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RESEARCH ARTICLE

Odds of Meeting Physical Activity Guidelines by Cancer History: Updated Results from the Health Information National Trends Survey (HINTS)

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Abstract

Background: Despite proven benefits of physical activity, adults in the United States may not be meeting activity guidelines for aerobic and strength exercise. There is an association between physical activity and reduced cancer risk, and reduced risk of reoccurrence among cancer survivors. This study aims to describe the odds of meeting aerobic, strength, and combined levels of physical activity based on the recommendations of the Physical Activity Guidelines for Americans among adults in the U.S., making comparisons by cancer status and demographics.

Methods: Logistic regression of cross-sectional data from Cycles 4 and 5 of the Health Information National Trends Survey (HINTS) was conducted. The independent variables were cancer type, age, race/ethnicity, education level, income, and data year; dependent variables included meeting aerobic, strength, and combined aerobic and strength physical activity guidelines. Analyses were stratified by gender.

Results: Among women, 25.6% who survived all other cancers met aerobic physical activity guidelines of at least 150 minutes of medium intensity or higher levels of physical activity weekly, while 32.4% of breast cancer survivors and 35.6% of those with no cancer history met aerobic guidelines. Female survivors of cancers other than breast cancer compared to those with no cancer history had significantly lower odds (OR = 0.6, p = 0.004) of meeting aerobic physical activity guidelines. Women and men of all age groups compared to those ages 18-34 had lower odds (all $p < 0.05$) of meeting both aerobic and strength physical activity guidelines. Non-Hispanic Black men compared to white men (OR = 2.5, $p < 0.001$), high-income women ($ 75,000 or more per year) compared to those making under $20,000 (OR = 1.5, p = 0.030), and women of all education levels compared to women with less than high school education had higher odds of meeting both aerobic and strength guidelines (all $p < 0.05$).

Conclusions: Female cancer survivors and older adults have lower odds of meeting physical activity guidelines; exercise interventions targeting these groups may be necessary to address this disparity.

Keywords

Aerobic exercise, Strength training, Cross-sectional survey, Breast cancer, Prostate cancer

Introduction

Cancer is the second leading cause of death in the United States, accounting for 21.8% of deaths in 2015-2016 [1]. There appears to be a relationship between physical activity and risk of cancer incidence; high versus low levels of physical activity is associated with lower risk for 13 cancer types [2] and as a result, there is a high level of interest in exploring the linkage further. The Physical Activity Guidelines for Americans published by the U.S. Department of Health and Human

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Services recommend 150 minutes of moderate intensity or 75 minutes of vigorous intensity aerobic activity weekly, in addition to muscle strengthening activities on at least 2 days per week for all adults [3]. For adults with cancer, current research-based guidelines suggest that survivors seek to achieve this level of activity as soon as possible after diagnosis and treatment [4].

Further, while the relationship between physical activity and cancer incidence is associational, there is also evidence that physical activity is associated with lower risk of adverse side effects of cancer and medical treatments, and lower mortality after diagnosis [5]. For instance, cancer patients undergoing treatment may suffer from the effects of cachexia, or muscle wasting, which is exacerbated by some kinds of cancer therapy [6]; chemotherapy in particular may cause side effects including fatigue, nausea, hair loss, weight changes, mood changes, and other effects that negatively impact quality of life [7]. Among cancer patients undergoing treatment, aerobic and strength activity interventions have been shown to increase muscle mass, muscle strength, physical functioning, and balance and reduce fatigue [8,9]. Physical activity can also improve multiple psychological and psychosocial outcomes, outcomes of particular focus for individuals diagnosed with cancer. Specifically, exercise interventions have led to improvements in depression, anxiety, body image, well-being, mood, and health-related quality of life in cancer patients [10,11].

Yet those with cancer and cancer survivors note a number of barriers impact their levels of physical activity. Barriers to exercise reported by those with cancer include pain, fatigue, and insomnia during cancer treatment, while cancer survivors note other barriers including being too busy, having little willpower, weather, responsibilities at home, and not enjoying exercise after treatment [12]. As it is essential for those diagnosed with and treated for cancer to overcome these barriers to improve and maintain health status, prevent reoccurrence, and potentially reduce the incidence of other chronic diseases through physical activity, it is important to improve our understanding of the factors that may impact adults' physical activity levels.

Prior work by Ottenbacher, et al. explored the likelihood of meeting aerobic and strength activity guidelines comparing cancer survivors to those with no history of cancer using the National Cancer Institute's Health Information National Trends Survey (HINTS) data for years 2011 & 2012 [13]. Since then, additional data have been collected, introducing the opportunity to explore whether these findings about physical activity among cancer survivors have persisted with more data. In addition, there are demographic factors that may influence physical activity previously unreported using HINTS data. This study thus aims to compare the odds of cancer survivors in the U.S. meeting recommendations from the Physical Activity Guidelines for Americans for aerobic and strength physical activity to the odds of adults with no history of cancer meeting these guidelines, controlling for age, race/ethnicity, income, and education.

