Associations Between Pregnancy-Related Complications, Work and Non-Work Physical Activity and Elevated Blood Pressure in Female Hospital Employees

By

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Abstract

Objectives: To determine whether work and non-work physical activity (PA) modifies the relationship between pregnancy-related complications and future increased blood pressure (BP) in adult working women.

Methods: Female full-time and part-time employees from a tertiary care hospital in South East Ontario (n = 330) provided demographic, PA and history of pregnancy complications information, and participated in anthropometric examination. Participants were classified according to BP status: 1) normal, defined as systolic blood pressure (SBP) < 120 mmHg and/or diastolic blood pressure (DBP) < 80 mmHg; and increased, defined as SBP ≥120 mmHg and/or DBP ≥ 80 mmHg or taking antihypertensive medication for BP control. Levels of PA and sedentary behaviour were calculated using the validated Global Physical Activity Questionnaire, which evaluates PA in the domains of work, transportation, and recreation.

Results: Nineteen percent of the sample reported having a pregnancy-related complication. Thirty five percent of participants were classified as having increased BP. Logistic regression analysis determined that working women with a history of pregnancy complications had an increased risk of having elevated BP, after controlling for covariates such as age, waist circumference, family history of high BP, and marital status (OR 5.0, 95% CI 2.4-10.6). Although 49% of the sample met the World Health Organization’s PA recommendations, self-reported health-enhancing PA levels did not modify this association.

Conclusion: Women with a history of pregnancy-related complications are at risk for future cardiovascular disease in the form of increased BP. While health-enhancing PA is known to decrease BP, we were unable to determine if self-reported PA modified the association between pregnancy complications and future elevated BP. Future studies with larger sample sizes and objective measures of the different domains of PA are needed.
Co-Authorship

This thesis project represents the work of Jane van de Ven-Dantes in collaboration with her supervisor, Dr. Joan Tranmer and committee members, Dr. Jennifer Medves and Dr. Graeme Smith. Data were obtained from a cohort study led by Dr. Tranmer, which was funded by the Canadian Institutes for Health Research. Jane van de Ven-Dantes was responsible for the conceptualization of this thesis project, as well as the statistical analyses, interpretation of study results, and composition of the manuscript, together with supervision by Dr. Tranmer and guidance from committee members Dr. Medves and Dr. Smith.
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List of Abbreviations

Physical activity ................................................................. PA

Occupational physical activity ............................................. OPA

Cardiovascular disease ......................................................... CVD

Blood pressure ........................................................................ BP

Systolic blood pressure ......................................................... SBP

Diastolic blood pressure ......................................................... DBP

Global Physical Activity Questionnaire ................................ GPAQ

International Physical Activity Questionnaire ...................... IPAQ

World Health Organization .................................................. WHO

National Health and Nutrition Examination Survey .............. NHANES

Metabolic equivalent of task .................................................. MET

Waist circumference .............................................................. WC

Body mass index ...................................................................... BMI

Research assistant ................................................................. RA

Odds ratio .............................................................................. OR

Hazard ratio ............................................................................. HR

Relative risk ............................................................................. RR

Confidence interval ............................................................... CI

Credible interval ...................................................................... CrI
Mean.................................................................................................................................M

Standard deviation..............................................................................................................SD
Chapter 1

Introduction

1.1 General Introduction

Hypertension is a leading modifiable risk factor contributing to global cardiovascular disease (CVD) morbidity and mortality (1-3). Approximately 5.3-million (17.7%) Canadians self-reported a diagnosis of high blood pressure (BP) in 2013 (4). In 2000, the worldwide prevalence of hypertension in females was estimated as 26.1% and this number was predicted to increase to approximately 29.5% by 2025 (2). Emerging research supports a significant association between pregnancy-related complications and future hypertension (5-12). Pregnancy is now recognized as a sex-specific opportunity to assess women for CVD risk (13-15), thus providing healthcare workers with an early chance to promote cardiovascular health (16).

It is well accepted that maintenance of “health enhancing” physical activity (PA) levels is associated with reduced risk for CVD (17,18); however, physical inactivity also contributes to approximately 3.2 million deaths per year (19). The Exercise and Hypertension Position of the American College of Sports Medicine (ACSM) maintains that exercise is the optimum primary prevention and treatment for hypertension control (20). The effect of low levels of PA on CVD risk is well documented (21-26); however, the effect of sedentary activity is not as well researched (27). Recent literature indicates sedentary activity is complex and cannot be considered simply the absence of PA (28). Sedentarism is associated with adverse cardiovascular (29) and cardiometabolic outcomes (30). The effect of occupational sedentarism is even less well understood. Occupational sedentary activity includes sitting time such as: work at a desk; transportation via car, truck, or bus; and office duties using a computer (31).
In 2011, 57.9% of the Canadian workforce was female (32). Many women return to work following pregnancy and since adult women spend a large portion of their time in work-related activities, there is a need to understand the nature and impact of PA levels, including work and non-work activity on cardiovascular risk. Given the hypothesized associations between PA and CVD risk (29) and pregnancy-related complications and CVD risk, determining if there is a moderating effect of PA on hypertensive status in identified at increased risk working-women, would help inform the development of work policy and current health promotion strategies.

1.2 Key Definitions

1.2.1 Hypertension.

Hypertension is caused by vasoconstriction of the peripheral arteries, which compromises blood flow and increases the workload of the heart (33). Generally, there are four different classifications of BP: normal (systolic blood pressure [SBP] < 120 mmHg and diastolic blood pressure [DBP] < 80 mmHg), prehypertension (SBP between 120-139 or DBP 80-89 mmHg), stage one (SBP 140-159 or DBP 90-99 mmHg), and stage two HTN (SBP ≥ to 160 or DBP ≥100 mmHg) (34). Prehypertension is not considered a disease category; rather, it is an early indication of future risk of developing hypertension, identifying the need for lifestyle modification (35). Ambulatory BP monitoring is considered the gold standard due to accuracy and reliability for the diagnosis of hypertension (36,37); however, the focus of this study is on early identification of women at risk, thus we will rely on a one-time measurement of BP. Women who have prehypertension, stage one or two hypertension, or who are currently taking antihypertensive medication for high BP control will be classified as having increased BP.
1.2.2 Pregnancy-related complications.

Preeclampsia is a pregnancy-related complication classified by having a SBP ≥ 140 mmHg or a DBP ≥ 90 mmHg, on at least two occasions after 20 weeks gestation and with protein present in the urine (measuring at least 1+ via dipstick; (30mg/dL) (38). Similarly, gestational hypertension has a BP pattern similar to preeclampsia, without the presence of protein in the urine (38). Hypertensive disorders of pregnancy, is a term used to combine preeclampsia and gestational hypertension (39). Furthermore, along with the hypertensive disorders of pregnancy, gestational diabetes mellitus, gestational impaired glucose tolerance, placental abruption, preterm birth, and intrauterine growth restriction, are identified by Smith, Pudwell, and Roddy as indicators associated with future CVD risk (see Appendix A) (16).

