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Association Between Regular Physical Activity and Cancer Prevalence: Cross-Sectional Analysis of NHANES 2017-2018

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Abstract

Introduction: *Physical activity is associated with a reduced risk of several chronic diseases; however, its association with cancer remains unclear, with mixed findings in the literature. This study investigated the relationship between exercise status and cancer diagnosis in a representative sample of U.S. adults, hypothesizing that regular physical activity is inversely associated with cancer diagnosis, independent of demographic and lifestyle factors.*

Methods: *Data from the 2017 to 2018 cycle of the National Health and Nutrition Examination Survey (NHANES) were analyzed, including 5567 participants after excluding cases with missing data. Exercise status, based on self-reported moderate or vigorous recreational activity, was the primary exposure variable, and history of cancer diagnosis was the outcome. Logistic regression models were used, adjusting for age, sex, race/ethnicity, ratio of income to poverty, education level, and obesity.*

Results: *This study analyzed data from 5,567 participants of the NHANES 2017-2018 survey. Regular physical activity was associated with lower odds of a self-reported cancer diagnosis. The crude model showed a significant protective effect of physical activity (OR = 0.66; 95% CI: 0.55–0.79; $p < 0.001$). After adjusting for covariates, this association persisted (OR = 0.72; 95% CI: 0.58–0.90; $p = 0.004$). Sensitivity analyses confirmed the robustness of this relationship, highlighting the potential protective role of physical activity on cancer prevalence.*

Discussion: *This study demonstrated an association between regular physical activity and reduced self-reported cancer diagnoses among adults in the United States. While the findings emphasize the importance of physical activity in public health strategies, the cross-sectional design and reliance on self-reported data limits causal interpretations. Aggregating all cancer types may dilute cancer-specific associations, warranting future research to explore these relationships and to establish causality through longitudinal designs.*

Introduction

Cancer remains one of the leading causes of mortality worldwide, with an estimated 20 million new cases and 9.7 million deaths in 2022, and it is projected that nearly one in five people will develop cancer in their lifetime (World Health Organization, 2020). Understanding modifiable factors that can help prevent cancer is essential for improving public health out-

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comes. Physical activity (PA) is a modifiable factor that has been widely recognized as a potential means of reducing the risk of cancer and improving patient survival (McTiernan et al., 2019). Investigating the association between physical activity and cancer is crucial in clinical research as it offers insights into preventive strategies that could lessen the burden of cancer worldwide.

Considerable research has demonstrated the protective effects of exercise against various cancers, including breast, lung, and colon cancers (Lian & Luo, 2024; Matthews et al., 2020). Studies have suggested that physical activity helps regulate body homeostasis through anti-inflammatory mechanisms, immune system activation, and hormone regulation, contributing to its antineoplastic effects (C et al., 2024). Regular physical activity offers several benefits that may help reduce the risk of cancer. It may decrease insulin and estrogen levels, which are linked to an increased likelihood of certain cancers, particularly breast and endometrial cancers (WCRF/AICR, 2018). In addition, physical exercise boosts the immune system, improving the ability of the body to detect and destroy cancer cells before they can multiply, and also increases the circulation of immune cells, improving immune surveillance. In addition, regular exercise helps reduce chronic inflammation, a significant risk factor for many cancers, by regulating inflammatory markers and reducing the chances of tumor development (Coussens & Werb, 2002).

Preclinical models and clinical-epidemiological studies have shown that exercise can reduce tumor growth and cancer risk (Idorn & Thor Straten, 2017). However, gaps still exist in the literature, particularly concerning the interaction between demographic factors such as age, gender, socioeconomic status, and cancer risk. Moreover, the decision to develop a sensitivity analysis to account for potential residual confounders, such as lifestyle habits, can help to further elucidate the specific role of exercise in cancer prevention.