Methods

Data source

The Health Information National Trends Survey (HINTS), sponsored by the National Cancer Institute (NCI), is fielded annually to a representative sample of U.S. adults over 18 years of age. HINTS collects data about how respondents seek and use information about cancer, as well as about communication practices, cancer risk perception, cancer prevention behavior, and demographics [14]. This study uses data from HINTS 4, cycles 1 (2011), 2 (2012), and 3 (2013), and HINTS 5, cycles 1 (2017) and 2 (2018). HINTS had a response rate of 37% in HINTS 4 Cycle 1, 40% in Cycle 2, 35% in Cycle 3, 32% in HINTS 5 Cycle 1 and 33% in HINTS 5 Cycle 2 [15]. Non-response was systematically more likely for respondents who were male, minority, younger, less educated, or Hispanic. HINTS is published with survey weights to allow the results to be more generalizable to the population.

In comparison to the original paper, three additional years of data and other covariates (i.e., income and data year) were added. In addition, all the independent variables are presented rather than used solely for adjustment. By incorporating an additional year of data, the sample size is increased (2011-2012: 7,310, 2011-2018: 16,773), allowing for the identification of patterns that were difficult previously to identify based on the smaller sample size in prior work. Following Ottenbacher's approach, we divided our sample into males and females, accounting for variation in physical activity and cancer type by gender.

Measures

HINTS includes two questions inquiring about aerobic physical activity: "In a typical week, how many days do you do any physical activity or exercise of at least moderate intensity, such as brisk walking, bicycling at a regular pace, swimming at a regular pace, and heavy gardening?" and "On the days that you do any physical activity or exercise of at least moderate intensity, how long are you typically doing these activities?" [16] HINTS also includes one question about muscle-strengthening activities: "In a typical week, outside of your job or work around the house, how many days do you do leisure-time physical activities specifically designed to strengthen your muscles such as lifting weights or circuit training (do not include cardio exercise such as walking, biking, or swimming)?" Responses to these three questions were transformed into binary variables indicating whether guidelines were met or not met; these became

the dependent variables in our analysis. Respondents met aerobic guidelines if total minutes of exercise of at least moderate intensity totaled 150 minutes per week or more. Strength guidelines were met if respondents reported 2 days or more of muscle-strengthening activities.

Two questions were asked to determine cancer history: "Have you ever been diagnosed as having cancer?" and "What type of cancer did you have?" Respondents were categorized based on cancer history. A categorical variable was created using the two most common cancer types, breast and prostate, to compare these cancers with all other cancers and people with no cancer history. Respondents in the "breast or prostate cancer category" reported a history of those cancer types; those in the "all other survivors" category had a history of any cancer other than breast, prostate, or non-melanoma skin cancer; and those in the "no history of cancer" category reported they had never been diagnosed with cancer, consistent with the approach followed by Ottenbacher, et al. [13] These cancer type categories were primary independent variables of interest in this analysis; other independent variables included income level, education level, age, race/ethnicity, and data year.

Statistical analyses

This analysis was loosely patterned on the analytic approach outlined previously by Ottenbacher, et al. [13] Notably, missing values were not imputed to take a conservative approach with assumptions in the data. Additionally, income was included as a covariate does not present in the original analysis to control for socioeconomic differences, and data year was added to examine differences over time. Multivariate logistic regression was used to assess the weighted association between the dependent variables, *meeting aerobic, strength*, and *combined physical activity guidelines*, and the independent variables, *cancer status, age, race/ethnicity, income*, *education,* and *data year*. Weighted percentages and confidence intervals were calculated for demographic data. All analyses were completed using Stata version 14 (2015, Stata Corp LP, College Station, TX).

Results

Demographics

The weighted demographic estimates for the pooled data years is shown in Table 1. Gender, race/ethnicity, age, education, data year, time since diagnosis, and type of cancer are presented. Of those with a history of cancer, 22.4% were survivors of breast cancer, 15.4% were prostate cancer survivors, and 62.3% were survivors of any other type of cancer.

Table 1: Demographics by cancer status.

	No history of cancer (n = 14,847) Weighted % (95% CI)	**Cancer survivors (n = 1,926) Weighted % (95% CI)**
Gender		
Male	49.2 (48.9 - 49.5)	40.0 (36.8 - 43.1)
Female	50.8 (50.5 - 51.1)	60.0 (56.9 - 63.2)
Race/ethnicity		
Hispanic	16.0 (15.8 - 16.3)	8.8 (6.6 - 11.0)
Non-Hispanic White	64.9 (64.5 - 65.2)	77.7 (74.9 - 80.5)
Non-Hispanic Black	11.1 (10.8 - 11.4)	8.7 (7.0 - 10.5)
Other	8.0 (7.8 - 8.2)	4.8 (3.3 - 6.3)
Age		
18-34	28.8 (27.8 - 29.7)	5.0 (2.7 - 7.4)
35-49	29.4 (28.5 - 30.4)	13.2 (10.6 - 15.8)
50-64	26.7 (26.1 - 27.4)	31.3 (28.4 - 34.2)
65-74	8.7 (8.5 - 8.9)	25.3 (22.8 - 27.8)
75+	6.4 (6.2 - 6.6)	25.1 (22.7 - 27.5)
Education		
Less than high school	10.7 (10.0 - 11.4)	11.4 (9.0 - 13.8)
High school graduate	22.3 (21.4 - 23.2)	25.9 (22.8 - 29.0)
Some college	34.9 (34.1 - 35.8)	35.0 (31.9 - 38.1)
College graduate or more	32.1 (31.7 - 32.5)	27.7 (25.2 - 30.1)
Income		
Less than $20,000	20.2 (19.1 - 21.4)	21.0 (18.0 - 24.0)

