Physical activity and supportive care intervention preferences: a cross-sectional study of barriers in advanced cancer

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ABSTRACT

Purpose Physical activity may greatly benefit adults living with advanced cancer; however, barriers to physical activity and preferences for supportive care interventions are not well understood. This study investigates barriers to physical activity and differences in intervention preferences by demographic and clinical characteristics among adults with advanced cancer.

Methods Data came from a cross-sectional study of 247 adults with advanced cancer who visited the University of Wisconsin Carbone Cancer Centre from January 2021 to January 2023. The Godin–Shepard Leisure Score Index (insufficiently active, moderately active and active) was used to assess physical activity. Physical activity barriers were reported as mean scores (1–5: 'not at all' to 'a great deal'). Differences in intervention preferences were assessed using X^2 tests.

Results Adults living with advanced cancer were insufficiently active (53%), moderately active (21%) or active (26%). Respondents identified several barriers to physical activity spanning tiredness ($\bar{x}$=3.2), winter weather concerns ($\bar{x}$=3.2) and lack of motivation ($\bar{x}$=2.7). Respondents were most interested in a supportive care intervention designed to increase energy (88%) and improve physical health (86%) with physical therapy (73%), walking (72%) and resistance exercises (72%). Differences in preferences emerged by demographic characteristics and to a lesser extent by clinical characteristics.

Conclusions Adults with advanced cancer reported several barriers to physical activity. Future interventions should emphasise increasing energy and physical health and include strategies to manage tiredness and winter weather concerns.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ General and cancer-specific barriers to physical activity exist for adults living with advanced cancer.
⇒ There is growing recognition that supportive care interventions (physical activity, nutrition and coping support) for adults living with advanced cancer may improve their health and quality of life.

WHAT THIS STUDY ADDS

⇒ Adults living with advanced cancer face significant barriers to physical activity, including managing tiredness, winter weather concerns and lack of motivation.
⇒ Multi-modal interventions were of great interest among adults living with advanced cancer, with most preferring interventions incorporating physical therapy, walking and resistance exercises.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Researchers should develop multi-modal supportive care interventions for adults living with advanced cancer to reduce their barriers to physical activity and improve energy and physical health.

INTRODUCTION

Cancer survivors and physical activity

Cancer survivors comprise a growing segment of the US population, with approximately 18.1 million survivors as of 2024.[1 2] Numbers are expected to increase due to the ageing of the US population and advances in the early detection of cancer and cancer treatments. Moreover, an increasing number of individuals are living longer with advanced or metastatic cancer that has progressed or spread past the primary cancer site.[3] Despite the number of advanced cancer survivors

anticipated to top 700 000 in 2025, the complex physical, functional and emotional needs of this unique population are not well understood.[3–5]

Physical activity may benefit those living with advanced cancer through mechanisms, such as improving energy, sleep, levels of pain, anxiety or depression, and overall health-related quality of life (HRQoL).[6 7] The American College of Sports Medicine has acknowledged a gap in research on physical activity among adults living with advanced cancer.[6] Growing evidence suggests that physical activity is safe and beneficial for adults living with advanced cancer and may lead to decreased fatigue and increased quality of life.[6 8 9]

Assessing barriers to physical activity among the advanced cancer population is a necessary first step towards developing targeted interventions. Barriers affecting adults living with advanced cancer may differ from those of early-stage cancer survivors due to differences in the intensity and ongoing nature of cancer treatment in the advanced cancer setting, as well as side effects of this treatment. For example, adults living with advanced cancer may experience greater fatigue or pain or have greater potential for injury as a result of bone metastases. An assessment of both general (eg, lack of time) and cancer-specific barriers (eg, neuropathy) is needed.[10 11]

Supportive care interventions to address barriers

Supportive care is defined by the National Cancer Institute as "care given to improve the quality of life of people who have an illness or disease by preventing or treating, as early as possible, the symptoms of the disease and the side effects caused by treatment of the disease".[12 13] Supportive care interventions can be multi-modal and include physical, social and/or psychological components, such as exercise, nutritional support, counselling and pain support to target declines in health and support ongoing health concerns of the whole person with advanced cancer. A recent review by Bergerot *et al*[14] on enhancing supportive cancer care recommended integrating psychosocial support, nutrition and physical activity using telehealth to optimise cancer care delivery.[14] Existing supportive care interventions have shown promise for improving the quality of life of people living with cancer and into survivorship.[15–17] Supportive care interventions may be particularly beneficial to improve long-term health and reduce future impairments for adults living with advanced cancer, given this population endures particularly intensive treatments, cycles on and off therapy and long recovery times.[18–20] Supportive care interventions may begin as early as diagnosis and continue until the end of life.[13]

To better design supportive care interventions that fit the complex needs of this population, an assessment of barriers to physical activity and preferences for future interventions is needed. This study aims to assess (1) barriers to physical activity by current physical activity level and (2) variation in supportive care intervention preferences by age, gender, urbanicity, retirement status, cancer type and treatment status.

