The Relationship Between Occupational Standing and Sitting and Incident Heart Disease

Over a 12-Year Period in Ontario, Canada

Peter Smith, Huiting Ma, Richard H Glazier, Mahée Gilbert-Ouimet, and Cameron Mustard

Correspondence to Dr. Peter Smith, Institute for Work & Health, 481 University Avenue, Suite 800, Toronto, ON, M5G 2E9, Canada (e-mail psmith@iwh.on.ca; phone 416-927-2027; fax 416-927-4167)

Author affiliations: Institute for Work & Health, Toronto, Ontario, Canada (Peter Smith, Mahée Gilbert-Ouimet, and Cameron Mustard); Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, Australia (Peter Smith); Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada (Peter Smith, Richard H Glazier, and Cameron Mustard); Institute for Clinical Evaluative Sciences, Toronto, Ontario, Canada (Huiting Ma, and Richard H Glazier); Department of Family and Community Medicine, University of Toronto and St. Michael's Hospital, Toronto, Ontario, Canada (Richard H Glazier); Centre for Urban Health Solutions, Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Ontario, Canada (Richard H Glazier); Centre de recherché du CHU de Québec, Hôpital du St-Sacrement, QB, Canada (Mahée Gilbert-Ouimet)

Conflict of interest: none declared

Running head: Occupational Standing and Heart Disease

Abstract

While a growing body of research is examining the impacts of prolonged occupational sitting on cardiovascular and other health risk factors, relatively little work examined the effects of occupational standing. The objectives of this paper were to examine the relationship between occupations that require predominantly sitting, and those that require predominantly standing, and incident heart disease. A prospective cohort study combining responses to a population health survey with administrative health care records, linked at the individual level was conducted in Ontario, Canada. The sample included 7320 employed labour market participants (50% male) working 15 hours a week or more and free of heart disease at baseline. Incident heart disease was assessed using administrative records over an approximately 12-year follow-up period (2003-2015). Models were adjusted for a wide range of potential confounding factors. Occupations involving predominantly standing were associated with an approximately two-fold risk of heart disease compared to occupations involving predominantly sitting. This association was robust to adjustment for other health, socio-demographic and work variables. Cardiovascular risk associated with occupations that involve combinations of sitting, standing and walking differed for men and women, with these occupations associated with lower cardiovascular risk estimates among men, but elevated risk estimates among women.

Keywords: administrative data, Canada, heart diseases, sitting position, standing position, occupational exposure

Footnotes page:

Abbreviations

BMI - body mass index

CCHS - Canadian Community Health Survey

CI – confidence interval

HR – hazard ratio

Cardiovascular disease continues to be a leading cause of morbidity and mortality worldwide, in particular among high-income countries (1). Sedentary behaviour is gaining increasing attention as a modifiable risk factor for a number of chronic disease outcomes, including cardiovascular disease (2, 3). While sedentary behaviour in general has been associated with increased risk of multiple disease outcomes, the available evidence that sedentary occupational activity is a cardiovascular risk factor is less convincing (3). A pooled analysis of five cohorts from England and two cohorts from Scotland (total N = 5,214) reported no relationship between prolonged occupational sitting compared to occupations involving standing and walking about, in relation to cardiovascular mortality over a 12.9 year follow-up period (4). Another recent examination of the relationship between occupational sitting time and ischemic heart disease among a Danish cohort of over 2,500 men and women also reported no relationship between sitting time and ischemic heart disease over a 12-year follow-up (5).

Compared to the research on prolonged sitting, relatively little research has examined the health effects of prolonged occupational standing (6-8). Although few in number, studies have demonstrated a relationship between prolonged standing at work and various cardiovascular

Page **4** of **24**

outcomes (9-12) as well as other health outcomes such as musculoskeletal pain (7, 8). The potential mechanisms linking prolonged standing to cardiovascular outcomes include blood pooling in the lower limbs, increased hydrostatic venous pressure, and enhanced oxidative stress (6, 10, 13). Despite these findings, there has been a greater degree of research emphasis on understanding the feasibility and effectiveness of reducing prolonged sitting as opposed to prolonged standing (6, 14).

The objectives of this study were to examine the relationship between imputed occupational body position exposures focused on sitting, standing, walking and other body positions, and incident heart disease over a 12-year period in Ontario, Canada.