1.2.3 Metabolic equivalent of task (MET).

A MET is a measure of energy expenditure (35) indicating the intensity of PA (work metabolic rate) compared to a resting metabolic rate (36). The ratio for a MET is total energy expenditure divided by resting energy expenditure (37). One MET is equal to 3.5ml of oxygen uptake per kilogram of body mass per minute (38). The Compendium of Physical Activities categorizes PA according to estimated MET values, in an effort to enable researchers to code participant self-reported PA from questionnaires (37).

1.2.4 Physical activity.

Physical activity is defined as any musculoskeletal bodily movement resulting in energy expenditure (39). In this study, the focus will be on the following components of PA: occupation, leisure-time, and transportation. Physical activity is often categorized and/or measured as the following: sedentary (1.0 to < 2.0 METs); light (2.0 to < 3.0 METs); moderate (3.0 to < 6.0 METs); and vigorous, (6.0 METs and above), respectively (40,41). The proposed study and the parent study use
MET/minutes/week, which is a continuous measure of PA to create categories of low, moderate, and high PA.

1.2.5 Sedentary activity.

There are various definitions of what constitutes sedentary activity. For the purposes of this study, the researcher will consider the terms “sedentary activity” and “sedentary behaviour” as acceptable representation for sedentary activity. Classification of sedentary activity relates to an individual’s low energy expenditure, which can vary from 1 to 1.5 METs (42,43) and 1 to < 2 METs (44). In this study, sedentary activity is defined as less than 2 METs. Sedentary activity includes: sitting time, viewing television, sitting in a vehicle during commuting, and using a computer (42). Pate, O’Neill, and Lobelo classify light PA as energy expenditure between 1.6 METs and 2.9 METs (e.g., cooking, or slow walking) and operationalize sedentary behaviour as energy expenditure between 1.0 MET and 1.5 METs (42).

1.3 Organizing Framework

Figure 1 Conceptualization of organizing framework
1.4 Objectives

The overall aim of this research project is to explore whether PA levels modify the hypothesized relationship between historically assessed pregnancy complications and increased BP, defined as SBP ≥ 120 mmHg and DBP ≥ 80 mmHg or currently taking antihypertensive medication for BP control, in working women. The specific objectives are, as follows:

1.4.1 Objective 1.
To describe and compare the demographic, lifestyle, and work characteristics, as well as the history of pregnancy-related complications, in normotensive women and women classified as having increased BP.

1.4.2 Objective 2.
To describe and compare levels of work and non-work related PA, as measured by the Global Physical Activity Questionnaire (GPAQ), in normotensive women and women classified as having increased BP.

1.4.3 Objective 3.
To explore the potential moderating effect of health enhancing PA levels at work and non-work, on the relationship between pregnancy-related complications and increased BP, while controlling for important covariates (e.g., age, waist circumference, marital status, and family history of high BP).

1.5 Thesis Organization and Outline

Organization of this manuscript format thesis will conform to the requirements of Queen’s University School of Graduate Studies. Chapter 1 provides a brief introduction of the topic of interest and the identification of key definitions. Chapter 2 provides an extensive literature review of relevant evidence to support the thesis topic. Chapter 3 is a manuscript titled: Associations between pregnancy-related complications, work and non-work physical activity, and increased blood pressure in adult female
hospital employees, which will be submitted to the journal entitled American Journal of Obstetrics & Gynecology. Chapter 4 provides a discussion of the findings from the manuscript, strengths and limitations of the investigation, implications, as well as recommendations for future research.
1.6 References


(18) Park S, Rink LD, Wallace JP. Accumulation of physical activity leads to a greater blood pressure reduction than a single continuous session, in prehypertension. J Hypertens 2006 Sep;24(9):1761-1770.


Chapter 2

Literature Review

2.1 General Introduction

The purpose of this literature review was to determine current knowledge and to identify research and knowledge gaps in the identified area of research using a comprehensive literature review strategy. This approach was selected to provide a general background for the study. The search strategy included reviewing multiple databases: Medical Literature On-Line (MEDLINE), Excerpta Medica Database (EMBASE), Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Database, and the Joanna Briggs Institute. Keywords utilized included: “pregnancy complication”, preeclampsia, “gestational diabetes”, “gestational hypertension”, “intrauterine growth restriction”, “cardiovascular risk”, “physical activity”, sedentary, “motor activity”, hypertension, prehypertension, work, and occupation. Subject headings identified by the use of keywords were the following: sedentary lifestyle, exercise, physical activity, sitting, cardiovascular risk, cardiovascular disease, risk factor, coronary artery disease, ischemic heart disease, work, and occupation. Search terms were exploded and focused, when available. The searches were narrowed by the use of the following restrictions: human, English language, female, all adult or adult (18-64yrs), years 2004-2014. Relevant articles were initially identified by title; the abstracts were then reviewed; and those articles that met topic focus, were selected for print and review. Secondary hand searches of bibliographies, specific journals, and grey literature were conducted to examine additional research. Pertinent literature was reviewed and summarized to identify current understanding and gaps in our knowledge, thus informing the thesis topic. See Appendix B for details of literature selection.
2.2 Hypertension

Hypertension or elevated blood pressure (BP) is common. The World Health Organization (WHO) reported that in 2008, 40% of the global population over the age of 25 had increased BP (1). Blood pressure is measured as cardiac output multiplied by total peripheral vascular resistance. Hypertension is a complex process and is caused by vasoconstriction of the peripheral arteries, which compromises blood flow thus increasing the workload of the heart (2). The *Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure* provides the current classifications of BP: normal (systolic blood pressure [SBP] < 120 mmHg and diastolic blood pressure [DBP] < 80 mmHg), prehypertension (SBP between 120-139 or DBP 80-89 mmHg), stage one (SBP 140-159 or DBP 90-99 mmHg), and stage two HTN (SBP ≥ 160 and/or DBP ≥100 mmHg) (3).

Self-reported, healthcare provider diagnosis of high BP among Canadians increased from approximately 4.8-million in 2007 to 5.3-million in 2013 (4,5). From March 2007 to February 2009, 15.1% of Canadian adult women were classified as prehypertensive (6). In an Ontario population-based cohort study using administrative data (1995, n = 7,908,562; 2000, n = 8,457,720; 2005, n = 9,283,155), the reported prevalence of hypertension increased relatively by 60% (p < 0.001) between 1995 and 2005 (7). Moreover, the study found that the incidence of hypertension in younger adults (≥ 20-years) rose significantly (25.7%, p < 0.001) and slightly more than hypertension in older adults (≥ 50-years; 25.1%, p < 0.001). Similarly, Ontario women reported the highest rates of increased BP within Canada, from 2009 to 2013 (4). Over one million Ontario females reported being diagnosed with high BP in 2013 (4).