METHODS

Patients were recruited from the University of Wisconsin Carbone Cancer Centre (UWCCC) to complete a mail-based survey with questions on physical activity engagement, barriers to physical activity, quality of life, supportive care programme preferences and demographic and clinical characteristics. Patients were eligible if they were between the ages of 18 and 80 years; had been diagnosed with stage three or four lymphoma or stage four breast, prostate or colorectal cancer between January 2021 and January 2023; and were able to read and write in English. We chose to recruit those who received care at UWCCC within the past 2 years as they were more likely to be alive, able to recount recent treatment(s) received and have a valid current address.

Data collection

In brief, we followed a modified Dillman approach using three mailings (pre-notice postcard, mailing of survey 2 weeks later, mailing a copy of the survey to non-responders 5 weeks later (see Agnew *et al* (2025) for flow diagram).[21 22] We fielded the survey among 737 patients at UWCCC. Survey recipients were given a small incentive of $2 with the first mailing; however, participation was completely voluntary, and a study information sheet containing the study's purpose, participant's rights and study team contact information was included.

Surveys were collected from 3 April to 31 July 2023. Among the patients who were deemed eligible following data collection (n=683), n=9 (1%) refused (opted out), n=3 (0.4%) returned a blank survey, n=393 (58%) did not respond, and the final sample consisted of 278 patients (41% response rate).[23] The analytic sample included those with complete data on demographic and clinical characteristics (n=247, 89%).

This study was approved as minimal risk by the University of Wisconsin's Minimal Risk Institutional Review Board (Protocol #2022–0966) and by the University of Wisconsin Carbone Cancer Centre's Protocol Review and Monitoring Committee (Protocol UW22103).

Survey measures

Physical activity levels were assessed using a modified Godin–Shepard Leisure-Time Physical Activity Questionnaire (GSLTPQ). Items asked about activity during the past 7 days with three designated intensities: light, moderate and strenuous.[24] The GSLTPQ has been used to collect physical activity data among cancer survivors previously.[25] Muscle-strengthening physical activity

data were collected using a modified Muscle-Strength Exercise Questionnaire (MSEQ), which asked about types and durations of strength-based activities during the past 7 days.[26]

Questions on barriers to physical activity were developed for use in this survey based on prior research.[10 11] The question, 'how much do these factors make it harder for you to be physically active?' was asked with seventeen barriers and response categories on a five-point Likert scale ranging from 'not at all' to 'a great deal' (see online supplemental table 1 for a full list of barriers).

Questions regarding intervention preferences were developed for the survey (see online supplemental table 2 for a list of questions and response options). The question of, 'how interested are you in participating in a supportive care programme designed for people with cancer consisting of physical activity, nutrition and/or coping support?' was asked as a five-point Likert scale question with responses ranging from 'not at all interested' to 'extremely interested'. We asked the intervention preference questions in a yes/no format while allowing respondents to write in other responses in addition to or instead of selecting predetermined responses.

Demographic and clinical characteristics (eg, time since last treatment) were collected using questions developed for the survey. Comorbidity data were collected using the 18-item Functional Comorbidity Index, which was designed to assess comorbidities that influence functional status.[27] Cancer type was derived from the electronic medical record.

Statistical analysis

Data were double-entered into REDCap (Research Electronic Data Capture) and reviewed for quality and completeness using REDCap's Data Comparison tool.[28] Data were analysed using SAS 9.4 (Cary, NC).

We calculated the Leisure Score Index to analyse physical activity data. To sum physical activity while accounting for intensity, weekly frequencies of light, moderate and strenuous activities were multiplied by their corresponding metabolic equivalents of task value (strenuous=9, moderate=5, light=3). Physical activity level was then classified using the Leisure Score Index (LSI) cut points for active (LSI of 24 or higher), moderately active (LSI of 14 to less than 24) and insufficiently active (LSI less than 14). Respondents who did not report any aerobic activity (score=0) were categorised as insufficiently active. Meeting the strength training guidelines was determined as answering 'yes' to the question 'Do you usually do muscle-strengthening exercise?' and reporting 2 or more days to the question 'How many days, in the last 7 days, did you do muscle-strengthening exercise?'. Respondents who did not report any muscle-strengthening activity (score=0) were categorised as not meeting the guidelines.

An overall Functional Comorbidity Index score was the number of self-reported 'yes' responses to the list of 18 comorbidities and was categorised from zero to three or more comorbidities. Descriptive statistics including means and SD of continuous variables and frequencies of categorical variables were calculated. Analysis of variance tests were used to assess differences in mean 'barrier to physical activity' scores for each individual barrier by Leisure Score Index (LSI) category (active, moderate, insufficient). Two-sample *t*-tests were used to assess differences in mean 'barrier to physical activity' scores by meeting the strength guidelines (yes, no). Pearson's X^2 tests were used to assess differences in intervention preferences by respondents' demographic (gender, age group, urbanicity and retirement status) and clinical characteristics (cancer type and treatment status) (see online supplemental tables 3 and 4 for urbanicity and retirement results).