METHODS

The data source for this analysis was respondents to the 2003 Canadian Community Health Survey (CCHS), whose responses were linked to administrative information in the Ontario Health Insurance Plan database covering physician services, and the Canadian Institute for Health Information Discharge Abstract Database for hospital admissions. Information from the Ontario Health Insurance Plan database and the Canadian Institute for Health Information Discharge Abstract Database databases was available up to March 31st, 2015. The administrative databases were linked to the CCHS responses using unique, encoded identifiers and analysed as the Institute for Clinical Evaluate Sciences. The accuracy of the linkage was verified against the Ontario Registered Persons Database using personal information provided by respondent such as health number, given name and surname, date of birth, age, sex, and postal code.

The CCHS collects information on health conditions, health behaviours, and working conditions from representative cross-sectional samples of the Canadian population. The overall

response rate from respondents from Ontario to the 2003 CCHS was 78.5% (15). Of the 40,507

Ontario respondents to the 2003 CCHS, 34,950 (86%) gave permission for their survey

respondents to be linked to administrative health care data. Of this sample a successful linkage

was obtained for 33,679 respondents (96% of those who gave permission to link). For the

purpose of this analysis we focused on currently employed respondents working more than 15

hours per week, who were aged 35 to 74 years of age (N = 8,873). Ethics approval for secondary

data analysis was granted through the University of Toronto, Health Sciences Ethics Board and

the Research Ethics Board of Sunnybrook Health Sciences Centre.

Patient involvement

This study was an analysis of secondary survey and administrative data. As such, patients were

not involved.

Outcome: Incident heart disease

Incident heart disease over the follow-up period was derived using the Ontario Myocardial

Infarction Database and the Ontario Congestive Heart Failure Database. Both these databases

were developed using validated algorithms, with sensitivity and specificity estimates of

approximately 0.85 or higher (16-18). These databases capture cases of heart disease from 1992

onwards, providing an approximate 12 year look back window for prevalent cases of each

condition in our sample. In all regression models respondents were right censored at the

development of heart disease; death from causes other than heart disease; or the end of the

follow-up period (March 31, 2015).

Page **6** of **24**

Main independent variable: primary type of occupational posture or body movement

The primary type of posture or body movement required to perform each respondent's occupation was imputed based on occupational information from the Human Resources and Skills Development Canada's Career Handbook (19). The Career Handbook assigns various occupational exposures to occupations at the 4-digit occupational level, equating to 520 different job titles. For each occupational title minimum and maximum exposures for multiple dimensions of work were assigned by trained occupational analysts using a modified Delphi procedure. After the consensus ratings for each occupation and exposure had been developed, the occupations were additionally reviewed by task to identify potential abnormalities (19).

The primary type of posture or body movement for each occupational title involves one of four possible categories: occupations requiring primarily sitting; occupations involving primarily standing and/or walking; occupations involving combinations of sitting, standing, and walking; and work that involves body postures other than sitting standing and walking such as bending, stooping, kneeling and crouching. Using the minimum and maximum occupational exposures we were able to classify occupations into those that require predominantly sitting (where minimum and maximum body positions was sitting); those that require predominantly standing (where minimum and maximum body position was standing); occupations with opportunities for sitting, standing and walking; and occupations that predominantly involve working in other body positions. Examples of the most common types of occupations for men and women within each of these groups are provided in Web Table 1.

Socio-demographic and health-related covariates

Other measures included in analyses were age; whether the respondent was male or female; marital status and presence of children under 12 in the house; highest educational level obtained; if the respondent was born in Canada; their ethnicity ("white" versus other categories); living location (urban/rural), and self-reported chronic medical conditions that have been diagnosed by a health professional and are expected to last, or have lasted more than 6 months. For chronic health conditions the following groups were derived: diabetes; high blood pressure; back problems; mood and anxiety disorders; and other chronic conditions. We also included a measure of whether a long term physical or mental health condition limited the type or amount of activity the respondent could do at work (never, sometimes or often).

Other work-related exposures

In addition to occupational posture and body movement a variety of other occupational exposures were also included. Self-reported exposures included the usual hours worked by the respondent each week (continuous), the number of weeks worked in the previous 12 months (1 to 26 weeks worked; 27 to 49 weeks; and 50 or more weeks), and current shift schedule (regular; evening or night shift; rotating; or other shift schedules). Imputed occupational exposures based on occupational title included the handling of loads 10kg or greater; exposure to dangerous chemical substances; exposure to constant or intermittent noise likely to cause distraction or possible hearing loss; exposure to oscillating or quivering motions (vibration); and exposure to noxious, intense or prolonged odours. Imputed exposures were defined as dichotomous variables.