Importantly, prehypertension is associated with future CVD (8-12) and stroke (10,13). A cross-sectional Canadian study (n = 1,388) found 30.6% of primary care practice patients without a diagnosis of hypertension (n = 999) were actually prehypertensive (14). Male participants (35.4%) were slightly more likely to have prehypertension compared to females (27.8%, Odds Ratio [OR] 1.27, 95% Confidence Interval [CI] 1.06-1.53) (14). Likewise, the United States National Center for Health Statistics reported
approximately 28% of the surveyed population in 2005-2006 had prehypertension, also with a significant difference between males (34%) and females (22%) (15).

Data from the Framingham Study cohort (n = 5,181) found 53% (n = 1,130) of female participants were prehypertensive and these women were significantly different from normotensive participants, p < .05 (11). Multivariate-adjusted (age, gender, smoking, obesity, diabetes mellitus, hypercholesterolemia, and study period) risk, indicated prehypertension was associated with increased risk of future myocardial infarction (Relative Risk [RR] 3.5, 95% CI 1.6-7.5) and coronary artery disease (RR 1.7, 95% CI 1.2-2.4) (11). Follow-up time in this study was approximately 10 years. Moreover, prehypertensive participants had double the risk of developing hypertension (RR 2.0, 95% CI 1.9-2.2). Notably, a Chinese population-based study (N = 11,061) found 32.6% of individuals with prehypertension, but free of any CVD at baseline, developed hypertension within a 28-month follow-up time frame (12). Thus, early identification of individuals with, or at risk for, prehypertension and/or hypertension is an important health promotion and disease prevention strategy.

2.2.1 Non-modifiable and modifiable risk factors associated with hypertension.
It is well known that there are both non-modifiable and modifiable factors that are associated with an increased risk for hypertension. Age, sex, diabetes mellitus (16) and family history of hypertension are all non-modifiable risk factors associated with hypertension (17,18). International evidence suggests that a large number of women with prehypertension are within the 35-59-year age range (18-20). Numerous cross-sectional studies indicate that the following modifiable risk factors are significantly associated with prehypertension in women: overweight, measured as body mass index (BMI) ≥ 25 kg/m² and < 30 kg/m²; obesity, indicated as BMI ≥ 30 kg/m² (16,18-24), increased waist circumference (18,19,21,22); decreased physical activity (PA), including leisure-time (9,21), work, and transportation activity (9); and self-reported sedentary lifestyle (23). Preventive strategies focus on interventions targeting these modifiable risk factors, in order to decrease CVD risk for women.
### 2.3 Pregnancy Complications and CVD Risk

Females entering adulthood and middle age are recognized as populations at high risk for CVD (25). Pregnancy is now recognized as a sex-specific opportunity to assess women for CVD risk (26-28) and provides healthcare workers with an ideal opportunity to screen women, in an attempt to promote necessary modifiable lifestyle changes for improved cardiovascular health (29). Research suggests that CVD and hypertensive disorders of pregnancy have similar disease mechanisms (30) such as endothelial dysfunction (31-33), inflammatory response (34), and metabolic abnormalities (32,35). However, temporal and causal effects of pregnancy complications and future CVD have yet to be shown.

Two systematic reviews and meta-analyses (36,37), as well as international case-control (31-33,35,38-43) and cohort studies (30,44-59), support a sex-specific relationship between pregnancy-related complications and future risk of CVD. In Bellamy’s review of 25 prospective and retrospective cohort studies, with a total sample of \( n = 3,488,160 \) women, 98,252 (5.7%) had preeclampsia and those women with preeclampsia had approximately 4 times the risk of future hypertension (RR 3.70, 95% CI 2.70-5.05) after follow-up of 14 years (36). In addition, these women had twice the risk of stroke (RR 1.81, 95% CI 1.45-2.27) after a 10.4-year follow-up and twice the risk of ischemic heart disease (RR 2.16, 95% CI 1.86-2.52) after 11.7 years.

McDonald et al.’s systematic review and meta-analysis included both case-controlled (\( n = 5 \)) and cohort studies (\( n = 10 \)). The total sample included \( n = 2,259,576 \) normotensive women and \( n = 116,175 \) preeclamptic/eclamptic women. When pooling the case-controlled (OR 2.47, 95% CI 1.22-5.07) and cohort studies (RR 2.33, 95% CI 1.95-2.78), there was over a 2-fold risk of cardiac disease for women with a history of preeclampsia. The researchers also noted a graded relationship between the severity of preeclampsia/eclampsia and the risk of future cardiac disease with mild preeclampsia (RR 2.00, 95% CI 1.83-2.19), moderate preeclampsia (RR 2.99, 95% CI 2.51-3.58) and severe preeclampsia (RR 5.36, 95% CI 3.96-7.27). The pooled study results did not vary significantly when controlling for traditional risk factors, such as age, hypertension, smoking, and use of oral contraceptives (37). The risk of
cerebrovascular disease remained doubled after adjusting for confounding variables (RR 2.08, 95% CI 1.51-2.86). Notably, none of the original studies explored PA as a moderating variable.

Prospective and population-based cohort studies with follow-up time ranging between less than 1 year and 39 years (30,34,44-50,52-59) and case-controlled studies (31-33,35,39,40,42,43,60-62) also found associations between pregnancy-related complications, such as preeclampsia (30-33,35,40,42,43,45,48,49,52,53,55,57-60), gestational hypertension (30,35,45,47,48,52-54,58-61), gestational diabetes mellitus (30,48,51,63), small for gestational age (41,48,52), preterm delivery (30,48,52) and third trimester vaginal bleeding (30) and CVD. A weakness of the prospective cohort studies is the risk of bias due to attrition (loss of participants to follow-up) (45,48); however, one study adjusted for attrition in an effort to minimize bias (45). Similar to some case-control studies, a noted weakness of one cohort study was the variation in the definition of hypertensive disorders of pregnancy (45). Overall, current evidence supports associations between pregnancy-related risk indicators and future CVD (30-35,38-54,56-59,61). The prevalence of a woman having at least one pregnancy complication ranges from 15-24% (30,52,64).

A large prospective, Finnish population-based cohort study (N = 10,314) conducted in 1966, contributed novel findings for this literature review (54). With an average follow-up timeframe of 39.4 years, the researchers collected baseline sociodemographic and health data obtained from clinical records of community midwife-run maternity welfare clinics and follow-up data regarding chronic disease diagnoses from Finnish registers. Pregnant women were grouped into mutually exclusive categories including: normotension (n = 6,552), defined as BP < 145/95 mm Hg; isolated systolic hypertension (n = 866), defined as SBP ≥ 145 mm Hg any time during pregnancy without the presence of proteinuria; isolated diastolic hypertension (n = 742), defined as DBP ≥ 95 mm Hg any time during pregnancy also without proteinuria; isolated systolic or diastolic hypertension with proteinuria in more than one urine sample at any time during pregnancy (n = 137); gestational hypertension (n = 991), which included women who were normotensive prior to 20 weeks gestation but had increased BP after 20 weeks; preeclampsia/eclampsia (n = 242), defined as women who developed an increased BP after 20 weeks.
gestation with proteinuria in more than one sample of urine; chronic hypertension \( (n = 668) \), which included women who had an increased BP prior to 20 weeks gestation and continuing past six weeks postpartum or use of antihypertensive medication for maintenance of previous hypertension; and superimposed preeclampsia/eclampsia \( (n = 116) \), which is present in chronic hypertensive women (54). Approximately 17% of all the included study’s participants had new-onset isolated elevation in SBP or DBP during pregnancy (54). Moreover, approximately 30% of these women experienced a cardiovascular event before the age of 70 and 3% of these women actually died from a myocardial infarction when compared to normotensive women. Thus, seemingly isolated elevations of BP during pregnancy are also associated with increased cardiovascular risk.