RESULTS

Sample characteristics

Of the respondents (n=247), adults living with advanced cancer in our sample were on average 66.3±10.3 years of age and the majority identified as men (60%) (table 1). Most of the respondents were not employed (retired, 62%) and were married or living with a partner (75%). About a third (35%) were residing in a rural area, with 25% living in an urban area and 40% in a suburban area. In terms of clinical characteristics, respondents included adults living with advanced prostate (32%), myeloma (23%), lymphoma (16%), breast (18%) or colorectal (11%) cancer. Most of our sample reported currently receiving chemotherapy, immunotherapy and/or hormone therapy (73%) and had one or more comorbidities (82%).

Overall, 53% of the sample was considered insufficiently active, 21% of the sample was moderately active and 26% of the sample was active by the Leisure Score Index cutpoints (table 1, online supplemental table 5). 27% of the sample was meeting the muscle strength guidelines.

Assessment of interest in supportive care intervention programming and delivery preferences

Most adults with advanced cancer were at least a little interested in a supportive care intervention (72%) (table 1). Adults who were more interested in a supportive care intervention tended to be younger, female, had higher levels of education, worked full- or part-time, were moderately active or active and met muscle-strength activity guidelines (table 1).

Of those adults who selected at least one reason for their interest and at least one activity of interest, most were interested in an intervention designed to increase energy (88%), improve physical health (86%) and develop muscle strength (81%) (table 2). Physical therapy (73%), walking (72%) and resistance exercises

Table 1 Demographic, clinical and physical activity characteristics of individuals with advanced cancer separated by interest in a physical activity intervention

	Analytic sample	Not at all interested	At least a little interested
	N (%) or mean (SD)		
Characteristics	**n=247**	**n=68 (28)**	**n=179 (72)**
Demographics			
Current age–mean (SD)	66.3 (10.3)	69.0 (8.1)	65.2 (10.8)
Age group			
<60 years old	52 (21)	8 (12)	44 (25)
60 to 70 years old	86 (35)	25 (37)	61 (34)
> 70 years old	109 (44)	35 (51)	74 (41)
Gender			
Woman	99 (40)	20 (29)	79 (44)
Man	148 (60)	48 (71)	100 (56)
Marital status			
Married/living with partner	185 (75)	54 (79)	131 (73)
Not married/living with partner	62 (25)	14 (21)	48 (27)
Educational level			
High school or less	52 (21)	26 (38)	26 (15)
Some college/associate's degree	73 (30)	15 (22)	58 (32)
Bachelor's degree or higher	122 (49)	27 (40)	95 (53)
Employment status			
Full or part- time	65 (26)	11 (16)	54 (30)
Not employed, retired	153 (62)	48 (71)	105 (59)
Not employed, other	29 (12)	9 (13)	20 (11)
Urbanicity			
Urban	61 (25)	11 (16)	50 (28)
Suburban	99 (40)	33 (49)	66 (37)
Rural	87 (35)	24 (35)	63 (35)
Clinical characteristics			
Cancer type			
Breast	45 (18)	4 (6)	41 (23)
Colorectal	27 (11)	8 (12)	19 (10)
Myeloma	57 (23)	20 (29)	37 (21)
Prostate	79 (32)	27 (40)	52 (29)
Lymphoma	39 (16)	9 (13)	30 (17)
Current treatment type*			
Chemo/immune/hormonal therapy	181 (73)	45 (66)	136 (76)
Radiation therapy	21 (9)	6 (9)	15 (8)
Surgery (in the past 6 months)	14 (6)	3 (4)	11 (6)
Bone marrow or stem cell transplant (in the past 6 months)	6 (2)	3 (4)	3 (2)
Current treatment status			
On treatment	198 (80)	53 (78)	145 (81)
Not on treatment	49 (20)	15 (22)	34 (19)
Functional comorbidity index category			
No comorbidities	45 (18)	14 (21)	31 (17)
1 comorbidity	48 (19)	13 (19)	35 (20)
2 comorbidities	52 (21)	18 (26)	34 (19)
3 or more comorbidities	102 (41)	23 (34)	79 (44)
Physical activity levels			
Godin Leisure Score Index Category			
Insufficiently active/sedentary	130 (53)	39 (57)	91 (51)
Moderately active	52 (21)	11 (16)	41 (23)

Continued

Table 1 Continued

Characteristics	Analytic sample N (%) or mean (SD) n=247	Not at all interested n=68 (28)	At least a little interested n=179 (72)
Active	65 (26)	18 (27)	47 (26)
Meeting muscle strength guidelines			
Yes	67 (27)	15 (22)	52 (29)
No	180 (73)	53 (78)	127 (71)

*Respondents could select more than one treatment type, so these data reflect the number who checked each box and do not add up to 100%.

using weights or bands (72%) were the most selected options for physical activity preferences. Interest in nutrition programming was greatest for receiving nutrition information/recipes for people with cancer, 74% overall. Among coping support activities, interest was greatest for individual therapy with a provider (62%).

