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ORIGINAL ARTICLE

Barriers and Facilitators of Surgical Prehabilitation Adherence from the Patient Perspective: a Mixed Method Study

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Abstract

Background Adherence to prehabilitation is crucial for optimal benefit, but reasons for low adherence to home-based programs remain unexplored. Our aim was to identify and explore barriers and facilitators to prehabilitation adherence among patients undergoing abdominal surgery.

Methods Nested in a single-center randomized controlled trial on prehabilitation (Perioperative Optimization With Enhanced Recovery (POWER)), this study had an explanatory sequential design with a connect integration. Patients randomized to the intervention arm were included in the quantitative analysis, and a subset of them was invited for a semi-structured interview. The exposure was the frequency of barriers to physical activity and healthy eating, and the outcome was adherence to those components of prehabilitation. Logistic or linear regression was used as appropriate.

Results Among 133 participants in the intervention arm, 116 (87.2%) completed the initial survey ((56.9% women, median age 61 years old (IQR 49.0; 69.4)). The most frequent barriers to exercise and healthy eating were medical issues (59%) and lack of motivation (31%), respectively. There was no significant association between the barriers to physical activity score and adherence to this component of the program (OR 0.89, 95% CI 0.78–1.02, p=0.09). Higher barriers to healthy eating scores were associated with lower Mediterranean diet scores pre- and post-intervention (coef.: −0.32, 95% CI: −0.49; −0.15, p<0.001; and coef.: −0.27, 95% CI: −0.47; −0.07, p=0.01, respectively). Interviews with 15 participants revealed that participating in prehabilitation was a motivator for healthy eating and exercising through goal setting, time-efficient workouts, and promoting self-efficacy.

Conclusions We identified key barriers to be addressed and facilitators to be leveraged in future prehabilitation programs.

Trial Registration NCT04504266

Keywords Prehabilitation · Exercise · Nutrition · Surgery

Introduction

Considering the psychosocial and financial burden of surgical complications, efforts to reduce their risk are critically needed. Growing evidence suggests that prehabilitation may reduce postoperative complications and lead to faster recovery among patients undergoing gastrointestinal surgery.[1-6] Despite being a potentially powerful tool to potentialize the effect of Enhanced Recovery Programs (ERP), which have been shown to be cost-effective by reducing complication rates and length of stay[7-9], data supporting the inclusion of prehab in ERPs are still weak. An Achilles' heel of prehabilitation studies may be the natural human tendency to resist lifestyle changes, leading to suboptimal adherence. A systematic review showed that there is opportunity for

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improvement in the degree of adherence to prehabilitation, which is about 70% for home-based programs among patients undergoing major intra-abdominal cancer surgery, even in the context of randomized controlled trials.[10,11]

A Canadian study on patient preferences for prehabilitation revealed that most patients are not interested in attending weekly exercise sessions and prefer home-based activities.[12] Thus, an interactive home-based, app-delivered prehab program may be more appealing to patients than traditional intensive in-person programs. Patients also emphasize flexibility as an essential aspect to facilitate prehab adherence.[13] To cater to those preferences, we have developed home-based prehabilitation programs that can be tailored to individuals' preferred activity levels. Despite that, adherence has been relatively low (34–56%).[4,14,15]

The reasons for low adherence despite the convenience and flexibility of these home-based programs have not been explored. Thus, this study aims to (i) identify barriers to prehab adherence, (ii) assess the association between those barriers and adherence to the physical activity and nutrition components of the prehab program, and (iii) explore how barriers and facilitators to physical activity and healthy eating affect participation in the prehab program. We hypothesized that significant barriers to prehabilitation exist, and they limit our ability to test its efficacy in reducing complication rates.

Methods

Nested in an ongoing randomized controlled trial ("Perioperative Optimization With Enhanced Recovery", or "POWER" study, NCT04504266), this study used a mixed method explanatory sequential design (collection and analysis of the main quantitative outcomes proceeded the collection and analysis of qualitative data). Integration of data occurred through connecting (quantitative data informed sampling of participants for the qualitative part of the study) and at the reporting level (eFigure 1).[16] This study was approved by the Stanford University Institutional Review Board and followed the STROBE and COREQ reporting guidelines.

