my dietary intake will…") and the same analysis approach was used.

Sociostructural factors were assessed by examining barriers and facilitators of physical activity and a healthy diet [41]. To evaluate barriers, questions started with "the past 3 months I was unable to change my physical activity/dietary intake, because…", whilst facilitators were evaluated using questions starting with "the past 3 months I was able to change my physical activity/ dietary intake, because …". All questions were answered using a 5-point Likert-scale ranging from "strongly agree"/ "very often" to "strongly disagree"/ "never". Data was summed resulting in scores for 4 categories (i.e., barriers to changing physical activity, or diet, and facilitators for changing physical activity, or diet) with a higher score indicating more barriers or more facilitators. Cronbach's alpha was determined for internal consistency of the questionnaire, which was >0.80 for all categories.

2.5. Statistical analyses

SPSS version 27.0 (IBM, Armonk, USA) was used for analysis. Data was presented as mean ± standard deviation (SD) for continuous variables, as number (percentage) for categorical variables and as median (Inter quartile range (IQR)) for data with a skewed distribution. Multiple linear regression analyses were used to examine which variables were associated with physical activity (i.e., PASE score for total and leisure time) or dietary intake (i.e., WCRF lifestyle adherence score and DHD-index). Demographic characteristics (age, education level), clinical variables (cancer stage and treatment, comorbidity) and sociocognitive constructs (knowledge regarding WCRF recommendations, physical, social self-evaluative and cancer-specific outcome expectations, barriers and facilitators for physical activity or diet change, self-efficacy for adhering to recommendations) were included in the models. A backward selection procedure was applied, in which variables that were not significantly ($p < 0.05$) associated with the outcome were removed from the model one by one and only significant variables were retained in the model. In the case of data with a skewed distribution, we performed a sensitivity analysis with square root transformed data.

3. Results

Of the 257 eligible patients, 81 participated in the randomized controlled trial of whom 76 completed the questionnaire, and 63 patients completed the one-time questionnaire. Consequently, data from 139 patients were available for the current analyses (Fig. 1). Participants were on average 59 ± 11 years old, 92.1% had a western-European background and 73% lived together with a partner (Table 1).

3.1. Physical activity and its determinants

Participants reported a median (IQR) PASE activity score of 50 (24–94) and the majority (64.6%) was in the action/ maintenance phase of physical activity (Table 1). The absence of comorbidity (β = 74.0, 95% CI = 35.2; 112.7), lower physical outcome expectations (β = −4.3, 95% CI = −8.4; −0.3), higher cancer specific outcome expectations (β = 9.1, 95% CI = 4.1; 14.0) were independently associated with higher physical activity levels (Table 2). The final model for total physical activity explained 18% of the variance in the total PASE score. No significant association was found for education level, cancer stage and treatment, knowledge regarding WCRF lifestyle recommendations, barriers and facilitators for physical activity (Supplemental Fig. 1), social and self-evaluative outcome expectations and self-efficacy for adhering to the physical activity recommendation. Higher leisure time physical activity was independently associated with the absence of comorbidity (β = 23.1 95% CI = 4.9; 41.3), and higher self-efficacy for adhering to the physical activity recommendation (β = 9.1, 95% CI = 3.8; 14.3). These determinants explained 15% of the variance in leisure PASE score. Results from the sensitivity analysis with root transformed data of PASE scores were comparable to the results of non-transformed data, which therefore appeared to be robust for non-normality of PASE scores.

3.2. Dietary intake and its determinants

Participants had a mean (SD) dietary intake of 1831 ± 604 kcal/day and 76 ± 27 g protein/day. The majority (range 75.4–93.8%) of the

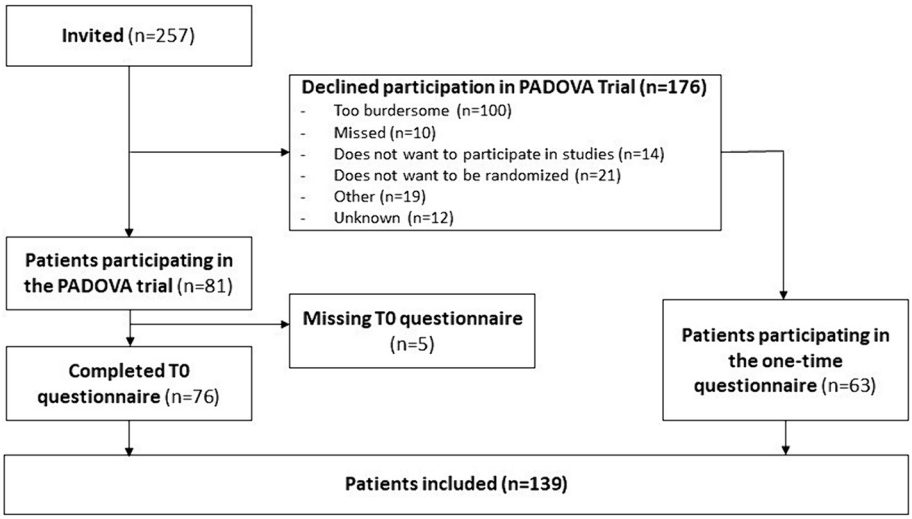

Fig. 1. Flowchart of participants.