2.4 Physical Activity and CVD Risk

The positive health benefits of PA in relation to elevated BP (65-71) and CVD mortality risk (72-74) are well established, however, there is lack of data to determine the threshold level of PA that confers beneficial effects to cardiovascular health (74). The World Health Organization recommends the following PA guidelines (75):

1. Adults aged 18–64 should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate- and vigorous-intensity activity.
2. Aerobic activity should be performed in bouts of at least 10 minutes duration.
3. For additional health benefits, adults should increase their moderate-intensity aerobic physical activity to 300 minutes per week, or engage in 150 minutes of vigorous-intensity aerobic physical activity per week, or an equivalent combination of moderate- and vigorous-intensity activity.
4. Muscle-strengthening activities should be done involving major muscle groups on 2 or more days a week. (p. 26)

A recent systematic review investigating the relationship between PA and mortality in patients with high BP found inverse relationships in both men \( (n = 48,448) \) and women \( (n = 47,625) \) (70). Although the total number of participants was large, only six studies met inclusion criteria, specifically, longitudinal design with a follow up time greater than one year; identified hypertensive status; and measurement of
BP, PA, and mortality. Importantly, this review did not identify different domains of PA. Furthermore, a meta-analysis was not conducted due to the inconsistencies between studies regarding the measurement and classification of PA (70). Future research using consistent measurement and including the different domains of PA would enhance our understanding of the effects of various types of PA on mortality risk.

Warburton, Charlesworth, Ivey, Nettlefold, and Bredin’s systematic review of the literature, which was used to inform the Canadian PA guidelines for adults, included relevant articles that had at least three levels of PA (74). Data regarding PA was obtained by self-report via questionnaires. In women, the relationship between PA and CVD ($n = 446,883$) and PA and hypertension ($n = 63,551$) support inverse relationships, respectively. However, the particular dosage of PA to demonstrate a benefit was unclear.

Out of 49 articles investigating the association between PA and CVD in the previously mentioned review, only 22 studies included female participants (74). The predominant classification of PA in the studies involved leisure-time PA, although there were varying measures of PA (e.g., MET-hour/week; times per week; low, moderate, high, kcal per week, METs, kcal per kilogram per day; sedentary, light, moderate, active; quartiles: low to high; passive, somewhat active, active; greater than or less than 60 minutes per week; hours per week; MET hours per day; MET minutes per day; sitting at work; and sedentary time). Only two studies included the classification of occupational PA, and two studies included the measurement of sedentary time (74).

Likewise, out of 12 articles investigating the relationship between PA and hypertension, eight studies included females and only five studies supported an inverse association in women (74). Three of the studies included occupational PA and one study used physical fitness quartiles (METs: < 9.0 least fit, 10.2, 11.4, > 11.4 most fit) to represent PA. Only one study included sedentariness as a category. Thus, there is very limited research investigating the association between PA and hypertension, particularly within the female population. Research is still needed to clarify the optimal dose of PA to convey a benefit, specifically in women. The future direction of research investigating the relationship between PA and hypertension should consider consistent and objective measures of PA and the inclusion of different categories, particularly sedentary activity, in diverse female participants.
2.5 Sedentarism and CVD Risk

Globally, more women are inactive compared to men (76,77). Physical inactivity is among the most important behavioural risk factors associated with CVD in the form of high BP (78). Janssen (79) employed a prevalence-based approach to determine the 2009 Canadian financial burden of sedentary behaviour. He reported the estimated burden as $2.4 billion, in direct costs; $4.3 billion, in indirect costs; and $6.8 billion in total health care costs (79). Direct costs included money paid for treatment of illness; whereas indirect costs involved earnings lost due to illness, disability or death (79).

Data obtained from the 2007-2009 Canadian Health Measures Survey, provided Colley et al. with objective measurement of Canadian adults’ PA (80). The sample was representative of 96% of the Canadian population. Data was collected at 15 sites across Canada and the survey had an 88% response rate from adults, ages 20 to 79. Eighty-three percent of participants who completed the survey also participated in the mobile physical assessment. Physical activity was objectively measured through the use of an omnidirectional Actical accelerometer. Data was considered valid if participants had 10 hours of wear time in 24 hours ($n = 2,832$, 87%) (80). The study included three age categories: 20-39, 40-59, and 60-79 and the number of female participants in each category was $n = 509$, $n = 547$, and $n = 449$, respectively (80). Pregnant women were excluded. Surprisingly, 69% of females were sedentary an average of 9.8-hours per day and only approximately 14% (13.7%, 95% CI 10.1-17.3) of women actually met the Canadian and WHO recommendation of accumulating 150 minutes per week of moderate to vigorous PA in 10-minute bouts (80). Approximately 30% (95% CI 25.4 -34.6) of Canadian women averaged more than 10,000 steps per day, which was significantly different than men’s average steps (39%, 95% CI 33.0 – 45.0, $p < .05$) (80).

Sedentariness is not considered the same as lack or absence of moderate-to-vigorous PA (81,82). In fact, Koster et al. found that sedentary behaviour was associated with over 3 times the risk of mortality, independent of moderate-to-vigorous PA (Hazard Ration [HR] 3.26; 95% CI 1.59-6.69), after controlling for covariates affecting all-cause mortality: age, gender, race/ethnicity, education, alcohol consumption,
smoking, BMI, self-reported chronic illnesses (diabetes, congestive heart failure, coronary heart disease, stroke, cancer) and self-reported mobility limitations, for example, inability to climb a flight of stairs without resting (83). Data was obtained from the participants ($n = 1,906$) of the 2003-2004 National Health and Nutrition Examination Survey (NHANES), who wore a uniaxial Actigraph accelerometer to objectively measure sedentary time. Accelerometer data was valid if a participant had $\geq 10$ hours of wear time in 24 hours. Accelerometer count under 100 counts per minute during wear time was considered a measurement of sedentary time. The follow up time was an average of 2.8-years (83). Future research needs to be conducted using longer follow up timeframes.

A systematic review and meta-analysis, which included 16 prospective and two cross-sectional studies ($n = 794,577$), found time spent in sedentary activity was associated with chronic diseases with an increased risk of cardiovascular events (RR 2.47; 95% CI 1.44-4.24), diabetes (RR 2.12, 95% credible interval [CrI] 1.61, 2.78), and cardiovascular mortality (HR 1.90, 95% CrI 1.36, 2.66) (84). Studies using the term physical inactivity were excluded from the review (84). Television viewing, self-reported sitting time, and screen-based entertainment were included as sedentary behaviours.