Therefore, this study aimed to evaluate the association between physical activity and cancer risk among adults using data from the NHANES 2017-2018, which is a cross-sectional survey designed to assess the health and nutrition of the non-institutionalized resident U.S. civilian population. The study employs Logistic regression models to analyze the relationship between regular physical activity and the likelihood of cancer diagnosis, adjusting for relevant demographic and socioeconomic variables. By addressing existing gaps in the literature, this study seeks to provide further evidence supporting the inclusion of physical activity in cancer prevention guidelines, ultimately contributing to better public health initiatives aimed at reducing the global burden of cancer. These activities are accessible through community programs at the YMCA's, the "Let's Move" campaign in schools, workplace wellness campaigns, and healthcare guidance, helping overall well being of the population with preventive interventions.

Materials and Methods

This descriptive, cross-sectional study was conducted to determine the influence of exercise on cancer prevalence among adults using data from the 2017 to 2018 National Health and Nutrition Examination Survey (NHANES). This survey collected health-related data from a non-institutionalized U.S. population living in 50 states and D. C., providing detailed information about demographic characteristics, health conditions, physical activity, and socioeconomic factors.

A total of 16,211 participants were selected from 30 different locations; of these, 9,254 were examined, with a final sample size of 5567. To assess the research question "Is regular physical activity associated with a lower prevalence of self-reported cancer diagnoses?" A binary variable was created to represent exercise, dividing the participants into two groups: those who exercised regularly and those who did not.

Inclusion criteria were defined as patients with complete data about the history of cancer during their lifetime ("Ever told you had cancer or malignancy") and physical activity status ("Moderate and vigorous recreational activities"). Any patient with missing data for these variables was excluded.

Physical activity, the main exposure, was measured using the Global Physical Activity Questionnaire (GPAQ), which provides respondent-level data from physical activity interviews. Multiple covariates reported in the literature were included in the analysis. Age was analyzed in quartiles because of sample skewness. Sex was binary (male vs. female). Ethnicity included categories such as non-Hispanic White, non-Hispanic Black, Mexican American, other Hispanics, and other/multiracial. Education level was categorized as High School, Some College, and College Graduate. Obesity was defined as a Body Mass Index (BMI) equal to or higher than 30 kg/m^2, based on the guidelines established by the World Health Organization (WHO, 2000), which categorizes BMI values of 30 or higher as indicative of obesity. In a sensitivity analysis, alcohol consumption was included as a binary variable, categorized as moderate drinkers (average $\leq$ 2 drinks per day) or heavy drinkers (average >2 drinks per day) over the past year, based on public health guidelines from the National Institute on Alcohol Abuse and Alcoholism (NIAAA); and smoking was used as a binary variable based on a positive history of smoking at least 100 cigarettes in lifetime (NIAAA, 2021).

The Poverty Family Income Ratio (PIR) calculation used in this dataset represents the ratio of a family's income to the federal poverty threshold, adjusted for family size and inflation for a given year. a PIR 1 means poverty level, 1.0-199 low income, PIR>2.0 middle to higher income (NHANCE, 2024).

Data cleaning, management, and analysis were performed using STATA 18 BE statistical software. A logistic regression model was used to examine the relationship between exercise status and the likelihood of having cancer. Two models were developed: a crude model that included only exercise status (Figure 1) and an adjusted model that controlled for additional covariates such as age, gender, race/ethnicity, education level, obesity, and poverty ratio (Figure 2). In both models, a multivariable logistic regression analysis was successfully performed to obtain important information regarding the coefficient of correlation, likelihood ratio (LR) chi-square, and pseudo-R^2. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to estimate the strength of associations in both models. Statistical significance was assessed using a threshold of $P < 0.05$.

The crude model assessed the direct association between exercise and cancer using OR to measure the unadjusted relationship. The adjusted model included additional variables to better understand the association while accounting for potential confounders. This approach allowed for a more accurate view of the relationship between exercise status and cancer risk, while considering demographic and socioeconomic factors.

Sensitivity analyses were conducted to test the reliability of the findings and to examine how other health-related factors might influence the results. Analyses of cancer risk included adults aged ≥ 20 years from the NHANES 2017–2018 dataset. Participants with complete data on physical activity, cancer diagnosis, and covariates such as age, sex, race/ethnicity, education level, ratio of income to poverty, educational level, and obesity were included in the analyses. We excluded participants with missing data, including those who refused to answer or answered "don't know" about physical activity, cancer diagnosis, or any covariate used in our analysis.