patients was in the action/ maintenance phase for the WCRF dietary recommendations, and on average patients adhered to 3 out of 5 components of the WCRF dietary recommendations. Furthermore, 11% of the patients adhered to the recommended fruit and vegetable intake of >400 g/day, while 96% of the patients adhered to taking ≤1 alcoholic drink/day. The majority (83.5%) was in the action/ maintenance phase of protein intake (Table 1). A higher age (β = 0.02, 95% CI = 0.00; 0.03), lower cancer specific outcome expectations (β = −0.1, 95% CI = −0.1; −0.0), and a higher diet-related self-efficacy (β = 0.02, 95% CI = 0.01; 0.03) were significantly associated with a higher adherence to the WCRF dietary recommendations (Table 3). A higher diet-related self-efficacy (β = 0.2, 95% CI = 0.0; 0.4) was significantly associated with a higher DHD-index was significantly. The final model explained 11% and 5% of the variance in adherence to the WCRF dietary recommendations and DHD-index, respectively. No significant associations were found for education level, cancer stage and treatment, presence of comorbidity, diet specific outcome expectations, knowledge regarding WCRF lifestyle recommendations, barriers, facilitators and body weight related self-efficacy. None of the variables analysed was significantly associated with a higher daily caloric intake or protein intake.

4. Discussion

This study investigated levels of physical activity and dietary intake among patients with ovarian cancer, and studied which demographic, clinical and sociocognitive determinants were associated with these behaviours. We demonstrated that patients with ovarian cancer generally reported low levels of physical activity, had a suboptimal diet and showed limited knowledge regarding WCRF lifestyle guidelines. Additionally, we found that higher physical activity levels were associated with the absence of a comorbidity, lower physical outcome expectations, higher cancer-specific outcome expectations and higher self-efficacy. A higher age, lower cancer specific outcome expectations and a higher self-efficacy were associated with a healthier diet as assessed by the WCRF dietary adherence score and the DHD-index. Altogether, these results imply that there is room to improve physical activity and dietary intake in patients with ovarian cancer, and to improve their

Table 2
Unstandardized and standardized regression coefficients and their 95% confidence intervals as results from univariable and multivariable regression analyses with total PASE score as dependent variable.

	Univariable model Unstandardized β (95% CI)	Multivariable model Unstandardized β (95% CI)[a]	Multivariable Standardized β
Age	−0.28 (−1.19; 0.63)	–	–
Education level		–	–
Low	Reference		
Middle	−9.90 (−37.53; 17.73)		
High	2.14 (−24.20; 28.48)		
Treatment		–	–
Neoadjuvant	Reference		
Adjuvant, low FIGO stage	−20.83 (−45.21; 3.55)		
Adjuvant, high FIGO stage	−27.91 (−51.6; −4.2)*		
Comorbidity	63.04 (25.18; 100.91)*	73.96 (35.18; 112.73)*	0.31
Knowledge regarding WCRF recommendations	0.17 (−3.84; 4.19)	–	–
Physical outcome expectations	1.20 (−1.74; 4.14)	−4.32 (−8.39; −0.25)*	−0.26
Social outcome expectations	4.10 (1.00; 7.20)	–	–
Self-evaluative outcome expectations	2.94 (0.08; 5.80)*	–	–
Cancer-specific outcome expectations	4.78 (1.31; 8.26)*	9.06 (4.13; 13.98)*	0.45
Barriers for physical activity change	−0.93 (−2.25; 0.40)	–	–
Facilitators for physical activity change	−0.63 (−2.89; 1.64)	–	–
Self-efficacy for adhering to physical activity recommendation	16.04 (4.17; 27.90)*	–	–

* = $P < 0.05$.
[a] The final model for total physical activity explained 18% of the variance in total PASE score.

Table 3
Unstandardized and standardized regression coefficients and their 95% confidence intervals as results from univariable and multivariable regression analyses with level of adherence to WCRF dietary recommendations as dependent variable.