Physical activity and sedentary behaviour can be measured in various ways. Utilization of validated questionnaires, which rely on participant self-report, provides a subjective measurement of both. Whereas, use of accelerometers, provides an objective measurement of PA and sedentary activity (85,86). Self-reported data may be susceptible to recall and social desirability biases (80); although, Sternfeld and Goldman-Rosas assert the relevance of using self-report data to assess PA and sedentary behaviour (87). There are also various domains of PA and sedentary activities. Numerous studies have focused on the health effects of leisure-time PA and sedentary behaviour, while few studies have investigated occupational physical activity (OPA), particularly involving sedentariness.

### 2.6 Occupational Physical Activity

The work environment is a key setting for potential sedentary or moderate levels of activity (88,89). Employed individuals spend a long portion of the day at work and many occupations are now becoming
more sedentary due to technological advances (90). An examination of the US trends in OPA spanning five decades revealed that there has been a decrease in work-related PA by 100 calories over time (91). Data was obtained from the NHANES surveys, the Current Employment Statistics Program, and the Current Population Survey. Occupations were assigned MET values based on Tudor-Locke, Ainsworth, Washington, and Troiano’s article (92). The US trends displayed a consistent increase in light (2.0 to 2.9 METs) and sedentary (<2 METs) jobs and a steady decline in moderate intensity (≥ 3.0 METs) work between the years 1960 to 2010 (91). There was an increase in service sector careers and a decrease in manufacturing, agricultural, and goods producing occupations (91). Likewise, a Canadian cross-sectional analysis using data from the National Population Health Surveys and the Canadian Community Health Surveys found that between the years 1994 to 2005 women self-reported less inactivity during leisure time PA and transportation and more inactivity at work (93).

Another American study using cross-sectional data from the NHANES (n = 1,826), found women working in full-time sedentary occupations spent significantly more time sedentary during weekdays (p = 0.008) than healthy unemployed people (90). This ethnically diverse study (n = 892 men, n = 934 women) found job type (i.e., active or sedentary) to be a strong predictor of daily activity levels in both genders (90). Strength of this study was the objective measurement of PA via ActiGraph uniaxial accelerometers. Total PA was measured through mean wear-time counts per minute calculated each day. Participants were instructed to wear accelerometers for a period of seven days; accelerometers were to be removed during sleeping, swimming, and bathing (90).

A recent Australian cross-sectional study involving a convenience sample of office, customer service, and call centre employees (n = 193) found the proportion of sitting time was significantly higher on workdays (marginal mean: 70.4; 95% CI 69-71.2) compared to non-work days (62.9; 95% CI 61.6-64.1; p < 0.001) (89). Physical activity was objectively and subjectively measured using an Actigraph uniaxial accelerometer and a PA diary, respectively. Objective activity count levels of less than 100 counts per minute represented sedentary (sitting) activity, which is consistent with other literature (83,89,90,94,95). Similarly, a study using data from the Australian National Health Survey (n = 10,785)
found that workers from both genders who reported decreased OPA had higher levels of leisure time PA and transportation-related PA (96).

Other research has found women with sedentary occupations tended to have sedentary activity outside of work (97) and female workers who had physically active jobs were more active during non-work hours compared with women with sedentary occupations (98). Cross-sectional, observational, and prospective cohort studies investigating sedentary behaviour have typically relied on self-reported PA (99-103). Work PA or sedentariness provides important data to consider when investigating the health effects of total PA (88,104). Importantly, prolonged sitting is a risk factor for all-cause mortality independent of PA (105). Therefore, this thesis study will contribute novel information on the moderating influence of work and non-work PA on the cardiovascular health of working women who may already be identified, through pregnancy, as having increased risk for future CVD.

2.7 Summary

Empirical evidence suggests women have increasing risks of cardiovascular-related morbidity and mortality years after having a specific complication of pregnancy. Currently, there is limited research investigating the associations between increased BP and PA, using reliable and valid measures of work and non-work PA, in the female working population. Furthermore, we were unable to identify any studies that explored the potential beneficial effect of PA (using the different domains), on women at increased risk for hypertension, due to previous pregnancy complications.
2.8 References


(4) Statistics Canada. CANSIM, Table 105-0501. 2014;Catalogue no. 82-221-x.

(5) Statistics Canada. CANSIM, Table 105-0501. 2012;Catalogue no. 82-221-x.


(86) Panter J, Griffin S, Ogilvie D. Correlates of reported and recorded time spent in physical activity in working adults: Results from the Commuting and Health in Cambridge Study. PLoS ONE 2012 07;7(7):1-11.


Chapter 3

Associations Between Pregnancy-Related Complications, Work and Non-Work Physical Activity, and Increased Blood Pressure in Adult Female Hospital Employees
Abstract

**Objective:** Pregnancy-related complications are now recognized as a sex-specific risk factor for future cardiovascular disease (CVD). Given increased levels of physical activity (PA) are associated with a reduction in CVD, we explored the modifying effect of work and non-work levels of PA on the association between pregnancy complications and elevated levels of blood pressure (BP).

**Study Design:** We conducted a cross-sectional study, with a cohort of women (n = 330) employed at an Ontario acute care hospital. Historical assessment of pregnancy-related complications and current PA as measured with the Global Physical Activity Questionnaire (GPAQ) were obtained through self-report. Women were categorized into two groups based on BP assessment: normotensive, defined as systolic blood pressure (SBP) < 120 mmHg and diastolic blood pressure (DBP) < 80 mmHg and elevated BP, defined as SBP ≥ 120 mm Hg and/or DBP ≥ 80 mmHg or currently taking medication for control of high BP.

**Results:** Thirty-five percent of our sample had elevated BP. Women with a pregnancy complication were more likely to have elevated BP (OR 5.0, 95% CI 2.4-10.6), while controlling for covariates (age, waist circumference, family history of increased BP, and marital status). Forty-nine percent of participants met the World Health Organization’s recommended guidelines for PA; however, health enhancing levels of PA were not significantly associated with elevated BP; thus PA did not modify the associations between pregnancy complications and elevated BP status.

**Conclusion:** Our study further validates the association between pregnancy-related complications and future elevated BP. Unfortunately, self-reported PA levels did not effect this association in this sample. Future studies need to consider objective measurement of positive lifestyle behaviours with larger sample sizes.
3.1 Introduction

The global burden of hypertension in women is projected to increase from 26.1% in 2000 to 29.5% by 2025 (1). Since hypertension is the leading modifiable risk factor contributing to cardiovascular disease (CVD) morbidity and mortality (1-3), there is a need to identify women who may be at increased risk and who could benefit from early health promotion strategies, such as health-enhancing physical activity (PA). Current evidence shows an association between pregnancy-related complications and increased CVD risk (4-7). Given that many women return to work following pregnancy and spend a large portion of their time in work-related activities, we explored the nature and impact of PA levels, including work and non-work activity on blood pressure (BP) levels in women with or without a history of pregnancy complications. Elevated BP was defined as systolic blood pressure (SBP) \(\geq 120\) mmHg and diastolic blood pressure (DBP) \(\geq 80\) mmHg or currently taking antihypertensive medication for BP control.