Results

Sample Characteristics

This study used data from the 2017 to 2018 NHANES survey, which included a representative sample of U.S. adults with the following details, as shown in Table 1. A total of 5,567 participants aged ≥ 20 years were analyzed, as shown in Table 1; of these, 53.1% were female ($n = 2{,}865$), and the average age was 48.3 years (SD = 17.2). Most participants were Non-Hispanic White, with the remainder coming from other racial and ethnic groups. Other details of the sample are age, gender, race/ethnicity, education level, obesity, and the ratio of family income to poverty. Overall, 47% of the participants (2,340 individuals) without a history of cancer engaged in moderate physical activity, compared to 37% of the participants (218 individuals) who reported a history of cancer.

Unadjusted and Adjusted Models

We used two logistic regression models to assess the association between regular physical activity and the chance of being diagnosed with cancer. The first was a crude model, and the second was adjusted for other factors.

In the crude model, which only included exercise status, the results showed that regular exercise was linked to a lower chance of having cancer (Odds Ratio [OR] = 0.66, 95% Confidence Interval [CI]: 0.55–0.79, $p < 0.001$), as shown in Table 2. This shows that people who exercise regularly are about 34% less likely to have cancer than those who don't exercise.

In the adjusted model, we also examined variables such as age, gender, race/ethnicity, education level, and poverty ratio as potential factors that could affect the results. Once we accounted for these other factors, the link between exercise and cancer remained (OR: 0.726, CI: 0.58 - 0.90, $p = 0.004$), as shown in Table 2, suggesting that individuals who exercise have 27.4% lower odds of having been diagnosed with cancer than those who did not exercise. A higher income-to-poverty ratio slightly increases the odds of having cancer (OR = 1.082, $p = 0.026$). In addition, smoking significantly increased the risk of cancer odds (OR = 1.27, $p = 0.022$).

Sensitivity Analysis

To test whether regular physical activity is linked to cancer, we examined other factors, such as age and lifestyle. This analysis aimed to understand whether the protective effect of exercise on cancer risk remained consistent when other factors were included.

Figure 3 shows how age, race/ethnicity, smoking, and alcohol consumption affect the link between exercise and cancer. Adjusting for alcohol and smoking consumption slightly weakened this association, but exercise still protected against cancer. This suggests that alcohol consumption and smoking may affect the

```
. logistic Has_cancer ExerciseStatus

Logistic regression                                     Number of obs =  5,567
                                                        LR chi2(1)    =  20.65
                                                        Prob > chi2   = 0.0000
Log likelihood = -1867.2211                             Pseudo R2     = 0.0055
```

Has_cancer	Odds ratio	Std. err.	z	P>|z|	[95% conf.	interval]
ExerciseStatus	.6677146	.060029	-4.49	0.000	.5598427	.7963716
_cons	.1399848	.0077807	-35.37	0.000	.1255363	.1560963

Note: **_cons** estimates baseline odds.

Figure 1: *Crude model that included only exercise status.*

```
. logistic Has_cancer ExerciseStatus i.Age_quartile Gender i.RaceHispanicorigin Ratiooffamilyincometopovert i.Edu_cat Obesity

Logistic regression                                     Number of obs =  4,773
                                                        LR chi2(13)   = 522.78
                                                        Prob > chi2   = 0.0000
Log likelihood = -1375.6701                             Pseudo R2     = 0.1597
```

Has_cancer	Odds ratio	Std. err.	z	P>|z|	[95% conf.	interval]
ExerciseStatus	.717807	.0785004	-3.03	0.002	.5793208	.8893983
Age_quartile						
Q2: 33-50	3.954249	1.371817	3.96	0.000	2.00338	7.804855
Q3: 51-64	9.803667	3.268158	6.85	0.000	5.100719	18.84281
Q4: 65+	26.10633	8.535138	9.98	0.000	13.75486	49.54907
Gender	.9154963	.0912897	-0.89	0.376	.7529707	1.113102
RaceHispanicorigin						
Other Hispanic	.8565124	.2216919	-0.60	0.550	.5157229	1.422496
Non-Hispanic White	1.883456	.3496171	3.41	0.001	1.309034	2.709942
Non-Hispanic Black	.840698	.1758004	-0.83	0.407	.5580115	1.266592
Other Race - Including Multi-Racial	.7188266	.1645097	-1.44	0.149	.459007	1.125717
Ratiooffamilyincometopovert	1.07465	.0379598	2.04	0.042	1.002767	1.151686
Edu_cat						
Some College	1.396656	.1660176	2.81	0.005	1.106391	1.763071
College Graduate	1.337797	.196021	1.99	0.047	1.003848	1.782842
Obesity	.9731227	.0986197	-0.27	0.788	.797818	1.186947
_cons	.0081935	.0030388	-12.95	0.000	.0039607	.0169499