Study Population

For the quantitative component, we used survey response data from patients randomized to the intervention arm (prehabilitation arm). For the qualitative component, we individually interviewed a subset of those patients. All participants were recruited at Stanford Health Care. Eligibility criteria to participate in the POWER study were as follows: major gastrointestinal surgery scheduled for 3 weeks or more from enrollment, ability to maintain oral nutrition, ability to perform at least low-intensity physical activity (e.g., walking at a casual pace, hip bridges, arm circles), access to a smartphone, and good English comprehension. Through block randomization, participants were randomized to either control or intervention (allocation ratio of 1:1). All patients randomized to the intervention arm from August 2020 to August 2022 were included in the quantitative analysis.

For the qualitative component of this study, we recruited patients through voluntary sampling from a pool of participants who had completed all the study surveys (enrollment, preoperative, 30-day postoperative, 60-day postoperative, and 180-day postoperative). We prioritized recruitment of patients with highest and lowest adherence to prehabilitation. From July 2022 to August 2022, we sent e-mails to those POWER study participants inviting them for a 20-min virtual semi-structured interview. Interviewees received a $25 gift card as compensation for their time.

Intervention

In the intervention arm of the POWER study, participants receive access to a mobile app that guides them through the prehab program. In the app, they receive reminders to watch instructional videos on strength exercises and can find tips for healthy eating, emphasizing the Mediterranean diet. There are four levels of strength exercises, and the research team adjusts the level according to the patient's feedback. We provided patients with a Garmin Vivosmart 4, which tracks their step count and is synced to the app. The research team helps patients set up their watch and app and monitors their activity every week, checking in with those who have suboptimal activity to help them achieve their exercise and nutrition goals.

The control arm receives a handout encouraging them to exercise three to five times a week and to follow the Mediterranean diet. This arm does not receive the wearable device nor has access to the mobile app.

Quantitative Data Collection and Outcome Measures

Upon enrollment in the POWER study, participants completed a questionnaire regarding barriers to physical activity and healthy eating (eFigure 2).[17] The answers were treated as binary for analysis ("not a barrier"/"a somewhat important or very important barrier").

Adherence to the exercise component of the program was defined as completing at least three strength workouts per week or reaching their daily average step goal (3000 steps/day if frail or 5000 steps/day if non-frail).

Diet quality during the intervention period was assessed through the Mediterranean Diet Assessment Tool, a 14-item validated questionnaire.[18] Participants completed this assessment upon enrollment and in the week prior to

surgery. The Mediterranean Diet Assessment Tool score was treated as a continuous variable, without a specific threshold for adherence to the diet component of the program.

Qualitative Data Collection

Patients who completed all the questionnaires were contacted via e-mail and invited to participate in a 1:1 semi-structured 20- to 30-min-long interview. A member of the research team (S.E.C.) who was not involved with the quantitative data collection or analysis conducted the interviews, avoiding potential interviewer bias. In addition, she received proper training regarding the interview process, and the participants did not know her prior to the interview, allowing them to feel comfortable providing candid feedback about the program. No field notes were made during the interviews.

Quantitative data informed sampling and the development of the interview guide, which aimed to investigate barriers and facilitators encountered during the prehabilitation period (interview guide available in eFigure 3). The interviews were conducted individually via a secure teleconferencing platform, and participants provided verbal and written consent for audio recording. The recordings were transcribed verbatim using TranscribeMe! via their HIPAA-compliant transcription service, and the transcripts were not returned to the participants for comments.

Statistical Analysis

Baseline demographic data and frequency of barriers were reported with descriptive statistics. We used *t*-test to compare the frequency of barriers between men and women and between older adults (65 years or older) and younger adults.