Body mass index and health behaviours

Page **8** of **24**

Measures of body mass index (BMI) based on self-reported height and weight

(underweight/normal weight; overweight; obese); current smoking status (regular smoker;

occasional smoker; non-smoker); alcohol consumption (non-drinker; regular drinker but never

having 5 or more drinks in one sitting; regular drinker who has 5 or more drinks on an occasional

to weekly basis); and leisure time physical activity categorised according to Statistics Canada's

definitions (inactive = less than 1.5 kcal/kg/day (e.g. walking less than half an hour each day),

moderately active = between 1.5 and 2.9 kcal/kg/day (e.g. walking 30 to 60 minutes a day, or

taking an hour-long exercise class three times a week); active = greater than 3 kcal/kg/day (e.g.

walking an hour a day or jogging 20 minutes a day)), were also available in the dataset. The

handling of BMI and health behaviours in the analytical models is described in further detail

below.

Analyses

Of the original sample of 8,873 respondents 350 (4%) either reported having pre-existing heart

disease, or were captured in the Ontario Myocardial Infarction Database or the Ontario

Congestive Heart Failure Database databases prior to the interview date, and were removed

leaving a sample of 8,523 respondents. Of this sample 562 respondents were missing information

on work exposures, with an additional 641 respondents missing information on socio-

demographic characteristics, health measures, or health behaviours, leaving a final analytic

sample of 7,320 respondents (50% male), which is 86% of the eligible sample. A logistic

regression analysis examined variables associated with the probability of missing work

exposures, and missing socio-demographic, health, or health behaviour measures. Men were

more likely than women to be missing work exposure information, while women, respondents in

urban locations, and those working in other body positions were more likely to be missing socio-demographic, health, or health behaviour measures. No relationship was found between age and having missing information on work exposures, or on having missing information on socio-demographic, health, or health behaviour measures.

Initial descriptive analyses examined the relationships between incident heart disease and occupational standing and sitting. Time to event regression models then examined the relationships between occupational standing and sitting exposures using a series of nested regression models. The first model was adjusted for age, male/female, education and weeks of work in the previous 12 months (minimally adjusted model). Additional adjustment was made for other socio-demographic variables, followed by a model that additionally included other work exposures. A final model adjusted for BMI and health behaviours (smoking, alcohol consumption, leisure time physical activity). The reason for the separate adjustment for BMI and health behaviours is because it is not clear whether these factors are confounders or mediators in the occupational exposure to heart disease outcome relationship. Given it is unlikely that an individual's BMI or health behaviours result in them being in particular occupations, including these factors in regression models could be considered a form of over-adjustment (20).

To ensure an adequate number of predictors to events in our final models work exposures that were not related to heart disease in either univariate or multivariable models were removed. The main exclusions were other occupational exposures, which included dangerous chemical substances; noise; vibration and odours. Regression models were run for the full sample, and for males and females separately, to examine differences in the relationship between occupational exposures and heart disease outcomes between men and women. Differences between estimates from male and female regression models were assessed using methods that take into account the

estimate and standard error around the estimate from stratified regression models (21, 22). A final set of models examined the relationships between occupational exposures and incident heart disease removing events that occurred in the first two years of follow-up, to reduce the possibility of reverse causation.

All analyses were conducted in SAS version 9.4 (SAS Institute Inc., Cary, NC) and survey weights were applied to the sample to account for the initial probability of selection into the CCHS and non-response to the survey, as recommended by Statistics Canada (15). To account for the clustered design of the CCHS, variance estimates around each prevalence and hazard ratio (HR) have been adjusted using 500 bootstrap replicate weights using the SURVEY procedures in SAS (23).

RESULTS

Table 1 presents descriptive information for incident heart disease across our main independent variable and for men and women. Over the study period, there were 83,424 person-years of follow-up (median follow-up 11.73 years); 3.4% of the study population developed heart disease, with a higher incidence among men (4.6%) than women (2.1%). The risk of incident heart disease was elevated among occupations requiring predominantly standing compared to occupations requiring predominantly sitting. No statistically significant differences were observed in the incidence of heart disease across other occupational exposure groups. Additional information on the incidence of heart disease across all other study variables is available in Web Table 2.

