Gynecologic Oncology 202 (2025) 167–173

Contents lists available at ScienceDirect

Gynecologic Oncology

journal homepage: www.elsevier.com/locate/ygyno

Development and optimization of an integrated exercise and nutrition program for ovarian cancer patients: Phase I of the BENITA multi-center study

Tabea Maurer [a,*], Matthias H. Belau [b], Birgit-Christiane Zyriax [c], Götz Welsch [d], Bettina Jagemann [c], Jenny Chang-Claude [e], Anne Daubmann [b], Anika Buchholz [b], Alexander Fierenz [b], Karin Glismann [d], Annika Moeller [d], Jalid Sehouli [f], Hannah Woopen [f], Pauline Wimberger [g], Philipp Harter [h], Sabrina Kaiser [h], Nicolai Maass [i], Marion Kiechle [j], Tobias Engler [k], Barbara Schmalfeldt [l,1], Holger Schulz [a,1]

[a] Center for Psychosocial Medicine, Department of Medical Psychology, University Medical Center Hamburg-Eppendorf, Hamburg, Germany
[b] Institute of Medical Biometry and Epidemiology, University Medical Center Hamburg-Eppendorf, Hamburg, Germany
[c] Midwifery Science-Health Care Research and Prevention, Research Group Preventive Medicine and Nutrition, Institute for Health Service Research in Dermatology and Nursing (IVDP), University Medical Center Hamburg-Eppendorf, Hamburg, Germany
[d] UKE Athleticum, Orthopedic Sports Medicine, Department of Trauma and Orthopedic Surgery, University Medical Center Hamburg-Eppendorf, Hamburg, Germany
[e] Division of Cancer Epidemiology, German Cancer Research Center (DKFZ), Heidelberg, Germany; University Medical Centre Hamburg-Eppendorf, University Cancer Centre Hamburg (UCCH), Hamburg, Germany
[f] Charité – Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin and Humboldt-Universität zu Berlin, Department of Gynecology with Center for Oncological Surgery, Charite Comprehensive Cancer Center, Berlin, Germany
[g] National Center for Tumor Diseases Dresden and Department of Gynecology and Obstetrics, University Hospital Dresden, TU Dresden, Dresden, Germany
[h] Department of Gynecology & Gynecologic Oncology, Ev. Kliniken Essen-Mitte, Essen, Germany
[i] Department of Gynecology and Obstetrics, University Hospital of Schleswig-Holstein, Campus Kiel, Kiel, Germany
[j] Department of Gynecology and Obstetrics, TUM University Hospital Klinikum Rechts der Isar, Technical University Munich (TU), Munich, Germany
[k] Department of Women's Health, Tübingen University Hospital, Tübingen, Germany
[l] Department of Gynecology, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

HIGHLIGHTS

- Interviews with patients, health care providers, and an insurer informed development of an exercise and nutrition program.
- Motivators: enjoyment, external encouragement, and autonomy to choose when/how to participate.
- Barriers: chemotherapy-related fatigue, physical limitations, and uncertainty about what is safe after surgery/chemotherapy.
- Safety/support needs: well-informed physiotherapists/dietitians, clear guidance, and regular expert counseling (video/phone).
- Implementation: home-based, app-supported blended care with low-threshold options and counseling. Phase II tests efficacy.

ARTICLE INFO

Article history:
Received 14 June 2025
Received in revised form 2 October 2025
Accepted 8 October 2025
Available online 17 October 2025

Keywords:
Lifestyle intervention
Ovarian cancer
Exercise & nutrition
Development and optimization

ABSTRACT

Background. Ovarian cancer patients face treatment-related challenges such as malnutrition and muscle wasting associated with cancer cachexia. If left untreated, these complications can severely impact quality of life and autonomy. The BENITA study aims to develop and evaluate a tailored exercise and nutrition program during and after first-line chemotherapy. Phase I focused on program development and optimization; Phase II will test its effectiveness in a randomized controlled trial.

Methods. Semi-structured interviews were conducted with patients, survivors, physicians, nutrition and physiotherapy experts, and a health insurance representative. Thematic analysis following Braun and Clarke was used to identify key insights for program design and implementation.

Results. Patients' motivation to engage in exercise and nutrition was driven by enjoyment and external encouragement. Barriers included chemotherapy-induced fatigue, physical weakness, and psychological strain. Uncertainty about safe training post-surgery was common. Regular support from healthcare professionals was seen as essential for confidence and adherence.

* Corresponding author.
E-mail address: ta.maurer@uke.de (T. Maurer).
[1] Authors contributed equally

https://doi.org/10.1016/j.ygyno.2025.10.005

Discussion. Findings highlight the need for a personalized, flexible program tailored to ovarian cancer patients' needs. A blended digital approach combining self-guided elements with professional support could improve implementation, offering customized exercise routines, nutrition plans, and regular check-ins to facilitate patient-centered participation.

