Journal of Physical Activity Research, 2023, Vol. 8, No. 1, 32-39
Available online at http://pubs.sciepub.com/jpar/8/1/6
Published by Science and Education Publishing
DOI:10.12691/jpar-8-1-6

Do Hematologic Cancer Survivors Differ from Others in Their Adherence to Physical Activity Guidelines? An Analysis of the 2017-2018 NHIS

Claire L. McCann[1,*], Moya L. Alfonso[1], Steven Hecht[2], Sara Knox[3]

[1]Dr. Pallavi Patel College of Health Care Sciences, Nova Southeastern University, Fort Lauderdale, Florida 33314-7796, USA
[2]Abraham S. Fischler College of Education, Nova Southeastern University, 3301 College Avenue, Fort Lauderdale, Florida 33314-7796, USA
[3]College of Health Professions, Medical University of South Carolina, 151 Rutledge Avenue, Charleston, SC 29407, USA
*Corresponding author: dr.claire.mccann@gmail.com

Received May 14, 2023; Revised July 01, 2023; Accepted July 12, 2023

Abstract Fewer cancer survivors adhere to physical activity guidelines than the general US population. A preliminary study indicated that adherence to physical activity guidelines may be lower among hematologic cancer survivors than other cancer survivors. The purpose of this study was to describe U.S. hematologic cancer survivor adherence to ACSM's physical activity guidelines for cancer survivors between 2017-2018 and to determine whether there is a difference in adherence to the guidelines for hematologic cancer survivors compared to other cancer survivors. A secondary analysis of the 2017 and 2018 National Health Interview Survey was performed. Participants were cancer survivors aged 18 or older. Descriptive statistics were completed for participants' characteristics and adherence to the aerobic, strength, and combined (aerobic and strength) physical activity guidelines. Logistic regression was used to compare adherence to physical activity guidelines for hematologic cancer survivors and other cancer survivors. The study included 235 hematologic cancer survivors and 5,667 other cancer survivors. Adherence to the aerobic, strength, and combined guidelines was 18.3%, 23.6%, and 9.4% for hematologic cancer survivors and 15.1%, 22.4%, and 6.4% for non-hematologic cancer survivors. After controlling for demographic, health-status, and cancer history variables, no difference was found in adherence between hematologic cancer survivors and other cancer survivors. Overall, very few cancer survivors adhered to physical activity guidelines. In contrast to prior studies, more cancer survivors adhered to the strength than the aerobic guideline. Findings from this study indicate that hematologic cancer survivors are not more affected by barriers to physical activity than other cancer survivors and that cancer survivors face greater challenges in adhering to guidelines for aerobic activity than strengthening activity. Further research is needed to identify and minimize barriers to cancer survivor adherence to both aerobic and strength activity guidelines to maximize health benefits.

Keywords: *secondary analysis, physical activity, aerobic, strengthening, cancer survivors, hematologic cancer*

Cite This Article: Claire L. McCann, Moya L. Alfonso, Steven Hecht, and Sara Knox, "Do Hematologic Cancer Survivors Differ from Others in Their Adherence to Physical Activity Guidelines? An Analysis of the 2017-2018 NHIS." *Journal of Physical Activity Research*, vol. 8, no. 1 (2023): 32-39. doi: 10.12691/jpar-8-1-6.

1. Introduction

1.1. Background

Improving mortality rates mean that more Americans are living as hematologic cancer survivors [1]. Hematologic cancer survivors frequently experience long-term side effects of their disease and treatments that often lead to restrictions in daily activities and life roles that can significantly impact their quality of life (QoL) [2,3]. Prior research has demonstrated that exercise diminishes long-term side effects of hematologic cancer [4]. However, cancer survivors often experience barriers to participation in physical activity, such as cancer-related fatigue (CRF), pain, lack of motivation, lack of facilities, weakness, and fear of falling [5].

The first physical activity guidelines for cancer survivors were published in 2010 [6]. In the most recent update, Campbell et al. [7] concluded that there is strong evidence that physical activity is associated with reduced anxiety, fewer depressive symptoms, reduced CRF symptoms, improved health related QoL, and improved physical function. Despite international consensus that physical activity is highly beneficial for cancer survivors, National Cancer Institute estimated that only 15.7% of U.S. cancer survivors meet current physical activity guidelines in 2021 [8].

Previous studies have found that physical deconditioning can often persist for many years for hematologic cancer survivors. Andrykowski et al. [2] and

Kopp et al. [3] found that hematologic cancer survivors scored significantly less on the physical function subscale of the short form 36 (SF-36) compared to age-matched controls five years or more after initial treatment. Similarly, Dirou et al. [9] found that 62.3% of 71 hematologic cancer survivors reported lower than expected physical function subscale SF-36 scores one year after initial treatment. In addition, Dirou et al. [9] measured the exercise capacity of hematologic cancer survivors and found that 49.3% had moderate to severe impairment in exercise capacity. Güçlü et al. [10] also found that hematologic cancer survivors had lower exercise capacity than age-match controls. In that study, hematologic cancer survivors had an average 6-minute walk test score of 580m compared to 677m for the control group ($p < .001$) [10]. Persistent physical deconditioning may affect hematologic cancer survivors' ability or motivation to adhere to the physical activity guidelines.