$20,000 to < $35,000	14.0 (13.0 - 15.1)	14.4 (12.1 - 16.7)
$35,000 to < $50,000	14.2 (13.2 - 15.2)	15.4 (12.4 - 18.3)
$50,000 to < $75,000	17.6 (16.5 - 18.6)	19.5 (16.6 - 22.4)
$75,000 or greater	33.9 (32.7 - 35.2)	29.7 (26.7 - 32.7)
Data year		
2011	19.6 (19.5 - 19.6)	20.0 (18.8 - 21.2)
2012	19.8 (19.7 - 19.9)	19.8 (18.7 - 21.0)
2013	19.5 (19.4 - 19.6)	17.9 (16.8 - 19.0)
2017	20.6 (20.5 - 20.6)	20.4 (19.1 - 21.8)
2018	20.6 (20.5 - 20.6)	21.8 (20.1 - 23.5)
Time since diagnosis		
Less than 1 year	----------	12.2 (10.1 - 14.3)
2-5 years	----------	23.7 (20.9 - 26.6)
6-10 years	----------	19.5 (16.9 - 22.0)
11 or more years	----------	44.6 (41.6 - 47.6)
Type of cancer		
Breast cancer	----------	22.4 (19.7 - 25.1)
Prostate cancer		15.4 (13.2 - 17.5)
All other survivors	----------	62.3 (59.0-65.5)

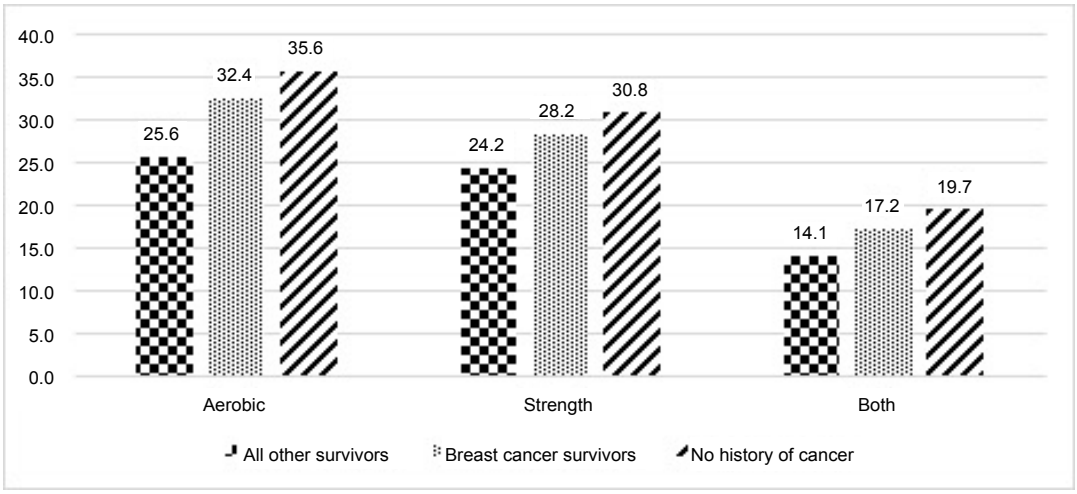

Figure 1: Percent of women meeting physical activity guidelines.

Women meeting physical activity guidelines

Only 25.6% of women who survived all other cancers met aerobic guidelines, while 32.4% of breast cancer survivors and 35.6% of those with no cancer history met guidelines (Figure 1). Women who survived cancers other than breast had lower odds of meeting aerobic guidelines compared to women with no history of cancer (OR = 0.6, p = 0.004). Women of all age groups had significantly lower odds of meeting aerobic guidelines compared to women aged 18-34. Non-Hispanic Black women and women who were part of the 2018 cohort had significantly lower odds of meeting aerobic guidelines. Women with any education level of high school graduate or more had higher odds of meeting aerobic guidelines compared to women with less than a high school education.

Of all other female cancer survivors, 24.2% met strength guidelines, 28.2% of breast cancer survivors met guidelines, and 30.8% of those with no cancer history met strength guidelines (Figure 1). There were no differences in meeting strength guidelines by cancer status among women. Women in the 50-64, 65-74, and 75+ year age brackets had lower odds of meeting the strength guidelines compared to women aged 18-34. Women in the 2012, 2013, 2017, and 2018 cohorts and women in the highest income bracket – more than $75,000 per year – had higher odds of meeting the strength guidelines.

Women with all other cancers were least likely to meet both guidelines (14.1%), followed by breast cancer survivors (17.2%) and those with no cancer history (19.7%) (Figure 1). There were no significant differences

among women by cancer status. There were lower odds of women in all age categories meeting both guidelines compared to those ages 18-34 (all $p < 0.05$). There were higher odds of women in all education categories meeting both guidelines compared to women with less than a high school education (all $p < 0.05$). The odds of meeting both guidelines were significantly higher for women with an income > $75,000 and women in the 2017 cohort (Table 2).