[Insert Table 1 about here]

Table 2 presents HRs for occupational standing and sitting after adjustment for age, male/female, education and weeks worked (model one), other socio-demographic and health related conditions (model two), other work exposures (model three) and health behaviours and BMI index (model four). Similar to the descriptive analyses, predominantly standing occupations were associated with an increased risk of heart disease compared to sitting (HR = 2.18, 95% Confidence interval (CI) 1.11, 4.27) after adjustment for socio-demographic, health and work related variables. Additional adjustment for body mass index and health behaviours attenuated this association slightly; however workers employed in occupations that required predominantly standing were still almost twice as likely to have incident heart disease over the study period compared to those requiring predominantly sitting (HR = 1.97, 95% CI 0.99, 3.90). These estimates remained robust to potential reverse causation, slightly strengthening, and in the case of model four attaining statistical significance, after the removal of incident cases of heart disease that occurred in the first two years of follow-up (HR = 2.21, 95% CI 1.10, 4.46 for model three and HR = 2.06, 95% CI 1.00, 4.24 for model four; results not presented, but available upon request).

[Insert Table 2 about here]

Table 3 provides HR estimates for occupational standing and sitting exposures separately for men and women. The HR estimates of standing occupations was relatively consistent among men and women (HR = 2.01 for men; HR = 1.86 for women). However, the HR estimates of occupations that require combinations of sitting, standing and walking, compared to those that

required predominantly sitting, differed between men and women. Among men sitting, standing and walking occupations were associated with a protective HR on heart disease risk (HR = 0.61, 95% CI 0.33, 1.13), but an elevated HR was observed among women (HR = 1.80, 95% CI 0.78, 4.12). While neither of these estimates reached statistical significance, the difference between the HR estimates for men and women was statistically significant. Similar to the HR estimates in the full sample, removing incident cases of heart disease in the first two years of follow-up strengthened these estimates, with the protective HR estimate for combinations of standing, walking and sitting achieving statistical significance among men in this sensitivity analysis (HR = 0.49, 95% CI 0.27, 0.88 – results not shown, but available upon request).

[Insert Table 3 about here]

DISCUSSION

The health impact of increases in sedentary occupational exposures has received a great deal of recent research interest (2,3,14). While work in this area has examined the impact of prolonged occupational sitting, relatively little research has examined the health impacts of prolonged standing. In this study of more than 7,300 labour market participants in Ontario, Canada, we observed that occupations that involve predominantly standing were associated with a two-fold risk for incident heart disease, compared to predominantly sitting occupations, over a 12-year follow-up period. Estimates were similar for men and women and robust to adjustment for other health, socio-demographic, and work exposures. Adjustment for health behaviours and body mass index led to an attenuation of hazard ratio estimates associated with predominantly standing occupations. After this adjustment although the resulting hazard ratio was still close to two, the lower bound of the CI was just below one. In addition, the risk associated with occupational standing strengthened in a sensitivity analysis where heart cases in the first two years of follow-up were removed. The cardiovascular risk associated with occupations that involve combinations of sitting, standing and walking differed for men and women, with these occupations associated with protective cardiovascular risk estimates among men, but elevated cardiovascular risk estimates (although not statistically significant) among women. Taken together these findings suggest that occupational standing should receive similar, if not more, attention compared to occupational sitting, in relation to potential adverse cardiovascular outcomes (6, 14).

These findings have important implications for the prevention of cardiovascular disease, and the role of the work environment as a cardiovascular risk factor. First, predominantly standing occupations, as opposed to predominantly sitting occupations was the occupational

body position category most strongly associated with heart disease. This finding suggests that combinations of sitting and standing are likely to have beneficial cardiovascular health benefits. However, the introduction of this type of work environment should not only focus on occupations that involve prolonged sitting, but also on occupations that involve prolonged standing (14). While predominantly standing occupations were not as common as predominantly sitting occupations in our sample, the prevalence of this exposure was just under 10% in our cohort of employed respondents who were aged 35 and older and free of heart disease at baseline.