3.2 Materials and Methods

3.2.1 Research design.

A cross-sectional descriptive study design, with a retrospective assessment of pregnancy-related complications was employed. Data was obtained from a cohort study led by Dr. Tranmer, entitled "Shift Work and Cardiovascular Risk in Working Women". A subsample of the study population and selected measures were used for this study. Ethics approval was obtained from the Queen’s University Health Sciences Research Ethics Board for the parent study, Shift Work and Cardiovascular Risk in Working Women, File # 6006076 NURS-273-11 and the current study, File #6011134 NURS-319-14 (see Appendix C). Participants provided informed consent and had the option to leave the study at any time. Data were kept in a locked facility.
3.2.2 Sample and setting.

All women employed for at least 2 years from a local tertiary acute care hospital were invited to participate. The total number of female employees within the hospital with over 2 years of service was 2,517 out of 3,013 workers (83.5%); 330 full time and part-time employees participated in the study. Work experience was inclusive of maternity, education, and short-term sick leaves. Women, who were pregnant at the study onset, were excluded from participating in the study.

3.2.3 Data collection.

Data were collected in accordance with the original cohort study protocol. All female employees within the study site were notified of the study by a variety of methods (i.e., email notices, postings on each unit, advertisements in local newspapers, and media) and were invited to participate. A Project Manager screened women for inclusion and exclusion criteria. Interested women were scheduled for an intake interview, where written consent was obtained. Participants were introduced to the study protocol and provided with a questionnaire package to complete.

A trained research assistant (RA) obtained anthropometric data, including waist circumference (WC), body mass index (BMI), height, and weight measurements. Demographic information, such as marital status, number of children, level of education, and pre-tax household income were collected. Additional questions in the package included those pertaining to general health (e.g., reproductive, cardiovascular, long term illness, family history of premature heart disease, smoking status, alcohol use, and medication use). Additionally, fasting blood work was obtained to provide data regarding potential cardiovascular risk indicators.

Systolic, diastolic, and mean arterial pressures were measured with the BpTRU device. Evidence suggests that the average of five BPs taken using this device is moderately correlated with ambulatory blood pressure monitoring (BpTRU $r = .57$) (8). An initial BP reading was taken while the RA was present. When the participant was alone, the device took five more individual measurements at 1 to 5-minute intervals. Measurements were then averaged. Participants were
asked if they were currently being treated for hypertension. Any values at or above the prehypertension values of SBP 120 mmHg or DBP 80 mmHg and/or the use of any medications for hypertension control were used to categorize women with elevated or non-elevated BP.

Women recalled their history of pregnancy-related complications, specifically preeclampsia, gestational hypertension, gestational diabetes mellitus or gestational impaired glucose tolerance, preterm birth, placental abruption, and intrauterine growth restriction. Women having one or more of these indicators were grouped together and compared to women without any pregnancy-related complications. In Ontario, the estimated prevalence of pregnancy-related indicators is 20.6% (9).

Work and nonwork-related PA was obtained by retrospective self-report through completion of the Global Physical Activity Questionnaire (GPAQ) – Version 2 (GPAQv2). The GPAQ was designed to assess levels of PA in domains of transportation, work, and leisure, as well as to assess sedentary behaviour (10). The World Health Organization (WHO) developed the GPAQ to standardize assessment of PA internationally (11,12). The questionnaire was used to assess PA in approximately 50 countries and was found to be as valid and reliable as the International Physical Activity Questionnaire (IPAQ) (11,13). The evaluation of the GPAQv2 for validity using objective PA (accelerometer and pedometer), subjective PA (IPAQ), physical fitness, and body composition measures for comparison demonstrated low to moderate validity (r = .25-.63) (14). Short- (10-day) and long-term (3-month) test-retest reliability was also established (interclass correlation coefficients = .83-.96 and .53-.83, respectively) (14). Of note, when the GPAQ was compared to objective measures of PA, the GPAQ overestimated PA (14,15).

The GPAQ contains 15 questions related to PA in three domains: activity at work; travel activity, to and from places; and recreational activity (includes sports, fitness, and recreation) (12). Question 16 assesses time spent in sedentary behaviours i.e., sitting/reclining occurring in all three domains, but not including sleeping time. Specific analysis guidelines and calculations were used to clean data and create continuous and categorical variables. In order to calculate total PA, “MET values are
applied to the time variables according to intensity (moderate or vigorous) of the activity”, p. 14 (12):

- Work – moderate MET value = 4.0; vigorous MET value = 8.0
- Transport – cycling and walking MET value = 4.0
- Recreation – moderate MET value = 4.0; vigorous MET value = 8.0 (12)

In accordance with the WHO health enhancing PA recommendations, the following category was calculated based on PA per week:

- 150 minutes of moderate-intensity or
- 75 minutes of vigorous-intensity or
- An equivalent combination of moderate- and vigorous-intensity PA achieving at least 600 MET-minutes (12)

The MET value of vigorous work was calculated by multiplying: number of days (in a typical week) a participant engaged in vigorous PA, total vigorous PA minutes per day, and 8.0 (MET value). Similar calculations were done for moderate work activity, using 4.0 (MET value). The MET value of transportation activity was calculated as: number of days (in a typical week) a participant engaged in transportation PA multiplied by total travel minutes/day, and 4.0 (MET value). Finally, the MET values for vigorous and moderate recreational activities were calculated by multiplying: number of days (in a typical week) a participant engaged in vigorous or moderate intensity recreational activity by total vigorous or moderate recreational activity minutes/day, and 8.0 and 4.0 (MET values), respectively. The sum of all PA per week was calculated by adding weekly MET-minute values of: vigorous and moderate work activity, transport activity, and vigorous and moderate recreational activity.

3.2.4 Data analysis.

Data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) Version 22. Women were categorized into 2 groups: 1) elevated BP, defined as SBP ≥ 120 and/or DBP ≥ 80
mmHg, or if currently taking medication for BP control and 2) normal BP, defined as SBP < 120 and/or DBP < 80 mmHg, and not taking medication for BP control. Demographic, work characteristic, and health history for women in each group were compared. The sample was described using standard descriptive statistics (i.e. mean, standard deviation, and percent).

Physical activity scores measured by GPAQ responses were analyzed using Chi-square or Fisher’s Exact statistics for categorical groupings (work, transportation, and leisure). Continuous PA and sedentary mean ($M$) and standard deviation ($SD$) scores were log transformed, as these data were not normally distributed. Continuous PA and sedentary scores were compared using t-tests, when the participants were grouped by BP status.

The effect of PA on the association between pregnancy-related complications and current BP status was explored using multivariate logistical regression, while controlling for important covariates (e.g., age, WC, family history of early CVD). Variables with a $p$-value $\leq .15$ for comparison between PA and BP status were considered for logistic regression analysis. Pregnancy-related complication was entered as the independent variable and current BP status or current treatment for hypertension was the dependent variable (outcome of interest). The odds ratio with a 95% confidence interval was interpreted.

