Preventive Medicine Reports 2 (2015) 247–249

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: http://ees.elsevier.com/pmedr

Relationships between sitting time and health indicators, costs, and utilization in older adults

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ARTICLE INFO

Available online 30 March 2015

Keywords:
Motor activity
Aged
Health information systems

ABSTRACT

Objective. To examine whether self-reported sitting time is related to various health indicators, health costs, and utilization in adults over age 65.

Methods. A retrospective cross-sectional cohort study was conducted using the electronic health record (EHR) from an integrated health system in Washington State. Members who completed an online health risk assessment (HRA) between 2009 and 2011 (N = 3538) were eligible. The HRA assessed sitting time, physical activity, and health status. Diagnosis codes for diabetes and cardiovascular disease (CVD), height and weight for body mass index (BMI) calculations, health care utilization and health costs were extracted from the EHR. Linear regression models with robust standard errors tested differences in sitting time by health status, BMI category, diabetes and CVD, health costs, and utilization adjusting for demographic variables, BMI, physical activity, and health conditions.

Results. People classified as overweight and obese, that had diabetes or CVD, and with poorer self-rated health had significantly higher sitting time ($p < .05$). Total annual adjusted health care costs were $126 higher for each additional hour of sitting ($p < .05$; not significant in final models including health conditions).

Conclusion. Sitting time may be an important independent health indicator among older adults.

Introduction

Sedentary behavior, defined as activities that produce little or no energy expenditure and involve a sitting, reclining, or lying down position (Owen et al., 2010; Rosenberg et al., 2008; Ainsworth et al., 2011; Dunstan et al., 2011), is highly prevalent in the context of societal technological advances. Emerging research suggests that sedentary behavior is related to mortality, diabetes, and obesity in people over the age of 50 independent of physical activity levels (de Rezende et al., 2014; Gardiner et al., 2011; Swartz et al., 2012; Leon-Munoz et al., 2013). Little is known about differences in sedentary time among populations with cardiometabolic conditions, nor whether sedentary time relates to health care utilization and costs. The goal of this study was to examine relationships between sitting time and 1) self-rated health, body mass index, diabetes, and cardiovascular disease; and, 2) health care costs and utilization.

Methods

A retrospective cross-sectional cohort study was conducted using electronic health record (EHR) data from members of an integrated health system in Washington State, Group Health (GH). Eligibility criteria included age 65 +, continuous enrollment from 2009 to 2011, and having completed a health risk assessment (HRA) between January 1, 2009 and December 31, 2011 through a web-based patient portal. The most recently completed HRA was used in analyses. The following exclusion criteria were obtained from the EHR:HRA question on sitting time incomplete or indicated 0 h/day sitting, more than 16 h/day of physical activity reported, wheelchair required for mobility, residence in long-term care, hospice care, or skilled nursing, and serious mental health or substance use disorder.

Data obtained from the EHR included demographics, height and weight, and diagnoses, for the year 2010. Costs and utilization were obtained from the GH claims system. For the 1% of the sample without a visit in 2010, data from 2009 was used.

Physical activity and sitting time were self-reported using the International Physical Activity Questionnaire (IPAQ). The IPAQ assesses the average number of minutes spent sitting on a usual weekday (Rosenberg et al., 2008; Craig et al., 2003). Physical activity items were scored according to the IPAQ scoring protocol. Participants were then classified into 6 categories of activity (0 min, >0 min and <1 h, 1 to <2 h, 2 to <3 h, 3 to <5 h, and 5 + h/day).

Self-rated health was assessed with the single item global assessment from the SF-36 which asks people to categorize their health as excellent, very good, good, fair, or poor (Ware and Sherbourne, 1992a; Ware and Sherbourne, 1992b).

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http://dx.doi.org/10.1016/j.pmedr.2015.03.011

Body mass index (BMI) was calculated as weight (kg) / [height (m)]^2 using the most recent height and weight between 2009 and 2010. Members were classified as normal weight (BMI < 25), overweight (25–29.9), or obese (30+). Demographic characteristics captured in the EHR included sex, race, age, and ethnicity. ICD-9 codes captured diagnoses of diabetes (249–251) and CVD (410–414, 427–429, 430–438.99, 440, 443). Having a prior cancer diagnosis (used as a covariate only) was captured using SEER codes. Total healthcare costs (sum of inpatient, outpatient, pharmacy, radiology, laboratory, and ancillary services such as home health and medical equipment), hospital admissions, and number of visits to primary and specialty care were obtained from GH claims files.

Linear regression models were fit using GEE with robust standard errors (Liang and Zeger, 1986) to examine the relationship between sitting time and health conditions, self-rated health status, and health costs and utilization adjusting for demographic variables (age, race, sex). We then sequentially adjusted for physical activity and BMI (partially adjusted model) and diabetes, CVD, and cancer (fully adjusted model). Analyses were conducted using R version 3.0.2 (Vienna, Austria) (R Core Team, 2014).

