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Association between television viewing time and risk of incident stroke in a general population: results from the REGARDS study

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Abstract

Objectives—The purpose of this study was to explore the relationship between TV/video viewing, as a measure of sedentary behavior, and risk of incident stroke in a large prospective cohort of men and women.

Methods—This analysis involved 22 257 participants from the REasons for Geographic And Racial Differences in Stroke (REGARDS) study who reported at baseline the amount of time spent watching TV/video daily. Suspected stroke events were identified at six-monthly telephone calls and were physician-adjudicated. Cox proportional hazards models were used to examine risk of stroke at follow-up.

Results—During 7.1 years of follow-up, 727 incident strokes occurred. After adjusting for demographic factors, watching TV/video 4 h/day (30% of the sample) was associated with a hazard ratio of 1.37 increased risk of all stroke (95% confidence interval (CI), 1.10-1.71) and incident ischemic stroke (hazard ratio 1.35, CI 1.06-1.72). This association was attenuated by socioeconomic factors such as employment status, education and income.

Conclusions—These results suggest that while TV/video viewing is associated with increased stroke risk, the effect of TV/video viewing on stroke risk may be explained through other risk factors.

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Regular moderate to vigorous physical activity (MVPA) is associated with better health outcomes, particularly in reducing the risk of premature death (Lollgen et al., 2009) and stroke (McDonnell et al., 2013). However, time spent in MVPA may not be enough to counteract the effects of sedentary behavior, i.e. any waking activities expending <1.5 metabolic units while in a sitting or reclining posture (Pate et al., 2008; STM, 2015). Recently, evidence is emerging that sedentary behavior is a powerful risk factor for mortality, independent of time spent in MVPA (Dunstan et al., 2011; Koster et al., 2012; Matthews et al., 2012). The association between sedentary behavior and cardiovascular health is particularly strong, with a systematic review reporting a relative risk (RR) of 2.47 for cardiovascular events for those in the most sedentary category, and strong associations were also present for cardiovascular mortality (hazard ratio (HR) 1.90) and diabetes (RR 2.12) (Wilmot et al., 2012).

The association between sedentary behavior and stroke risk has recently been examined in post-menopausal women, where sitting more than 10 hours a day was associated with an increased risk of stroke (multivariable adjusted hazard ratio 1.21) (Chomistek et al., 2013). Prolonged sitting may increase stroke risk through the detrimental effect on cardiometabolic markers such as glycemic control (Dunstan et al., 2007), blood pressure and waist circumference (Healy et al., 2008) which are known stroke risk factors. These associations have been demonstrated in studies focused on television viewing time (Dunstan et al., 2007; Healy et al., 2008) and self-reported sitting time (Staiano et al., 2014). Further research is needed to investigate the effect of sedentary behavior on stroke risk in men and women.

The most common leisure-time sedentary behavior is TV viewing time, again strongly associated with cardiovascular risk factors - independent of leisure time exercise (Dunstan et al., 2010) and moderate-to-vigorous-intensity physical activity (Gardiner et al., 2011; Stamatakis et al., 2011). A life-table analysis has examined the reduction in life expectancy with excessive TV viewing and proposed that every hour of TV watched after the age of 25 years reduces your life expectancy by 22 minutes, suggesting that sedentary time is comparable in magnitude to other behavioral risk factors such as obesity and smoking (Veerman et al., 2012). Excessive TV viewing, measured via self-report, is also associated with cardiovascular and all-cause mortality (Ikehara et al., 2015; Wijndaele et al., 2011). Due to the strong association between TV viewing and increased cardiovascular events, diabetes and risk of premature death, we propose that TV viewing may also be associated with increased risk of stroke. The aim of this study was to explore the relationship between TV viewing and risk of incident stroke in the REGARDS cohort. We propose that TV viewing time is likely to be a conservative measure of sedentary behavior, considering that other seated activities could include screen time for computer use, reading, sitting for transportation etc. However, we have focused on this because of the detrimental effect of TV viewing time on cardiometabolic biomarkers and stroke risk factors.