	Univariable model Unstandardized β (95% CI)	Multivariable model Unstandardized β (95% CI)[a]	Multivariable model Standardized β
Age	0.01 (−0.01; 0.02)	0.02 (0.00; 0.03)*	0.24
Education level		–	–
Low	Reference		
Middle	−0.06 (−0.38; 0.27)		
High	0.13 (−0.18; 0.44)		
Treatment		–	–
Neoadjuvant	Reference		
Adjuvant, low FIGO stage	−0.02 (−0.31; 0.27)		
Adjuvant, high FIGO stage	−0.17 (−0.46; 0.11)		
Comorbidity	0.32 (−0.14; 0.78)	–	–
Knowledge regarding WCRF recommendations	0.06 (0.01; 0.11)*	–	–
Physical outcome expectations	0.01 (−0.03; 0.06)	–	–
Social outcome expectations	0.03 (−0.02; 0.07)	–	–
Self-evaluative outcome expectations	0.02 (−0.02; 0.05)	–	–
Cancer specific outcome expectations	−0.01 (−0.05; 0.04)	−0.05 (−0.09; −0.01)*	−0.22
Barriers for diet change	−0.02 (−0.04; 0.00)	–	–
Facilitators for diet change	−0.02 (−0.05; 0.01)	–	–
Self-efficacy for healthy diet	0.07 (0.04; 0.10)*	0.02 (0.01; 0.03)*	0.29

* $= P < 0.05$.
[a] The final model explained 11% of the variance in adherence to the WCRF dietary recommendations.

knowledge of healthy behaviour. Additionally, improving self-efficacy and outcome expectations could be important strategies for improving these behaviours.

The median PASE score of 50 (24–94) found in the current sample of patients with ovarian cancer is substantially lower than PASE scores found in patients with other types of cancer such as breast cancer (mean 99.0 [27]), hematologic cancer (mean 96.9 [28]), or head and neck cancer (median 84 [42]). This difference could be attributed to the higher disease stage at diagnosis and disease-related adverse effects such as ascites that may limit physical activity [43]. Additionally, age may also be a contributing factor, as ovarian cancer is typically diagnosed in middle-aged women. Older people generally experience more comorbidities hampering physical activity [44]. Interestingly, 64.6% of our participants report that they are in the action/maintenance phase. To address this potential tendency of overestimation, we propose incorporating a strategy of providing women with feedback on their objective levels of physical activity [45]. This tailored approach aims to bridge the gap between self-perceived and objectively assessed physical activity levels, empowering patients with ovarian cancer to make informed decisions about improving their level of physical activity, which is expected to benefit their health and wellbeing.

In addition to physical inactivity, this study also revealed suboptimal dietary intake and limited knowledge about WCRF guidelines among patients with ovarian cancer. The overall adherence to the WCRF dietary recommendations was 60%, which was comparable to findings of other types of cancers, including colorectal cancer survivors and an elderly population of female cancer survivors [46,47]. The lowest adherence was observed for the fruit and vegetable intake and dietary fibre intake, whilst these are promising dietary factors to prevent cancer recurrence and optimize survival [48,49]. In addition, patients are often unaware of their unhealthy dietary habits, as illustrated by the limited knowledge of the WCRF lifestyle recommendations. This could perhaps be explained by the fact that malnutrition is more prevalent among patients with ovarian cancer than other types of gynaecological cancer patients [50]. The high prevalence indicates the need for additional dietary support. Given the positive associations of increased physical activity and healthy dietary intake with positive cancer outcomes found in individuals with other types of cancer [51], attention should be raised to improving the low physical activity levels and suboptimal diet in patients with ovarian cancer.

Our determinants were derived from a combination of the Bandura's Social Cognitive Theory and other demographic and clinical variables. These determinants of physical activity among patients with ovarian cancer, however, only explained 18% of the variance of total physical activity in our multivariable model. Although this is similar to the percentages reported in other studies [41,52], it suggests that there are additional variables that may explain physical activity levels among patients with ovarian cancer that were not included in our study for example the symptom burden. Among the determinants of the Bandura's Social Cognitive Theory, cancer-specific outcome expectations were found to be most strongly associated with physical activity, with more positive expectations of benefits for coping with cancer treatment leading to higher levels of physical activity. Surprisingly, patients with more positive outcome expectations of physical activity (e.g., improvement in muscle strength or physical functioning), reported lower levels of physical activity. This may be because patients who are already physically fit may anticipate less impact of physical activity change on their physical functioning, however, they still expect a high impact on cancer-specific outcomes. Therefore, targeting cancer-specific outcome expectations (e.g., with cognitive behavioural therapy) may be an effective strategy to promote behaviour change [53]. Interestingly, another determinant of the Bandura's Social Cognitive Theory, namely self-efficacy, was not associated with total physical activity levels, but was related with leisure time physical activity. This implicates that increasing self-efficacy could be a target for interventions specifically aiming to improve leisure time physical activity. Notably, the initial significant association observed in the univariable model for self-efficacy and total physical activity did not persist in the multivariable analysis, suggesting that other variables incorporated into the model may have exerted a stronger influence. In our study we observed associations between certain theoretical constructs from the Bandura's Social Cognitive Theory and physical activity. This highlights the nuanced nature of these relationships, signifying that not all Bandura's Social Cognitive Theory determinants are uniformly correlated with physical activity in this population. Our recommendation is to direct interventions targeting this population toward the determinants that have demonstrated significant associations. Overall, tailoring interventions to the needs and abilities of patients with ovarian cancer while promoting positive outcome expectations seems essential for improving physical activity.

