Published in final edited form as:
Ann Epidemiol. 2011 October ; 21(10): 787–790. doi:10.1016/j.annepidem.2011.04.012.

A prospective analysis of prolonged sitting time and risk of renal cell carcinoma among 300,000 older adults

Stephanie M. George, PhD, MPH, MA,
Nutritional Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute

Steven C. Moore, PhD,
Nutritional Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute

Wong-Ho Chow, PhD,
Occupational Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute

Arthur Schatzkin, MD [DrPH],
Nutritional Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute

Albert R. Hollenbeck, PhD, and
AARP

Charles E. Matthews, PhD
Nutritional Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute

Abstract

Purpose—Accumulating evidence suggests an etiologic role in renal cell carcinoma (RCC) for physical activity. However, it is unknown if prolonged sitting, which is thought to be distinct from too little moderate-vigorous physical activity, is an independent risk factor for RCC. The authors prospectively examined the relationship of prolonged sitting and risk of RCC among 289,512 women and men in the National Institutes of Health—AARP Diet and Health Study.

Methods—From 1996 through 2006, 1206 invasive RCC cancer cases were identified. Cox proportional hazards regression was used to estimate multivariate hazard ratios (HR) and 95% confidence intervals (CI).

Results—After controlling for known risk factors for RCC, we did not find evidence of associations between RCC risk and time spent per day sitting while watching television or videos ($HR_{7+hrs:<1\ hr}$: 0.96 (0.66, 1.38), *p*trend=0.707) or total sitting time ($HR_{9+hrs:\ <3hrs}$: 1.11 (0.87, 1.41), *p*trend=0.765).

Conclusion—Prolonged sitting time was not associated with RCC risk among men and women in this large cohort.

Correspondence to: Stephanie M. George.

MESH keywords

sedentary lifestyle; kidney neoplasms; cohort studies

Introduction

Kidney and renal pelvis cancers together rank 8th in cancer incidence in the US, with over 58,000 new cases estimated for 2010 (1). Over 90% of cancers originating in the kidney are adenocarcinomas, or renal cell carcinomas (RCC), for which incidence has continued to rise (2). Accumulating evidence has suggested a role for physical activity in RCC etiology (2), as well as a relationship between sedentary behavior (e.g., prolonged sitting)—thought to be distinct from physical activity—and RCC risk factors such as obesity and cardio-metabolic health biomarkers (2). Yet no published studies have examined whether prolonged sitting is itself an RCC risk factor. Prolonged sitting may affect cancer risk by displacing light-intensity activities of daily living, which can lower physical activity energy expenditure and increase risk for weight gain and poor metabolic health (3-4). We hypothesized that time spent sitting while watching television or videos and total time spent sitting are positively associated with RCC risk, independent of physical activity and other relevant confounding factors.

Methods

Study population

The NIH-AARP Diet and Health Study has been described in detail elsewhere (5). In 1995-1996, participants completed a self-administered baseline questionnaire on demographic and anthropometric characteristics, dietary intake, and health-related behaviors. In 1996-1997, a second questionnaire was sent to collect more detailed information about cancer risk factors, including sedentary behavior (time spent watching television or videos and total time spent sitting in a typical 24 hour period), recreational moderate-vigorous physical activity (MVPA), and weight history (6-7). We did not have direct evidence of validity or reliability of the sedentary behavior or physical activity questions we asked; however, our questions were similar to questions from measures with reasonable validity and reliability that included assessment on television watching (8), sitting (9-10), and recreational moderate/vigorous activity (11-14).

334,889 respondents completed both questionnaires and prospective follow-up data. We excluded those who were proxies for the intended respondents (n=10,383), had prevalent cancer (n=18,862) or a cancer cause of death record only (n=983), had missing data on sedentary behavior (n=2,496) or MVPA (n=12,601), or had extreme or missing values for energy intake (n=2,349) or body mass index (BMI) (n=6375). After exclusions, our analytic cohort consisted of 119,237 women and 170,275 men, who were on average 63 years of age.

Cancer ascertainment

First primary invasive RCC cases through December 31, 2006 were identified through linkage with eleven state cancer registry databases. RCC was defined using the International Classification for Oncology code C649 and histology codes 8140-8570, 8940, and 8959.