Methods

The REGARDS study has been described in detail elsewhere (Howard et al., 2005). Briefly, 30 239 participants were recruited between 2003-2007 from the continental United States to determine the causes for the excess stroke mortality in African Americans and those living

in the Southeastern US. Participants aged 45 years and over were recruited by mail and telephone from a commercially available list of residents. Those who consented were interviewed by telephone to collect data on demographic and risk factors, followed by an in-home assessment to collect physical measures, an electrocardiogram (ECG) and self-administered questionnaires. Relevant stroke risk factors included as covariates in this analysis were body mass index (kg/m^2), waist circumference (cm), physical activity levels (self-reported number of times per week engaged in intense physical activity, sufficient to work up a sweat, with categories 0, 1-4 and 4 times per week), systolic blood pressure (mmHg), self-reported statin use (yes or no), left ventricular hypertrophy or atrial fibrillation (on measured ECG, yes or no), smoking status (never versus past versus current use of cigarettes), alcohol use (heavy, 7 drinks/wk for women, 14 drinks/wk for men; moderate, 1-7 for women, 1-14 for men; and none) and diabetes mellitus (fasting glucose, 126 mL/dL or non-fasting glucose 200 mL/dL, or self-reported use of oral hypoglycemic medications or insulin). Participants, or their proxies, are contacted every six months by telephone to assess potential stroke, with retrieval and central physician adjudication of medical charts of suspected strokes. All involved Institutional Review Boards approved the study methods.

Assessment of sedentary behavior

Television/video viewing time was determined during the baseline self-administered questionnaire with the question “How many hours do you watch television or video, per day or per week, on average?” Self-reported TV viewing time has been established as a valid (criterion validity = 0.3) and reliable measure among adults (intraclass correlation = 0.82, 95% CI 0.75 to 0.87) (Salmon et al., 2003). Responses were initially categorized into 6 groups: none, 1-6 hours per week, 1 hr/day, 2 h/day, 3 h/day, and 4 or more h/day. At baseline, 23 703 participants responded to this question, 78.4% of the sample.

Assessment of incident stroke

Incidence of stroke was confirmed in a three-stage process, as previously described (Howard et al., 2011). Briefly, reports of possible stroke events result in retrieval of medical records which were reviewed by a stroke nurse and then reviewed by at least 2 physician members of a panel of stroke experts in accordance with the World Health Organization (WHO) definition (Aho et al., 1980). Events not meeting this definition due to a duration of symptoms < 24 hours and neuroimaging consistent with acute ischemia or hemorrhage were classified as “clinical strokes” or “probable strokes” if adjudicators agreed that the event was likely to a stroke or death related to stroke, but information was incomplete for WHO or clinical classification.

Statistical analysis

Cox proportional hazards analysis was used to determine the hazard ratios (HR) and 95% confidence intervals (CI) for the association between prior TV viewing and all incident stroke, and incident ischemic stroke during follow-up. The six TV viewing categories were collapsed into three, based on previous studies investigating the link between TV viewing

and mortality (Dunstan et al., 2010): < 2 hours a day, 2 to < 4 h/day, 4 h/day. For the purposes of statistical analysis, TV viewing time was seen as the predictor variable and the reference value was watching TV less than two hours a day. Models were initially adjusted for the demographic factors age, race, sex, and age-race interaction, then for socioeconomic factors (income and education). Additional models adjusted for physical activity levels at baseline, then other factors which may affect TV viewing: self-reported general health (poor, fair, good, very good or excellent), marital status, employment status and depressive symptoms (defined as a score 4 on the Centers for Epidemiologic Studies of Depression CESD-4 scale (Melchior et al., 1993)). The final model adjusted for other stroke risk factors (body mass index and waist circumference, systolic blood pressure, statin use, left ventricular hypertrophy, atrial fibrillation, alcohol use, smoking and diabetes). Baseline differences between TV viewing categories were determined using analysis of variance for continuous variables, and Chi square tests for categorical data. Interactions between TV viewing and covariates, with stroke as the end point, were conducted using the Wald Chi-square type 3 test. All analyses were conducted using SAS software (version 9.3; SAS Institute Inc, Cary, NC) and results were considered significant at $P < 0.05$.