1. Background

Ovarian cancer ranks as the seventh most common cancer in women globally and is a leading cause of gynecological cancer-related deaths. Its asymptomatic progression and nonspecific initial symptoms, such as abdominal discomfort, bloating, and fatigue, contribute to delayed detection and a five-year survival rate of only 30–40 % [1,2]. Its aggressive treatment leads to significant physical and nutritional challenges, including malnutrition and muscle wasting as described in cancer cachexia [3,4]. Sustaining or enhancing patients' physical abilities and improving nutritional status is of utmost importance and could support survivors in leading autonomous lives, thereby boosting their overall health related quality of life (HRQoL). Notably, a higher HRQoL at the initiation of adjuvant chemotherapy has been associated with longer overall survival, emphasizing the need to address physical and nutritional well-being as early as possible in the treatment trajectory [5]. Exercise and nutritional interventions have shown promise in mitigating treatment-related side effects in other cancer populations, particularly in breast cancer, where structured programs have been associated with improved physical fitness, cancer-related fatigue (CRF), body composition, and survival outcomes [6,7]. Adherence to nutritional guidelines, such as the Mediterranean diet, has also been linked to improved HRQoL and reduced cancer mortality [8,9]. Despite these findings, the applicability of these interventions to ovarian cancer patients remains underexplored, as they face unique challenges, including advanced disease stages, complex treatment regimens, and higher baseline frailty. Observational studies have shown that higher post-diagnosis physical activity is associated with better HRQoL in ovarian cancer survivors [10,11]. However, post-treatment activity levels remain low in many women. In a cross-sectional cohort only about **19 %** of ovarian cancer survivors met recommended activity guidelines, implying that the vast majority remained insufficiently active [12]. **Longitudinal trajectories corroborate this pattern up to 24 months post-diagnosis** [13]**.** Emerging evidence suggests that tailored interventions initiated during active treatment may be particularly beneficial in reducing the progression of complications, such as cachexia. Feasibility studies, such as our own [14] or those by Mizrahi, et al. [15] and Newton, et al. [16] have demonstrated that moderate-intensity exercise and dietary counseling are safe and well-tolerated during chemotherapy, with promising trends in improving physical functioning, fatigue, and nutritional status. Despite these findings, randomized controlled trials (RCTs) investigating combined exercise and dietary interventions tailored specifically to ovarian cancer patients remain limited. Existing trials include the Lifestyle Intervention for Ovarian Cancer Enhanced Survival (LIVES) study, which focuses on post-treatment interventions [17], and the PADOVA study, which evaluates a combined exercise and nutrition intervention during chemotherapy [18]. The BENITA study is distinctive in its emphasis on an individualized, patient-centered approach that begins during first-line chemotherapy and extends into survivorship (ClinicalTrials.gov (NCT06250686)) [19]. The BENITA study consists of two phases. Phase I focused on developing and optimizing a combined exercise and nutrition intervention tailored to the specific needs of ovarian cancer patients undergoing first-line chemotherapy and beyond. To inform this process, semi-structured interviews were conducted with key stakeholders, including patients, survivors, nutritionists, physiotherapists, physicians, and health insurers. These interviews provided valuable insights into barriers, facilitators, and patient preferences, which were used to refine the program to ensure its feasibility and adaptability to the physical, emotional, and logistical challenges faced by this population. The primary aim of Phase I was to create an intervention that could be seamlessly integrated into clinical practice, addressing both the immediate side effects of treatment and promoting long-term health and quality of life. The ongoing Phase II assess the effectiveness of the optimized program in a multicenter randomized controlled trial (RCT), evaluating its impact on physical functioning, health-related quality of life (HRQoL) and treatment adherence. By combining qualitative and quantitative research methods, the BENITA study aims to develop and evaluate a patient-centered, evidence-based intervention that empowers ovarian cancer patients to adopt sustainable lifestyle changes during and after treatment. This paper presents the findings from Phase I.

2. Methods

2.1. Study design

A qualitative approach was adopted to explore barriers, facilitators, and opportunities for developing and implementing a personalized exercise and nutrition program. Semi-structured interviews were conducted by one of the authors (MB) with a range of relevant stakeholders, to ensure a comprehensive understanding of the needs of patients and healthcare providers.

2.2. Participants

The study incorporated two primary groups: patients and survivors, and health care providers, as well a representative from a national health insurance company. The selection of participants from these groups was guided by the principle of purposeful sampling. This approach entailed the strategic selection of participants with the objective of enhancing the study's findings. As Phase I prioritized qualitative development, the following were not systematically collected for patients and survivors: time since completion of first-line therapy, comprehensive demographic/pathological data, and a standardized physical activity instrument.

- Patients and Survivors ($N = 7$): Patients were recruited from the Department of Gynecology at the University Medical Center Hamburg-Eppendorf (UKE), survivors through the German Ovarian Cancer Association. The objective was to capture lived experiences, preferences, and expectations regarding supportive care.
- Health care providers ($N = 11$): Health care providers from the UKE Department of Gynecology and the Department for Women's Medicine at the Charité University Hospital in Berlin, including physicians (gynecologic oncologists, $N = 4$), nutritionists ($N = 3$), and physiotherapists (N = 4), were recruited to assess feasibility and identify implementation challenges.
- Insurance Representatives ($N = 1$): A representative from a prominent German statutory health insurance company with a large membership base was recruited to assess potential funding structures and policy direction.