Men meeting physical activity guidelines

The percentage of men meeting aerobic activity guidelines was highest among those with no history of cancer (47.5%), then all other cancer survivors (40.4%), and lastly prostate cancer survivors (40.2%) (Figure 2). There were no significant differences in odds of meeting aerobic activity guidelines by cancer status for men (Table 3). Men in age groups 35-49, 50-64, and 75 and older had lower odds of meeting aerobic guidelines compared to men 18-34 (all $p < 0.05$). Non-Hispanic Black men and men with some college education had

Table 2: Odds of meeting physical activity guidelines for women.

	Meeting guidelines		Meeting guidelines		Meeting guidelines	
	Odds Ratio (95% CI)	**P-value[a]**	**Odds Ratio (95% CI)**	**P-value[a]**	**Odds Ratio (95% CI)**	**P-value[a]**
	Aerobic guidelines		**Strength guidelines**		**Both guidelines**	
Cancer Status						
All other survivors (n = 703)	0.6 (0.5 - 0.9)	0.004	0.8 (0.6 - 1.1)	0.178	0.7 (0.5 - 1.0)	0.076
Breast cancer survivors (n = 473)	1.0 (0.7 - 1.4)	0.973	1.2 (0.8 - 1.7)	0.403	1.2 (0.7 - 1.9)	0.555
No history of cancer (n = 8,807)	----------	--------	----------	--------	----------	--------
Age						
18-34	----------	--------	----------	--------	----------	--------
35-49	0.7 (0.6 - 0.9)	0.003	0.8 (0.6 - 1.0)	0.075	0.7 (0.6 - 0.9)	0.011
50-64	0.7 (0.6 - 0.9)	0.002	0.8 (0.6 - 1.0)	0.048	0.7 (0.5 - 0.9)	0.008
65-74	0.7 (0.6 - 0.9)	0.004	0.7 (0.5 - 0.9)	0.011	0.6 (0.5 - 0.9)	0.006
75+	0.5 (0.4 - 0.7)	< 0.001	0.7 (0.5 - 0.9)	0.013	0.6 (0.4 - 0.9)	0.010
Race/ethnicity						
Non-Hispanic White	----------	--------	----------	--------	----------	--------
Hispanic	0.8 (0.7 - 1.0)	0.106	1.1 (0.9 - 1.4)	0.382	1.1 (0.8 - 1.4)	0.535
Non-Hispanic Black	0.7 (0.6 - 0.9)	0.003	1.2 (0.9 - 1.5)	0.174	1.0 (0.8 - 1.3)	0.931
Other	0.8 (0.6 - 1.0)	0.098	0.9 (0.6 - 1.2)	0.420	0.8 (0.5 - 1.2)	0.239
Education						
Less than high school	----------	--------	----------	--------	----------	--------
High school graduate	1.5 (1.0 - 2.1)	0.029	1.1 (0.7 - 1.6)	0.735	1.8 (1.1 - 3.0)	0.025
Some college	1.8 (1.2 - 2.6)	0.002	1.2 (0.8 - 1.9)	0.292	1.8 (1.1 - 3.0)	0.029
College graduate or more	1.9 (1.3 - 2.8)	0.001	1.3 (0.9 - 1.9)	0.206	2.1 (1.2 - 3.5)	0.006
Income						
Less than $20,000	----------	--------	----------	--------	----------	--------
$20,000 to < $35,000	0.8 (0.6 - 1.1)	0.135	0.9 (0.6 - 1.2)	0.488	0.8 (0.5 - 1.2)	0.244
$35,000 to < $50,000	0.8 (0.6 - 1.1)	0.115	0.9 (0.6 - 1.3)	0.575	0.9 (0.6 - 1.3)	0.524
$50,000 to < $75,000	1.0 (0.8 - 1.3)	0.930	1.2 (0.9 - 1.7)	0.180	1.3 (0.9 - 1.8)	0.194
$75,000 or greater	1.1 (0.8 - 1.4)	0.590	1.4 (1.0 - 2.0)	0.038	1.5 (1.0 - 2.2)	0.030
Data year						
2011	----------	--------	----------	--------	----------	--------
2012	1.1 (0.9 - 1.3)	0.601	1.3 (1.0 - 1.6)	0.039	1.3 (1.0 - 1.6)	0.051
2013	1.1 (0.9 - 1.3)	0.602	1.3 (1.0 - 1.6)	0.045	1.2 (0.9 - 1.5)	0.278
2017	1.1 (0.9 - 1.3)	0.453	2.1 (1.6 - 2.8)	< 0.001	1.8 (1.3 - 2.5)	< 0.001
2018	0.7 (0.6 - 0.9)	0.008	1.5 (1.2 - 1.9)	0.002	1.0 (0.8 - 1.3)	0.832

[a]All p-values determined using multinomial logistic regression.

Table 3: Odds of meeting physical activity guidelines for men.