Prior research suggests that some types of cancer may impact survivor adherence to physical activity guidelines differently than other types of cancer [11,12]. Ottenbacher et al. found that breast cancer survivors behaved more like cancer-free people than other cancer survivors [11]. Mama et al. [12] also demonstrated that type of cancer could affect adherence to physical activity guidelines. They found that after adjusting for age, cancer type, gender, and income, lung cancer survivors were less likely to adhere to the aerobic guidelines than prostate, breast, colorectal, or gynecological cancer survivors (OR = 0.3, 95% CI = [0.1, 0.9]) [12]. To our knowledge, no published studies directly compare hematologic cancer survivors' adherence to physical activity guidelines to other cancer survivors. Consequently, we conducted a preliminary examination of the 2018 National Health Information Survey (NHIS) and found that only 7.1% of hematological cancer survivors adhered to combined physical activity guidelines. This suggests that hematological cancer survivors may have lower adherence rates than the general population of cancer survivors (15.7%) [8].

1.2. Purpose

The purpose of the study was to describe U.S. hematologic cancer survivor adherence to ASCM's physical activity guidelines for cancer survivors during the 2017-2018 period and to determine whether there is a difference in adherence to physical activity guidelines for hematologic cancer survivors compared to other cancer survivors. The research question was, does adherence to current guidelines for aerobic activity, strengthening activity, and combined activity differ between hematologic cancer survivors and other cancer survivors?

2. Methods

2.1. Study Design

This retrospective, cross-sectional study used publicly available data from the National Health Information Survey (NHIS). The data files used were the 2017 and 2018 'adult sample' files [13,14]. The NHIS has been conducted annually since 1956 [15] and provides de-identified cross-sectional data from a sample of the U.S. population. The U.S. Census Bureau administers the NHIS and trains interviewers who collect data throughout the year using computer-assisted personal interviews. Interviews are primarily conducted in participants' homes. Phone calls are used to complete interviews upon participant request or in cases of challenging weather or travel conditions [16]. Questions about physical activity are included in the adult sample portion of the NHIS. National Center for Health Statistics (NCHS) revised the NHIS physical activity questions in 1997 based on questions previously utilized in surveys in Australia, Finland, Canada, and other U.S. surveys. With the revisions, NCHS aimed to improve the validity and reliability of the physical activity items while maintaining consistency with other areas of the NHIS. Since 1997, there have been minimal changes to the NHIS physical activity questions [17]. The total household response rate of the 2017 NHIS was 66.5%, with a conditional sample adult response rate of 80.7% [18]. For the 2018 NHIS, the total household response rate was 64.2% and the conditional adult sample response rate was 83.9% [16]. For further information on the 2017 and 2018 NHIS, including information on validity and reliability, please refer to the survey description documents that are freely available on the NHIS website [16,18]. The Institutional Review Board of Nova Southeastern University granted this study exempt status on the basis that it used previously collected data. The NHIS does not require a data use agreement to be signed.

2.2. Participants

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Participant in 2017 or 2018 adult sample NHIS	Missing data for both aerobic and strength activity
Aged 18 years or older at time of survey	Refused to answer what kind of cancer
Responded 'yes' when asked if ever been diagnosed with cancer	Responded 'don't know' to what kind of cancer
	Reported both hematologic cancer and non-hematologic cancer

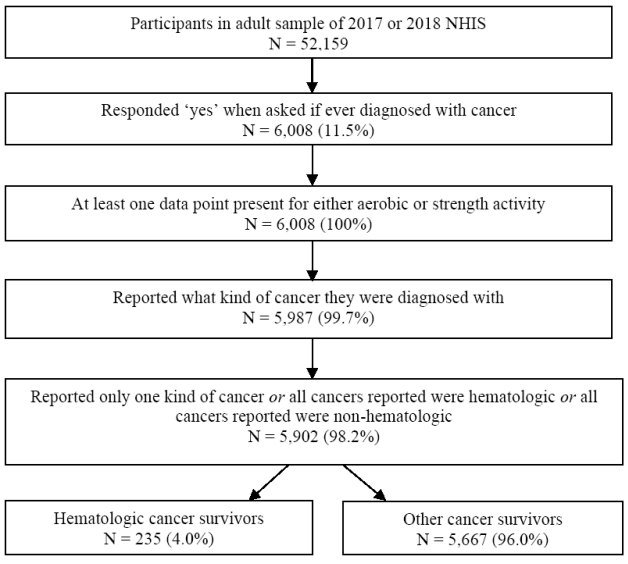

Figure1. Cohort Selection

The inclusion criteria used by NCHS for the NHIS were persons residing in residential households or non-institutional group quarters within the 50 states of the U.S. and the District of Columbia [16]. There were 26,742 participants in the adult sample portion of the 2017 NHIS and 25,417 participants in the adult sample of the 2018 NHIS. Inclusion and exclusion criteria for this study were chosen so that the resulting cohort would include cases in which at least one of the dependent variables was present, and the comparison groups were mutually exclusive. The inclusion and exclusion criteria are shown in Table 1 and the cohort selection diagram is shown in Figure 1.

2.3. Variables

Independent Variable. The independent variable for the study was the type of cancer the participant reported having. The independent variable was identified using the NHIS question, "What kind of cancer?" Participants who responded that they had (a) blood cancer, (b) leukemia, or (c) lymphoma were classified as having hematologic cancer. Participants who did not indicate any of these types of cancer were classified as having other cancer.