We used linear regression to determine whether gender and older age were associated with scores on the barriers to healthy eating and barriers to physical activity measures and whether the barriers to healthy eating score was associated with the Mediterranean Diet Assessment score. We used logistic regression to assess whether adherence to the exercise component of the program differed by gender, older adult status, or barrier to physical activity scores. We used a paired *t*-test to compare pre- and post-intervention Mediterranean Diet Assessment scores. A two-sided *p*-value of 0.05 or less was considered significant. Analyses were performed using STATA Release 17 (College Station, TX: StataCorp LLC), and graphs were generated using Microsoft Excel (Redmond, WA: Microsoft Corporation) and Tableau (Seattle, WA: Tableau Software, LLC).

Qualitative Data Analysis

Qualitative data was analyzed from August 2022 to September 2022. Five researchers (C.S.K., Y.L., C.J.A., S.E.C., and C.K.) coded the transcripts individually and inductively. The researchers discussed the codes to develop a final codebook and discussed disagreements until reaching consensus and agreeing that thematic saturation was reached. We analyzed transcripts and their codes using Dedoose Version 9.0.17 (Los Angeles, CA: SocioCultural Research Consultants, LLC).

Quantitative and Qualitative Data Integration

Quantitative and qualitative data were integrated and interpreted using the Theoretical Domains Framework, which synthesizes 33 behavior change theories.[19] In this framework, there are three main components to behavior, capability, motivation, and opportunity, and 14 constructs are clustered in each of these domains. We correlated the survey responses with the themes that emerged from the interviews and mapped them to the Theoretical Domains Framework (eFigure 1).

Results

As of August 30, 2022, 133 participants were enrolled in the POWER study and had been randomized to the intervention arm. Of those, 116 completed the initial survey (87.2% response rate). Baseline demographics are shown in Table 1. Most patients were women (56.9%), had a median age of 61 years (IQR 49.0; 69.4), and were enrolled in the program for a median of 43.5 days (IQR 31; 69) prior to surgery.

Quantitative Results

Barriers to Physical Activity and Adherence to the Exercise Component of Prehabilitation

Medical issues, pain, and lack of motivation were the most frequently reported barriers to physical activity (Fig. 1). Women reported more barriers to physical activity compared to men (Fig. 1), with mean scores of 3.5 (SD 3.2) and 2.4 (SD 2.2) (p=0.04). There was no difference in scores between older (mean score 2.8, SD 0.4) and younger adults (mean score 3.1, SD 0.3), p=0.61.

Overall adherence to the exercise component of the program was 56.9% (66/116). More men adhered to the exercise recommendations than women (68% vs. 48%,

Table 1 Patients' demographics

Characteristic	Value
Gender, *n* (%)	
Female	66 (56.9)
Male	50 (43.1)
Age, median (IQR) (y)	61.0 (49.0; 69.4)
Age category (y)	
<35	5 (4.3)
35–44	16 (13.8)
45–54	20 (17.2)
55–64	32 (27.6)
≥65	43 (37.1)
Period enrolled in prehab, median (IQR) (days)	43.5 (31; 69)
BMI, mean (SD) (kg/cm^2)	27.9 (6.4)
BMI category (kg/cm^2)	
<18.5	2 (1.7)
18.5–24.9	33 (28.4)
25–29.9	39 (33.6)
≥30	42 (36.2)
Race/ethnicity	
White	84 (72.4)
Black	4 (3.4)
Asian	9 (7.7)
Hispanic or Latino	14 (12.1)
Other or not reported	9 (7.8)

p=0.04), and a higher proportion of older adults adhered to the program compared to younger adults (67% vs. 51%, *p*=0.08).

There was no significant association between the barriers to physical activity score and adherence to this component of the program adjusting for gender and older adult status (OR 0.91, 95% CI 0.79; 1.04, *p*= 0.187).

Barriers to Healthy Eating and Adherence to the Mediterranean Diet

Medical issues, lack of motivation, and lack of information were the most frequently reported barriers to healthy eating (Fig. 2). There was no significant difference between men and women regarding barriers to healthy eating, with mean scores of 2.2 (SD 2.6) and 1.9 (SD 2.5), *p*=0.46. However, older adults reported fewer barriers to healthy eating than younger adults, with mean scores of 1.1 (SD 1.6) and 2.6 (SD 0.3), *p*=0.004.

