DAILY SEDENTARY TIME AND RISK OF CARDIOVASCULAR DISEASE: THE NATIONAL FINRISK 2002 STUDY

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Tunnettujen sydän- ja verisuonitautien (sv-tautien) riskitekijöiden – kuten verenpainetauti ja diabetes – rinnalle on noussut viimeaikaisten tutkimusten perusteella myös liikkumattomuus, jota arvioidaan istumisen määrällä. Aiemmat tutkimukset ovat keskittyneet lähinnä ruutuajan, työpäivän tai vapaa-ajan istumisen sv-tautivaikutusten analysoimiseen. Tämän tutkimuksen tavoitteena oli selvittää päivittäisen istumisajan yhteys sv-tautisairastuvuuteen ja -kuolleisuuteen.

Tutkimuspopulaatioksi valittiin FINRISKI 2002-kohortista 4601 suomalaista, joilla ei ollut tutkimuksen alkuvaiheessa sv-tauteja. Rekrytointivaiheessa suoritettiin terveystarkastukset, haastattelut ja otettiin verinäytteitä. Kohortti yhdistettiin sairaaloiden poistoilmoitusrekisteriin ja kuolinsyyrekisteriin. Keskimääräinen seuranta-aika oli 8,8 vuotta. Sv-tautiriski analysoitiin Coxin regressioanalyysillä, jossa huomioitiin päivittäiset istumistunnit, työmarkkina-asema, sosioekonominen asema, ikä ja muita sv-tautien riskitekijöitä.

Seuranta-aikana raportoitiin 188 sv-tautitapahtumaa. Tutkimuksessa havaittiin, että päivittäinen kokonaisistumisaika ei ollut yhteydessä sv-tautitapahtumiin. Sen sijaan työelämän ulkopuolisuus yhdistettynä runsaaseen päivittäiseen istumiseen oli itsenäinen sv-tautien ilmaantuvuuden riskitekijä (HR 2.71, 95 % luottamusväli 1.35 - 5.46) verrattuna työssäkäyviin ja vähemmän istuviin. Tulokset säilyivät tilastollisesti merkitsevinä useilla erilaisilla sekoittavilla tekijöillä vakioitunakin.

Tutkimuksen perusteella istumisen kokonaismäärä ei näytä vaikuttavan sv-tautiriskiin, mutta tulokseen voi vaikuttaa istumisen mittaaminen itseraportoinnilla. Tulevaisuudessa istumisen terveysriskejä arvioivissa tutkimuksissa olisi tarpeen huomioida istumisen määrään vaikuttavia tekijöitä – kuten työtilanne ja sosioekonomiset taustatekijät – sekä tarkentaa istumisen yhteyksiä sv-tauteihin myös objektiivisin mittarein itsearvioinnin ohella.

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1 Introduction

Modern lifestyle has profoundly changed the activities of daily life in developed countries. More time than ever before is spent in sedentary behaviours: we sit when commuting, working, having a meal, watching television (TV) and while participating in other leisure time activities. It is estimated that for instance an average western person spends more than half of his waking hours in sedentary behaviours (1). Recently sitting and sedentary behaviours have increasingly been studied in relation to health, particularly concerning occupational sitting (2,3), overall daily sitting (1,4), driving a car (5) and screen or TV time (6,7).

Previous studies suggest that sedentary behaviour associates independently with various health outcomes, even when taking into account leisure time physical activity. Prolonged sitting has been reported to associate with obesity, metabolic syndrome, glucose metabolism, type 2 diabetes, and coronary heart disease risk factors (1,2,4,7-16). Most commonly used marker of sedentary behaviour is TV viewing, although it has been suggested that overall amount of sitting may also be important in the development of ill health (10,13,14,17). TV viewing reflects the way people choose to spend their recreational time and it naturally leads to low energy expenditure (18). In addition, TV viewing is a harmful behaviour because it is associated with intake of energy dense snacks and beverages (19). Thus, there is fairly much evidence on the deleterious role of TV viewing on health, but the evidence of daily overall amount of sitting on health is lacking.