	Meeting guidelines		Meeting guidelines		Meeting guidelines	
	Odds Ratio (95% CI)	P-value[a]	Odds Ratio (95% CI)	P-value[a]	Odds Ratio (95% CI)	P-value[a]
Aerobic guidelines	**Aerobic guidelines**		**Strength guidelines**		**Both guidelines**	
Cancer Status						
All other survivors (n = 389)	0.7 (0.5 - 1.1)	0.093	0.9 (0.5 - 1.3)	0.500	0.7 (0.5 - 1.1)	0.126
Prostate cancer survivors (n = 330)	0.9 (0.6 - 1.4)	0.796	0.8 (0.5 - 1.2)	0.300	0.6 (0.4 - 1.0)	0.066
No history of cancer (n = 5,783)	----------	--------	----------	--------	----------	--------
Age						
18-34	----------	--------	----------	--------	----------	--------
35-49	0.7 (0.5 - 0.9)	0.018	0.6 (0.5 - 0.9)	0.008	0.6 (0.4 - 0.8)	0.002
50-64	0.7 (0.5 - 0.9)	0.006	0.6 (0.5 - 0.9)	0.005	0.6 (0.4 - 0.8)	0.001
65-74	0.9 (0.7 - 1.2)	0.415	0.6 (0.5 - 0.9)	0.005	0.7 (0.5 - 0.9)	0.021
75+	0.5 (0.3 - 0.7)	< 0.001	0.7 (0.4 - 1.0)	0.038	0.5 (0.3 - 0.7)	0.001
Race/ethnicity						
Non-Hispanic White	----------	--------	----------	--------	----------	--------
Hispanic	0.9 (0.7 - 1.2)	0.432	1.1 (0.9 - 1.5)	0.393	1.1 (0.8 - 1.5)	0.702
Non-Hispanic Black	1.6 (1.1 - 2.3)	0.012	2.7 (2.0 - 3.8)	< 0.001	2.5 (1.7 - 3.6)	< 0.001
Other	0.7 (0.5 - 1.1)	0.116	1.1 (0.8 - 1.6)	0.468	0.9 (0.6 - 1.4)	0.769
Education						
Less than high school	----------	--------	----------	----------	----------	--------
High school graduate	1.1 (0.7 - 1.7)	0.630	0.8 (0.5 - 1.2)	0.261	1.0 (0.6 - 1.8)	0.887
Some college	1.6 (1.1 - 2.4)	0.025	1.0 (0.7 - 1.6)	0.852	1.2 (0.7 - 2.0)	0.417
College graduate or more	1.5 (1.0 - 2.2)	0.062	1.5 (1.0 - 2.3)	0.035	1.6 (0.9 - 2.6)	0.082
Income						
Less than $20,000	----------	--------	----------	--------	----------	--------
$20,000 to < $35,000	0.8 (0.6 - 1.2)	0.340	0.8 (0.5 - 1.2)	0.205	0.7 (0.4 - 1.2)	0.176
$35,000 to < $50,000	1.1 (0.7 - 1.6)	0.605	0.9 (0.6 - 1.3)	0.507	0.9 (0.6 - 1.4)	0.635
$50,000 to < $75,000	1.2 (0.8 - 1.7)	0.330	0.9 (0.6 - 1.3)	0.668	0.9 (0.6 - 1.4)	0.791
$75,000 or greater	1.3 (1.0 - 1.8)	0.084	1.1 (0.8 - 1.6)	0.441	1.3 (0.9 - 2.0)	0.178
Data year						
2011	----------	--------	----------	--------	----------	--------
2012	1.3 (1.0 - 1.8)	0.034	1.0 (0.7 - 1.4)	0.847	1.3 (0.9 - 1.9)	0.103
2013	1.5 (1.2 - 2.0)	0.004	1.2 (0.9 - 1.7)	0.192	1.4 (1.0 - 2.0)	0.056
2017	1.1 (0.8 - 1.5)	0.709	1.7 (1.2 - 2.3)	0.001	1.8 (1.3 - 2.5)	< 0.001
2018	0.7 (0.5 - 1.0)	0.057	1.1 (0.8 - 1.5)	0.579	0.9 (0.6 - 1.4)	0.675

[a]All p-values determined using multinomial logistic regression.

higher odds of meeting aerobic guidelines. Those in the 2012 and 2013 cohorts had higher odds of meeting aerobic guidelines than those in the 2011 cohort.

The percentage of men with prostate cancer meeting strength guidelines was 32.3%, the percentage of all other survivors was 37.1%, and the percentage with no cancer history was 39.5% (Figure 2). There were no significant differences in the odds of men meeting strength guidelines by cancer status. All age groups had lower odds of meeting the strength guidelines compared to men ages 18-34 (all $p < 0.05$). Non-Hispanic Black men, college graduates, and men in the 2017 cohort were more likely to meet the strength guidelines.

Men with prostate cancer were least likely to meet both guidelines (15.7%), 23.8% of all other cancer survivors met guidelines, and 27.9% of men with no cancer history met guidelines (Figure 2). The odds of meeting both guidelines were not significantly different by cancer history for men after adjusting for demographics. There were lower odds of men in all age groups meeting the guidelines compared to men ages 18-34 (all $p < 0.05$). Non-Hispanic Black men and men in the 2017 cohort had higher odds of meeting both guidelines.