In terms of intervention delivery preferences, most adults selected 'at diagnosis' as the best time to introduce the intervention (28%) compared with other time points throughout the cancer journey (table 3). Most respondents were interested in delivery via in-person activities at the cancer centre before or after a clinic visit, 54% overall, followed by in-person at a facility close to home, 49%. In terms of participation, respondents were most interested in one-on-one activities with a provider (51%), followed closely by 'in a group with other people with cancer' (50%), and 'on your own' (49%). 'Printed materials' (69%) followed by 'on the internet (website, online videos)' (58%) were the top two overall preferences for information delivery. Almost everyone had personal access to a smartphone

Table 2 Supportive care intervention programming preferences by demographic characteristics of adults living with advanced cancer

Programming preferences	Overall N (%)	Gender Women n=77	Gender Men n=96	Age group (years) <60 n=43	Age group (years) 60–70 n=60	Age group (years) 70+ n=70
Total	173 (70%)	Proportions				
Reasons for participating						
To increase your energy	153 (88%)	0.86	0.91	0.88	0.88	0.89
To improve physical health	149 (86%)	0.87	0.85	0.86	0.85	0.87
To develop muscle strength	140 (81%)	0.79	0.82	0.74	0.82	0.84
To find support and motivation	135 (78%)	0.84	0.73	0.79	0.80	0.76
To improve mental health	134 (77%)	**0.86**	**0.71**	0.86	0.82	0.69
To improve your balance	114 (66%)	0.61	0.70	**0.51**	**0.67**	**0.74**
Physical activities						
Physical therapy	126 (73%)	0.69	0.76	0.70	0.75	0.73
Walking	125 (72%)	0.73	0.72	0.67	0.65	0.81
Resistance exercises	124 (72%)	0.75	0.69	0.67	0.75	0.71
Using weight machines	90 (52%)	0.44	0.58	0.53	0.57	0.47
Holistic exercises	88 (51%)	**0.70**	**0.35**	**0.63**	**0.58**	**0.37**
Occupational therapy	71 (41%)	0.40	0.42	0.23	0.50	0.44
Chair-based exercises	63 (36%)	**0.45**	**0.29**	0.23	0.43	0.39
Group aerobics class	55 (32%)	**0.48**	**0.37**	0.35	0.32	0.30
Nutrition programming						
Nutrition information/recipes	128 (74%)	0.77	0.72	0.77	0.80	0.67
Consultation with a dietitian	94 (54%)	0.62	0.48	**0.65**	**0.62**	**0.41**
Cooking classes	51 (29%)	0.30	0.29	**0.44**	**0.30**	**0.20**
Coping support						
Individual therapy with a provider	107 (62%)	**0.70**	**0.55**	**0.77**	**0.67**	**0.49**
Mindfulness techniques	102 (59%)	**0.75**	**0.46**	0.65	0.60	0.54
Group therapy sessions	80 (46%)	0.48	0.45	0.44	0.42	0.51

Statistical significance (shading and **bold**) is defined as p<0.05.

Note: X^2 tests were conducted separately for gender and age group within each variable of interest. The proportions are out of each column total and reflect those who selected at least one reason for participating and at least one activity (n=173).

Table 3 Supportive care intervention delivery preferences by demographic characteristics of adults living with advanced cancer

		Gender		Age group (years)		
	Overall	Women	Men	<60	60–70	70+
Delivery preferences	**N (%)**	**n=77**	**n=96**	**n=43**	**n=60**	**n=70**
Total	173 (70%)	Proportions				
Timing*						
At diagnosis	49 (28%)	**0.41**	**0.19**	0.42	0.32	0.16
After diagnosis, but before treatment	41 (24%)	**0.21**	**0.26**	0.22	0.30	0.18
During treatment	34 (20%)	**0.22**	**0.18**	0.15	0.18	0.22
During a break from treatment	25 (15%)	**0.04**	**0.23**	0.09	0.08	0.22
Other	23 (13%)	**0.12**	**0.15**	0.09	0.12	0.16
Delivery mode						
In person, at the cancer centre before/after the visit	93 (54%)	0.55	0.53	0.53	0.60	0.49
In person, at a facility close to home	85 (49%)	**0.60**	**0.41**	**0.60**	**0.55**	**0.37**
Remotely, at own home	70 (40%)	**0.49**	**0.33**	0.47	0.43	0.34
In person, during a clinic visit	65 (38%)	0.42	0.34	0.33	0.40	0.39
Participation						
One-on-one with a provider	89 (51%)	**0.61**	**0.44**	**0.65**	**0.57**	**0.39**
In a group with other people with cancer	87 (50%)	0.57	0.45	0.51	0.50	0.50
On your own	84 (49%)	0.52	0.46	0.49	0.55	0.43
With a family member or friend	57 (33%)	0.35	0.31	0.35	0.33	0.31
Delivery of Information						
Printed materials	120 (69%)	0.71	0.68	0.65	0.67	0.74
On the internet (website, online videos)	100 (58%)	0.64	0.53	**0.70**	**0.68**	**0.41**
On an app (eg, smartphone-based content)	43 (25%)	**0.38**	**0.15**	**0.42**	**0.23**	**0.16**
Phone call	39 (23%)	0.27	0.19	0.19	0.25	0.23
Video call	21 (12%)	**0.21**	**0.05**	0.09	0.20	0.07
Access to internet and phone						
Yes—personal access to smartphone or tablet	155 (90%)	0.95	0.85	**0.98**	**0.92**	**0.83**
Yes—internet access at home*	165 (96%)	**1.00**	**0.93**	0.98	0.95	0.96
Device use to track health or activity						
Yes, I do currently	42 (24%)	**0.30**	**0.20**	**0.44**	**0.18**	**0.17**
Yes, I have in the past but do not currently	26 (15%)	**0.26**	**0.06**	**0.12**	**0.20**	**0.13**
No	105 (61%)	**0.44**	**0.74**	**0.44**	**0.62**	**0.70**
Interest in a device to track health or activity*						
Yes	97 (60%)	0.68	0.54	0.80	0.56	0.52
No	64 (40%)	0.32	0.46	0.20	0.44	0.48