Results

Of the 37,492 members who met age and eligibility criteria, 3538 completed the HRA after excluding those missing BMI (N = 367) and physical activity (N = 62) data (see Table 1). Mean sitting time was 6.1 h/day. HRA completers tended to be younger, male, white, non-Hispanic, and have fewer chronic conditions than non-completers (data not shown).

Table 1
Characteristics of Washington State Group Health members completing at least one health risk assessments in 2009–2011 by self-reported sitting time.

Characteristic	Overall	Self-reported sitting time	
		<7 h/day	≥7 h/day
Total sample, N	3538	2395	1143
Age, mean (SD)	72.6 (6)	72.6 (5.8)	72.8 (6.5)
Male, N (%)	1790 (51%)	1170 (49%)	620 (54%)
White, N (%)	3266 (92%)	2218 (93%)	1048 (92%)
Hispanic, N (%)	76 (2%)	49 (2%)	27 (2%)
BMI category, N (%)			
Healthy weight	1014 (29%)	748 (31%)	266 (23%)
Overweight	1507 (43%)	1040 (43%)	467 (41%)
Obese	1017 (29%)	607 (25%)	410 (36%)
BMI, mean (SD)	28.1 (5.2)	27.6 (4.9)	29.1 (5.7)
Diabetes, N (%)	544 (15%)	320 (13%)	224 (20%)
Cardiovascular disease, N (%)	1151 (33%)	726 (30%)	425 (37%)
Self-reported sitting time, mean (SD)	6.1 (3.2)	4.3 (1.3)	9.6 (2.8)
Self-reported physical activity, N (%)			
None	536 (15%)	236 (10%)	300 (26%)
>0–<1 h/day	265 (7%)	173 (7%)	92 (8%)
1–<2 h/day	866 (24%)	582 (24%)	284 (25%)
2–<3 h/day	573 (16%)	399 (17%)	174 (15%)
3–<5 h/day	836 (24%)	623 (26%)	213 (19%)
>5 h/day	462 (13%)	382 (16%)	80 (7%)
Self-rated health, N (%)			
Excellent	401 (11%)	312 (13%)	89 (8%)
Very good	1511 (43%)	1088 (45%)	423 (37%)
Good	1216 (34%)	810 (34%)	406 (36%)
Fair	348 (10%)	164 (7%)	184 (16%)
Poor	62 (2%)	21 (1%)	41 (4%)
Cancer, N (%)	678 (19%)	462 (19%)	216 (19%)
Total costs, mean (SD)	7308.7 (10,521.7)	6850.2 (9505.7)	8269.4 (12,332.7)
Hospital admissions, mean (SD)	0.2 (1.2)	0.2 (1.1)	0.3 (1.3)
Primary care visits, mean (SD)	4.7 (4.1)	4.5 (3.8)	5 (4.7)
Specialty visits, mean (SD)	6.9 (6.4)	6.7 (6.3)	7.2 (6.5)

In fully adjusted models, people classified as overweight (adjusted M = 5.96 h/day) and obese (adjusted M = 6.53 h/day) reported significantly more sitting time than healthy weight individuals (5.71 h/day; see Table 2). BMI was correlated with sitting time (Spearman r = .19). People with diabetes had higher sitting time (adjusted M = 6.37 h/day) than those without (adjusted M = 5.99). People with CVD had higher sitting time (adjusted M = 6.29) than those without (adjusted M = 5.94). Self-rated health was significantly associated with sedentary time.

Total health care costs were $126 higher for each additional hour of sitting in partially adjusted models but this was greatly attenuated in fully adjusted model (p = .23; see Table 2). Hospital admission rates, primary care provider visit rates, and specialty visit rates did not differ significantly by sitting time in fully adjusted models. Sensitivity analyses were conducted (e.g. log transformed total costs) and the results were unchanged (results not shown).

Discussion

Among older adults within a health system who completed HRAs, higher sitting time was observed among those with diabetes, CVD, and obesity in final models suggesting that sedentary time may be an important independent health indicator among older adults with chronic conditions. The older adults in our sample reported 366 min of sitting time on average. Our results provide important new data as few previous reports have been able to directly link sedentary time to health indicators in older adults (most published research relies on surrogate markers of health) (de Rezende et al., 2014). Thresholds for levels of self-reported sitting time that may be associated with adverse health outcomes are not clear. A recent review suggested 7 h/day as a threshold (Pedisic, 2014). Many of those with chronic conditions in our sample would meet this threshold and be considered potential targets for interventions. For example, 41% of people with diabetes in our sample had high sitting time by this threshold.