In prospective studies, associations are reported between TV viewing and type 2 diabetes incidence or CVD and all-cause mortality (5,7,14,20-23). Current literature is not extensive enough to support the hypothesis that overall amount of sitting causes CVD. Studies have not used overall sitting as a measure in their studies and CVD incidence has not been included as an end point. Only one study was found on this topic, by Manson et al (24) and they suggested that daily sitting of 16 hours or more was associated with incident CVD when compared to 4 hours or less daily sitting.

We examined the association of overall daily sitting time with incident fatal and non-fatal CVD in a Finnish cohort of 4601 participants. Our secondary aim was to study the effect of socio-economic factors on the association between sedentariness and CVD incidence.

2 Material and methods

Study population was part of the National FINRISK 2002 Study, a population based study that monitors CVD risk factors in Finland in five-year intervals. Sample was drawn from population register as a stratified random sample that was stratified by sex, area, and 10-year age group. The sample comprised 13000 Finnish men and women aged 25 to 74 years who were invited to participate in a health examination in January-April 2002. Participation rate was 65%. Of the entire sample, 9179 were part of the physical activity sub-sample and 5971 participated. Participants gave a blood sample and had their weight, height and blood pressure measured, as well as filled in questionnaires on health behaviour, health status, disease history, and detailed information on physical activity and sedentary behaviour. The Ethics Committee for the Research in Epidemiology and Public Health approved the study protocol and the participants provided their written consent. The entire study protocol, including sampling, laboratory measurements and analyses, followed closely the WHO MONICA Project protocol (25) and the recommendations of the European Health Risk Monitoring Project (26). The study is described elsewhere (27).

At the health examination, participants' height and weight were measured for the calculation of body mass index (BMI) as weight divided by squared height (kg/m^2). BMI was divided into categories of normal weight (under 25), overweight (25-29.9) and obesity (30 and above). Systolic and diastolic blood pressures were measured three times from right arm using sphygmomanometer, where average values of 140/90 mmHg were treated as cut point for elevated blood pressure levels. Furthermore, self-reported use of medication for high blood pressure was used in the analyses as a dichotomous variable. Venous blood specimen was

taken from left arm. The specimen was sent to the central laboratory at National Institute for Health and Welfare (formerly National Public Health Institute) for total serum cholesterol level analyses. In our analyses, use of cholesterol lowering medication or total cholesterol level 5.0 mmol/L and above were defined as the high risk group.

Sitting time was determined by a question: “How much time did you spent sitting in a typical weekday? This includes work and leisure time sitting, sitting at home and while visiting, and studying and travelling. This also includes sitting or lying down while reading or watching TV.” This question was part of the International Physical Activity Questionnaire (28). The cut-off point for daily sitting time was set to 10 hours. This was decided on the basis of estimated daily working hours (8 hours per day) and average daily television viewing time (2 hours). Education was self-reported as the total number of years of schooling, which was further dichotomized into less than 12 years and 12 years and above. Working status was defined from current occupation, where options house wife, retired and unemployed were combined into a category of not currently in work life. Leisure time physical activity was assessed with a question: How much do you exercise and stress yourself physically in your leisure time? The four response options were: 1) In my leisure time I read, watch TV, and work in the household with tasks which do not make me move much and which do not physically exhaust me, 2) In my spare time I walk, cycle or exercise otherwise at least 4 hours per week. This includes walking, fishing and hunting, light gardening etc. but excludes travel to work, 3) In my spare time I exercise to maintain my physical condition, e.g. running, jogging, skiing, gymnastics, swimming, playing ball games or I do heavy gardening or the like for at least 3 hours per week, and 4) In my spare time I regularly exercise several times a week competitive sports such as running, orienteering, skiing, swimming, playing ball games or other heavy sports. The responses were dichotomized to physically inactive (category 1) and physically active (categories 2-4). Occupational physical activity measured how physically demanding the work was and the four response options varied from very light (mostly sitting) to very demanding (forest and farm work). The responses were dichotomized into physically inactive and physically active at work. Smoking was assessed with a set of questions that allowed us to categorize daily smokers, former smokers, and never smokers.