Statistical significance (shading and **bold**) is defined as p<0.05.

Note: X^2 tests were conducted separately for gender and age group within each variable of interest. The proportions are out of each column total and reflect those who selected at least one reason for participating and at least one activity (n=173).

*Total missingness for these variables is 0.1% (n=1) for 'time to start an intervention' and 'access to internet', and 7% (n=12) for 'interest in a device to track health or activity'.

or tablet (90%) and internet access at home (96%). Interest in using a health or activity tracker was high (60%).

Assessment of general and cancer-specific physical activity barriers by activity level

Results of the barrier scores varied by respondents' level of activity, that is, insufficiently active, moderately active or active; and meeting the muscle strength guidelines. In general, those who were insufficiently active had higher mean scores for all barriers, except lack of time, compared with those who were moderately active or active. The highest reported barriers to physical activity were attributed to winter weather concerns, with higher scores reported by those who were insufficiently active compared with moderately active or active (3.2 vs 2.8 and 2.4; p<0.0001), tiredness (3.2, 2.7, 2.2; p<0.0001) and difficulty getting motivated (2.7 vs 2.4 and 1.9; p=0.0004); (figure 1, online supplemental table 1). Fear of falls or injury mean scores were also greater among those insufficiently active adults (2.2) compared with those who were moderately active or active (1.4 and 1.5, respectively; p<0.0001). In terms of cancer-specific barriers, neuropathy mean scores were greater among those