To our knowledge, health care utilization and costs associated with sitting time in older adults have not been described previously. We found that sitting time is strongly associated with costs but the relationship diminishes when models include adjustments for health conditions that are on the causal pathway. Our results differ from a prior study in younger, middle-aged women showing no association between sitting time and health costs (Peeters et al., 2014). Further study is needed to determine whether interventions to reduce sedentary behavior may be an effective strategy to reduce healthcare expenditures.

Study limitations

There may be selection bias among those who completed the HRA. The health plan developed the HRA so that the analysis is limited to the data that was available. Given the cross-sectional nature of the data it is not possible to make conclusions about the directions of relationships nor describe causal pathways. Relationships between weight gain, weight-related chronic conditions and sedentarism are likely to be bi-directional. There is concern that self-reported sitting time may be cognitively challenging for people to estimate (Yates et al., 2012; van Uffelen et al., 2011) with potential for desirability biases in reporting among older adults (Chastin et al., 2014). Inaccurate estimates could distort the nature of relationships so future studies using objective measures may provide better indicators of relationships (Celis-Morales et al., 2012).

Conclusions

Findings from this preliminary study contribute to emerging data on relationships between sitting time and chronic health conditions in older

Table 2
Associations between sitting time, health conditions, self-rated health, and costs and utilization (with sequential adjustment for covariates) in Washington State Group Health members completing a health risk assessment in 2009–2011.

Variable	Category	Demographic model[a]		Partially adjusted model[b]		Fully adjusted model[c]	
		Mean difference in hours sitting/day (95% CI)	p-Value	Mean difference in hours sitting/day (95% CI)	p-Value	Mean difference in hours sitting/day (95% CI)	p-Value
Health conditions							
BMI	<25	Ref		Ref		Ref	
	25–30	0.41 (0.17, 0.65)	0.002	0.27 (0.04, 0.51)	0.022	0.24 (0.01, 0.48)	0.042
	30 and over	1.31 (1.03, 1.59)	<0.001	0.93 (0.65, 1.2)	<0.001	0.82 (0.53, 1.10)	<0.001
Diabetes	No	Ref		Ref		Ref	
	Yes	0.82 (0.51, 1.14)	<0.001	0.39 (0.09, 0.7)	0.011	0.37 (0.07, 0.68)	0.016
CVD	No	Ref		Ref		Ref	
	Yes	0.52 (0.28, 0.77)	<0.001	0.36 (0.13, 0.59)	0.003	0.35 (0.11, 0.58)	0.003
Self-rated health status							
Excellent		Ref		Ref		n/a	
Very good		0.45 (0.13, 0.77)	0.006	0.22 (−0.09, 0.53)	0.168	n/a	
Good		0.83 (0.51, 1.16)	<0.001	0.40 (0.07, 0.73)	0.017	n/a	
Fair		2.28 (1.79, 2.77)	<0.001	1.48 (1.01, 1.96)	<0.001	n/a	
Poor		3.59 (2.50, 4.68)	<0.001	2.57 (1.51, 3.63)	<0.001	n/a	

Variable	Effect per additional hour sitting (95% CI)	p-Value	Effect per additional hour sitting (95% CI)	p-Value	Effect per additional hour sitting (95% CI)	p-Value
Health costs and utilization						
Total costs, mean change	181.34 (76.2, 286.47)	0.001	126.24 (17.87, 234.61)	0.022	62.88 (−39.76, 165.52)	0.230
Hospitalization rate/1000, mean change	15.6 (3.53, 27.68)	0.011	14.89 (2.68, 27.11)	0.017	0.01 (0.00, 0.02)	0.065
PCP visit rate/100, mean change	6.69 (2.39, 10.99)	0.002	3.61 (−0.77, 8.00)	0.106	0.02 (−0.03, 0.06)	0.431
Specialty visit rate/100, mean change	7.01 (0.26, 13.76)	0.042	4.17 (−2.77, 11.11)	0.239	0.00 (−0.06, 0.07)	0.932

[a] The demographic model includes age, race (white versus other), and sex as covariates.
[b] The partially adjusted model includes age, race, sex, BMI (except BMI model), and total physical activity as covariates.
[c] The fully adjusted model includes age, race, sex, BMI, total physical activity, diabetes, cardiovascular disease, and cancer as covariates (note: results shown for BMI, diabetes, and CVD are from a single model).

adults. Our findings support the importance of collecting information on sitting time within health systems. In the future, HRA data could be used to identify people with high sitting time and deliver interventions proactively. Our preliminary findings suggest that further observational and intervention studies are warranted.

Conflicts of interest

The authors declare that there are no conflicts of interest.

Acknowledgments

Funding for this study was provided by the Group Health Research Institute. We thank Susan Carol Bradford and Peter Lee Thompson for providing the HRA data.

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