The primary end point in this study was newly diagnosed CVD that was identified using the Finnish Hospital Discharge register for non-fatal outcomes and the Finnish Death register for fatal outcomes. Hospital Discharge register includes also information on invasive procedures. Each participant was followed using a unique social security number. International Classification of Diseases (ICD) was used to identify fatal cases of ischaemic heart disease (IHD) (ICD-10 codes I20–I25, I46, R96, R98) including invasive procedures (CABG and angioplasty), non-fatal cases of IHD (ICD-10 codes I20–I25**)** and fatal and non-fatal strokes (ICD-10 codes I61, I63 (not I636), I64). Participants were followed until December 31, 2010.

For the analyses, we excluded those participants who had a prevalent CVD event before the baseline measurements in 2002 (n=293) and had any missing information the variables that were included in the analyses (n=977). Thus, for the final analyses, we included 4601 men and women. Cox regression model was used for statistical testing with proportional hazards ratio to estimate the time from baseline measurements to incident CVD. In the analyses the effect of daily sitting hours on CVD incidence was studied. Adjustments were made for age, gender, sitting time, education, employment status, smoking status, occupational and leisure time physical activity, BMI, total cholesterol level or its medication and blood pressure or its medication. We found a statistically significant interaction of sitting time and employment status with incident CVD and studied also their combined effect on CVD. Analyses were done with SPSS software (Illinois, Champagne).

3 Results

The mean follow-up time was 8.8 years and 188 CVD events occurred (127 in men and 61 in women). At the baseline, mean age was 47 years (SD 13 years) and 44.9% were men. The mean daily sitting time was 6.4 hours (SD 3.4 hours) and the median sitting time 6.0 hours (interquartile range 4.0-9.0 hours). Table 1 presents baseline characteristics of the participants by incident CVD status information. Compared to healthy group, people with

incident CVD event were more often older, male, more obese, less educated, daily smokers, and not engaged in working life (pensioners, unemployed or house wives), as well as had a physically less demanding job.

Table 1. Characteristics of the study population (n=4601) by incident cardiovascular disease status.

	Healthy (4413)		**CVD event (188)**		**p-value (x^2)**
	n	%	N	%	
Age group, years					
25-34	988	22.4	3	1.6	<0.001
35-44	1079	24.5	14	7.4	
45-54	1060	24.0	39	20.7	
55-64	990	22.4	78	41.5	
65-74	296	6.7	54	28.7	
Sex					
Men	1939	43.9	127	67.6	<0.001
Women	2474	56.1	61	32.4	
Education in years (mean, SD)	12.9	3.8	10.2	3.7	<0.001
Working status					
Working	3314	75.1	79	42.0	<0.001
Not working[a]	1099	24.9	109	58.0	
Sitting hours per day (mean, SD)	6.4	3.33	6.7	3.46	0.194
Sitting					
Less than 10 hours	3931	89.1	164	87.2	0.406
More than 10 hours	482	10.9	24	12.8	
Leisure time physical activity					

Low	957	21.7	48	25.5	0.208
High	3456	78.3	140	74.5	
Occupational physical activity					
Low	2215	50.2	125	66.5	<0.001
High	2198	49.8	63	33.5	
Body mass index					
Less than 25.0	1800	40.8	41	21.8	<0.001
25.0-29.9	1772	40.2	96	51.1	
30.0 and above	841	19.1	51	27.1	
Smoking					
Never smokers	2365	53.6	80	42.6	0.012
Former smokers	903	20.5	47	25.0	
Daily smokers	1145	25.9	61	32.4	
High blood pressure or use of medication[b]					
No	443	10.0	11	5.9	0.033
Yes	3970	90.0	177	94.1	
High blood cholesterol or use of medication[c]					
No	814	18.4	39	20.7	0.239
Yes	3599	81.6	149	79.3	

Chi-square test for categorical variables and independent samples T-test for education.

[a] House wives (12.1%), retired (63.4%), unemployed (24.5%)

[b] High blood pressure if over 140/90 mmHg

[c] Total cholesterol above 5.0 mmol/L

In Cox regression model, higher sitting time was not an independent risk factor for incident CVD (Table 2). The hazard ratios (HR) for CVD events among more sedentary people, as compared to less sedentary people, were higher in both models 1 and 2, but did not reach statistical significance. In the age and gender adjusted model HR for higher sitting was 1.37

(95% CI 0.89-2.11) and in the fully adjusted model HR for high sitting was 1.45 (95% CI 0.91-2.29).