Second, the differences in the HR estimates of standing, sitting and walking occupations among men and women demonstrate that other work context factors will also shape the effectiveness of workplace-based interventions to increase occupational physical activity. While occupations that involved combinations of sitting, standing and walking were associated with a decreased risk of heart disease among men, they were associated with an increased risk of heart disease among women. Examination of common occupational titles within sitting, standing and walking occupations showed that the types of occupations within this occupational group differed greatly for men and women (Web Table 1); and this is one potential reason for this difference in estimates (6, 24). In addition, research has shown that the physical and psychosocial work environment can differ for men and women even within the same occupational title (25), and it is possible that these differences are more pronounced in sitting, standing and walking occupations than they are in prolonged standing or prolonged sitting occupations. This differential associations between occupations that involve greater walking on cardiovascular outcomes for men and women suggests that a focus solely on occupational

activity, ignoring other occupational conditions such as the psychosocial and other aspects of the physical work environment, is unlikely to lead to meaningful changes in cardiovascular risk (26).

These findings should be interpreted given the following strengths and limitations. The administrative data used to capture heart disease require use of health services, and therefore will not capture out of hospital myocardial infarction or angina. However, out of hospital services are likely relatively rare in comparison to those captured in each database given the publically funded healthcare system in Ontario. The assessment of working conditions involved assessment at one point in time, and we have no information beyond the 12 months prior to the survey as to the occupational title, or labour market participation, of each respondent. While the use of imputation based on occupational title does have advantages in limiting the potential for common-method bias to inflate the association between perceived occupational standing or sitting and unmeasured risk factors for heart disease (27) as well as the demonstrated inconsistency between self-reported and objectively measured sitting (28), it also presents a limitation in that potentially important differences within occupational groups (e.g. the ability to take breaks during the work schedule) are assumed to be equivalent across all members of the same occupational classification, while this may not be the case (6). In addition, we have limited information on the amount of time spent standing or sitting in each occupational group which may be potentially important in assessing the relationship between sitting and standing and health outcomes (29). The potential misclassification introduced by these factors would likely lead to a bias towards the null in the estimates for occupational sitting and standing, and therefore the estimates presented in this paper may be underestimates of the true association between occupational standing and cardiovascular disease. Strengths include our alibility to adjust for a wide range of work-related and non-work-related covariates that could potentially

confound the relationship between occupational body position and incident heart disease, and our ability to examine the potential for reverse causation in explaining our findings. Our ability to minimise reverse causation could be one explanation for why our findings differ from previous studies that have demonstrated a protective relationship between greater daily time spent standing (not necessarily occupational) and mortality (30, 31).

In conclusion, in a study of more than 7,300 Canadians, occupations that involve primarily standing represent an important, but often overlooked, cardiovascular risk factor, which is independent of other health, socio-demographic and labour market characteristics. This evidence suggests that primary prevention efforts targeted towards reducing occupational standing should be considered, while taking into account the broader occupational context, and potential differences in occupational context between men and women.

References

1   Kassebaum NJ, Arora M, Barber RM, et al. Global, regional, and national disability-
    adjusted life-years (DALYs) for 315 diseases and injuries and healthy life expectancy
    (HALE), 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015.
    Lancet. 2016;388(10053):1603-1658.

2   Owen N, Healy GN, Matthews CE, et al. Too much sitting: The population health science
    of sedentary behavior. *Exerc Sport Sci Rev.* 2010;38(3):105-113.

3   van Uffelen JGZ, Wong J, Chau JY, et al. Occupational sitting and health risks. A
    systematic review. *Am J Prev Med.* 2010;39(4):379-315.

4   Stamatakis E, Chau JY, Pedisic Z, et al. Are sitting occupations associated with increased
    all-cause, cancer and cardiovascular disease mortality risk? A pooled analysis of seven
    British population cohorts. *PLoS ONE.* 2013;8(9):e73753.

5   Moller SV, Hannerz H, Hansen AM, et al. Multi-wave cohort study of sedentary work
    and risk of ischemic heart disease. *Scand J Work Env Health.* 2016;42(1):43-51.

6   Messing K, Stock S, Cote J, et al. 2014 William P. Yant award lecture. Is sitting worse
    than static standing? How a gender analysis can move us toward understanding
    determinants and effects of occupational standing and walking. *J Occup Environ Hyg.*
    2015;12(3):D11-D17.

7 Messing K, Fortin M, Rail G, et al. Standing still: Why North American workers are not insisting on seats despite known health benefits. *Int J Health Ser.v* 2005;35(4):745-763.