Results

Of the 30 239 participants in the REGARDS study, 56 with data anomalies were excluded. We then excluded individuals with a history of stroke at baseline (2 032) and those who had not answered the TV/video viewing question (5 984), leaving 22 257 participants for the current analysis.

The characteristics of participants are shown in Table 1, categorized by amount of TV/video viewing. Only 20% of participants watched TV for < 2 h/day and almost a third of participants watched TV 4 h/day (30%). Those who watched TV 2 h/day were more likely to be older, African American, unmarried, unemployed, live in urban areas; and less likely to have a higher education or an income US\$35,000. There were also significant trends in stroke risk factor profile, with greater proportions of smoking, physical inactivity, left ventricular hypertrophy, hypertension, obesity and statin use in those who watched more TV.

There were 727 confirmed cases of stroke within a mean follow up of 7.1 ± 2.6 years. There was a statistically significant trend towards greater incidence of total stroke across TV viewing categories, with 363 strokes in the group who watched 2 to < 4 hours of TV/day (3.3% of the total participants in this category), 241 in the group who watched 4 h/day (3.6%) compared with 123 in the group who watched < 2 h/day (2.7%, analysis of variance, $P = 0.04$). There was no significant difference in the incidence of ischemic stroke ($P = 0.05$).

Participants who watched TV 4 h/day were significantly more likely to suffer a stroke than those who watched < 2 h/day HR 1.37, 95% (CI 1.10-1.71) in the initial model that adjusted for demographic factors (age, race, sex, region, age-race interaction, see Table 2). Further adjustment for education and income attenuated this effect (HR 1.21, CI 0.96-1.53), with additional multivariable models adjusting for physical activity and general health variables, and stroke risk factors, attenuating the effect further. Similar HRs were observed for incident

ischemic stroke (see Table 2), with a significant increase in stroke risk in participants who watched TV 4 h/day after adjustment for demographic factors (HR 1.35, CI 1.06-1.72). There was a dose-dependent effect, with those watching 2 to < 4 hours of TV/day having a significantly greater risk of ischemic stroke (HR 1.28, CI 1.03-1.60), but not all incident stroke after adjusting for demographic factors, with a similar attenuation of the effect when corrected for socioeconomic factors, health status and stroke risk factors. The association between TV viewing and hemorrhagic strokes was not investigated separately due to the small number of hemorrhagic stroke events.

Despite the baseline differences in demographic characteristics between TV viewing categories, there was no significant interaction between age, race, sex, region or urban group on the primary outcome of incident stroke. The significantly greater proportion of diabetes in those participants who watched TV 4 h/day was not associated with stroke risk in isolation (Wald Chi-square type 3 test, $P = 0.09$). The only variable that was independently associated with stroke incidence was employment status, with a greater risk of stroke for those who watched 4 h/day and were unemployed ($P = 0.008$).

Discussion

Sedentary behavior, particularly sitting for prolonged periods when viewing TV/video, is associated with increased mortality risk, particularly from cardiovascular disease (Bjork Petersen et al., 2014; Wilmot et al., 2012). Our results provide some support for an association between increased risk of stroke and prior self-reported TV/video viewing time. In the demographic model, participants who reported watching TV/video 4 h/day at baseline were more likely to suffer a stroke than those who watched < 2 h/day, with a hazard ratio of 1.37. However, this effect was attenuated when controlling for socioeconomic factors and traditional stroke risk factors.