Table 2. Hazard ratios (HR) with 95% confidence intervals (95% CI) for incident cardiovascular disease.

	Model 1		**Model 2**	
	HR	**95% CI**	**HR**	**95% CI**
Gender				
Women	1.00	-	1.00	-
Men	2.41	1.78-3.28	2.19	1.58-3.02
Age	1.10	1.08-1.11	1.10	1.08-1.12
Overall daily sitting				
Low (10h or less)	1.00	-	1.00	-
High (10h and more)	1.37	0.89-2.11	1.45	0.91-2.29

Model 1: Gender, age, and daily overall sitting (10hour cutoff-point).
Model 2: Model 1 + employment status, education, smoking, occupational physical activity, leisure time physical activity, body mass index, high blood pressure or use of antihypertensive medication, and high blood cholesterol or use of medication for cholesterol.

In an age and sex adjusted interaction test, the amount of sitting (as a continuous variable) and employment status (as working vs. not working) showed a statistically significant joint effect on the risk of incident CVD. Thus, we examined the combined association of daily sitting hours and working status on incident CVD risk by analyzing four different groups (Table 3). The first, the reference group, included persons who were working and reported less than 10 hours of daily sitting time (workers-low sit), the second group included people who were working and sat more than 10 hours daily (workers-high sit). The third group consisted of participants not engaged in work life and sitting less than 10 hours daily (no work-low sit). Those who were not employed and sat more than 10 hours formed the fourth group (no work-high sit). Using Cox regression model we found that after adjusting for age, gender, education, smoking status, occupational and leisure time physical activity, BMI, blood pressure or its medication use and dyslipidemia or its medication use, the incidence of CVD

was highest in the “no work-high sit”-group, as compared to the “working-low sit”-group, with HR of 2.71 (95% CI 1.35-5.46). The hazard ratios for other groups were 0.95 (95% CI 0.49-1.86) in “working-high sit” group and HR 1.20 (95% CI 0.75-1.91) in “no work-low sit” group.

Table 3. Combined effect of sitting and employment status on incident cardiovascular disease (Hazard ratios, HR, with 95% confidence intervals, 95% CI).

	Working		**Not working**	
	n	HR (95% CI)	n	HR (95% CI)
Low sitting	2954	1.00	1141	1.20 (0.75-1.91)
High sitting	439	0.95 (0.49-1.86)	67	2.71 (1.35-5.46)

Adjusted for gender, age, education, smoking, occupational physical activity, leisure time physical activity, body mass index, high blood pressure or use of antihypertensive medication, and high blood cholesterol or use of medication for cholesterol.

4 Discussion

These data do not support the assumption that overall amount of sitting, as measured by daily hours, have a direct association with CVD. Instead, a combined effect of sitting time and employment status on CVD was found, suggesting that the pathway from sedentariness to CVD is mediated by socioeconomic factors.

4.1 Comparison to previous studies

This is one of the first prospective studies to analyze associations of overall daily sitting time with incident CVD. One previous study (24) reported an increased CVD risk during a 5.9 follow-up time when sitting daily more than 16 hours as compared to less than 4 hours. Notably, no CVD risk was detected for sitting from 4 to 16 hours. We reported no CVD risk with a cut point of 10 hours daily sitting in 8.8 years of mean follow-up. When using CVD

mortality as the end point measure, one study (8) reported a direct association between daily sitting and CVD deaths.

We found prospective studies that have used TV viewing or other type of sitting as exposure variables to estimate CVD risk. For CVD incidence, one study (7) reported higher CVD incidence risk with higher TV watching. For CVD mortality, studies have reported independent associations between mortality and TV watching (5,21), sitting in a car (5), and sitting during leisure time (9). These studies are not comparable to our findings in terms of exposure variable.