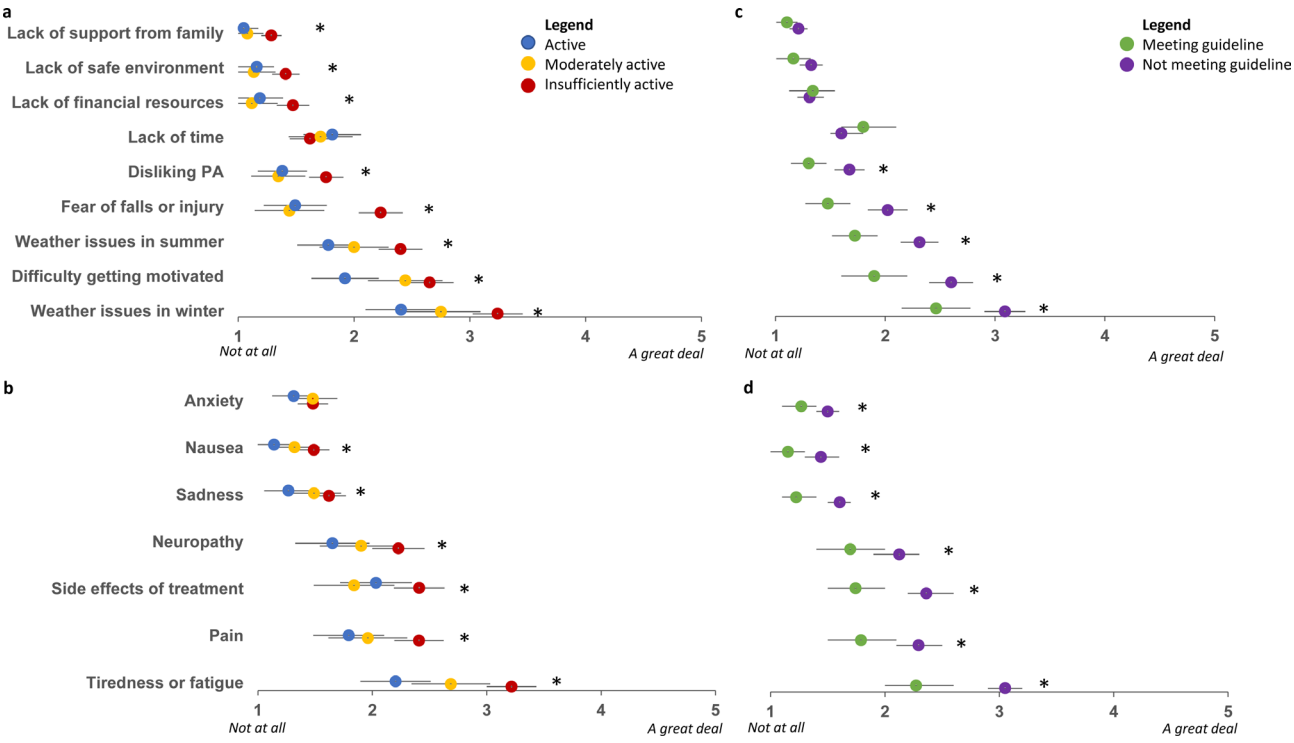

Figure 1 Mean scores of general and cancer-specific barriers to physical activity by Leisure Score Index (LSI) and meeting strength guidelines among adults living with advanced cancer. Statistical significance (*) is defined as p<0.05. Note: total missingness for barriers ranges from 1.6% (n=2) for the lack of time to 2.8% (n=7) for side effects of treatment in figure 1. Precise p values are presented in online supplemental tables 1 and 6. Bars represent 95% CIs for mean scores. For (a) and (b) LSI categories (active, moderately active, insufficiently active), the p value is from the analysis of variance to assess whether differences exist between the mean scores of the three activity groups. For (c) and (d) meeting strength guideline categories (meeting strength guidelines, not meeting strength guidelines), p value is of the pooled equal variances t-test to assess whether there is a difference between the mean scores of the two groups.

who were insufficiently active (2.2) compared with those who were moderately active or active (1.9 and 1.7, respectively; p=0.01). Similar trends were found when comparing those who met the strength guidelines to those who did not meet the strength guidelines (figure 1, online supplemental table 6).

Intervention programming preferences by demographic and clinical characteristics

In terms of demographic differences, women were more interested than men in an intervention to improve mental health, and older individuals were more interested than younger individuals in an intervention to improve balance (table 2). We found higher interest in holistic exercises, chair-based exercises and group aerobics among women compared with men. Younger individuals were also more interested than older individuals in holistic exercises such as Yoga or tai chi. Differences by cancer type emerged for interest in holistic exercises and chair-based exercises; individuals with advanced breast cancer showed the most interest in both activities compared with the other cancer types (table 4).

Interest in nutrition programming received high endorsement across all demographic characteristics. A consult with a dietician and cooking classes was of greatest interest among younger individuals compared with older individuals. Preferences were similar across clinical characteristics.

Interest in individual therapy with a provider received higher endorsement among women vs men and younger age groups compared with the oldest age group. In terms of clinical characteristics, individual therapy with a provider was of greater interest among those not currently on treatment (79%) compared with those on treatment (58%), and group therapy sessions for people with cancer were also of greater interest among those not currently on treatment (64%) compared with those on treatment (42%).

Intervention delivery preferences by demographic and clinical characteristics

Several intervention delivery preferences differed by demographic and clinical characteristics (table 3 and table 5). Women most strongly preferred for the intervention to start at diagnosis, while men most preferred for the intervention to start after diagnosis but before the beginning of treatment. In terms of clinical characteristics, individuals with advanced breast cancer and myeloma preferred for the intervention to begin at diagnosis compared with other timing preferences among other cancer types. Women and younger

Table 4 Supportive care intervention programming preferences by clinical characteristics of adults living with advanced cancer

	Cancer type					On treatment status	
	Breast	Colorectal	Prostate	Myeloma	Lymphoma	No	Yes
	n=41	n=19	n=49	n=36	n=28	n=33	n=140
Programming preferences	Proportions						
Reasons for participating							
To increase your energy	0.93	0.79	0.96	0.78	0.89	0.85	0.89
To improve physical health	0.95	0.74	0.88	0.83	0.82	0.79	0.88
To develop muscle strength	0.80	0.74	0.90	0.81	0.71	0.70	0.84
To find support and motivation	0.88	0.79	0.69	0.78	0.79	0.82	0.77
To improve mental health	0.88	0.84	0.67	0.69	0.86	0.82	0.76
To improve your balance	0.68	0.42	0.78	0.64	0.61	0.61	0.67
Physical activities							
Physical therapy	0.63	0.58	0.82	0.81	0.71	0.76	0.72
Walking	0.80	0.63	0.71	0.75	0.64	0.70	0.73
Resistance exercises using bands or weights	0.78	0.84	0.73	0.61	0.64	0.73	0.71
Using weight machines	0.41	0.68	0.59	0.53	0.43	0.52	0.52
Holistic exercises such as Yoga or Tai-Chi	**0.78**	**0.53**	**0.39**	**0.44**	**0.39**	0.42	0.53
Occupational therapy	0.37	0.21	0.45	0.42	0.54	0.52	0.39
Chair-based exercises	**0.54**	**0.11**	**0.39**	**0.42**	**0.18**	0.30	0.38
Group aerobics class	0.44	0.26	0.24	0.31	0.32	0.36	0.31
Nutrition programming							
Nutrition information/recipes for people with cancer	0.71	0.74	0.78	0.78	0.68	0.76	0.74
Consultation with a dietician	0.61	0.42	0.55	0.47	0.61	0.61	0.53
Cooking classes	0.32	0.32	0.24	0.25	0.39	0.33	0.29
Coping support							
Individual therapy with a provider	0.63	0.58	0.49	0.67	0.79	**0.79**	**0.58**
Mindfulness techniques for people with cancer	0.73	0.53	0.49	0.61	0.57	0.61	0.59
Group therapy sessions for people with cancer	0.46	0.58	0.39	0.44	0.54	**0.64**	**0.42**

Statistical significance (shading and **bold**) is defined as p<0.05.