The detrimental effects of excessive sitting have been known since the seminal study of increased mortality for London bus drivers compared with bus conductors in the 1950s (Morris et al., 1953). Sedentary behavior can include a range of activities in sitting or lying postures, commonly occurring during work, leisure and transportation. Although TV viewing is just one aspect of sedentary behavior, it reflects the most common behavior involving prolonged sitting (Salmon et al., 2003). Despite our TV/video viewing time variable being a proxy measure for total daily sitting time, our finding of a significantly increased risk of stroke in the unadjusted model corresponds to that found by Chomistek and colleagues (Chomistek et al., 2013). They followed 71 018 women for a median of 12.2 years and observed a multivariable-adjusted HR of 1.21 (95% CI 1.07-1.37) for all strokes in those who sat for 10 h/day. Our results suggest a dose-dependent relationship between amount of TV/video viewing and ischemic stroke risk. This is consistent with the meta-analysis conducted by Grontved and Hu (2011), that found every two hours of TV viewing per day increased the risk of fatal and non-fatal cardiovascular disease by 1.15 (95% CI 1.06-1.23).

Although several reports confirm that TV/video viewing time is the predominant leisure-time sedentary behaviour (ABS, 2006; Clark et al., 2009; United States Department of

Labor) we do not have information about other activities performed concurrently with TV viewing. It is possible that some people were active while watching TV, perhaps exercising on a stationary bike or performing light physical activity such as ironing. However, it is more likely that excessive TV/video viewing is accompanied by unhealthy behaviors such as smoking or poor diet (Schmid and Leitzmann, 2014), which is reflected by the poorer cardiovascular risk factor profile of those who watched TV 4 h/day TV viewing category as shown in Table 1. It is clear from our results that any effect of TV/video viewing is attenuated when controlling for socioeconomic, health and stroke risk factors, in the fully adjusted model, making it difficult to clarify the additional risk for stroke from sitting alone. Our weak association between TV/video viewing time and stroke risk is not consistent with the strong association between sedentary time and mortality, independent of physical inactivity (Dunstan et al., 2011; Koster et al., 2012; Matthews et al., 2012). Therefore, in our study it does not appear as though excessive TV/video viewing poses an additional risk of stroke compared to known socioeconomic and traditional stroke risk factors.

Research into sedentary behavior has found that total sitting time, and how long each period of sitting lasts, are associated with increased risk of cardiovascular disease and cardiovascular and all-cause mortality (Dunstan et al., 2011; Wilmot et al., 2012). The association with prolonged sitting is particularly consistent for diabetes, with a meta-analysis confirming a relative risk of 1.12 for diabetes in both prospective and cross-sectional studies (Wilmot et al., 2012). In the present study there was a significantly greater prevalence of diabetes in those who watched more TV, but the interaction between diabetes and TV viewing category on stroke outcome was not significant ($P = 0.09$). However, for those who were unemployed there was a significant interaction between TV viewing and stroke incidence, and when adjusting for socioeconomic factors the stroke risk was attenuated. We can speculate that those who are unemployed may be retired older adults who are known to sit more than younger adults (Harrington et al., 2014). Alternatively, the unemployed may have accumulated more TV viewing time in prolonged bouts without interruption, which has been associated with poorer postprandial blood glucose control (Dunstan et al., 2012). However, we do not have any data regarding interruptions to sitting (prolonged bouts versus intermittent) in our sample. Further information regarding the control of diabetes, and duration of the disease, is needed to explore the potency of prolonged sedentary time on stroke risk specifically for those with diabetes.

In the United States physical activity recommendations advocate 150 minutes per week of moderate intensity physical activity for cardiovascular health benefits (Physical Activity Guidelines Advisory Committee, 2008). Recent national guidelines in Australia (Department of Health, 2014) and Finland (STM, 2015) have included the advice that adults should avoid sedentary behaviors as well as meeting physical activity recommendations. The paradigm shift aims to redress the situation where Australian adults spend four hours a day in sedentary behaviors, including 13 hours a week watching TV (ABS, 2013). Americans have a similar activity profile: only 50% of Americans meet the current physical activity guidelines (Go et al., 2014). While a sedentary lifestyle is discouraged in the US physical activity guidelines and stroke prevention guidelines (Meschia et al., 2014), they do not specifically address sedentary time and this may be an important factor to incorporate in the future.