Statistical analysis

Hazard ratios (HR) and 95 % confidence intervals (CI) were estimated with Cox proportional hazards models (SAS Institute, v. 9.1.3). Person-years were calculated from the date the second questionnaire was received until cancer diagnosis, death, move-out of the

registry areas, or the end of follow-up (December 31, 2006), whichever occurred first. The test for linear trend across categories of sedentary behavior was performed by assigning participants the median value of their categories and entering it as a continuous term in a regression model.

We adjusted for previously established RCC risk factors (see Table 1), except for education, family history of cancer, red meat intake, and menopausal hormone therapy use, which did not remain statistically significant ($p<0.05$) in our final multivariate model. We chose not to adjust for BMI and hypertension, because of their likelihood in the exposure-disease pathway; however, we report in the text on the further influence on risk estimates that adding these variables would make. We also explored whether associations differed by race, obesity, hypertension, or MVPA.

Results

The HR of RCC for those who reported watching television or videos for 7 or more hours versus less than 1 hour per day was 0.96 (95% CI: 0.66, 1.38, *p*trend=0.707) (Table 1). The HR for those whose total sitting time was 9 or more hours versus less than 3 hours per day was 1.11 (95% CI: 0.87, 1.41, *p*trend=0.765). The associations were comparable for men and women separately. Additional adjustment for BMI and hypertension yielded parallel conclusions, and results were similar when we limited the analysis to clear cell tumors, the largest subtype (data not shown). We did not find evidence of effect modification by any of the investigated factors.

Discussion

In this study of nearly 300,000 men and women, we did not observe an association between prolonged sitting time and RCC. Our study is the first to examine this etiologic relationship and featured refined definitions of RCC using histology codes, measurement of important RCC risk factors, long-term follow-up, and a large sample size, affording us ample statistical power to detect an association.

We previously noted an inverse association between physical activity and RCC (15). While our data suggest that reducing sedentary time may not independently protect against RCC, we cannot rule out a weak association between sedentary behavior and RCC, which may have been masked by measurement error. However, sedentary behavior has been positively related to other obesity-related cancers (endometrial, colon) in our cohort (16-18).

Among older adults, “too much sitting” is prevalent health behavior and is thought to be distinct from “too little MVPA” given its own contextual determinants and possibly health effects (3). Additional research and improvements in sedentary behavior assessment may help improve our understanding of the health benefits associated with not only reducing but also breaking up prolonged sitting.

Acknowledgments

This work was supported in part by the Intramural Research Program of the National Institutes of Health, National Cancer Institute. Cancer incidence data from the Atlanta metropolitan area were collected by the Georgia Center for Cancer Statistics, Department of Epidemiology, Rollins School of Public Health, Emory University. Cancer incidence data from California were collected by the California Department of Health Services, Cancer Surveillance Section. Cancer incidence data from the Detroit metropolitan area were collected by the Michigan Cancer Surveillance Program, Community Health Administration, State of Michigan. The Florida cancer incidence data used in this report were collected by the Florida Cancer Data System (FCDC) under contract with the Florida Department of Health (FDOH). The views expressed herein are solely those of the authors and do not necessarily reflect those of the FCDC or FDOH. Cancer incidence data from Louisiana were collected by the Louisiana Tumor

Registry, Louisiana State University Medical Center in New Orleans. Cancer incidence data from New Jersey were collected by the New Jersey State Cancer Registry, Cancer Epidemiology Services, New Jersey State Department of Health and Senior Services. Cancer incidence data from North Carolina were collected by the North Carolina Central Cancer Registry. Cancer incidence data from Pennsylvania were supplied by the Division of Health Statistics and Research, Pennsylvania Department of Health, Harrisburg, Pennsylvania. The Pennsylvania Department of Health specifically disclaims responsibility for any analyses, interpretations or conclusions. Cancer incidence data from Arizona were collected by the Arizona Cancer Registry, Division of Public Health Services, Arizona Department of Health Services. Cancer incidence data from Texas were collected by the Texas Cancer Registry, Cancer Epidemiology and Surveillance Branch, Texas Department of State Health Services.

We are indebted to the participants in the NIH-AARP Diet and Health Study for their outstanding cooperation.