Dependent Variables. American College of Sports Medicine's (ACSM) Physical Activity Guidelines for Cancer Survivors [19] were used to define three dependent variables: participant adherence to (a) the aerobic guideline, (b) the strength guideline, and (c) combined aerobic and strength guidelines. A summary of the ASCM guidelines can be found in Table 2. ***Adherence to Aerobic Guidelines***: ACSM states that cancer survivors should perform at least 150 minutes of moderate aerobic activity, or 75 minutes of vigorous aerobic activity, or an equivalent combination [19]. The ACSM guidelines imply that minutes of vigorous aerobic activity are worth double that of moderate aerobic activity. Consistent with the guidelines and methods used in prior studies [20, 21], we calculated participants' total aerobic activity minutes by adding the number of moderate aerobic activity minutes to two times the number of vigorous aerobic activity minutes. Participants whose total aerobic activity minutes met or exceeded 150 were classified as having met the aerobic activity guidelines. Participants whose total aerobic activity minutes were less than 150 minutes were classified as failing to meet the aerobic activity guidelines. ***Adherence to Strengthening Activity Guidelines***: The ACSM guideline for strengthening activity is that strengthening activities be performed at least twice per week. Therefore, participants who reported performing strengthening activities two or more days a week were classified as adhering to the guideline. Participants who said they did not perform strengthening physical activity or only performed strengthening once a week were classified as not adhering to the guideline. ***Adherence to Combined Activity Guidelines***: To be classified as adhering to the combined guidelines, participants needed to meet the aerobic and strengthening requirements, as defined above.

Confounders. Ten covariates from the NHIS dataset were included in the multivariate analysis as potential confounding variables based on evidence from prior literature. Age and time since cancer diagnosis were included as continuous variables. Sex, race, marital status, parental status, obesity, comorbidities, childhood cancer diagnosis, and functional limitation were included as categorical variables.

Table 2. Physical Activity Guidelines for Cancer Survivors

	Aerobic	Strengthening
Frequency	3-5 days/week	2-3 days/week
Intensity	Moderate (RPE 12-13) or vigorous (14-17)	Start with low resistance (<30% 1RM) and progress with the smallest increments possible.
Time	75 mins/week vigorous-intensity or 150 mins/week moderate-intensity or an equivalent combination of the two.	At least 1 set of 8-12 repetitions
Type	Prolonged rhythmic activities using large muscle groups (e.g., walking, cycling, swimming)	Free weights, resistance machines, or weight-bearing functional tasks targeting all major muscle groups.

Note. Adapted from ACSM's Guidelines for Exercise Testing and Prescription (10th ed.) by American College of Sports Medicine, 2018, Philadelphia, Wolters Kluwer. Copyright 2018 by American College of Sports Medicine. RPE = rating of perceived exertion; 1RM = one repetition max.

2.4. Power

G*Power software [22] was used to calculate the minimum required sample size for the logistic regression. The estimated effect size was calculated by the software using the prevalence of hematologic cancer survivors adhering to the combined guidelines in the 2018 NHIS (7.1%) and the NCI estimate of 16% for all cancer survivors. This provided an estimated odds ratio (OR) of 2.53 (considered a small effect size [23]). When applying an expected odds ratio of 2.53, a power of .80, and an alpha level of .01, a total minimal sample size of 3,786 participants was needed to detect a difference in adherence to physical activity guidelines between hematologic cancer survivors and other cancer survivors. Using frequency tables of summary data available from NCHS, it was calculated that two years of NHIS data would be needed to achieve the minimum sample size.

2.5. Statistical Methods

All statistical analyses were performed using IBM SPSS software (v. 28.0). The group characteristics were compared using the Chi-Squared Test for Independence with Yates' Correction for Continuity for categorical variables and independent samples t-tests for the continuous variables. Separate binary logistic regression analyses were performed for each of the dependent variables. The significance level for the analyses was set at $p < .01$. Results were not adjusted for the complex multi-stage sampling design used for the NHIS.

3. Results

3.1. Participants

The 5,902 participants in the study had a mean age of 66.72 years (interquartile range [IQR] 59.00 – 77.00

years). Most participants were female (59.4%) and White (89.0%). Black/ African American, American Indian or Alaska Native (AIAN), Asian, and multiple races comprised 6.4%, 0.4%, 2.3%, and 0.1% of the study population. Participants were almost equally split between married/cohabiting (50.8%) and not married/ not cohabiting (49.0%), and most participants did not have a dependent child at home (89.3%). More than two-thirds of the participants had two or more comorbidities (69.2%). The mean BMI of participants was 28.03 (IQR 23.75 – 31.01), and 64.7% of participants were obese. Around two-thirds of participants had a functional limitation (67.7%). Most participants were diagnosed with cancer in adulthood (96.3%), and on average, there had been 12.88 years since participants were first diagnosed with cancer. Participant characteristics are summarized in Table 3.