There are several limitations to consider with our study. Only two-thirds of the total REGARDS cohort answered the TV viewing question, with the most highly educated participants the most likely to return the survey, suggesting our results may under-represent those with lower levels of education (Judd et al., 2014). The TV viewing question was collected by self-report several years before stroke incidence, and lifestyle changes and health conditions may have altered TV viewing habits in the intervening years. As discussed above, how sedentary time is accumulated influences health and we did not have any data regarding position changes during the time spent viewing TV. Finally, although TV viewing is a strong indicator of sedentary behavior, it was a proxy measure as we did not have objective data on total sedentary time in these participants, or travel or occupational sitting. However, measurement of TV viewing time has been established as a reasonable proxy measure of overall sedentary behavior (Sugiyama et al., 2008). The strengths of this study include the prospective design, the large sample size including 40% African Americans and long follow up period, and careful adjudication of stroke events.

In conclusion, higher amounts of previous TV viewing is associated with an increased risk of total incident stroke and ischemic stroke in this sample of Americans, but the association is attenuated when taking into consideration socioeconomic factors such as unemployment and traditional stroke risk factors.

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Highlights

Sedentary behaviour is now an important risk factor for cardiovascular disease

- The effect of prolonged sitting on stroke risk is unknown
- We assessed pre-stroke TV viewing habits for 22 257 adults in the REGARDS study
- We followed up participants for incident stroke occurrence over ~ 7 years
- Watching 4 hrs of TV/video/day at baseline was associated with a 37% rise in stroke incidence at follow-up
- This effect was attenuated by employment status, education and income

Table 1

Baseline Characteristics of REGARDS Participants Among Different TV/Video Viewing Groups

		< 2 h/day	2 h/day < 4	4 h/day	P value
Characteristics		N=4568	N=11004	N=6685	
Incident Stroke, n (%)		123(2.7)	363(3.3)	241(3.6)	0.04
Incident Ischemic, n (%)		103(2.3)	321(2.9)	197(3.0)	0.05
Age, mean (SD)		63.7(9.5)	65.3(9.3)	65.2(9.1)	<0.0001
Urban group, n (%)					
	Urban	3099(75.3)	7388(74.6)	4872(80.4)	<0.0001
	Mixed	496(12.1)	1242(12.5)	622(10.3)	
	Rural	521(12.7)	1274(12.9)	564(9.3)	
Women, n (%)		2535(55.5)	5742(52.2)	4084(61.1)	<0.0001
Black, n (%)		1381(30.2)	3174(28.8)	3375(50.5)	<0.0001
Region, n (%)					
	Stroke Belt	1536(33.6)	3742(34.0)	2409(36.0)	<0.001
	Stroke Buckle	978(21.4)	2513(22.8)	1371(20.5)	
	Non-belt	2054(45.0)	4749(43.2)	2905(43.5)	
Education >=High School, n (%)		4172(91.4)	10154(92.3)	5571(83.4)	<0.0001
Income >=35K, n (%)		2548(63.1)	5765(59.3)	2253(38.5)	<0.0001
Diabetes, n (%)		669(15.2)	1862(17.5)	1615(25.1)	<0.0001
Depression, n (%)		358(7.9)	846(7.8)	947(14.2)	<0.0001
Smoking, n (%)					
	Current	448(9.9)	1274(11.6)	1304(19.6)	<0.0001
	Never	2412(53.1)	5064(46.2)	2613(39.2)	
	Past	1686(37.1)	4627(42.2)	2748(41.2)	
Physical activity, n (%)					
	None	1155(25.7)	3134(28.8)	2779(42.2)	<0.0002
	1-3x/wk	1746(38.9)	4244(39.1)	2155(32.7)	
	4+/wk	1592(35.4)	3487(32.1)	1652(25.1)	
Alcohol use, n (%)					
	Heavy	178(4.0)	484(4.5)	280(4.3)	<0.0001
	Moderate	1651(36.6)	4056(37.5)	1971(30.1)	
	None	2679(59.4)	6275(58.0)	4292(65.6)	
Employment Status, n (%)					
	Employed	1387(47.5)	2699(39.2)	956(23.2)	<0.0001
	Not employed	397(13.6)	846(12.3)	1001(24.3)	
	Retired	1138(39.0)	3339(48.5)	2167(52.6)	
Atrial fibrillation, n (%)		57(1.3)	165(1.5)	91(1.4)	0.45
LVH, n (%)		346(7.7)	890(8.2)	725(11.0)	<0.0001
Statin use, n (%)		1206(26.4)	3535(32.1)	2219(33.2)	<0.0001
Marital Status, n (%)					
	Divorced	591(12.9)	1375(12.5)	1161(17.4)	<0.0001