2.3. Data collection and analysis

The interviews were guided by a structured framework covering themes such as exercise preferences, nutrition habits, logistical challenges, and emotional and physical barriers. To safeguard the confidentiality and privacy of the subjects, all interviews were anonymized, audio-recorded, and transcribed. Thematic analysis, following the methodology established by Braun and Clarke [20], was employed to identify key patterns and insights. Two researchers (TM, MB) independently coded all transcripts using an inductive–deductive approach consistent with Braun and Clarke. Discrepancies were resolved by consensus in regular team meetings. The analysis of the data was conducted in two distinct ways: first, an inductive approach was used to identify emergent themes and second, a deductive approach was employed to align the findings with the objectives of the study. Thematic saturation was defined a priori and considered achieved when no new codes or themes emerged in the final two interviews. Fig. 1 shows the topics that guided the semi-structured interviews.

3. Results

A comprehensive analysis revealed five central themes that emerged across all stakeholder groups: (1) motivation and individual preferences, (2) barriers and challenges, (3) safety and confidence in interventions, (4) information needs and guidance, and (5) feasibility and integration into daily life. To ensure the clarity and precision of the findings, quotations have been meticulously organized by topic, to facilitate a nuanced understanding of the variations in stakeholder perspectives as shown in Table 1.

4. Discussion

The results of Phase I of the BENITA study underscore the critical need for a patient-centered, adaptable strategy that incorporates exercise and nutrition for patients diagnosed with ovarian cancer. The challenges faced by this population are multifaceted, including advanced disease stages, chemotherapy-related side effects, aggressive surgery, and a high average age, which necessitate interventions that prioritize safety, accessibility, and individualization. Concurrently, meticulous intervention design is imperative to alleviate the burden on patients, ensuring high levels of motivation and providing continuous encouragement to foster long-term adherence.

4.1. Patient motivation

Motivation has been identified as a critical factor in adherence to exercise and nutrition regimens. Patients identified personal enjoyment, external encouragement, and goal achievement as pivotal motivators. Perceived health benefits were identified as strong motivational factors, with 99 % of cancer patients in a cross-sectional study by Mizrahi, et al. [15] reporting that their awareness of health improvements encouraged them to engage in physical activity. Previous studies have highlighted the role of group-based exercise programs in enhancing motivation, as they provide social support and a sense of belonging [21,22]. However, in contrast to these findings, our participants emphasized the importance of flexibility and individual autonomy in program participation. Rather than structured group activities, they preferred interventions that could be adapted to their personal schedules and physical condition.

4.2. Barriers and challenges to participation

Patients encounter substantial challenges, including chemotherapy-induced fatigue, dizziness, and psychological distress such as depression. Fatigue is a common symptom among cancer patients, described as a feeling of exhaustion that often limits their ability to participate in physical activity [23]. Psychological distress, including depression and anxiety, was frequently reported as a major barrier to engagement in physical activity [24]. Consequently, the implementation of adaptable, low-impact options for both the exercise and nutrition intervention such as ready-made snack options or exercises that can be carried out while lying down were identified as imperative to effectively address these barriers. The presence of tools/products (e.g., resistance band) can help to adapt an exercise program to the individuals needs and therefor to facilitate participation [25,26]. Similarly, effective cancer