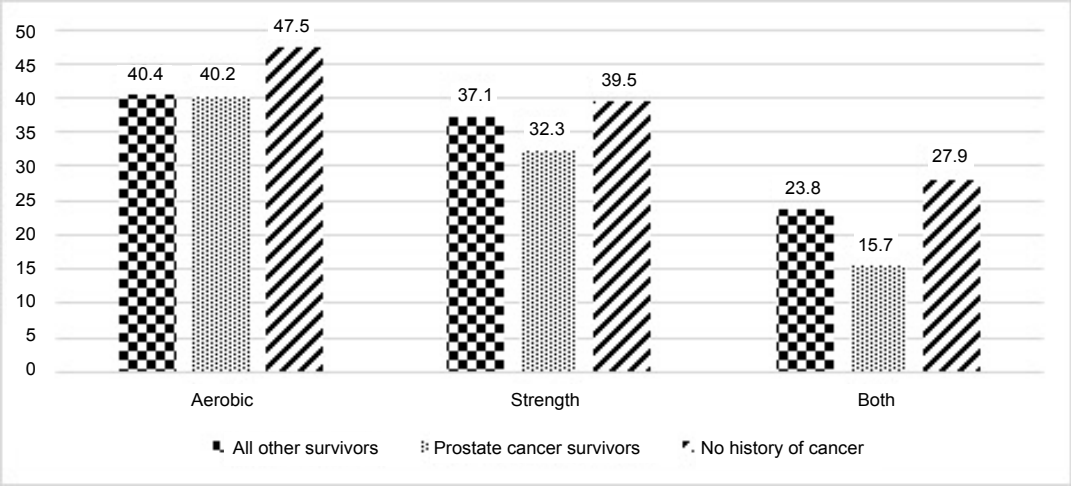

Figure 2: Percent of men meeting physical activity guidelines.

Discussion

After adjusting for demographic factors, women who survived cancers other than breast cancer were less likely to meet guidelines for aerobic activity compared to women with no history of cancer. As breast cancer is often caught earlier with routine screening, this earlier detection suggests there may be less morbidity among women who had breast cancer compared to other cancers [17]. Earlier diagnosis may make it easier for these women to exercise, however, it was not possible to assess stage of cancer diagnosis and level of treatment using these data. Further, the documented preventive effect of exercise on breast cancer reoccurrence may encourage physical activity among breast cancer survivors [18]. A prior meta-analysis reported that 83% of physical activity interventions included breast cancer survivors [19], but physical activity interventions targeting survivors of other cancers may be needed to close this gap. Interestingly, women with a history of cancer other than breast did not have significantly lower odds of meeting strength guidelines when adjusting for demographic factors. While there is evidence that many physical activity interventions for cancer survivors focus on strength activities to prevent or treat muscle and strength loss [9,19], future research could assess whether this trend continues among cancer survivors.

There was an income effect on meeting strength and both guidelines for women, with high-income women (> $75,000) having higher odds of meeting guidelines compared to women in the lowest income category; notably, for men, there was no income effect. These results are consistent with the results of prior research that has shown that individuals with higher incomes may be more likely to live in environments conducive to physical activity [20]. There was another effect of socioeconomic status: women with higher education levels had higher odds of meeting aerobic and both exercise guidelines. The results for men were less significant; only those with some college education had higher odds of meeting aerobic guidelines, and those with college degrees had higher odds of meeting strength guidelines. These relationships did not persist for meeting both guidelines. While the relationship between education level and physical activity has been previously documented [21], studies of physical activity split by both gender and physical activity type have been rare. In this study, women's odds of exercise were more strongly impacted by socioeconomic status variables than men; our findings thus invite future research about the relationship between socioeconomic status and physical activity among women.

There were significant effects of race/ethnicity on physical activity for both genders. Non-Hispanic Black women performed significantly less aerobic activity than non-Hispanic White women. This disparity for Black women has been previously documented [22], with additional studies showing that Black women may be more successful at improving physical activity levels when programs are tailored to their preferences [23]. Environmental factors may contribute to this disparity between White women and women of other races/ethnicities, as there is evidence that there are fewer exercise facilities in high-minority neighborhoods independent of socioeconomic status [24]. However, we additionally found that non-Hispanic Black men met all exercise guidelines more than non-Hispanic White men. The gender difference may be partially explained by prior research suggesting that men are more likely to participate in sports and physically active leisure activities than women, and that women are more likely than men to report environmental, social or cultural barriers to physical activity than men [25,26]. This result is surprising as multiple other studies have shown higher rates of exercise among non-Hispanic Whites than among non-Hispanic Blacks; however, not many of these studies have been stratified by gender nor have they controlled for other demographic factors [27,28]. The raw rates of physical activity may be similar between non-Hispanic White and non-Hispanic Black men

in other studies, but the rates may be artificially low for non-Hispanic Black men due to educational and income effects [28]. In addition, there is evidence that non-Hispanic Black men are more likely to have active jobs but less leisure time physical activity; since HINTS counts all physical activity, those with active jobs and those who exercise more in their leisure time may both meet guidelines and are unlike studies that only examine leisure time activity [28]. Additional research about these racial and gender trends is necessary to better explore facilitators and barriers to physical activity among different racial, ethnic, and mixed gender populations.