Table 3. Comparison of Group Characteristics

	All participants N = 5,902 (range or %)	**Hematologic Cancer Survivors N = 235 (range or %)**	**Other Cancer Survivors N = 5,667 (range or %)**	**Test statistic (t or x^2 value)**	**Significance level**
Mean age (IQR)	66.72 (59.00-77.00)	60.66 years (48-75)	66.98 years (60-77)	-5.507	< .001*
Sex					
Male	2,408 (40.8%)	129 (54.9%)	2,279 (40.2%)	19.525	< .001*
Female	3,494 (59.2%)	106 (45.1%)	3,388 (59.8%)		
Race					
White	5,254 (89.0%)	201 (85.5%)	5,053 (89.2%)	4.442	.488
Black/African American	376 (6.4%)	21 (8.9%)	355 (6.3%)		
AIAN	26 (0.4%)	1 (0.4%)	25 (0.4%)		
Asian	136 (2.3%)	8 (3.4%)	128 (2.3%)		
Multiple	7 (0.1%)	0	7 (0.1%)		
Not releasable	103 (1.7%)	4 (1.7%)	99 (1.7%)		
Marital Status					
Married/ cohabiting	3,001 (50.8%)	130 (55.3%)	2,871 (50.7%)	1.720	.190
Not married/ not cohabiting	2,893 (49.0%)	105 (44.7%)	2,788 (49.3%)		
Parental Status					
Child in home	632 (10.7%)	39 (16.6%)	593 (10.5%)	8.243	.004*
No child in the home	5,270 (89.3%)	196 (83.4%)	5,074 (89.5%)		
Comorbidities[a]					
≥2	4,083 (69.2%)	139 (59.1%)	3,944 (69.8%)	11.445	< .001*
<2	1,806 (30.6%)	96 (40.9%)	1,710 (30.2%)		
Mean BMI		27.66	28.05		
Obese[b]	3,819 (64.7%)	155 (66.0%)	3,664 (64.7%)	0.144	.705
Not obese	1,915 (32.4%)	73 (31.1%)	1,842 (32.5%)		
Functional limitation[c]	3,998 (67.7%)	146 (62.1%)	3,852 (68.0%)	3.472	.062
Mean time since diagnosis	12.88 years	11.04 years	12.95 years	-2.816	.005*
Childhood diagnosis					
Childhood	166 (2.8%)	24 (10.2%)	142 (2.5%)	46.200	< .001*
Adulthood	5,681 (96.3%)	209 (88.9%)	5,472 (96.6%)		

Note: [a] Comorbidities variable included coronary heart disease, angina, heart attack/myocardial infarction, other heart conditions, stroke, emphysema, COPD, asthma, diabetes, arthritis/rheumatoid, arthritis/gout/lupus/fibromyalgia, hypertension, and high cholesterol. [b] Obesity was defined as a body mass index > 25 kg/m^2. [c] The functional limitation variable was derived from the NHIS variable "FLA1AR" which is calculated based on participant answers to 12 activities. [d] Childhood diagnosis was defined as receiving a first cancer diagnosis at age 17 or younger.
* $p < .01$

The hematologic cancer survivors were younger than the other survivors ($p < .001$). Compared to other cancer survivors, hematologic cancer survivors were also more likely to be male ($p < .001$), have a dependent child at home ($p = .004$), and have been diagnosed with cancer in childhood ($p < .001$). In addition, hematologic cancer survivors were less likely to have two or more comorbidities ($p < .001$). At the time of the survey, other cancer survivors were more years out from their initial cancer diagnosis than hematologic cancer survivors ($p = .005$). No other variables demonstrated significant differences between hematologic cancer survivors and other cancer survivors.

Of the 235 hematologic cancer survivors, most had lymphoma diagnoses (62.6%), whereas fewer reported leukemia (28.1%), and blood cancer (10.6%). Non-melanoma skin cancer (22.8%) was the most common cancer among participants with other cancers. That was followed by breast cancer (20.4%), prostate cancer (12.6%), unknown type skin cancer (9.7%), melanoma (8.0%), cervical cancer (5.8%), colon cancer (5.8%), other non-listed cancer (5.6%), uterine cancer (3.9%), lung cancer (3.2%), bladder cancer (2.8%), thyroid cancer (2.8%), and ovarian cancer (2.0%). All other defined cancers individually represented less than 1% of the non-hematologic cancer survivors. Details of the cancer diagnoses reported by participants are displayed in Table 4.

Table 4. Summary of Cancer Diagnoses Reported by Participants

	N	% Total	% Subgroup
Hematologic			
Blood	25	0.4	10.6
Leukemia	66	1.1	28.1
Lymphoma	147	2.5	62.6
Non-Hematologic			
Bladder	161	2.7	2.8
Bone	47	0.8	0.8
Brain	33	0.6	0.6
Breast	1,156	19.6	20.4
Cervix	326	5.5	5.8
Colon	331	5.6	5.8
Esophagus	33	0.6	0.6
Gall Bladder	4	0.1	0.1
Kidney	130	2.2	2.3
Laryngeal	21	0.4	0.4
Liver	27	0.5	0.5
Lung	180	3.0	3.2
Melanoma	452	7.7	8.0
Mouth/tongue/lip	26	0.4	0.5
Ovary	115	1.9	2.0
Pancreas	31	0.5	0.5
Prostate	713	12.1	12.6
Rectum	37	0.6	0.7
Skin – non-melanoma	1,292	21.9	22.8
Skin – unknown	548	9.3	9.7
Soft tissue	28	0.5	0.5
Stomach	43	0.7	0.8
Testis	48	0.8	0.8
Throat/pharynx	50	0.8	0.9
Thyroid	159	2.7	2.8
Uterus	231	3.9	4.1
Other	371	5.4	5.6

3.2. Results

Performance was low across all three outcome measures. Only 15.2% (n = 896) of all cancer survivors adhered to the aerobic guideline, and 22.4% (n = 1313) met the strength guideline. Adherence to the combined guidelines was very low at 6.5% (n = 383). Of all the 5,902 cancer survivors in this study, only 1,826 (31.1%) adhered to at least one of the physical activity guidelines.