Adherence to the Mediterranean diet was measured with pre- and post-intervention Mediterranean Diet Assessment Tool scores. Of the 116 participants, 98 (84.5%) completed the assessment at both timepoints. The Mediterranean diet score ranges from 0 to 14, with higher scores indicating greater adherence to a Mediterranean diet pattern. The mean score upon enrollment was

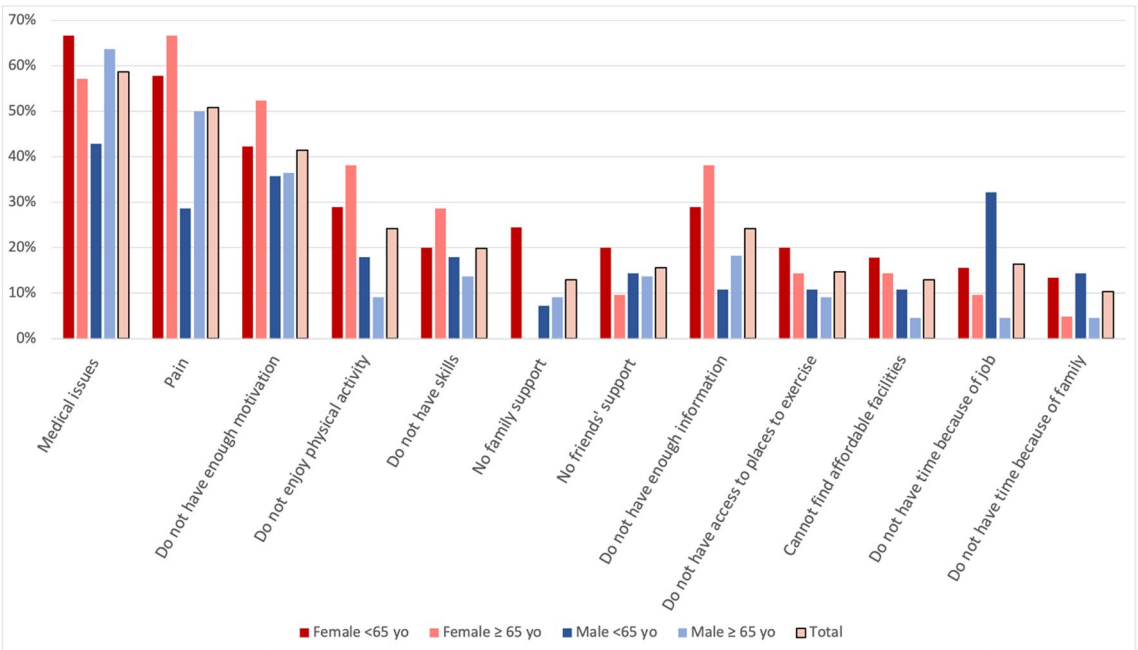

Fig. 1 Barriers to physical activity according to gender and age

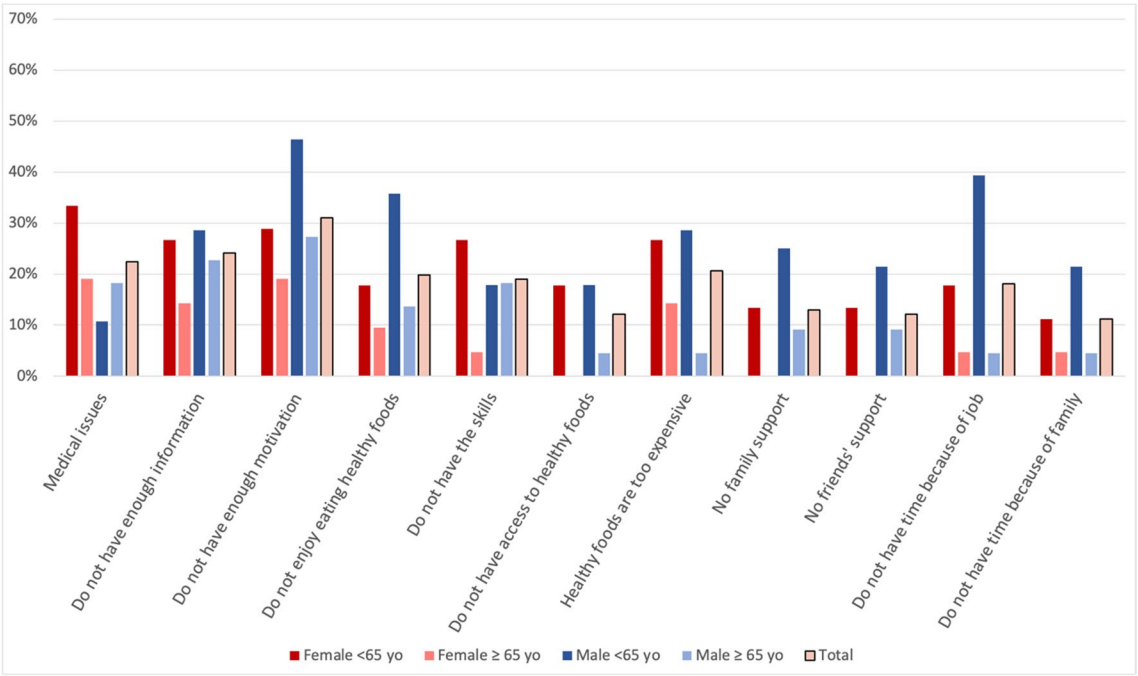

Fig. 2 Barriers to healthy eating according to gender and age

5.5 (SD 2.6). There was no difference between men's and women's baseline scores (5.4 (SD 2.5) and 5.4 (SD 2.6)), nor between older and younger adults' scores (5.8 (SD 2.1) and 5.2 (2.7), $p = 0.22$).

After the prehabilitation period, the mean Mediterranean diet score increased to 6.1 (SD 2.6), $p<0.001$. There was no significant difference between men's and women's post-intervention scores (6.0 (SD 2.6) and 6.2 (SD 2.5), $p=0.65$), nor was there difference in scores between older and younger adults (6.2 (SD 2.2) vs. 6.1 (SD 2.8), $p=0.73$).

Adjusting for gender and older adult status, a higher number of barriers were significantly associated with lower Mediterranean diet scores both pre- and