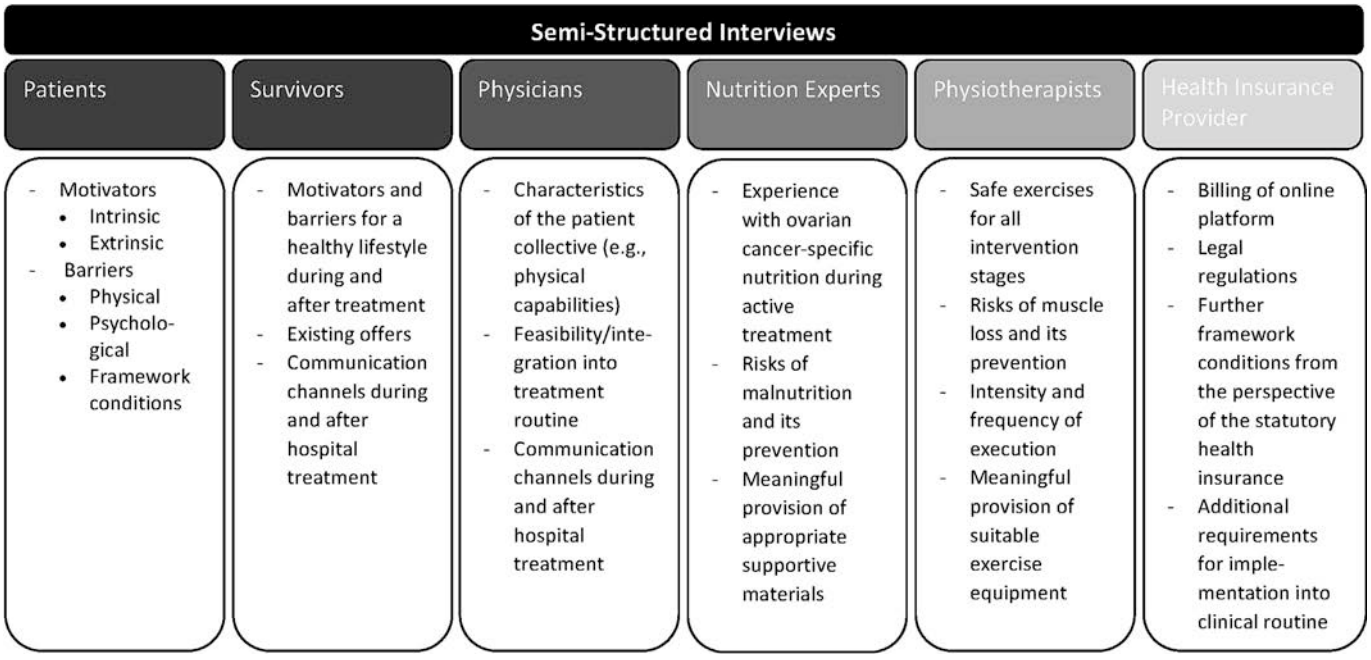

Fig. 1. Topics to guide semi-structured interviews.

Table 1
Themes, key insights and examplary quotes of all shareholders interviewes in phase I of the BENITA-Study.

Theme	Key Insights	Shareholder	Exemplary Quote
1. Motivation and Individual Preferences	Motivation stems from personal goals, external encouragement, and a sense of enjoyment in activities.	Patients	• I spend time outside with my dogs every day. We have the forest right at our doorstep, and I usually spend about two hours there. • I try to do some cycling exercises at home while lying down (laughs), as much as I can.
		Physicians	• I think it's definitely useful to ask patients what they enjoy doing because only then will they stick to it. • I think you need someone from the outside to say, 'Okay, today you have to exercise again.' Or you need a plan. And you simply need that motivation where someone consistently follows up.
		Nutritionists	• And sometimes it's actually the family members I end up advising, because the patient says, 'Right now, I have so many things going on that nutrition isn't my top priority, especially since what I might still enjoy is also being taken away from me. • I believe that most women undergoing treatment, including therapy, don't need additional motivation because they want to fight. They want to make changes, they want to transform their lives.
		Physio-therapists	• It should really be about empowering people to feel confident and comfortable with movement. • I like to ask, 'Is there anything you enjoyed doing as a child, like sports?' […] I try to build on that.
2. Barriers and Challenges	Physical limitations, fatigue, and psychological barriers hinder program adherence.	Patients	• You're just exhausted and, of course, not very fit […] I've been outside a few times, even just around the block, but it's really hard. I get dizzy, and then I start sweating. • I reacted very sensitively to the chemotherapies and medications. That means I was basically knocked out for a week.
		Physicians	• Because of such a large incision—the abdomen is completely opened—they have difficulties with anything involving abdominal strain. • It's really exhausting. At first, [from a patient's perspective:] I might be highly motivated, but eventually, I realize it's too much for me. [from a physician's perspective] That's why I think this at-home concept is really great.
		Nutritionists	• We often encounter digestive issues, diarrhea, and sometimes constipation. Bloating is also a common problem • Most of the time, I only get involved when, as they say, the damage has already been done
		Physio-therapists	• Why should movement or physical activity cause harm? Of course, it needs to be adapted. • You can't forget that sometimes patients are also depressed, and then they often just stay in bed and simply don't want to move.
3. Safety and Confidence in Interventions	Both trust in professional guidance and a sense of safety are essential for engagement. Knowledge about ovarian cancer and its treatment are necessary to ensure safety	Patients	• No, not for me, because we have this scar. We have the abdominal incision. We don't know—or at least I don't know—if we're even allowed to use our abdominal muscle groups or not. • Yes, eat healthy, five a day, blah blah blah, no matter if I had constipation or diarrhea—it wasn't individualized.
		Physicians	• Especially when they've just had surgery and then come to our day clinic, it becomes clear over time which days they feel good and which days they feel bad after chemo. Then you can try to identify those days and perhaps create a fixed plan, of course, tailored individually. • After major surgery, they are not allowed to lift anything heavy for at least six weeks—nothing over five kilograms. After that, they can slowly start rebuilding muscle. What I've occasionally seen is that if they start too early, they sometimes end up with a hernia.
		Nutritionists	• And what really motivates is a conversation about what nutrition can ultimately do—what different foods can change in the body • We don't prescribe diets in the strict sense; instead, we always talk to patients individually, tailoring our approach to their specific nutritional situation. That means we start with a nutrition log or a 24-h recall to first assess where the patient currently stands
		Physio-therapists	• After a major abdominal surgery, deep abdominal breathing exercises are, of course, essential. Either focusing solely on breathing or combining it with pelvic movements, which help release and enhance the process further. We combine both. Movements in the lower abdomen and lower back area are also very important for patients because both, deep abdominal breathing and pelvic movements, additionally stimulate bowel activity. • All movements should be carried out gently, based on how the body feels—never pushing into pain, only to the point of slight discomfort
4. Information Needs and Guidance	Clear and accessible educational materials are vital for empowering patients.	Patients	• It's really great when someone says, 'At this and that place, we have contacts who know a bit about this. • Then, well, I've been to rehab two or three times. Of course, they cook healthy meals there, and you also get guidance and instructions. I always take quite a bit of that back home with me.
		Physicians	• And yes, many, many patients have questions about nutrition, like: Which additional vitamins or supplements can I take? What should I avoid eating? And especially, what about sugar? • I think everyone should receive lifestyle counseling, including nutritional advice. And it should happen right from the start, without requiring any specific criteria to be met.
		Nutritionists	• There is a website called 'What to Eat When You Have Cancer,' created by this group—colleagues who are 150 % experts in the field. I am extremely grateful for this site because then it's not just me, Büscher [author], saying, 'A keto diet doesn't make