Note: X^2 tests were conducted separately for cancer type and treatment status within each variable of interest. The proportions are out of each column total and reflect those who selected at least one reason for participating and at least one activity (n=173).

individuals preferred delivery via in-person activities at a facility close to home. Delivery mode preferences were similar across clinical characteristics.

In terms of differences in preferred information delivery by age group, younger individuals preferred for information to be delivered on the internet (70%) or an app (40%) compared with older individuals (41% and 16%, respectively). Information delivery preferences were similar across clinical characteristics.

Younger respondents had greater personal access to a smartphone or tablet than older individuals. More women and individuals in younger age groups reported current use of an activity tracker for health or activity compared with men and older individuals. Interest in a device to track health and activity was highest among individuals with breast and colorectal cancer.

DISCUSSION

Our study investigates general and cancer-specific barriers to physical activity along with differences in supportive care intervention preferences among a sample of adults with advanced cancer, a growing population whose barriers to activity are not well understood. In terms of physical activity levels, less is known about the amount of physical activity completed by adults living with advanced cancer in the USA. Our study shows that while respondents engage in some activity including aerobic and muscle-strengthening activities, most respondents are considered insufficiently active using both the Godin Leisure Score Index cut-offs and muscle strength guidelines. We also demonstrate key barriers to physical activity and preferences for future interventions among this population.

Our study reveals differences in both general and cancer-specific barriers to physical activity by current activity level among adults with advanced cancer. Adults who were moderately active or active tended to rate most barriers less strongly than their insufficiently active counterparts. Overall, the greatest barriers were weather issues in the winter and tiredness or fatigue among those who were insufficiently active. In contrast to our findings, bad weather was not considered a highly reported barrier among the sample of

Table 5 Supportive care intervention delivery preferences by clinical characteristics of adults living with advanced cancer

	Cancer type					On treatment status	
	Breast	Colorectal	Prostate	Myeloma	Lymphoma	No	Yes
	n=41	n=19	n=49	n=36	n=28	n=33	n=140
Delivery preferences	**Proportions**						
Timing*							
At diagnosis	**0.39**	**0.11**	**0.20**	**0.40**	**0.25**	0.21	0.30
After diagnosis, but before treatment	**0.22**	**0.42**	**0.22**	**0.14**	**0.29**	0.36	0.21
During treatment	**0.22**	**0.16**	**0.12**	**0.29**	**0.21**	0.12	0.22
During a break from treatment	**0.02**	**0.26**	**0.27**	**0.06**	**0.14**	0.21	0.13
Other	**0.15**	**0.05**	**0.18**	**0.11**	**0.11**	0.09	0.14
Delivery mode							
In person, at the cancer centre before/after the visit	0.51	0.47	0.51	0.50	0.71	0.67	0.51
In person, at a facility close to home	0.56	0.42	0.45	0.50	0.50	0.55	0.48
Remotely, at own home	0.56	0.32	0.39	0.33	0.36	0.30	0.43
In person, during a clinic visit	0.37	0.53	0.33	0.31	0.46	0.52	0.34
Participation							
One-on-one with a provider	0.59	0.53	0.45	0.50	0.54	0.48	0.52
In a group with other people with cancer	0.56	0.58	0.41	0.53	0.50	0.61	0.48
On your own	0.56	0.47	0.43	0.47	0.50	0.58	0.46
With a family member or friend	0.32	0.32	0.31	0.36	0.36	0.33	0.33
Delivery of Information							
Printed materials	0.73	0.53	0.61	0.78	0.79	0.73	0.69
On the internet (website, online videos)	0.71	0.53	0.55	0.50	0.57	0.64	0.56
On an app (eg, smartphone-based content)	0.37	0.37	0.14	0.17	0.29	0.30	0.24
Phone call	0.20	0.21	0.18	0.25	0.32	0.33	0.20
Video call	0.22	0.11	0.04	0.17	0.07	0.06	0.14
Access to the internet and phone							
Yes—personal access to smartphone or tablet	0.95	0.95	0.82	0.94	0.86	0.85	0.91
Yes—internet access at home*	1.00	1.00	0.92	0.97	0.93	0.94	0.96
Device use to track health or activity							
Yes, I do currently	0.29	0.32	0.24	0.19	0.18	0.18	0.26
Yes, I have in the past but do not currently	0.29	0.11	0.06	0.19	0.07	0.06	0.17
No	0.41	0.58	0.69	0.61	0.75	0.76	0.57
Interest in a device to track health or activity*							
Yes	**0.81**	**0.78**	**0.52**	**0.50**	**0.46**	0.58	0.61
No	**0.19**	**0.22**	**0.48**	**0.50**	**0.54**	0.42	0.39

Statistical significance (shading and **bold**) is defined as p<0.05.