Interestingly, a recent systematic review indicated no association between occupational sitting with health outcomes (2). This is in line with our non-significant findings and with our further analyses on joint association. We could only find a statistically significant association for those who did not work but who sat more than 10 hours per day. Our joint analyses suggest that employment status markedly affects daily activities and it may actually be irrelevant to study absolute amount of daily sitting. For health benefits, it also makes sense to concentrate on sedentariness outside of working hours, as this where the competing interest of physical activity and sedentariness takes place.

Physical activity is important and essential part of maintaining ones health, but according to the current epidemiological evidence, it may not be sufficient protection against CVD-morbidity and mortality on its own. According to present findings one needs not only to preserve low intensity activity in ones daily tasks and engage in recommended amount of vigorous physical activity, but also avoid predominant and prolonged sedentary time.

4.2 Methodological considerations

The strengths of this study included a large population-based sample with a good representation and generalizability. All the data concerning identification of incident CVD cases was collected from registers and their reliability has been reported to be high (29,30). The direction of the association between sitting and CVD appeared as what was

hypothesized, while the statistical significance remained non-significant in the adjusted model. This may be a question of statistical power, where few more years in the follow-up could perhaps give stronger association. Of course this is only speculation and our data do not support this at the moment.

One limitation of the study was self-reported data, which can cause under or overestimations in the variables under study. For our main exposure variable, daily sedentary behavior, validation study suggests a good test-retest reliability and adequate correlation against accelerometer counts (31).

4.3 Conclusions

CVD is a leading cause of death worldwide. All the risk factors of CVD are therefore important to recognize. Our data suggest that overall daily sitting as absolute hours per day may not be an independent risk factor for CVD incidence. Instead, sitting proves hazardous to heart when taking place outside of work and being more than 10 hours daily. These findings emphasize importance of asking “why do you sit?” in addition to “how much do you sit?” In future research, more effort should be paid to understand pathways from sedentary behaviour to development of CVD.

References

1. Healy GN, Wijndaele K, Dunstan DW, et al. Objectively measured sedentary time, physical activity, and metabolic risk: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Diabetes Care*. 2008; 31: 369-71.

2. van Uffelen JG, Wong J, Chau JY, et al. Occupational sitting and health risks: a systematic review. *Am J Prev Med*. 2010; 39: 379-88.

3. McCrady SK and Levine JA. Sedentariness at work: how much do we really sit? *Obesity (Silver Spring)*. 2009; 17: 2103-5.

4. Thorp AA, Healy GN, Owen N, et al. Deleterious associations of sitting time and television viewing time with cardiometabolic risk biomarkers: Australian Diabetes, Obesity and Lifestyle (AusDiab) study 2004-2005. *Diabetes Care*. 2010; 33: 327-34.

5. Warren TY, Barry V, Hooker SP, Sui X, Church TS and Blair SN. Sedentary behaviors increase risk of cardiovascular disease mortality in men. *Med Sci Sports Exerc*. 2010; 42: 879-85.

6. Wijndaele K, Healy GN, Dunstan DW, et al. Increased cardiometabolic risk is associated with increased TV viewing time. *Med Sci Sports Exerc*. 2010; 42: 1511-8.

7. Wijndaele K, Brage S, Besson H, et al. Television viewing and incident cardiovascular disease: prospective associations and mediation analysis in the EPIC Norfolk Study. *PLoS One*. 2011; 6: e20058.

8. Katzmarzyk PT, Church TS, Craig CL and Bouchard C. Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Med Sci Sports Exerc*. 2009; 41: 998-1005.

9. Patel AV, Bernstein L, Deka A, et al. Leisure time spent sitting in relation to total mortality in a prospective cohort of US adults. *Am J Epidemiol*. 2010; 172: 419-29.

10. Owen N, Healy GN, Matthews CE and Dunstan DW. Too much sitting: the population health science of sedentary behavior. *Exerc Sport Sci Rev*. 2010; 38: 105-13.

11. Swartz AM, Squires L and Strath SJ. Energy expenditure of interruptions to sedentary behavior. *Int J Behav Nutr Phys Act*. 2011; 8: 69.