Table 1 (*continued*)

Theme	Key Insights	Shareholder	Exemplary Quote
			sense,' or, 'This or that doesn't make sense,' or '[a specific nutrient supplement] and other nutrient supplements don't make sense.' It's a fantastic site, even including recipes."
		Physio-therapists	• Sometimes it's enough to correct the person just once. Then the patient knows, for example: This is how it's done. I think it's also more comfortable for them. They feel a bit more confident that they're doing it correctly • I think it's great if it's done well. [use of digital support] For many, it's very practical."
5. Practicality and Integration into Daily Life	Programs must seamlessly fit into patients' daily routines to ensure long-term adherence and be adjusted to patients' needs during treatment	Patients	• I do my morning exercises using some YouTube videos, whether it's Gabi Fastner, Fit with Anna, or others. • I cook every day. And my daughter, even though she doesn't live with me, always appreciates it when grandma cooks for her every few days
		Physicians	• Most patients tend to feel quite weak during the week after chemotherapy. So, it might be helpful to tailor something to fit their cycle • This long-term concept simply has to be in place. I need to be able to integrate it into my daily life, ideally with minimal scheduling. And there are women who can motivate themselves. I think you have to assess that as well. Is it someone who will follow a training plan on their own, or is it someone I need to call three times a week and say, 'Okay, now it's time'?
		Nutritionists	• Please, simple recipes. Nothing fancy, nothing unusual where people need to buy spices they don't already have at home. Just really simple, quick recipes • I've also looked into which restaurants in our area offer takeout. What can people pick up, and how can they combine it with something else to make a balanced meal? I always approach this individually, depending on who I'm working with.
		Physio-therapists	• If someone has the opportunity to go to a physiotherapy practice, or for a home visit, then of course it's better if the person can also do it at home, right? It certainly saves a lot of time and the travel. And for some, especially older women, all of this can be quite exhausting." • And anything that gives them a sense of normality, like regular housework, is good.
6. Reimburse-ment & Regulation	The framework for prescribable digital interventions provides a structured reimbursement path, but its strict requirements limit flexibility.	Health Insurance Provider	• A few years ago, lawmakers introduced the so-called DiGAs (digital health application framework). This means that if an app meets the DiGA requirements, it can be included in the DiGA directory. Then, all health insurance providers are required to cover the costs when prescribed by a doctor.
7. Legal requirements	Regulatory restrictions, such as those imposed by the Innovation Fund, limit the development of new digital solutions, forcing reliance on pre-existing products rather than fostering innovation.	Health Insurance Provider	• The development costs for the app cannot be covered by the fund. […] Products, such as medical devices, cannot be developed within the framework of Innovation Fund funding.
8. Engagement and Adherence	Long-term engagement with digital tools is a major challenge—without sustained motivation, many users abandon apps after initial use, highlighting the need for engagement strategies.	Health Insurance Provider	• The app is downloaded, one or two modules are completed, and then it just sits idle. […] It is important that usage is sustainable and supports lifestyle changes.
9. Implemen-tation	Blended therapy models, which combine digital tools with human support, enhance patient acceptance and are more effective than purely digital approaches.	Health Insurance Provider	• A blended therapy, where support is still available, is perceived as more pleasant by patients.

symptom management strategies were a significant facilitator of physical activity participation [27].

4.3. Safety concerns

Many patients fear injury from physical activity and exercise, particularly after surgery. Kinesiophobia, an excessive irrational and debilitating fear of movement or physical activity, was a major barrier to physical activity engagement among cancer patients, who were concerned about falls and injuries [27]. Pain and injury were also common perceived risks across different cancer types [28]. To address these concerns, clear professional guidance from highly trained exercise and nutrition experts, as well as the implementation of structured exercise plans, is essential to build confidence and ensure safe participation. Including exercise science professionals in healthcare teams has been shown to provide a structured and safe approach to physical activity participation [29]. However, healthcare providers in Europe and the US reported that time pressure in clinics limited their ability to support and guide cancer patients in their physical activity engagement [30].

4.4. Need for guidance

Ongoing expert support has been identified as playing an important role in adherence to the program. Regular implementation of check-ins, conducted via video calls or in-person consultations, has been suggested to improve motivation and safety. Limited support and guidance from clinicians were frequently cited as barriers to physical activity engagement [27]. Moreover, cancer patients preferred receiving physical activity information from oncologists, followed by physiotherapists and nurses [31]. Including exercise science professionals in healthcare teams has been found to ensure proper education and guidance [29].