		< 2 h/day	2 h/day < 4	4 h/day	P value
Characteristics		N=4568	N=11004	N=6685	
	Married	2978(65.2)	7149(65.0)	3363(50.3)	
	Single	193(4.2)	488(4.4)	475(7.1)	
	Widowed	701(15.4)	1839(16.7)	1488(22.3)	
General Health, n (%)					
	Excellent	1113(24.4)	2068(18.8)	750(11.3)	<0.0001
	Very good	1603(35.1)	3849(35.0)	1736(26.0)	
	Good	1316(28.9)	3767(34.3)	2559(38.4)	
	Fair	459(10.1)	1120(10.2)	1297(19.5)	
	Poor	71(1.6)	184(1.7)	327(4.9)	
SBP, mean (SD)		124.6(16.0)	126.9(15.9)	128.8(16.9)	<0.0001
BMI, mean (SD)		28.0(5.8)	28.8(5.7)	30.3(6.8)	<0.0001
Waist, mean (SD)		92.5(15.1)	95.1(15.0)	98.3(16.1)	<0.0001

BMI= Body mass index; SBP = systolic blood pressure.

* p-values based on ANOVA tests for mean differences and Chi-square tests for differences in proportions

Table 2

Association between TV/video viewing time and risk of incident stroke and incident ischemic stroke.

	Demographic model	SES model	Health/activity model	Risk factor model
All incident stroke				
< 2 h/day (n = 4568)	1	1	1	1
2- < 4 h/day (n = 11004)	1.19 (0.97-1.46)	1.13 (0.91, 1.41)	1.1 (0.87, 1.40)	1.13 (0.88, 1.45)
4 h/day (n = 6685)	1.37 (1.10-1.71) *	1.21 (0.96, 1.53)	1.14 (0.88, 1.48)	1.12 (0.85, 1.48)
Incident ischemic stroke				
< 2 h/day (n = 4568)	1	1		1
2 to < 4 h/day (n = 11004)	1.28 (1.03, 1.60) *	1.2 (0.95, 1.52)	1.19 (0.91, 1.54)	1.16 (0.88, 1.51)
4 h/day (n = 6685)	1.35 (1.06, 1.72) *	1.18 (0.91, 1.53)	1.16 (0.88, 1.55)	1.08 (0.80, 1.45)

Hazard ratios and confidence intervals are provided for the following four models: the initial regression model adjusted for demographics (age, race, sex, region, age-race interaction); further adjustments were performed for socioeconomic status (education and income), health/activity (physical activity, general health, marital status, employment status, depressive symptoms), and traditional stroke risk factors (body mass index, waist circumference, systolic blood pressure, statin use, left ventricular hypertrophy, atrial fibrillation, smoking, alcohol use, diabetes).

* Significant association between TV viewing and stroke ($P_{\text{trend}} < 0.05$).