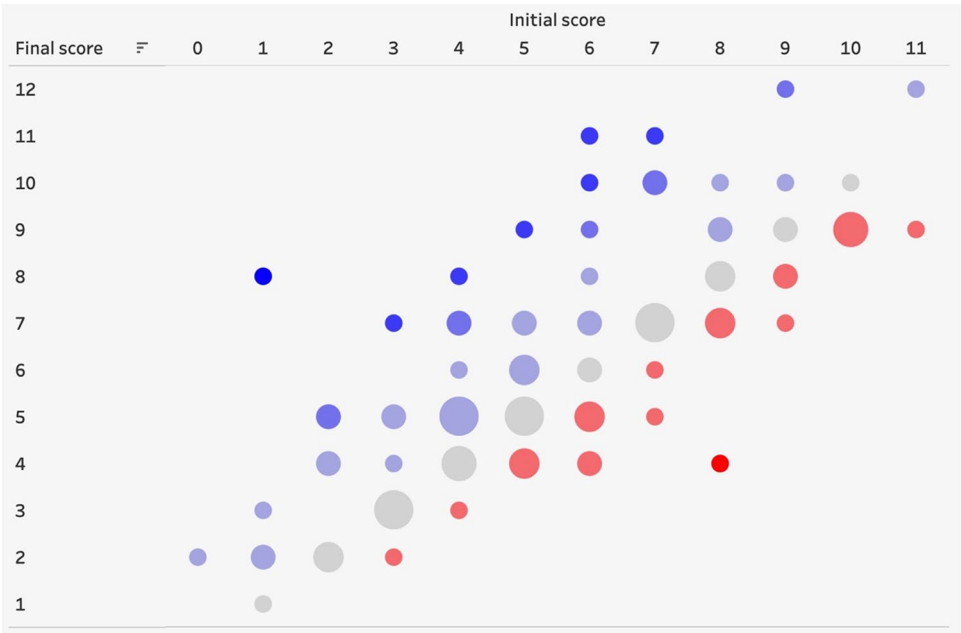

Fig. 3 Differences in pre- and post-intervention Mediterranean Diet Assessment Tool scores. The size of the circles corresponds to the number of people in each category. Gray indicates no change, blue indicates increase in score, and red circles indicates decrease in score

post-intervention (coef.: −0.31, 95% CI: −0.49; −0.13, p-value <0.001; and coef.: −0.27, 95% CI: −0.49; −0.06, p=0.01).

Pre- and post-intervention scores are shown in Figure 3.

Qualitative Results

Of the 30 patients invited to participate in the interview, 15 agreed to participate. After coding the 15th interview, the research team agreed that thematic saturation was achieved and there was no need to recruit more participants. Of the 15 patients, six were women, 14 were white, and 11 were married or had a life partner. Three patients were younger than 45 years old, seven were 45 to 64 years old, and five were 65 or older. Six patients underwent hepatopancreatobiliary surgery, six underwent colorectal surgery, and three underwent upper gastrointestinal surgery. Most patients (12/15) had a cancer diagnosis.

Major themes identified from the data were as follows: comorbidities as a barrier, the effect of chemotherapy on taste, energy and appetite, participation in the study leading to greater self-efficacy and motivation, food as a source of comfort and indulgence, poor relationship with food in the past, environment as a potential barrier to exercise or facilitator for healthy eating, the importance of time-efficient exercises, the importance of engaging the person who cooks, challenges of eating healthfully during social gatherings, and prior experience with physical exercise and healthy eating as facilitator or barrier.

Other themes that emerged included the following: the importance of considering the stage of behavioral change, gamification as a motivator for physical activity, goal setting as a motivator (especially with regard to step counts), fighting cancer and recovering from surgery as a motivator, cost of healthy foods as a barrier, and technology as barrier or facilitator.

The coding tree can be found in eTable 1.

Integration and Interpretation

We mapped the survey questions and main themes into the constructs of the Theoretical Domains Framework. Integration of the findings is displayed in Table 2. Qualitative data corroborated and explained part of the quantitative data, such as the effect of chemotherapy on taste and poor appetite due to underlying medical issues. Integration of the findings also revealed how prehabilitation could facilitate healthy eating and exercising through goal setting, offering time-efficient workouts, and promoting awareness regarding self-efficacy. It also revealed that baseline assumptions and misconceptions about the Mediterranean diet were significant barriers that prevented some participants from trying it.

Discussion

Home-based prehabilitation offers more flexibility and can reach more patients. However, adherence to such programs is still suboptimal, and the reason for low adherence remains largely unexplained.[10,14,15] This mixed method study identified and explored major barriers and facilitators to physical activity and healthy eating, critical components of multimodal prehabilitation. The surveys revealed that medical issues, pain, and lack of motivation were frequent barriers to physical activity and healthy eating. Integration of the quantitative and qualitative findings provided a comprehensive understanding of issues that can be addressed in future prehabilitation programs.

Our quantitative results indicate that women reported more barriers to physical activity than men and had lower adherence to the exercise component of the program. Older and younger adults reported a similar number of barriers to physical activity, but older adults had a somewhat higher adherence to the exercise component of prehabilitation. A review on barriers and facilitators to physical activity participation in middle-aged and older adults concluded that certain motivators vary by age group, while barriers are similar across age groups.[20] Nevertheless, most facilitators identified in the present study (goal setting, beliefs about consequences, social support, and prior experience) were common to both middle-aged and older adults in that review. Thus, future prehabilitation programs will likely achieve higher adherence rates by addressing the most frequent barriers and capitalizing on the facilitators. In addition, when controlling for gender and age, the number of barriers to physical activity was not significantly associated with lower adherence to the exercise component of the program, suggesting that an individual's motivators might outweigh the barriers.