4.5. Practicality and integration into daily life

Patients have indicated a preference for interventions that require minimal scheduling and integrate easily into daily routines. Time pressure due to work commitments and medical appointments was identified as a major factor limiting physical activity participation [30]. Consequently, nutritional and exercise strategies characterized by simplicity and adaptability have demonstrated efficacy in fostering long-

term adherence [32]. The availability of tailored, home-based physical activity programs was identified as a strong facilitator of sustained participation [33]. Additionally, structured exercise and nutrition plans that seamlessly fit into patients' routines were key to maintaining engagement [34].

4.6. Healthcare providers' insights into implementation

In Germany, the new framework for prescribable digital interventions delineates a structured reimbursement pathway for digital health applications. However, it imposes stringent regulatory requirements. Selective contracts with individual insurers offer an alternative but add complexity and administrative burden [30]. Moreover, large providers of healthcare research funding, such as the German Innovation Fund, do not include the development of new medical products, thus constraining funding opportunities for innovative solutions. Consequently, reliance on existing digital tools is necessary rather than creating tailored interventions. However, many users abandon apps after initial use, highlighting the need for behavioral nudging and blended support models [32]. Digital interventions must be designed with long-term engagement strategies in mind, as initial enthusiasm often fades [34].

4.7. Comparison to other lifestyle interventions in ovarian cancer

To date, two randomized controlled trials have tested the effects of an exercise and nutrition program on health outcomes in ovarian cancer patients [17,35]. Phase I of the BENITA study identified both similarities and differences compared to these trials, which could influence the effectiveness of such programs. The LIVES study focused on an intervention after primary treatment to enhance ovarian cancer patients' survival. In contrast, PADOVA and BENITA implement their interventions during chemotherapy, aiming to counteract cancer cachexia early, a condition that often develops during primary treatment and becomes refractory if left unaddressed. PADOVA delivers its intervention in-person within a hospital setting, ensuring direct supervision. LIVES, by contrast, relies on remote coaching through telephone and email. Findings from BENITA phase I indicate that a blended approach could address both flexibility and structured support needs by integrating a digital application with video-guided exercises, nutrition guidance, and recipe suggestions, while also offering scheduled video consultations to provide expert support. PADOVA follows a highly standardized program, ensuring consistency but leaving little room for personalization. LIVES promotes self-guided behavioral coaching, granting patients more autonomy but with less structured support. Phase I of BENITA suggests that a hybrid model, combining structured guidance with personalized exercise and nutrition plans, could enhance adherence while addressing individual needs. Based on these results, we modified the intervention tested in the feasibility study [14] for the randomized controlled trial (Phase II of the BENITA study) [19].

4.8. Strength and limitations

This study has several merits. First, the qualitative approach, using semi-structured interviews, enabled an in-depth understanding of the needs, barriers, and facilitators related to an exercise and nutrition intervention for ovarian cancer patients. The inclusion of multiple stakeholder perspectives (patients, healthcare providers, and insurance representatives) ensured a comprehensive evaluation of real-world feasibility and implementation challenges.

A further strength of the study is its emphasis on co-developing a tailored and adaptable intervention, which aligns with patient-centered care principles. The iterative optimization of the program based on participant feedback enhances its potential effectiveness and long-term feasibility. Additionally, the study contributes to the limited body of research on lifestyle interventions for ovarian cancer patients.

Despite these strengths, several limitations must be acknowledged. Phase I of the BENITA study was conducted mainly in Hamburg, which may limit the generalizability of findings to other regions with different healthcare structures, resource availability, or patient populations. Although we deliberately focused on stakeholders in gynecological oncology, the absence of primary care and other medical specialties may have limited our coverage of factors such as comorbidity management, or polypharmacy. Additionally, the relatively small sample size, particularly for the subgroup of insurance representatives, may not fully capture all relevant perspectives on reimbursement and implementation. Although thematic saturation was achieved, a broader sample with a diversity of patient experiences, including more diverse socioeconomic and geographic backgrounds, could have provided further insights.

5. Conclusion

Phase I of the BENITA study offers significant insights into the specific needs and challenges of ovarian cancer patients undergoing chemotherapy. Based on these insights, we adapted the intervention to be highly personalized, and seamlessly integrated into daily life to ensure long-term adherence and effectiveness. We incorporated an app-supported platform that provides customized exercise regimens and nutritional guidance to address limitations faced by patients who are unable to attend in-person sessions due to physical or logistical constraints. Patients can access exercise regimens and nutritional counsel from their home, which is especially important for those grappling with fatigue or physical limitations. We added weekly or biweekly video calls for regular expert counseling, providing personalized support that can enhance program adherence and help adjust plans according to the patient's changing needs and complemented counseling with app-based educational content to support self-management between contacts and enable training at self-selected times. In addition, we introduced very low-threshold exercise options (e.g., bed−/chair-based protocols) to accommodate fatigue and fluctuating capacity. We trained physiotherapists and dietitians in ovarian cancer specific considerations to address safety and build trust.

Phase II of the BENITA study evaluates the effectiveness of the app-based exercise and nutrition program under non-standardized conditions of clinical routine in a multicenter randomized controlled trial across seven German study centers. Results will be reported once available.