There was an effect of age on meeting physical activity guidelines, as people had lower odds of meeting guidelines if they were older than 34 years of age. This finding is consistent with studies that have shown decreased physical activity as people age [29]. Among men only, the age group 65-74 did not have lower odds of meeting aerobic activity guidelines than 18-34 year old's while all other age groups did. This could be related to increased leisure time upon retirement, but then later declines again with age. As the risks for cancer and other chronic diseases increase with age, the preventive effects of physical activity could offset some of this risk among older adults, yet physical problems such as arthritis, pain, and obesity may create barriers to exercise in population [30,31]. Chronic disease prevention interventions that incorporate physical activity must consider these physical problems as well as preventing inflammation and further damage when designing exercise programs to meet the needs of older adults [32].

There was an increase in the odds of meeting strength guidelines among women in data years after 2011, an increase in the odds of meeting aerobic guidelines among men for 2012 and 2013, and an overall trend for higher odds of physical activity in 2017 for both genders. This may reflect a general increase in physical activity, as other research shows an increase in physical activity among adults in the United States and reducing prevalence of inactivity [33]. However, the lower odds of aerobic activity among women in 2018 does not follow this trend. More years of data and data from other sources in the future may provide insight about whether the increase in physical activity has plateaued, or if it is only a trend in HINTS data for 2018. Additionally, future research regarding whether any demographic groups are increasing activity at different rates is important to tailor physical activity interventions.

As with all studies, there are strengths and limitations of our analysis. One strength is the addition of data, strengthening statistical power. The use of data from HINTS allows for analysis of a large, nationally representative sample. Also, the addition of income to the model allowed for adjustment of another potential confounder. One limitation of self-reported data is potential bias, as prior research has suggested that people may report a higher amount of physical activity than they are actually performing [34]. Further, while data from HINTS allows for consideration of both strength and aerobic activity, this survey does not specify kinds of activities performed, and moderate versus vigorous intensity activity. The minutes reported per week were at least of moderate intensity, but the minutes of each intensity were not reported. Using cross-sectional data alone does not allow us to assess a causal relationship between physical activity and cancer. Without multiple time measurements, for instance, it is unclear whether people who were inactive were more likely to get cancer or whether cancer itself reduced activity among cancer survivors. Similarly, it is hard to assess what kinds of treatments people received and when using this dataset, and people who are currently being treated may be less active than usual. The study was not able to assess time since diagnosis as an independent variable; it is collinear with cancer history and could not be included in the adjusted model. Additionally, with 1,926 cancer survivors, when divided by sex and cancer type, the groups have less statistical power; differentiating more cancer types would further weaken the analysis. Future analyses could include more details about the effect of time since cancer diagnosis on physical activity levels, and include other cancer types.

Conclusions

Physical activity has been shown to be associated with lower risk of cancer reoccurrence, improved quality of life during cancer treatment, and reduced risks for other chronic diseases and mortality. Despite these positive effects, physical activity rates among older adults, those with lower incomes, those with lower education levels, non-Hispanic Black women, and women who survived cancer remain low leaving these groups at higher risk for adverse health outcomes. Older adults, those with lower socioeconomic statuses, racial and ethnic minorities, and cancer survivors already may experience increased risk for additional health problems, and lower levels of exercise may further exacerbate these problems. Although there has been an increase in physical activity among adults in the United States, health promotion efforts may need to target certain groups who still are less likely to achieve ideal levels of physical activity. Developing physical activity interventions that target specific populations who could benefit from increased activity such as cancer survivors, older adults, racial and ethnic minorities, and women may help improve survival as well as reduce risk for cancer reoccurrence and other chronic diseases.

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Author Contribution

All authors contributed to the design, analysis or interpretation, writing and editing of this work.