Note: **_cons** estimates baseline odds.

Figure 2: *Adjusted model that controlled for additional covariates such as age, gender, race/ethnicity, education level, obesity, and poverty ratio.*

	Ever told you have cancer or a malignancy	
	No	**Yes**
Total Number	4,979 (89.4%)	588 (10.6%)
Exercise status	0.47 (0.499)	0.37 (0.48)
Age (quartile - years)		
Q1: < 33	1,072 (21.5%)	12 (0.2%)
Q2: 33-50	1,433 (28.8%)	61 (10.4%)
Q3: 51-64	1,340 (26.9%)	149 (25.3%)
Q4: 65+	1,134 (22.8%)	366 (62.2%)
Gender		
Female	2,553 (51.3%)	312 (53.1%)
Male	2,426 (48.7%)	276 (46.9%)
Ethnicity		
Mexican American	688 (13.8%)	47 (8.0%)
Other Hispanic	481 (9.7%)	36 (6.1%)
Non-Hispanic White	1,586 (31.9%)	348 (59.2%)
Non-Hispanic Black	1,201 (24.1%)	97 (16.5%)
Other Race - Including Multi Racial	1,023 (20.5%)	60 (10.2%)
Ratio Family income to poverty	2.53 (1.60)	2.77 (1.58)
Educational Status		
High School	2,205 (44.4%)	236 (40.3%)
Some College	1,577 (31.7%)	200 (34.1%)
College Graduate	1,186 (23.9)	150 (25.6%)
Obesity		
BMI < 30 kg/m²	2,693 (54.1%)	311 (52.9%)
BMI ≥ 30 kg/m²	2, 285 (45.9%)	277 (47.1%)
Smoke at least 100 cigarettes in life		
>100 cigarettes	2,947 (59.2%)	287 (48.8%)
< 100 cigarettes	2,032 (40.8%)	301 (51.2%)

Table 1: *Sample characteristics.*

results, but it does not fully explain the link between exercise and lower cancer prevalence.

Discussion

This study demonstrates a significant association between regular physical activity and a reduced likelihood of cancer diagnosis among U.S. adults using data from the NHANES 2017-2018 dataset. The crude model revealed a strong protective effect of physical activity (OR, 0.66; 95% CI: 0.55–0.79; $p < 0.001$). After adjusting for covariates, including age, sex, race/ethnicity, education level, income, alcohol consumption, and smoking, the association persisted, albeit with a slightly attenuated effect (OR, 0.72; 95% CI: 0.58–0.90; $p = 0.004$). These findings underscore the potential role of physical activity in cancer prevention and its relevance in public health strategies.

However, the cross-sectional design of the NHANES dataset imposes important limitations on the interpretation. The variable used to measure cancer outcomes was derived from participants' responses to the question, "Ever told you had cancer before?" This reflects a history of self-reported cancer diagnoses rather than the active cancer prevalence or incidence at the time of data collection. Similarly, physical activity was self-reported and assessed at the time of the survey, making it challenging to establish temporal relationships between physical activity and cancer outcome. Therefore, while the findings support an association between physical activity and a reduced likelihood of cancer diagnosis, they should not be interpreted as evidence of causation or direct preventive effects.

Additionally, this study aggregated all cancer types into a single outcome, which is a significant limitation. Different cancers have distinct etiologies, risk factors, and associations with physical activity. For example, physical activity has a stronger protective effect against cancers such as breast and colon cancer than against other cancers (Kyu et al., 2016). Aggregating cancer types may dilute specific associations, thus limiting the ability to identify cancer-specific protective effects. Future studies should explore these associations in individual cancer types to provide more nuanced insights.