CRediT authorship contribution statement

Tabea Maurer: Writing – review & editing, Writing – original draft, Visualization, Project administration, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Matthias H. Belau:** Writing – review & editing, Investigation, Formal analysis, Conceptualization. **Birgit-Christiane Zyriax:** Writing – review & editing, Funding acquisition, Conceptualization. **Götz Welsch:** Writing – review & editing, Funding acquisition, Conceptualization. **Bettina Jagemann:** Writing – review & editing, Conceptualization. **Jenny Chang-Claude:** Writing – review & editing, Funding acquisition, Conceptualization. **Anne Daubmann:** Writing – review & editing. **Anika Buchholz:** Writing – review & editing. **Alexander Fierenz:** Writing – review & editing. **Karin Glismann:** Writing – review & editing, Conceptualization. **Annika Moeller:** Writing – review & editing, Conceptualization. **Jalid Sehouli:** Writing – review & editing. **Hannah Woopen:** Writing – review & editing. **Pauline Wimberger:** Writing – review & editing. **Philipp Harter:** Writing – review & editing. **Sabrina Kaiser:** Writing – review & editing. **Nicolai Maass:** Writing – review & editing. **Marion Kiechle:** Writing – review & editing. **Tobias Engler:** Writing – review & editing. **Barbara Schmalfeldt:** Writing – review & editing, Supervision, Funding acquisition. **Holger Schulz:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization.

Ethics approval and consent to participate

This study was approved by the local psychological ethics committee at the Center for Psychosocial Medicine (LPEK), University Medical Center Hamburg-Eppendorf (Reference No. LPEK-0602). Written informed consent was obtained from all participants prior to the interviews.

Funding

The study is funded by the "G-BA (Federal Joint Committee) Innovationsfonds" (01VSF22031). The funding organization does not have any influence on study design, collection, management, analysis, interpretation of data, writing, or publication process.

Declaration of competing interest

The authors declare that they have no competing interests.

Acknowledgements

We thank all individuals who participated in the interviews for sharing their experiences and perspectives. We are especially grateful to the women affected by ovarian cancer, both patients and survivors, whose openness and trust made this study possible. Their insights were essential in shaping a program that reflects real-world needs. We also thank the healthcare professionals and the health insurance representative for their valuable contributions, as well as the clinical teams at all participating sites for their support.

Data availability

The datasets generated and analyzed during the current study are not publicly available due to privacy restrictions, but anonymized excerpts are available from the corresponding author upon reasonable request.