Among hematologic cancer survivors, adherence was 18.3% for the aerobic guidelines, 23.6% for the strengthening guidelines, and 9.4% for the overall guidelines. These numbers compare to 15.1%, 22.4%, and 6.4% among other cancer survivors. A summary of participant adherence to the physical activity guidelines are displayed in Table 5. Univariate analysis demonstrated that there were no significant differences between the groups for any of the guidelines. The results of the binary logistic regression are shown in Table 6.

3.3. Other Analyses

Multivariate analysis demonstrated that, when controlling for age, sex, race, marital status, parental status, comorbidities, obesity, functional limitation, time since diagnosis, and childhood diagnosis, there remained no significant differences between the groups for any of the guidelines. The Chi-Square Test for Goodness of Fit demonstrated that a greater proportion of participants adhered to the strengthening guideline than the aerobic guideline among both hematologic cancer survivors (p = .036) and other cancer survivors (p < .001).

Table 5. Cancer Survivor Adherence to Physical Activity Guidelines

	All N = 5,902		**Hematologic CS N = 235**		**Other CS N = 5,667**	
	Adhere	*Do not adhere*	*Adhere*	*Do not adhere*	*Adhere*	*Do not adhere*
Aerobic	896 (15.2%)	5002 (84.8%)	43 (18.3%)	192 (81.7%)	853 (15.1%)	4810 (84.9%)
Strength	1313 (22.4%)	4546 (77.6%)	55 (23.6%)	178 (76.4%)	1258 (22.4%)	4368 (77.6%)
Overall	383 (6.5%)	5472 (93.5%)	22 (9.4%)	211 (90.6%)	361 (6.4%)	5261 (93.5%)
p-value for difference between aerobic and strength	< .001*		.036*		< .001*	

Note: C.S. = cancer survivor

* = significant difference between adherence to the aerobic and strength guidelines.

Table 6. Binary Logistic Regression Comparing Hematologic to Other Cancer Survivors

	B	*S.E.*	Wald	*df*	*p*	OR	95% CI for OR	
							Lower	*Upper*
Aerobic	.233	.173	1.825	1	.177	1.263	0.900	1.772
Strength	.070	.158	.199	1	.655	1.073	0.788	1.461
Combined	.418	.231	3.293	1	.070	1.520	0.967	2.388

4. Discussion

Overall, participant adherence to the physical activity guidelines was low, with 69% of all the cancer survivors surveyed not adhering to any of the physical activity guidelines. Adherence to the aerobic and combined physical activity guidelines was somewhat lower than in previous studies. In prior studies of cancer survivors, adherence to the combined guidelines varies from 9% to 22% [11,12,20,21,24], and adherence to the aerobic guideline varies from 24% to 51% [11,12,20,21,24]. Response bias may be responsible for some of this difference. Most previous studies sampled cancer survivors specifically and used surveys that were narrowly focused on physical activity habits, meaning that cancer survivors interested in physical activity were more likely to respond. In contrast, this study used data from a survey designed to study health and health habits more globally and for the general population. Therefore, response bias is

likely less of a factor in the NHIS than in the studies that focused narrowly on physical activity.

Low adherence to physical activity guidelines is a public health problem. Rates of heart disease and other diseases that are preventable with increased physical activity are rising, along with expenditures to treat them [25]. Cancer survivors are more at risk of these preventable diseases than those without cancer [26,27]. Adherence to the physical activity guidelines has multiple benefits for cancer survivors, including symptom management, prevention of secondary cancers, primary prevention of comorbid conditions, and, in the case of some cancers, improved survival [7]. A functional limitation is one possible consequence of cancer or cancer interventions that physical activity can help alleviate [7]. The fact that around 68% of all the cancer survivors in this study had a functional limitation highlights the need for cancer survivors to be physically active. Efforts to improve adherence to physical activity guidelines are essential for the general population's health; this study highlights the need for increased focus on improving adherence to physical activity guidelines for cancer survivors.

Logistic regression analyses did not indicate any difference between hematologic cancer survivors and other cancer survivors in adherence to the aerobic, strengthening, or combined physical activity guidelines. There were some important differences between the groups: the hematologic cancer group was younger, contained more males, and was less likely to have two or more comorbidities. These characteristics are associated with a higher likelihood of adhering to the physical activity guidelines. However, after adjusting for these covariables, there was no significant effect of type of cancer on adherence to the physical activity guidelines.

An interesting difference between the results of this study and prior studies is that cancer survivors' adherence to the strengthening guidelines was better than the aerobic guideline. Most prior studies of cancer survivors have found that more cancer survivors adhered to the aerobic guideline than the strength guideline whereas, the large-scale examination of the 2015 Behavioral Risk Factor Surveillance System (BRFSS) by Bennie et al. [28] reported similar findings to ours. They found that the adjusted prevalence ratio of cancer survivors adhering to the strength-only guideline was higher than those adhering to the aerobic-only guideline [29].