Despite these limitations, the observed protective effect of physical activity aligns with prior evidence, suggesting that exercise reduces cancer risk through mechanisms such as inflammation reduction, immune system enhancement, and hormone regulation. Even after accounting for demographic and socioeconomic factors, physical activity remained a significant protective factor. Age was a notable risk factor as cancer risk increased with advancing age. Additionally, individuals identified as Non-Hispanic

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. logistic Has_cancer ExerciseStatus i.Age_quartile Gender i.RaceHispanicorigin Ratiooffamilyincometopovert i.Edu_cat Obesity i.alcohol
> _cat Smokedatleast100cigarettesi

Logistic regression                                     Number of obs =  4,773
                                                        LR chi2(15)   = 527.70
                                                        Prob > chi2   = 0.0000
Log likelihood = -1373.2101                             Pseudo R2     = 0.1612

------------------------------------------------------------------------------------------------------
                         Has_cancer | Odds ratio   Std. err.      z    P>|z|     [95% conf. interval]
------------------------------------------------------------------------------------------------------
                     ExerciseStatus |   .7262255   .0796551    -2.92   0.004      .585745    .9003979
                                    |
                       Age_quartile |
                        Q2: 33-50   |    3.87967   1.346635     3.91   0.000     1.964908    7.660326
                        Q3: 51-64   |   9.598335   3.201539     6.78   0.000      4.99202    18.45506
                          Q4: 65+   |   25.55417   8.358133     9.91   0.000     13.46031    48.51417
                                    |
                             Gender |   .8612857   .0893254    -1.44   0.150     .7028582    1.055423
                                    |
                 RaceHispanicorigin |
                  Other Hispanic    |   .8598567    .222723    -0.58   0.560     .5175413    1.428589
              Non-Hispanic White    |   1.817304   .3387321     3.20   0.001     1.261159    2.618697
              Non-Hispanic Black    |   .8188256   .1717657    -0.95   0.341     .5427929    1.235232
Other Race - Including Multi-Racial |   .7189509   .1647652    -1.44   0.150     .4588023    1.126608
                                    |
        Ratiooffamilyincometopovert |   1.082729   .0387275     2.22   0.026     1.009424    1.161357
                                    |
                            Edu_cat |
                    Some College    |   1.406457   .1675819     2.86   0.004     1.113536    1.776432
                College Graduate    |   1.379856   .2044609     2.17   0.030     1.032064    1.844849
                                    |
                            Obesity |   .9747324   .0988565    -0.25   0.801     .7990194    1.189087
                                    |
                        alcohol_cat |
                       >2 drinks    |   1.002502   .1037706     0.02   0.981     .8184194    1.227989
        Smokedatleast100cigarettesi |   1.265119    .134199     2.22   0.027     1.027636    1.557485
                              _cons |   .0075733   .0028871   -12.81   0.000     .0035875    .0159874
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Figure 3: *Age, race/ethnicity, smoking, and alcohol consumption affect the link between exercise and cancer.*

Predictor	Crude OR (95% CI)	Adjusted OR (95% CI)
Regular Physical Activity	0.66 (0.55–0.79)	0.72 (0.58 0.90)0

Table 2: *Logistic regression results.*

White had a higher likelihood of cancer diagnosis than other racial/ethnic groups, likely due to differences in healthcare access and lifestyle factors (Betts et al., 2019).

The strengths of this study include the use of a large, nationally representative dataset, which lends high generalizability to the findings. Adjustment for multiple confounders enhanced the reliability of the observed associations. However, limitations such as recall bias in self-reported physical activity and cancer diagnoses, lack of dietary data, and inability to capture lifetime physical activity patterns highlight areas for further research.

In conclusion, while this study supports the association between regular physical activity and reduced cancer risk, public health efforts should prioritize promoting physical activity, particularly among high-risk groups. Future research should address the limitations related to the aggregation of cancer outcomes, incorporate dietary and other lifestyle factors, and employ longitudinal designs to establish causal relationships between physical activity and cancer prevention.

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Conflicts of Interest

The authors declare no conflict of interest.

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