8 Waters TR, Dick RB. Evidence of health risks associated with prolonged standing at work and intervention effectiveness. *Rehabil Nurs*. 2015;40(3):148-165.

9 Krause N, Lynch JW, Kaplan GA, et al. Standing at work and progression of carotid atherosclerosis. *Scand J Work Env Health*. 2000;26(3):227-236.

10 Antle DM, Vezina N, Messing K, et al. Development of dicomfort and vascular and muscular changes during a prolonged standing task. *Occup Ergon*. 2013;11(1):21-33.

11 Ngomo S, Messing K, Perreault H, et al. Orthostatic symptoms, blood pressure and working postures of factory and service workers over an observed work day. *Appl Ergon*. 2008;39(6):729-736.

12 Tuchsen F, Hannerz H, Burr H, et al. Prolonged standing at work and hospitalisation due to varicose veins: A 12-year prospective study of the Danish population. *Occup Environ Med*. 2005;62(12):847-850.

13 Flore R, Gerardino L, Santoliquido A, et al. Enhanced oxidative stress in workers with a standing occupation. *Occup Environ Med*ю 2004;61(6):548-550.

14 Callaghan JP, De Carvalho D, Gallagher K, et al. Is standing the solution to sedentary office work? *Ergon Des*. 2015;23(3):20-24.

15 Statistics Canada. *User Guide to the 2003 Canadian Community Health Survey*. Ottawa, ON: Statistics Canada; 2005. Report No.: 82M0013GPE.

16   Tu JV, Austin PC, Filate WA, et al. Outcomes of acute myocardial infarction in Canada. *Can J Cardiol.* 2003;19(8):893-901.

17   Schultz SE, Rothwell DM, Chen Z, et al. Identifying cases of congestive heart failure from administrative data: a validation study using primary care patient records. *Chronic Dis Inj Can.* 2013;33(3):160-166.

18   Kennedy CE, Brien SE, Tu JV. An overview of the methods and data used in the CCORT Canadian Cardiovascular Atlas project. *Can J Cardiol*. 2003;19(6):655-663.

19   Human Resources & Skills Development Canada. *National Occupational Classification Career Handbook*. 2nd Edition. Ottawa, ON: Government of Canada; 2011. Report No.: LM-410-05-03E.

20   Schisterman EF, Cole SR, Plat RW. Overadjustment bias and unnecessary adjustment in epidemiolgical studies. *Epidemiology.* 2009;20(4):488-495.

21   Austin PC, Hux JE. A brief note on overlapping confidence intervals. *J Vasc Surg*. 2002;36(1):194-195.

22   Wolfe R, Hanley J. If we're so different, why do we keep overlapping? When 1 plus 1 doesn't make 2. *Can Med Assoc J*. 2002;166(1):65-66.

23   Gagne C, Roberts G, Keown L-A. W*eighted estimation and bootstrap variance estimation for analyzing survey data: How to implement in selected software*. The Research Data Centres Information and Technical Bulletin. 2014;6(1):5-70.

24 Messing K, Punnett L, Bond M, et al. Be the fairest of them all: Challenges and recommendations for the treatment of gender in occupational health research. *Am J Ind Med.* 2003;43(6):648-629.

25 Messing K. Women workers and their working conditions. In: Rayman P, Sirianni C, eds. *One-eyed Science: Occupational Health and Women Workers*. Philadelphia, PA: Temple University Press; 1998:1-11.

26 Sorensen G, Landsbergis P, Hammer L, et al. Preventing chronic disease in the workplace: A workshop report and recommendations. *Am J Public Health.* 2011;101(S1):S196-S207.

27 Podsakoff PM, MacKenzie SB, Lee JY, et al. Common method biases in behavioral research: A critical review of the literature and recommended remedies. *J Appl Psychol.* 2003;88(5):879-903.

28 Lagersted-Olsen J, Korshoj M, Skotte J, et al. Comparison of objectively measured and self-reported time spent sitting. *Int J Sports Med.* 2014;35(6):534-540.

29 Coenen P, Willenberg L, Parry S, et al. Associations of occupational standing with musculoskeletal symptoms: a systematic review with meta-analysis. *Br J Sports Med.* 2016 [available online ahead of print November 24, 2016]; doi: 10.1136/bjsports-2016-096795.