Methodologic differences could account for the difference in findings regarding adherence to the strengthening versus aerobic guideline. While previous studies have used the same definitions of adherence to the aerobic and strengthening guideline as this study, many have not used the same question phrasing as the NHIS. For example, Ottenbacher et al. [11] used the Health Information National Trends Survey, Crawford et al. [20] and Tabaczynski et al. [24] used the Godin Leisure-Time Exercise Questionnaire, and Mama et al. [12] used items from the BRFSS. Differences in question phrasing between the NHIS and the other surveys may have led to cancer survivors reporting their physical activity differently. An analysis of the convergent validity of the relevant survey items would help explain differences in adherence levels between this study and prior studies of cancer survivor physical activity guidelines.

Other studies of cancer survivors have found that specific characteristics make it more likely that cancer survivors adhere to only the strength guideline over only the aerobic guideline. Tabaczynski et al. [24] reported that older survivors of kidney cancer were more likely to adhere to only the strengthening guideline compared to the aerobic guidelines (OR 3.26, 95% CI = 1.60; 6.64, $p < .01$) [22]. Tabaczynski et al. [23] suggested that strengthening activity can be done at lower intensities than aerobic activity, so adherence to the strengthening guidelines might be easier for older cancer survivors. Conversely, Tabaczynski et al. [23] also suggest that younger and more physically able cancer survivors may perceive aerobic activity as more important than strength activity, or perhaps they do not see the benefits of strengthening exercise. Our results indicate that many cancer survivors, not just older cancer survivors, may find strengthening physical activity easier than aerobic activity. Further research is needed into differences in cancer survivor adherence to the strength versus aerobic physical activity guideline.

5. Limitations

An inherent weakness of secondary data analysis is that the investigator was not involved in data collection and may not fully understand the intricacies of the data or fully appreciate the validity and reliability of the data collection methodology [29,30]. Another limitation of using secondary analysis for this study is that the results are not adjusted for the sampling strategy. The NHIS uses a complex multi-stage sampling design that we did not adjust for, therefore this study's results cannot be used as population estimates.

A significant limitation of the study is that it used self-report for the dependent variables. Although wearable technologies have become more accurate and practical in recent years, they have significant limitations and remain imprecise in measuring physical activity. Therefore, biological measures of physical activity for population-level studies remain limited, and self-report has been an accepted measure of physical activity for many years [31, 32]. All self-report measures are subject to response bias. The data collection methods used for the NHIS make it vulnerable to response bias caused by social desirability bias, incorrect recall, and inaccurate averaging of time spent performing physical activity.

An inconsistency between the current physical activity guidelines and how the NHIS measures aerobic activity may have affected the results of the study. The current recommendations for aerobic physical activity are that cancer survivors should participate in at least “75 minutes per week of vigorous-intensity or 150 minutes per week of moderate-intensity [aerobic] activity or an equivalent combination of the two” (p. 305) [19]. The NHIS asks one set of questions about vigorous aerobic activity and a second set of questions about light or moderate physical activity. Combining light and moderate activity in the same question may have inflated the estimate of adherence to aerobic activity because the current guidelines specify

the need for at least moderate aerobic activity. However, any overestimation would have occurred similarly in both groups and therefore should not substantially affect the results. Additionally, NCI uses NHIS data when reporting cancer tracking statistics. Thus, the statistics reported in this study are comparable to government statistics.

The study used survey data from the 2017 and 2018 NHIS, meaning that the data is slightly outdated. A redesign of the NHIS in 2019 placed the physical activity questions on a two-year rotation, so from 2019 onwards, they only appear in even-numbered years [17]. The most recent data available when the study was performed in 2022 was the 2020 NHIS data set. However, although the 2020 data set includes the physical activity question set, early research indicates that physical activity patterns were affected by the COVID-19 pandemic [33,34]. Although the COVID-19 pandemic has affected physical activity habits and warrants further investigation, such an investigation was beyond the scope of this study. Therefore, the most recent data before the pandemic was used to avoid introducing historical event bias into the study.

The results of this study only apply to the participants of the 2017 and 2018 NHIS and may not be generalizable to the general population of cancer survivors. The sampling strategy used by NCHS for the NHIS was designed for the general US population and not for cancer survivors, therefore, the sample in this study may not be representative of all U.S. cancer survivors. Despite these limitations, this study is the first large-scale study to examine physical activity guideline adherence among U.S. hematologic cancer survivors and highlights how few hematologic and non-hematologic cancer survivors adhere to the guidelines.

6. Conclusions

Very few U.S. cancer survivors are adhering to international physical activity guidelines. Despite long-lasting side effects of treatment, hematologic cancer survivors do not differ from other cancer survivors in terms of adherence to physical activity guidelines. A novel finding of this study is that more cancer survivors adhere to the strength guideline than the aerobic guideline. Because both aerobic and strengthening physical activity are important to reducing the burden of symptoms, further research is needed to investigate the difference in cancer survivor behavior between adherence to the strength guideline compared to the aerobic guideline.