Regarding barriers to healthy eating, there were no differences between men and women, but younger patients reported more barriers than older adults. Still, age did not affect Mediterranean diet scores, both pre- and post-intervention, and neither did gender. However, adjusting for gender and age, a higher number of reported barriers were associated with lower diet scores both pre- and post-intervention, suggesting that individual-level barriers might be implicated. Accordingly, a systematic review on barriers to adherence to a Mediterranean diet identified issues that are specific to this way of eating and vary on an individual level, such as aversion or concerns over specific components of the Mediterranean diet, low familiarity with this diet, upbringing context, and cultural differences.[21]

The qualitative data explored those issues and others that had not been identified through the surveys. The interviews revealed facilitators to physical activity provided by

Table 2 Integration of quantitative and qualitative findings

Domain[a]	Themes	Illustrative quote	Survey question	*N* (%)
Physical	Comorbidities as a barrier	"The only thing that limits my walking is my creaky arthritic knees."	Medical issues prevent me from exercising	68 (58.6)
			Pain prevents me from exercising	59 (50.9)
	Effect of treatment on taste and appetite	"Taste is a big thing, too, in chemotherapy and cancer because most things taste like a paper bag to a lot of people."	Medical issues prevent me from eating healthy foods	26 (22.4)
Knowledge	Prior experience as facilitator or barrier	"It's fairly easy for me to do it (Mediterranean diet) because I lived in the Middle East for a long time." "I did not do the diet. I think it's rich in olive oil and fish. I don't eat fish, and none of my family members do either."	Do not have enough information about a healthy diet	28 (24.1)
Beliefs about capabilities	Participation in the study leading to higher self-efficacy	"All the information about healthful eating and all the psychological stuff about, 'I'm in control of my health and I can impact my health for the better. It's kind of up to me,' it does have an impact, I think"	Do not have the motivation to exercise	48 (41.4)
Beliefs about consequences	Belief that healthy habits can help in the recovery process	"Okay, let's try to have me be in as good a shape as I can be in to try to heal and try to have my hospital stay be shorter"		
Reinforcement	Perception of the benefits leading to more motivation	"on the Mediterranean diet, (…) you almost feel like you've got good energy afterwards. (…) I'm awake and alert, and I'm not lethargic after a big red meat meal like before the program."	Do not have the motivation to eat a healthy diet	36 (31)
Intentions	Stage of behavioral change	"I don't necessarily always eat as healthy as I could"	-	-
Goals	Goal setting as important for accomplishing tasks	"The night before (the surgery) I walked two miles and I wasn't even out of breath at the end. I had worked my way up to that"	-	-
Environmental context and resources	Environment as a potential barrier to exercise	"I live in 103, 105-degree. My daughter has been walking with me lately and we've tried going after 8 o'clock at night when it cools down to about 97."	Do not have access to places to do physical activity or exercise	17 (14.7)
	Importance of being time-efficient	"If you had to spend a lot of time during the day doing those exercises, I probably would not have done it, but they were very time efficient"	Do not have time to exercise because of job	19 (16.4)
	Environment as a potential facilitator to healthy eating	"I have a huge garden, and so I eat lots of vegetables all the time anyway."	Do not have access to healthy foods	14 (12.1)

Table 2 (continued)

Domain[a]	Themes	Illustrative quote	Survey question	*N* (%)
Social influences	Importance of engaging the person who cooks	"But mostly, my wife, once she heard Mediterranean, she just bought a couple of cookbooks and went to town" "I live alone, I'm single, and so I was able to adopt them and not have to force somebody else to have the same diet or follow the examples."	No family support to eat a healthy diet	15 (12.9)
	Challenges of eating healthy during social interactions	"Buying things when you have guests over and then not being able to resist temptation"	No friends' support to eat a healthy diet	14 (12.1)
Emotion	Food as a source of comfort	"I've been very indulgent with sugar"	Do not enjoy eating healthy	23 (19.8)
	Poor relationship with food/eating disorders	"I already didn't have a good relationship with food. So, participating in a study that would ask me to track what I was eating or really monitor my food intake, I think that, personally, that was not a good study to participate in"		