30 Katzmarzyk PT. Standing and mortality in a prospective cohort of Canadian adults. *Med Sci Sports Exerc.* 2014;46(5):940-946.

31   van der Ploeg HP, Chey T, Ding D, et al. Standing time and all-cause mortality in a large

cohort of Australian adults. *Prev Med.* 2014;69:187-191.

Table 1. Incidence of Heart Disease Over a 12-Year Period (2003-2015) Across Occupational
Standing and Sitting Exposures in a Cohort of Employed Canadian Workers Aged 35 to 74
Years of Age (N = 7,320)

		All (N = 7,320)		Test for difference	
Variable	**N**	**Heart disease incidence** [a]	**95% CI** [b]	**Wald chi-square**	**P-value**
Sex					
Men	3,828	4.62	3.62,5.61	*ref*	
Women	3,492	2.08	1.27,2.89	15.12	< 0.001
Primary type of body posture or movement					
Sitting	2,683	2.82	2.04, 3.60	*ref*	
Standing	682	6.59	3.21, 9.97	4.56	0.03
Sitting, standing and walking	2,429	2.79	1.63, 3.94	0.00	0.97
Other body positions	1,526	4.01	2.82, 5.20	2.71	0.10

[a]All estimates are weighted for the probability of selection into the Canadian Community Health

Survey (CCHS) and initial survey non-response

[b]CI – confidence interval. Confidence limits have been adjusted to take into account the clustered

design of the CCHS

Table 2. HRs[a] Over a 12-Year Period (2003-2015) for Sitting and Standing Occupational Exposures and Incident Heart Disease.

Employed Canadian Workers Aged 35 to 74 Years of age (N = 7,320).

Primary type of body posture or movement	Model One[b]		Model Two[c]		Model Three[d]		Model Four[e]	
	HR[a]	95% CI[a]	HR[a]	95% CI[a]	HR[a]	95% CI[a]	HR[a]	95% CI[a]
Sitting	1.00	Referent	1.00	Referent	1.00	Referent	1.00	Referent
Standing	2.32[f]	1.16[f], 4.62[f]	2.28[f]	1.16[f], 4.45[f]	2.18[f]	1.11[f], 4.27[f]	1.97	0.99, 3.90
Sitting, standing and walking	0.97	0.58, 1.61	0.93	0.56, 1.55	0.93	0.56, 1.54	0.97	0.58, 1.62
Other body positions	1.09	0.70, 1.69	1.04	0.66, 1.66	1.04	0.42, 2.57	1.07	0.43, 2.65

[a]HR – hazard ratio; CI – confidence interval

[b]Model One adjusted for age, male/female, weeks worked in the previous 12 months and highest level of education

[c]Model Two: addition adjustment for immigrant status, ethnicity, marital status, presence of children, activity restrictions at work,

diabetes, hypertension, arthritis, mood and anxiety, and other chronic conditions

[d]Model Three: additional adjustment for shift work and physical work demands

[e]Model Four: additional adjustment for smoking, leisure time physical activity, alcohol consumption and body mass index

[f]Estimates with statistically significant relationships with heart disease

Table 3. HRs[a] Over a 12-Year Period (2003-2015) for Sitting and Standing Occupational Exposures and Incident Heart Disease, Stratified for Men and Women. Employed Canadian Workers Aged 35 to 74 Years of Age (N = 7,320)[b].

Primary type of body posture or movement	Men HR[a]	Men 95% CI[a]	Women HR[a]	Women 95% CI[a]	Chi-square for diff[a c]	P-value for diff[a]
Sitting	1.00	Referent	1.00	Referent		
Standing	2.01	0.85, 4.71	1.86	0.45, 7.71	0.01	0.93
Sitting, standing and walking	0.61	0.33, 1.13	1.80	0.78, 4.12	4.22[d]	0.04[e]
Other body positions	0.93	0.33, 2.64	0.68	0.16, 2.96	0.11	0.74

[a]HR – hazard ratio; CI – confidence interval; Diff – difference

[b]Model adjusted for age, weeks worked in the previous 12 months, highest level of education, immigrant status, ethnicity, marital status, presence of children, activity restrictions at work, diabetes, hypertension, arthritis, mood and anxiety, and other chronic conditions, shift work and physical work demands, corresponding to Model Three in Table 2

[c]Chi-square and p-values are for difference in estimates for men compared to women

[d]Estimates with statistically significant relationships with heart disease