References

[1] Henley S.J., Ward E.M., Scott S., MS, J., Anderson, R.N., Firth, A.U., Thomas, C.C., Islami, F., Weir, H. K., Lewis, D.R., Sherman, R.L., Wu, M., Bernard, V.B., Richardson, L.C., Jemal, A., Cronin, K., and Kohler, B.A. "Annual report to the nation on the status of cancer, part I: National cancer statistics", Cancer, 126(10), 2225-2249, May 2020, https://doi.org/10.1002/cncr.32802

[2] Andrykowski M.A., Bishop M.M., Hahn E.A., Cella, D.F., Beaumont, J.L., Brady, M.J., Horowitz, M.M., Sobocinski, K.A., Rizzo, J.D., and Wingard, J.R. "Long-term health-related quality of life, growth, and spiritual well-being after hematopoietic stem-cell transplantation", Journal of Clinical Oncology, 23(3), 599-608, January 2005, https://doi.org/10.1200/JCO.2005.03.189

[3] Kopp M., Holzner B., Meraner V., Sperner-Uterwger, B., Kemmler, G., Nguyen-Van-Tam, D.P., and Nachbaur, D. "Quality of life in adult hematopoietic cell transplant patients at least 5 years after treatment: a comparison with healthy controls", European Journal of Heamatogy, 74, 304-308, April 2005.

[4] Persoon S. Physical Exercise in Patients Treated with Hematopoietic Stem Cell Transplantation. Ph.D. thesis, University of Amsterdam. UvA-DARE Academic Digital Repository; 2018.

[5] Blaney J.M., Lowe-Strong A., Rankin-Watt J., Campbell A., and Gracey J.H. "Cancer survivors' exercise barriers, facilitators and preferences in the context of fatigue, quality of life and physical activity participation: A questionnaire-survey", Psycho-oncology, 22(1), 186-194, January 2013. https://doi.org/10.1002/pon.2072

[6] Schmitz K.H., Courneya K.S., Matthews C., Demark-Wahnefried, W., Galvão, D.A., Pinto, B.M., Irwin, M.L., Wolin, K.Y., Segal, R.J., Lucia, A., Schneider, C.M., von Gruenigen, V.E., and Schartz, A.L., "American college of sports medicine roundtable on exercise guidelines for cancer survivors", Medicine & Science in Sports & Exercise. 42(7), 1409-1426, July 2010. https://doi.org/10.1249/MSS.0b013e3181e0c112

[7] Campbell K.L., Winters-Stone K.M., Wiskemann J., May, A., Schwartz, A.L., Courneya, K.S., Zucker, D.S., Matthews, C.E., Ligibel, J.A., Gerber, L.H., Stephen, M.G., Patel, A.V., Hue, T.F., Perna, F.M., and Schmitz, K.H., "Exercise guidelines for cancer survivors: Consensus statement from international multidisciplinary roundtable", Medicine & Science in Sports & Exercise, 51(11), 2375-2390, November 2019. https://doi.org/10.1249/MSS.0000000000002116

[8] National Cancer Institute. "Cancer survivors and physical activity". Cancer Trends Progress Report. Published 2021. Accessed March 9, 2021. https://progressreport.cancer.gov/after/physical_activity

[9] Dirou S., Chambellan A., Chevallier P., Germaud, P., Lamirault, G., Gourraud, P-A., Perrot, B., Delasalle, B., Forestier, B., Guillaume, T., Peterlin, P., Garnier, A., Magnan, A., Blanc, F-X., and Lemarchand, P., "Deconditioning, fatigue and impaired quality of life in long-term survivors after allogeneic hematopoietic stem cell transplantation", Bone Marrow Transplantation, 53(3), 281-290, March 2018. https://doi.org/10.1038/S41409-017-0057-5

[10] Güçlü M.B., Bargı G., and Sucak G.T., "Impairments in dyspnea, exercise capacity, physical activity and quality of life of allogeneic hematopoietic stem cell transplantation survivors compared with healthy individuals: a cross sectional study", Physiotherapy Theory and Practice. 37(1), 52-63, January 2021. https://doi.org/10.1080/09593985.2019.1594473

[11] Ottenbacher A., Yu M., Moser R.P., Phillips S.M., Alfano C., and Perna F.M., "Population estimates of meeting strength training and aerobic guidelines, by gender and cancer survivorship status: Findings from the Health Information National Trends Survey (HINTS)", Journal of Physical Activity and Health. 12, 675-679, May 2015. https://doi.org/10.1123/jpah.2014-0003

[12] Mama S.K., Bhuiyan N., Foo W., Segal, J.E., Bluethmann, S.M., Winkels, R.M., Wiskemann, J., Calo, W.A., Lengerich, E.J., and Schmitz, K.H.' "Rural-urban differences in meeting physical activity recommendations and health status in cancer survivors in central Pennsylvania", Supportive Care in Cancer. 28, 5013-5022, October 2020. https://doi.org/10.1007/s00520-020-05342-y

[13] National Center for Health Statistics. NHIS - 2017 Data Release (Sample Adult) [Data Set].; 2018. Accessed August 31, 2022. https://www.cdc.gov/nchs/nhis/nhis_2017_data_release.htm

[14] National Center for Health Statistics. NHIS - 2018 Data Release (Sample Adult) [Data Set]. Published 2019. Accessed January 22, 2020. https://www.cdc.gov/nchs/nhis/nhis_2018_data_release.htm