References

1. Jemal A, Siegel R, Xu J, et al. Cancer statistics, 2010. CA Cancer J Clin. 2010; 60(5):277–300. [PubMed: 20610543]
2. Chow WH, Dong LM, Devesa SS. Epidemiology and risk factors for kidney cancer. Nat Rev Urol. 2010; 7(5):245–57. [PubMed: 20448658]
3. Owen N, Healy GN, Matthews CE, et al. Too Much Sitting: The Population Health Science of Sedentary Behavior. Exercise & Sport Sciences Reviews. 2010; 38(3):105–13. [PubMed: 20577058]
4. Lynch BM. Sedentary behavior and cancer: a systematic review of the literature and proposed biologic mechanisms. Cancer Epidemiology Biomarkers & Prevention. 2010
5. Schatzkin A, Subar AF, Thompson FE, et al. Design and serendipity in establishing a large cohort with wide dietary intake distributions : the National Institutes of Health-American Association of Retired Persons Diet and Health Study. Am J Epidemiol. 2001; 154(12):1119–25. [PubMed: 11744517]
6. Adams KF, Leitzmann MF, Albanes D, et al. Body Size and Renal Cell Cancer Incidence in a Large US Cohort Study. American Journal of Epidemiology. 2008; 168(3):268–77. [PubMed: 18544571]
7. George SM, Irwin ML, Matthews CE, et al. Beyond Recreational Physical Activity: Examining Occupational and Household Activity, Transportation Activity, and Sedentary Behavior in Relation to Postmenopausal Breast Cancer Risk. Am J Public Health. 2010
8. Matton L, Wijndaele K, Duvigneaud N, et al. Reliability and validity of the Flemish Physical Activity Computerized Questionnaire in adults. Res Q Exerc Sport. 2007; 78(4):293–306. [PubMed: 17941534]
9. Dipietro L, Caspersen CJ, Ostfeld AM, et al. A survey for assessing physical activity among older adults. Med Sci Sports Exerc. 1993; 25(5):628–42. [PubMed: 8492692]
10. Fjeldsoe BS, Marshall AL, Miller YD. Measurement properties of the Australian Women's Activity Survey. Med Sci Sports Exerc. 2009; 41(5):1020–33. [PubMed: 19346985]
11. Schuit AJ, Schouten EG, Westerterp KR, et al. Validity of the physical activity scale for the elderly (PASE): According to energy expenditure assessed by the doubly labeled water method. Journal of Clinical Epidemiology. 1997; 50(5):541–6. [PubMed: 9180646]
12. Washburn RA, Ficker JL. Physical Activity Scale for the Elderly (PASE): the relationship with activity measured by a portable accelerometer. J Sports Med Phys Fitness. 1999; 39(4):336–40. [PubMed: 10726435]
13. Washburn RA, McAuley E, Katula J, et al. The Physical Activity Scale for the Elderly (PASE): Evidence for Validity. Journal of Clinical Epidemiology. 1999; 52(7):643–51. [PubMed: 10391658]
14. Washburn RA, Smith KW, Jette AM, et al. The physical activity scale for the elderly (PASE): Development and evaluation. Journal of Clinical Epidemiology. 1993; 46(2):153–62. [PubMed: 8437031]
15. Moore SC, Chow WH, Schatzkin A, et al. Physical activity during adulthood and adolescence in relation to renal cell cancer. Am J Epidemiol. 2008; 168(2):149–57. [PubMed: 18468990]
16. Gierach GL, Chang SC, Brinton LA, et al. Physical activity, sedentary behavior, and endometrial cancer risk in the NIH-AARP Diet and Health Study. Int J Cancer. 2009; 124(9):2139–47. [PubMed: 19123463]

17. Howard RA, Freedman DM, Park Y, et al. Physical activity, sedentary behavior, and the risk of colon and rectal cancer in the NIH-AARP Diet and Health Study. Cancer Causes Control. 2008; 19(9):939–53. [PubMed: 18437512]

18. Moore SC, Gierach GL, Schatzkin A, et al. Physical activity, sedentary behaviours, and the prevention of endometrial cancer. Br J Cancer. 2010; 103(7):933–8. [PubMed: 20877336]

List of Abbreviations and Acronyms

RCC	renal cell carcinoma
MVPA	moderate-vigorous physical activity
BMI	body mass index
HR	hazard ratio
CI	confidence interval

Table 1

Risk of RCC according to levels of sedentary behavior among 289,512 men and women in the NIH-AARP Diet and Health Study