References

[1] H. Sung, et al., Global Cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries, CA Cancer J. Clin. 71 (2021) 209–249.
[2] B.M. Reid, J.B. Permuth, T.A. Sellers, Epidemiology of ovarian cancer: a review, Cancer Biol. Med. 14 (2017) 9–32.
[3] K.C. Fearon, M.D. Barber, A.G. Moses, The cancer cachexia syndrome, Surg. Oncol. Clin. N. Am. 10 (2001) 109–126.
[4] I.J. Rutten, et al., Loss of skeletal muscle during neoadjuvant chemotherapy is related to decreased survival in ovarian cancer patients, J. Cachexia. Sarcopenia Muscle 7 (2016) 458–466.
[5] L. Wenzel, et al., Quality of life and adverse events: prognostic relationships in long-term ovarian cancer survival, J. Natl. Cancer Inst. 113 (2021) 1369–1378.
[6] M.L. McNeely, et al., Effects of exercise on breast cancer patients and survivors: a systematic review and meta-analysis, CMAJ 175 (2006) 34–41.
[7] D. Schmid, M.F. Leitzmann, Association between physical activity and mortality among breast cancer and colorectal cancer survivors: a systematic review and meta-analysis, Ann. Oncol. 25 (2014) 1293–1311.
[8] C.M. Blanchard, K.S. Courneya, K. Stein, Cancer survivors' adherence to lifestyle behavior recommendations and associations with health-related quality of life: results from the American Cancer Society's SCS-II, J. Clin. Oncol. 26 (2008) 2198–2204.
[9] M.L. McCullough, et al., Following cancer prevention guidelines reduces risk of cancer, cardiovascular disease, and all-cause mortality, Cancer Epidemiol. Biomarkers Prev. 20 (2011) 1089–1097.
[10] C. Stevinson, et al., Associations between physical activity and quality of life in ovarian cancer survivors, Gynecol. Oncol. 106 (2007) 244–250.
[11] A. Smits, et al., Body mass index, physical activity and quality of life of ovarian cancer survivors: time to get moving? Gynecol. Oncol. 139 (2015) 148–154.
[12] D. Mizrahi, et al., Quantifying physical activity and the associated barriers for women with ovarian cancer, Int. J. Gynecol. Cancer 25 (2015) 577–583.
[13] S. Fleming, et al., Physical activity trajectories following gynecological cancer: results from a prospective, longitudinal cohort study, Int. J. Gynecol. Cancer 30 (2020) 1784–1790.
[14] T. Maurer, et al., An exercise and nutrition intervention for ovarian cancer patients during and after first-line chemotherapy (BENITA study): a randomized controlled pilot trial, Int. J. Gynecol. Cancer 30 (2020) 541–545.
[15] D. Mizrahi, et al., An exercise intervention during chemotherapy for women with recurrent ovarian Cancer: a feasibility study, Int. J. Gynecol. Cancer 25 (2015) 985–992.
[16] M.J. Newton, et al., Safety, feasibility and effects of an individualised walking intervention for women undergoing chemotherapy for ovarian cancer: a pilot study, BMC Cancer 11 (2011) 389.
[17] C.A. Thomson, et al., A randomized trial of diet and physical activity in women treated for stage II-IV ovarian cancer: rationale and design of the lifestyle intervention for ovarian Cancer enhanced survival (LIVES): an NRG oncology/gynecologic oncology group (GOG-225) study, Contemp. Clin. Trials 49 (2016) 181–189.
[18] M.F. Kenkhuis, et al., Effects of a combined exercise and dietary intervention on body composition, physical functioning and fatigue in patients with ovarian cancer: results of the PADOVA trial, Br. J. Cancer 131 (2024) 101–109.
[19] T. Maurer, et al., Study protocol of an exercise and nutrition intervention for ovarian cancer patients during and after first-line chemotherapy (BENITA) - a randomized controlled trial, BMC Cancer 24 (2024) 1379.
[20] V. Braun, V. Clarke, Using thematic analysis in psychology, Qual. Res. Psychol. 3 (2006) 77–101.
[21] C. Owusu, et al., Perspective of older African-American and non-Hispanic white breast cancer survivors from diverse socioeconomic backgrounds toward physical activity: a qualitative study, J. Geriatr. Oncol. 9 (2018) 235–242.
[22] L.M. Jones, L.L. Reinhoudt, F. Hilverda, C. Rutjes, S.C. Hayes, Using the integrative model of behavioral prediction to understand female breast cancer survivors' barriers and facilitators for adherence to a community-based group-exercise program, Semin. Oncol. Nurs. 36 (2020), 151071.
[23] V. Narayanan, C. Koshy, Fatigue in cancer: a review of literature, Indian J. Palliat. Care 15 (2009) 19–25.
[24] A.M. Husebø, B. Karlsen, H. Allan, J.A. Søreide, E. Bru, Factors perceived to influence exercise adherence in women with breast cancer participating in an exercise programme during adjuvant chemotherapy: a focus group study, J. Clin. Nurs. 24 (2015) 500–510.
[25] E. Karlsson, O. Dahl, E. Rydwik, M. Nygren-Bonnier, M. Bergenmar, Older patients' attitudes towards, and perceptions of, preoperative physical activity and exercise prior to colorectal cancer surgery-a gap between awareness and action, Support Care Cancer 28 (2020) 3945–3953.
[26] F. Swan, H. Chen, C.C. Forbes, M.J. Johnson, M. Lind, CANcer BEhavioural nutrition and exercise feasibility trial (CanBenefit); phase I qualitative interview findings, J. Geriatr. Oncol. 12 (2021) 641–648.
[27] J. Frikkel, et al., Fatigue, barriers to physical activity and predictors for motivation to exercise in advanced cancer patients, BMC Palliat. Care 19 (2020) 43.
[28] K.H. Karvinen, J. Vallance, P.R. Walker, Newly diagnosed lung cancer patients' preferences for and beliefs about physical activity prior to chemotherapy, Psychol. Health Med. 21 (2016) 593–600.
[29] C. Ijsbrandy, W.H. van Harten, W.R. Gerritsen, R.P.M.G. Hermens, P.B. Ottevanger, Healthcare professionals' perspectives of barriers and facilitators in implementing physical activity programmes delivered to cancer survivors in a shared-care model: a qualitative study, Support Care Cancer 28 (2020) 3429–3440.
[30] A. Smaradottir, A.L. Smith, A.J. Borgert, K.R. Oettel, Are we on the same page? Patient and provider perceptions about exercise in cancer care: a focus group study, J. Natl. Compr. Cancer Netw. 15 (2017) 588–594.
[31] J. Blaney, et al., The Cancer rehabilitation journey: barriers to and facilitators of exercise among patients with cancer-related fatigue, Phys. Ther. 90 (2010) 1135–1147.
[32] M. Cantwell, et al., Physical activity across the cancer journey: experiences and recommendations from people living with and beyond cancer, Phys. Ther. 100 (2020) 575–585.
[33] L.E. Hackshaw-McGeagh, et al., Acceptability of dietary and physical activity lifestyle modification for men following radiotherapy or radical prostatectomy for localised prostate cancer: a qualitative investigation, BMC Urol. 17 (2017) 94.
[34] H.E.T. Mikkelsen, et al., Cancer patients' long-term experiences of participating in a comprehensive lifestyle intervention study while receiving chemotherapy, Cancer Nurs. 43 (2020) 60–68.
[35] S. Stelten, et al., Rationale and study protocol of the physical activity and dietary intervention in women with OVArian cancer (PADOVA) study: a randomised controlled trial to evaluate effectiveness of a tailored exercise and dietary intervention on body composition, physical function and fatigue in women with ovarian cancer undergoing chemotherapy, BMJ Open 10 (2020), e036854.