[15] National Center for Health Statistics. NHIS - About the National Health Interview Survey. Published September 2020. Accessed August 3, 2021. https://www.cdc.gov/nchs/nhis/about_nhis.htm

[16] National Center for Health Statistics. Survey Description, National Health Interview Survey, 2018. National Center for Health Statistics; 2019. Accessed August 24, 2022. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2018/srvydesc.pdf

[17] National Center for Health Statistics. NHIS - Adult Physical Activity - Overview of Topics. Published 2017. Accessed August 3, 2021. https://www.cdc.gov/nchs/nhis/physical_activity/pa_overview.htm

[18] National Center for Health Statistics. Survey Description, National Health Interview Survey, 2017. National Center for Health Statistics; 2018. Accessed August 24, 2022. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2017/srvydesc.pdf

[19] American College of Sports Medicine, ACSM's Guidelines for Exercise Testing and Prescription, 10th ed., Wolters Kluwer, Philadelphia, 2018.

[20] Crawford J.J., Holt N.L., Vallance J.K., and Courneya K.S., "A new paradigm for examining the correlates of aerobic, strength, and combined exercise: an application to gynecologic cancer survivors", Supportive Care in Cancer, 24, 3533-3541, August 2016. https://doi.org/10.1007/s00520-016-3173-7

[21] Vallerand J.R., Rhodes R.E., Walker G.J., and Courneya K.S., "Correlates of meeting the combined and independent aerobic and strength exercise guidelines in hematologic cancer survivors"., International Journal of Behavioral Nutrition and Physical Activity, 14(1), 44, March 2017. https://doi.org/10.1186/s12966-017-0498-7

[22] Faul F., Erdfelder E., Lang A.G., and Buchner A., "G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences", Behavior Research Methods. 39(2), 175-191, May, 2007. https://doi.org/10.3758/bf03193146

[23] Chen H., Cohen P., and Chen S., "How big is a big odds ratio? Interpreting the magnitudes of odds ratios in epidemiological studies", Communications in Statistics- Simulation and Computation, 39(4), 860-864, 2010. https://doi.org/10.1080/03610911003650383

[24] Tabaczynski A., Strom D.A., Wong J.N., McAuley, E., Larsen, K., Faulkner, G. E., Courneya, K.S., and Trinh, L., "Demographic, medical, social-cognitive, and environmental correlates of meeting independent and combined physical activity guidelines in kidney cancer survivors", Supportive Care in Cancer, 28, 43-54, January 2020. https://doi.org/10.1007/s00520-019-04752-x

[25] Anderson E., and Durstine J.L., "Physical activity, exercise, and chronic diseases: A brief review", Sports Medicine and Health Science, 1(1), 3-10, December 2019. https://doi.org/10.1016/j.smhs.2019.08.006

[26] Armenian S.H., and Chow E.J., "Cardiovascular disease in survivors of hematopoietic cell transplantation", Cancer, 120(4), 469-479, February 2014. https://doi.org/10.1002/CNCR.28444

[27] Scott J.M., Armenian S., Giralt S., Moslehi J., Wang T., and Jones L.W., "Cardiovascular disease following hematopoietic stem cell transplantation: Pathogenesis, detection, and the cardioprotective role of aerobic training", Critical Reviews in Oncology/Hematology, 98, 222-234, February 2016. https://doi.org/10.1016/j.critrevonc.2015.11.007

[28] Bennie J.A., de Cocker K., Teychenne M.J., Brown W.J., and Biddle S.J.H., "The epidemiology of aerobic physical activity and muscle-strengthening activity guideline adherence among 383,928 U.S. adults", International Journal of Behavioral Nutrition and Physical Activity. 16, article number 24, 2019. https://doi.org/10.1186/S12966-019-0797-2

[29] Cheng H.G., and Phillips M.R., "Secondary analysis of existing data: opportunities and implementation", Shanghai Archives of Psychiatry. 26(6), 371-375, December 2014.

[30] Christensen L.B., Johnson R.B., and Turner L.A., Research Methods: Design and Analysis, 12th ed., Pearson, Boston, 2014.

[31] Ainsworth B., Cahalin L., Buman M., and Ross R., "The current state of physical activity assessment tools", Progress in Cardiovascular Disease. 57(4), 387-395, January-February 2015. https://doi.org/10.1016/J.PCAD.2014.10.005

[32] Strath S.J., Kaminsky L.A., Ainsworth B.E., Ekelund, U., Freedson, P., Gary, R.A., Richardson, C.R., Smith, D.T., and Swartz, A.M., "Guide to the assessment of physical activity: Clinical and research applications", Circulation. 128(20), 2259-2279, November 2013. https://doi.org/10.1161/01.CIR.0000435708.67487.DA

[33] Caputo E.L., and Reichert F.F., "Studies of physical activity and COVID-19 during the pandemic: A scoping review", Journal of Physical Activity and Health. 17(12), 1275-1284, December 2020. https://doi.org/10.1123/JPAH.2020-0406

[34] Tison G.H., Avram R., Kuhar P., Abreau, S., Marcus, G.M., Pletcher, M.J., and Olgin, J.E., "Worldwide effect of COVID-19 on physical activity: A descriptive study", Annals of Internal Medicine, 173(9), 767-770, November 2020. https://doi.org/10.7326/M20-2665