Note: Chi-squared tests were conducted separately for cancer type and treatment status within each variable. The proportions are out of each column total and reflect those who selected at least one reason for participating and at least one activity (n=173).

*Total missingness for these variables is 0.1% (n=1) for "time to start an intervention" and "access to internet", and 7% (n=12) for "interest in a device to track health or activity".

adults living with advanced cancer in Germany, with only 4.3% considering it a barrier.[29] This difference could be due to the differences in weather or geography (ie, the proportion of rural residents in our sample compared with the German sample) experienced by both populations. Another study in a Wisconsin sample of rural women found that weather issues in the winter were also reported as a notable barrier to physical activity.[10] Our assessment of intervention preferences included a variety of delivery modalities that could all be completed indoors during winter months if preferred. Acknowledging the potential impacts of local weather during the timeframe of the intervention is another concern for researchers to

consider, especially for interventions among populations experiencing harsh winters.

Similar to our findings, Knowlton *et al* found fatigue to be a commonly reported barrier among patients living with advanced disease (44.6%).[7] Research among Australian adults with myeloma and German adults living with advanced cancer found fatigue and tiredness/insomnia to be the most frequently reported barriers to physical activity.[29 30] We also found the greatest interest in an intervention designed to increase energy. Together, these findings further support the existing knowledge that individuals with advanced cancer experience fatigue as a barrier to physical activity and seek interventions to overcome energy deficits.[31–33]

Our findings support the existing research that adults living with advanced cancer have an interest in light- or moderate-intensity activities, with our sample having the highest interest in physical therapy and walking activities.[34] In a study conducted among older breast, prostate and colorectal cancer survivors who participated in a 1 year home-based diet and exercise intervention, Blair *et al* (2014) found that increasing levels of light-intensity activity were associated with higher scores of physical function measures.[35] We also found a greater interest in light- to moderate-intensity activities like physical therapy and walking among our sample.

Our results show differences in supportive care intervention programming preferences by demographic characteristics; however, we found less variation in differences by clinical characteristics. In a survey of metastatic cancer survivors in Alabama, Bail *et al* (2021) found interest in supportive care interventions (57%) with the highest overall preference for nutrition classes (46%), metastatic cancer support groups (38%) and gardening (31%).[36] Our sample reported greater interest in supportive care interventions (70%), and we did not find a lot of interest in cooking classes (29%). This contrast may be due to differences in the demographic and clinical characteristics of the two survey samples, with our sample having a higher percentage of male respondents, urban/suburban residents and respondents currently receiving chemotherapy. In our assessment of delivery preferences for a supportive care intervention, we found that most participants have access to a smartphone or tablet and internet at home, which is a promising finding for assessing online delivery of future interventions.

Strengths and limitations

Strengths of our analysis include a focus on the growing population of adults living with advanced cancer. Our study includes an electronic health record-verified cancer diagnosis and well-validated measures of physical activity, GSLTPAQ and MSEQ. We also investigate multiple types of physical activity and general and cancer-specific barriers, which is necessary to design future interventions best suited to meet the needs of this population. In terms of questions addressing intervention preferences, we include questions on both types of programming and delivery preferences to tailor future interventions to meet the unique needs of the population.

Limitations of our study include self-reported demographic and treatment data which may not accurately reflect the respondents' characteristics. We also use self-reported physical activity, as opposed to accelerometers or other wearables, which may have led to an overestimation of physical activity levels among respondents.[25 37] However, a study by Welch *et al* (2017) found little difference in moderate-vigorous activity estimates between accelerometry and self-report using the GSLTPAQ to assess physical activity among breast cancer survivors.[25] Our study sample is limited to one university-affiliated cancer centre in the Midwest, which may limit the generalisability of our results outside of this context.

CONCLUSIONS

Despite general and cancer-specific barriers to physical activity among this population, our study finds that many adults in our sample participate in some physical activity. Future interventions designed to improve physical activity among adults living with advanced cancer should pay attention to activity barriers among this growing population. For example, interventions could emphasise indoor activities and incorporate strategies to manage tiredness such as sleep hygiene and energy conservation techniques. In terms of designing supportive care interventions to meet the needs of adults living with advanced cancer, our study points to an interest in multi-modal interventions designed to improve energy and physical health with physical therapy and walking activities.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants. This study was approved as minimal risk by the University of Wisconsin-Madison's Minimal Risk Institutional Review Board

(Protocol #2022-0966) and by the University of Wisconsin's Carbone Cancer Center's (UWCCC) Protocol Review and Monitoring Committee (Protocol UW22103). An IRB-approved study information sheet was mailed along with the survey. Informed consent from the respondent was obtained through the voluntary return of the survey.

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