### 3.2.5 Sample size.

Based on the estimated prevalence of having one or more pregnancy complications of 20.6% (9) and the estimated prevalence of female hypertension of 19% (16), we estimated 67 women in the sample would have a history of a pregnancy complication and 61 women would have increased BP, respectively. A priori power analysis using G*Power 3.1 was conducted and calculated a sample size of 78 would provide 95% power to determine associations if they existed.

### 3.2.6 Results.

The demographic characteristics of our sample within each group are presented in **Table 1a**. Thirty-five percent ($n = 113$) of the sample was classified as having increased BP. Covariates
significantly associated with BP status were age, WC, BMI, and family history of increased BP. Fifty-four percent of the sample had at least post-secondary education and 52% of participants had an income of at least $50,000; neither of these characteristics was significantly associated with the outcome. Seventy-one percent of participants were currently married. There was a significant difference between women, with normal and increased BP, who were no longer married.

Interestingly, 61% of participants reported a family history of increased BP. The remaining demographic variables were not significantly associated with BP status, \( p > .05 \).

**Table 1a**

**Baseline Demographic Characteristics of Working Women With Normal and Increased BP**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Blood Pressure Status</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal ((n = 211))</td>
<td>Increased ((n = 113))</td>
</tr>
<tr>
<td><strong>M (SD)</strong></td>
<td><strong>M (SD)</strong></td>
<td></td>
</tr>
<tr>
<td>Age, yrs</td>
<td><strong>38.9 (10.8)</strong></td>
<td><strong>46 (10.6)</strong></td>
</tr>
<tr>
<td>Waist Circumference, (cm)</td>
<td><strong>82.9 (14.4)</strong></td>
<td><strong>93.1 (15.0)</strong></td>
</tr>
<tr>
<td>Body Mass Index, (kg/m(^2))</td>
<td><strong>26.0 (5.2)</strong></td>
<td><strong>30.0 (5.5)</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Education Level* (%), ( n ) (%)</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School</td>
<td>5 (2.4)</td>
</tr>
<tr>
<td>Post-secondary (cert./dipl.)</td>
<td>106 (50.7)</td>
</tr>
<tr>
<td>University (undergrad.)</td>
<td>80 (38.3)</td>
</tr>
<tr>
<td>Graduate (Master, PhD)</td>
<td>14 (6.7)</td>
</tr>
<tr>
<td>Other*</td>
<td>4 (1.9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Household Income* (%), ( n ) (%)</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $30,000</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>$30,000 to 49,999</td>
<td>18 (8.6)</td>
</tr>
<tr>
<td>$50,000 to 99,999</td>
<td>111 (53.1)</td>
</tr>
<tr>
<td>Greater than $100,000</td>
<td>79 (37.8)</td>
</tr>
<tr>
<td>Table 1a continued</td>
<td>Blood Pressure Status</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td></td>
<td>Normal</td>
</tr>
<tr>
<td>Marital Status (%)</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>154 (73.3)</td>
</tr>
<tr>
<td>No longer married</td>
<td>17 (8.1)$^T$</td>
</tr>
<tr>
<td>Single, never married</td>
<td>39 (18.6)</td>
</tr>
<tr>
<td>Smoking Status (%)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>16 (7.6)</td>
</tr>
<tr>
<td>No</td>
<td>195 (92.4)</td>
</tr>
<tr>
<td>Alcohol Use* (%)</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>15 (7.1)</td>
</tr>
<tr>
<td>Occasional</td>
<td>106 (50.5)</td>
</tr>
<tr>
<td>Weekly</td>
<td>86 (41.0)</td>
</tr>
<tr>
<td>Daily</td>
<td>3 (1.4)</td>
</tr>
<tr>
<td>Parity (%)</td>
<td></td>
</tr>
<tr>
<td>Nulliparous</td>
<td>41 (25.5)</td>
</tr>
<tr>
<td>Multiparous</td>
<td>120 (74.5)</td>
</tr>
<tr>
<td>HRT (%)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>13 (6.3)</td>
</tr>
<tr>
<td>No</td>
<td>194 (93.7)</td>
</tr>
<tr>
<td>Family Hx of Increased BP (%)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>104 (56.2)$^T$</td>
</tr>
<tr>
<td>No</td>
<td>81 (43.8)$^T$</td>
</tr>
<tr>
<td>Either Parent HA Before 60yr (%)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>31 (15.0)</td>
</tr>
<tr>
<td>No</td>
<td>176 (85.0)</td>
</tr>
</tbody>
</table>

Note. yrs = years. cert. = certificate. dipl. = diploma. undergrad. = undergraduate. BP = blood pressure. HRT = hormone replacement therapy. Hx = history. HA = heart attack. Education level Other = Physician or Resident and Other - collapsed due to no participants in the physician category. Income categories: Less than $30,000 = less than 15,000, 15,000 to 19,999, 20,000 to 29,999; $30,000 to 49,999 = 30,000 to 39,999 and 40,000 to 49,999; $50,000 to 99,999 = 50,000 to 74,999, 75,000 to 99,999; Greater than $100,000 = 100,000 to 150,000 and > 150,000. Marital status category composed of: married = married and living common-law; no longer married = widowed, separated, and divorced; and single, never married. Alcohol Use category: Never = Never, do not drink; Occasionally = < 1/month, once/month, 2-3 times/month; Weekly = once/week, 2-3 times/week, 4-6 times/week; Daily = every day.
Continuous variables compared with independent *t*-tests. Categorical variables compared with chi-square tests. *Fisher’s Exact test for cells with count less than 5. Column proportions significantly different, \( \gamma = p < .05 \)

Table 1b presents the comparison of work characteristics and BP status. There were no significant associations between work status, type of position, and shift work and BP status, all *p*-values > .05. Eighty-one percent of women in our study were employed in full-time positions and 97% of participants were in permanent positions. Sixty-four percent of women were in occupations involving shift work.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Blood Pressure Status</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal ((n = 211))</td>
<td>Increased ((n = 113))</td>
</tr>
<tr>
<td>Work Status (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>166 (78.7)</td>
<td>96 (85.0)</td>
</tr>
<tr>
<td>Part-time</td>
<td>45 (21.3)</td>
<td>17 (15.0)</td>
</tr>
<tr>
<td>Type of Position* (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent</td>
<td>205 (97.2)</td>
<td>109 (96.5)</td>
</tr>
<tr>
<td>Other</td>
<td>6 (2.8)</td>
<td>4 (3.5)</td>
</tr>
<tr>
<td>Shift Work (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>133 (63.0)</td>
<td>73 (64.6)</td>
</tr>
<tr>
<td>No</td>
<td>78 (37.0)</td>
<td>40 (35.4)</td>
</tr>
</tbody>
</table>

Note. Chi-Squared Test = \( p > .05 \), not significant. *Fisher’s Exact Test for cells with count less than 5.