Among Men and Women				
			Hazard ratios (95% confidence intervals)	
Sitting while watching television/videos (hrs/d)	**Cases**	**Person-years**	**Multivariate model without MVPA[1]**	**Full model[2]**
< 1	64	175,165	1.00	1.00
1 to 2	322	732,110	1.06 (0.81, 1.39)	1.06 (0.81, 1.39)
3 to 4	564	1,101,007	1.15 (0.88, 1.49)	1.15 (0.88, 1.49)
5 to 6	203	376,608	1.15 (0.86, 1.53)	1.15 (0.86, 1.53)
7+	53	120,262	0.96 (0.66, 1.39)	0.96 (0.66, 1.38)
*p*trend			0.692	0.707
Total sitting (hrs/d)				
< 3	220	501,433	1.00	1.00
3 to 4	402	731,624	1.20 (1.02, 1.42)	1.20 (1.02, 1.42)
5 to 6	320	695,341	1.02 (0.86, 1.21)	1.02 (0.86, 1.21)
7 to 8	166	367,315	1.05 (0.85, 1.28)	1.04 (0.85, 1.27)
9+	98	209,439	1.12 (0.88, 1.42)	1.11 (0.87, 1.41)
*p*trend			0.832	0.765
		Among Men		
			Hazard ratios (95% confidence intervals)	
Sitting while watching television/videos (hrs/d)	Cases	Person-years	Multivariate model without MVPA[3]	Full model[4]
< 1	43	94,065	1.00	1.00
1 to 2	251	437,352	1.16 (0.84, 1.60)	1.16 (0.84, 1.60)
3 to 4	430	648,062	1.23 (0.90, 1.69)	1.23 (0.90, 1.69)
5 to 6	151	206,100	1.26 (0.89, 1.77)	1.25 (0.89, 1.77)
7+	34	58,193	0.98 (0.62, 1.54)	0.97 (0.61, 1.53)
*p*trend			0.702	0.743
Total sitting (hrs/d)				
< 3	163	267,720	1.00	1.00
3 to 4	302	422,922	1.17 (0.96, 1.41)	1.16 (0.96, 1.41)
5 to 6	247	410,106	1.01 (0.83, 1.23)	1.00 (0.82, 1.22)

Among Men and Women				
			Hazard ratios (95% confidence intervals)	
Sitting while watching television/videos (hrs/d)	**Cases**	**Person-years**	**Multivariate model without MVPA[1]**	**Full model[2]**
7 to 8	121	216,994	0.97 (0.77, 1.23)	0.96 (0.76, 1.22)
9+	76	126,030	1.10 (0.83, 1.44)	1.08 (0.82, 1.42)
*p*trend			0.602	0.524
		Among Women		
			Hazard ratios (95% confidence intervals)	
Sitting while watching television/videos (hrs/d)	Cases	Person-years	Multivariate model without MVPA[3]	Full model[4]
< 1	21	81,100	1.00	1.00
1 to 2	71	294,758	0.87 (0.53, 1.42)	0.87 (0.53, 1.42)
3 to 4	134	452,945	1.00 (0.63, 1.59)	1.00 (0.63, 1.59)
5 to 6	52	170,508	0.96 (0.57, 1.61)	0.96 (0.57, 1.62)
7+	19	62,069	0.95 (0.50, 1.79)	0.96 (0.51, 1.82)
*p*trend			0.758	0.700
Total sitting (hrs/d)				
< 3	57	233,713	1.00	1.00
3 to 4	100	308,702	1.32 (0.96, 1.84)	1.32 (0.95, 1.84)
5 to 6	73	285,235	1.06 (0.75, 1.51)	1.06 (0.75, 1.51)
7 to 8	45	150,321	1.30 (0.87, 1.93)	1.31 (0.88, 1.95)
9+	22	83,409	1.17 (0.71, 1.93)	1.20 (0.72, 1.99)
*p*trend			0.631	0.572

[1] Adjusted for age, sex, race, history of diabetes, smoking, alcohol intake, diet quality and energy intake

[2] Adjusted for age, sex, race, history of diabetes, smoking, alcohol intake, diet quality, energy intake, and recreational moderate-vigorous physical activity

[3] Adjusted for age, race, history of diabetes, smoking, alcohol intake, diet quality, energy intake, age at first live birth/parity (women only)

[4] Adjusted for age, race, history of diabetes, smoking, alcohol intake, diet quality, energy intake, age at first live birth/parity (women only) , and recreational moderate-vigorous physical activity

Ann Epidemiol. Author manuscript; available in PMC 2012 October 01.