12. Hamilton MT, Hamilton DG and Zderic TW. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes*. 2007; 56: 2655-67.

13. Hamilton MT, Healy GN, Dunstan DW, Zderic TW and Owen N. Too Little Exercise and Too Much Sitting: Inactivity Physiology and the Need for New Recommendations on Sedentary Behavior. *Curr Cardiovasc Risk Rep*. 2008; 2: 292-8.

14. Thorp AA, Owen N, Neuhaus M and Dunstan DW. Sedentary behaviors and subsequent health outcomes in adults a systematic review of longitudinal studies, 1996-2011. *Am J Prev Med*. 2012; 41: 207-15.

15. Aadahl M, Kjaer M and Jorgensen T. Influence of time spent on TV viewing and vigorous intensity physical activity on cardiovascular biomarkers. The Inter 99 study. *Eur J Cardiovasc Prev Rehabil*. 2007; 14: 660-5.

16. Shields M and Tremblay MS. Sedentary behaviour and obesity. *Health Rep*. 2008; 19: 19-30.

17. Clark BK, Sugiyama T, Healy GN, Salmon J, Dunstan DW and Owen N. Validity and reliability of measures of television viewing time and other non-occupational sedentary behaviour of adults: a review. *Obes Rev*. 2009; 10: 7-16.

18. Sugiyama T, Healy GN, Dunstan DW, Salmon J and Owen N. Is television viewing time a marker of a broader pattern of sedentary behavior? *Ann Behav Med*. 2008; 35: 245-50.

19. Pearson N, Ball K and Crawford D. Mediators of longitudinal associations between television viewing and eating behaviours in adolescents. *Int J Behav Nutr Phys Act*. 2011; 8: 23.

20. Grontved A and Hu FB. Television viewing and risk of type 2 diabetes, cardiovascular disease, and all-cause mortality: a meta-analysis. *JAMA*. 2011; 305: 2448-55.

21. Dunstan DW, Barr EL, Healy GN, et al. Television viewing time and mortality: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Circulation*. 2010; 121: 384-91.

22. Hu FB, Li TY, Colditz GA, Willett WC and Manson JE. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA*. 2003; 289: 1785-91.

23. Hu FB, Leitzmann MF, Stampfer MJ, Colditz GA, Willett WC and Rimm EB. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. *Arch Intern Med*. 2001; 161: 1542-8.

24. Manson JE, Greenland P, LaCroix AZ, et al. Walking compared with vigorous exercise for the prevention of cardiovascular events in women. *N Engl J Med*. 2002; 347: 716-25.

25. World Health Organization. The World Health Organization MONICA Project (monitoring trends and determinants in cardiovascular disease): a major international collaboration. WHO MONICA Project Principal Investigators. *J Clin Epidemiol*. 1988; 41: 105-14.

26. Tolonen H, Kuulasmaa K, Laatikainen T, Wolf H and Project EHRM. *European Health Risk Monitoring Project. Recommendation for indicators, international collaboration, protocol and manual of operations for chronic disease risk factor surveys. www-publications from the EHRM Project*. Helsinki, Finland: National Public Health Institute, 2002.

27. Laatikainen T, Tapanainen H, Alfthan G, et al. *FINRISKI 2002. Tutkimuksen toteutus ja tulokset 1. Perusraportti*. Helsinki, Finland: National Public Health Institute, 2003.

28. Craig C, Marshall A, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc*. 2003; 35: 1381-95.

29. Tolonen H, Salomaa V, Torppa J, Sivenius J, Immonen-Raiha P and Lehtonen A. The validation of the Finnish Hospital Discharge Register and Causes of Death Register data on stroke diagnoses. *Eur J Cardiovasc Prev Rehabil*. 2007; 14: 380-5.

30. Pajunen P, Koukkunen H, Ketonen M, et al. The validity of the Finnish Hospital Discharge Register and Causes of Death Register data on coronary heart disease. *Eur J Cardiovasc Prev Rehabil*. 2005; 12: 132-7.

31. Rosenberg DE, Bull FC, Marshall AL, Sallis JF and Bauman AE. Assessment of sedentary behavior with the International Physical Activity Questionnaire. *J Phys Act Health*. 2008; 5 Suppl 1: S30-44.