[a]From the Theoretical Domains Framework

the prehab program, such as practical and time-efficient exercises, and the ability to track the activity. Other studies have described similar benefits of home-based prehabilitation among patients undergoing chemotherapy [22], with heart failure [23], and stroke [24]. Importantly, the belief that participating in prehabilitation could lead to better outcomes was a critical motivator identified in those studies, as well as in the present study. Surgery can be a teachable moment for behavior change and represents a unique and powerful opportunity to introduce long-term healthier lifestyle behaviors.[25,26] We also explored the barriers to healthy eating and identified some specific to cancer patients and patients with gastrointestinal diseases. For example, some patients reported that chemotherapy affected their taste and appetite, while others suffered from conditions that prevented them from tolerating certain foods (e.g., inflammatory bowel disease and obstructive tumors). While the prehabilitation program could not address those issues, we identified other critical points to be improved in future programs. For instance, patients often reiterated the importance of engaging family members in the program, specifically those who do food shopping and preparation. Moreover, it became clear that we needed to address patients' beliefs and concerns over the diet proposed by the program for optimal adherence.

Among the many strategies available for preoperative nutritional optimization[27], our rationale for choosing the Mediterranean diet was that this is a healthy and well-balanced diet that was sustainable and accessible for most participants. In addition to improving surgical outcomes, our goals with app-based prehabilitation were scalability and long-term behavior change. The Mediterranean diet is safe in the long term[28], appropriate for patients with chronic diseases[29], and associated with healthy aging.[30] In addition, studies suggest that the Mediterranean diet can be protective against frailty [31,32], colorectal diseases[33], and postoperative readmissions in patients with ileostomy.[34] Our main goal was to encourage the consumption of minimally processed and plant-based foods, rather the consumption of specific Mediterranean diet items such as olive oil and fish. However, with this study, we recognized that the Mediterranean diet may not be easily transferable to all populations. In future studies, we plan to provide tailored and culturally appropriate dietary suggestions.

This paper sheds light on how future trials might be designed to overcome barriers to prehabilitation adherence, maximizing the ability to detect whether it can reduce complication rates. For example, engaging family members and caregivers might be a powerful strategy, as several participants reported social support as a key motivator when present, or barrier when lacking. Additionally, time-efficient workouts and easy access to fresh foods were frequently mentioned as facilitators to adherence. Future studies might

explore the value of facilitating access to healthy foods (e.g., meal deliveries, grocery vouchers, partnership with food pharmacies[35]).

Some limitations of this study should be addressed. Firstly, we cannot exclude the possibility of selection bias, as patients who opted to enroll in the study are possibly more motivated to exercise and eat healthier than those who did not enroll. Second, the study population was predominantly white, and we did not include income measures in our analysis, which limits the generalizability of our findings. Diverse populations may experience barriers and motivators differently than those identified in this study, and low-income individuals may have different barriers and facilitators than high-income individuals, as well as different health habits. Lastly, the lack of psychosocial support in our prehabilitation program is an important limitation. Psychosocial support is a critical component of prehabilitation, and the emotional burden of undergoing surgery cannot be overlooked.[36] Several patients reported lack of motivation and using food to cope with stress as significant barriers, which could potentially be addressed with psychosocial support.

In conclusion, this study identified key barriers to be addressed and facilitators to inform the development of future prehabilitation programs. As patients cited pain and medical issues, as well as lack of time as major barriers to healthy eating and physical activity, it does appear that offering time-efficient workouts and promoting awareness regarding self-efficacy would be helpful in improving adherence. One-on-one coaching may also be helpful as patients often had preconceptions about the diet or exercise recommendations that hindered participation.

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Declarations

Competing Interests The authors declare no competing interests.

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