The adherence to the WCRF dietary recommendations is explained by several factors, including age, cancer-specific outcome expectation and self-efficacy, which accounted for 11% of the variance in this study. Patients with higher age, lower cancer-specific outcome expectation and higher self-efficacy were more likely to follow a healthier diet.

This is consistent with previous research linking levels of diet-related self-efficacy to a healthier diet in both adolescents [54] and adults [55]. To promote adherence to these recommendations, it is important to inform younger patients about the WCRF dietary recommendations. Increasing self-efficacy, for example through goal-setting and feedback [56], should also be part of lifestyle interventions for patients with ovarian cancer. Self-monitoring and feedback can further improve awareness of dietary habits [57]. Currently, the majority of the patients referred to the in-hospital dietitian are patients who are at risk of malnutrition or who are malnourished. Therefore, dietary counseling is less focused on promoting a healthy diet (e.g., DHD or WCRF guidelines) [57]. Our study shows that promoting a healthy diet is warranted. In the future, dietitians should also be involved in promoting a healthy diet in patients whose nutritional status did not deteriorate or after completion of counseling for malnutrition.

A strength of this study was the detailed insight into physical activity and dietary intake in patients with ovarian cancer, which has so far been understudied. We had a relatively high response rate (54%) of participants who were willing to fill in our questionnaire. In addition, we investigated the determinants of physical activity and dietary intake according to a Bandura's social cognitive theory, which helps to identify targets for behaviour change interventions. A potential limitation of this study is that physical activity levels were measured by a questionnaire and were not assessed objectively. However, the PASE questionnaire provides insights in subdomains of physical activity, has been validated in the elderly population [58] and this questionnaire has also been used to study physical activity in patients with other types of cancer allowing us to compare findings. Dietary intake was measured with food frequency questionnaires instead of 24-h recalls or food diaries. The food frequency questionnaire has been shown to accurately assess adherence to the DHD and WCRF guidelines [31]. However, results of the questionnaire that assessed energy and protein intake per day should be carefully interpreted, because this questionnaire could introduce some errors due to recall bias. Additionally, 54% of the patients who were eligible for inclusion wanted to participate in this study. As a consequence, it may be that this study could have potentially included a selection of patients with a higher education or patients with an interest in physical activity and dietary intake, as those patients could be more willing to fill in the questionnaire [27,41,59]. This could have resulted in an overestimation of the already levels of physical activity and healthy diet reported by the patients and thereby underestimating the problem of inactivity and unhealthy diet in this patient group.

5. Conclusions

The findings of this cross-sectional study shed light on the physical activity levels and dietary intake of patients with ovarian cancer and highlight the need for targeted lifestyle interventions. The low levels of physical activity and suboptimal diet reported by patients indicate a gap between their current behaviours and the recommended guidelines by the WCRF. The study also revealed that outcome expectations and self-efficacy were key factors associated with both physical activity and dietary intake, which should be addressed in future interventions. In addition, interventions should consider age and comorbidity as factors that may impact behaviour. Given the individual differences in self-efficacy and outcome expectations, personalized approaches to improve physical activity and dietary behaviour are warranted.

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CRediT authorship contribution statement

Yvonne A.W. Hartman: Data curation, Formal analysis, Visualization, Writing – original draft, Writing – review & editing. **Marlou-Floor Kenkhuis:** Formal analysis, Visualization, Writing – original draft, Writing – review & editing. **Stephanie Stelten:** Conceptualization, Data curation, Project administration, Writing – review & editing. **Calvin G. Brouwer:** Data curation, Writing – review & editing. **Luc R.C.W. van Lonkhuijzen:** Conceptualization, Investigation, Writing – review & editing. **Gemma G. Kenter:** Conceptualization, Investigation, Writing – review & editing. **Willemien J. van Driel:** Data curation, Writing – review & editing. **Renate M. Winkels:** Writing – review & editing. **Ruud L.M. Bekkers:** Data curation, Writing – review & editing. **Nelleke P.B. Ottevanger:** Data curation, Writing – review & editing. **Meeke Hoedjes:** Conceptualization, Investigation, Methodology, Writing – review & editing. **Laurien M. Buffart:** Conceptualization, Funding acquisition, Project administration, Supervision, Writing – review & editing.

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declaration of competing interest

All authors declare that they have no conflict of interests.

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