References

1. Heron M (2018) Deaths: Leading Causes for 2016. Natl Vital Stat Rep 67: 1-77.
2. Moore SC, Lee IM, Weiderpass E, Campbell PT, Sampson JN, et al. (2016) Association of Leisure-Time Physical Activity With Risk of 26 Types of Cancer in 1.44 Million Adults. JAMA Intern Med 176: 816-825.
3. (2018) U.S. Department of Health and Human Services. Physical Activity Guidelines for Americans, (2nd edn).
4. Rock CL, Doyle C, Demark-Wahnefried W, Meyerhardt J, Courneya KS, et al. (2012) Nutrition and physical activity guidelines for cancer survivors. CA Cancer J Clin 62: 243-274.
5. Ballard-Barbash R, Friedenreich CM, Courneya KS, Siddiqi SM, McTiernan A, et al. (2012) Physical activity, biomarkers, and disease outcomes in cancer survivors: a systematic review. J Natl Cancer Inst 104: 815-840.
6. Fearon K, Arends J, Baracos V (2013) Understanding the mechanisms and treatment options in cancer cachexia. Nat Rev Clin Oncol 10: 90-99.
7. American Cancer Society (2016) Chemotherapy side effects.
8. Furmaniak AC, Menig M, Markes MH (2016) Exercise for women receiving adjuvant therapy for breast cancer. Cochrane Database Syst Rev 9: CD005001.
9. Keilani M, Hasenoehrl T, Baumann L, Ristl R, Schwarz M, et al. (2017) Effects of resistance exercise in prostate cancer patients: a meta-analysis. Support Care Cancer 25: 2953-2968.
10. Gerritsen JK, Vincent AJ (2016) Exercise improves quality of life in patients with cancer: a systematic review and meta-analysis of randomised controlled trials. Br J Sports Med 50: 796-803.
11. Mehnert A, Veers S, Howaldt D, Braumann KM, Koch U, et al. (2011) Effects of a physical exercise rehabilitation group program on anxiety, depression, body image, and health-related quality of life among breast cancer patients. Onkologie 34: 248-253.
12. Blaney JM, Lowe-Strong A, Rankin-Watt J, Campbell A, Gracey JH (2013) Cancer survivors' exercise barriers, facilitators and preferences in the context of fatigue, quality of life and physical activity participation: a questionnaire-survey. Psychooncology 22: 186-194.
13. Ottenbacher A, Yu M, Moser RP, Phillips SM, Alfano C, et al. (2015) Population Estimates of Meeting Strength Training and Aerobic Guidelines, by Gender and Cancer Survivorship Status: Findings From the Health Information National Trends Survey (HINTS). J Phys Act Health 12: 675-679.
14. National Cancer Institute (2019) Health Information National Trends Survey.
15. National Cancer Institute (2019) Frequently Asked Questions about HINTS.
16. National Cancer Institute (2019) HINTS Survey Instruments.
17. American Cancer Society (2019) Cancer Facts & Figure 2019. Atlanta: American Cancer Society.
18. Brown JC, Winters-Stone K, Lee A, Schmitz KH (2012) Cancer, physical activity, and exercise. Compr Physiol 2: 2775-2809.
19. Speck RM, Courneya KS, Mâsse LC, Duval S, Schmitz KH (2010) An update of controlled physical activity trials in cancer survivors: a systematic review and meta-analysis. J Cancer Surviv 4: 87-100.
20. Smith M, Hosking J, Woodward A, Witten K, MacMillan A, et al. (2017) Systematic literature review of built environment effects on physical activity and active transport - an update and new findings on health equity. Int J Behav Nutr Phys Act 14: 158.
21. Kao MC, Jarosz R, Goldin M, Patel A, Smuck M (2014) Determinants of physical activity in America: a first characterization of physical activity profile using the National Health and Nutrition Examination Survey (NHANES). PM R 6: 882-892.
22. Watson KB, Frederick GM, Harris CD, Carlson SA, Fulton JE (2015) U.S. Adults' Participation in Specific Activities: Behavioral Risk Factor Surveillance System--2011. J Phys Act Health 12: 3-10.
23. Adams T, Burns D, Forehand JW, Spurlock A (2015) A community-based walking program to promote physical activity among African American women. Nurs Womens Health 19: 26-35.
24. Gordon-Larsen P, Nelson MC, Page P, Popkin BM (2006) Inequality in the built environment underlies key health disparities in physical activity and obesity. Pediatrics 117: 417-424.
25. Eyler AA, Matson-Koffman D, Young DR, Wilcox S, Wilbur J, et al. (2003) Quantitative study of correlates of physical activity in women from diverse racial/ethnic groups: The Women's Cardiovascular Health Network Project--summary and conclusions. Am J Prev Med 25: 93-103.
26. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, et al. (2012) Global physical activity levels: surveillance progress, pitfalls, and prospects. Lancet 380: 247-257.
27. Hooker SP, Hutto B, Zhu W, Blair SN, Colabianchi N, et al. (2016) Accelerometer measured sedentary behavior and physical activity in white and black adults: The REGARDS study. J Sci Med Sport 19: 336-341.
28. Saffer H, Dave D, Grossman M, Leung LA (2013) Racial, Ethnic, and Gender Differences in Physical Activity. J Hum Cap 7: 378-410.
29. Sun F, Norman IJ, While AE (2013) Physical activity in older people: a systematic review. BMC Public Health 13: 449.
30. Cohen-Mansfield J, Marx MS, Guralnik JM (2003) Motivators and Barriers to Exercise in an Older Community-Dwelling Population. Journal of Aging and Physical Activity 11: 242-253.
31. Justine M, Azizan A, Hassan V, Salleh Z, Manaf H (2013) Barriers to participation in physical activity and exercise among middle-aged and elderly individuals. Singapore Med J 54: 581-586.
32. Suzuki K (2019) Chronic inflammation as an immunological abnormality and effectiveness of exercise. Biomolecules 9:

223.

33. An R, Xiang X, Yang Y, Yan H (2016) Mapping the Prevalence of Physical Inactivity in U.S. States, 1984-2015. PLoS One 11: e0168175.

34. Dyrstad SM, Hansen BH, Holme IM, Anderssen SA (2014) Comparison of self-reported versus accelerometer-measured physical activity. Med Sci Sports Exerc 46: 99-106.