Table 2 provides characteristics related to BP status. Thirty-five percent of our sample was classified as having increased BP. Mean systolic and diastolic BPs of the normal group was 106 and 68 mmHg, respectively. The increased BP group had mean SBP of 127 and DBP of 80 mmHg, which are within the prehypertensive classification for BP (17). Among, working women within the latter group, 71% \((n = 80)\) were not being treated with medication. Only 29% \((n = 33)\) of women within the increased BP group were treated with anti-hypertensive medication.
Table 2
Characteristics Related to BP Status

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Normal (n = 211)</th>
<th>Increased (n = 113)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>SBP, mm Hg</td>
<td>106.0 (7.3)</td>
<td>127.0 (14.3)</td>
</tr>
<tr>
<td>DBP, mm Hg</td>
<td>68.1 (6.2)</td>
<td>80.0 (7.8)</td>
</tr>
</tbody>
</table>

Medication, BP control

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Increased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>0 (0.0)</td>
<td>33 (29.2)</td>
</tr>
<tr>
<td>No</td>
<td>211 (100.0)</td>
<td>80 (70.8)</td>
</tr>
</tbody>
</table>

Note.  SBP = systolic blood pressure; DBP = diastolic blood pressure; BP = blood pressure.  Continuous variables compared by independent t-test.  Categorical variables compared by chi square test.  Column proportions significantly different $^\dagger = p < .05$.  All levels of significance are two-tailed.

Table 3 displays comparisons of pregnancy complications and BP status.  The proportion of participants with any pregnancy complication was 19% (n = 61).  Pregnancy complications of preeclampsia (7%), gestational hypertension (8%), gestational diabetes (4%), and intrauterine growth restriction (2%) were significantly associated with BP status.  Women with any of these pregnancy complications were more likely to be classified as having elevated BP.  Approximately 7% of participants reported having preterm birth and 2% reported having placental abruption.  There was no difference in BP status between the two groups who reported these two complications.
Table 3
Pregnancy Complications Among Working Women Grouped by BP Status

<table>
<thead>
<tr>
<th>Pregnancy Complication</th>
<th>Blood Pressure Status</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal $(n = 211)$</td>
<td>Increased $(n = 113)$</td>
</tr>
<tr>
<td></td>
<td>$n$ (%)</td>
<td>$n$ (%)</td>
</tr>
<tr>
<td>Preeclampsia (%)</td>
<td>Yes 9 (4.3)$^T$</td>
<td>12 (10.6)$^T$</td>
</tr>
<tr>
<td></td>
<td>No 202 (95.7)$^T$</td>
<td>101 (89.4)$^T$</td>
</tr>
<tr>
<td>Gestational Hypertension (%)</td>
<td>Yes 8 (3.8)$^T$</td>
<td>18 (15.9)$^T$</td>
</tr>
<tr>
<td></td>
<td>No 203 (96.2)$^T$</td>
<td>95 (84.1)$^T$</td>
</tr>
<tr>
<td>Gestational Diabetes* (%)</td>
<td>Yes 3 (1.4)$^T$</td>
<td>9 (8.0)$^T$</td>
</tr>
<tr>
<td></td>
<td>No 208 (98.6)$^T$</td>
<td>104 (92.0)$^T$</td>
</tr>
<tr>
<td>Abruptio Placenta* (%)</td>
<td>Yes 4 (1.9)</td>
<td>2 (1.8)</td>
</tr>
<tr>
<td></td>
<td>No 207 (98.1)</td>
<td>111 (98.2)</td>
</tr>
<tr>
<td>Preterm Birth (%)</td>
<td>Yes 12 (5.7)</td>
<td>11 (9.7)</td>
</tr>
<tr>
<td></td>
<td>No 199 (94.3)</td>
<td>102 (90.3)</td>
</tr>
<tr>
<td>Intrauterine Growth Restriction* (%)</td>
<td>Yes 1 (0.5)$^T$</td>
<td>5 (4.4)$^T$</td>
</tr>
<tr>
<td></td>
<td>No 210 (99.5)$^T$</td>
<td>108 (95.6)$^T$</td>
</tr>
<tr>
<td>Any Pregnancy Complication (%)</td>
<td>Yes 25 (11.8)$^T$</td>
<td>36 (31.9)$^T$</td>
</tr>
<tr>
<td></td>
<td>No 186 (88.2)$^T$</td>
<td>77 (68.1)$^T$</td>
</tr>
</tbody>
</table>

Note. Chi-Square Test. Column proportions significantly different, $^T = p < .05$. *Fisher’s Exact Test for cells with count less than 5.

Table 4 presents comparison of GPAQ scores; log transformed values are attached in the Appendix. There were no significant associations between any GPAQ scores and BP status, all $p$-values > .05. Association between the sum of all activity/week, as a general measure of PA, and BP status had a $p$-value < .15.

Approximately 40% of women reported work-related PA, defined as vigorous or moderate-intensity PA at work, which “causes large increases in breathing or heart rate for at least 10 minutes
continuously”, p.4 (12); thus 60% of the sample did not report having physically active jobs. Fifty-five percent of participants engaged in transportation-related PA, defined as either walking or biking “for at least 10 minutes continuously to get to and from places”, p. 4 (12). Likewise, a high proportion (81%) of working women participated in recreation PA. Recreation-related PA included vigorous or moderate-intensity sports, fitness or recreational activities causing an “increase in breathing or heart rate for at least 10 minutes continuously”, p. 5 (12). Over 83% of the sample reported participating in vigorous PA. Yet, only 49% of women were classified as meeting the WHO recommended PA guidelines (12).
<table>
<thead>
<tr>
<th>Physical Activity Variables</th>
<th>Total N</th>
<th>Normal</th>
<th>Increased</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work-related PA per day (min.)</td>
<td>114</td>
<td>73, 132.1 (169.0)</td>
<td>41, 97.4 (113.4)</td>
<td>.62</td>
</tr>
<tr>
<td>Yes (%)</td>
<td>114</td>
<td>73 (39.5)</td>
<td>41 (41.4)</td>
<td></td>
</tr>
<tr>
<td>No (%)</td>
<td>170</td>
<td>112 (60.5)</td>
<td>58 (58.6)</td>
<td>.80</td>
</tr>
<tr>
<td>Travel-related PA per day (min.)</td>
<td>154</td>
<td>104, 49.0 (83.4)</td>
<td>50, 32.2 (37.2)</td>
<td>.23</td>
</tr>
<tr>
<td>Yes (%)</td>
<td>157</td>
<td>105 (56.8)</td>
<td>52 (52.5)</td>
<td></td>
</tr>
<tr>
<td>No (%)</td>
<td>127</td>
<td>80 (43.2)</td>
<td>47 (47.5)</td>
<td>.53</td>
</tr>
<tr>
<td>Recreation-related PA per day (min.)</td>
<td>230</td>
<td>155, 71.6 (208.0)</td>
<td>75, 53.1 (49.6)</td>
<td>.51</td>
</tr>
<tr>
<td>Yes (%)</td>
<td>230</td>
<td>155 (83.8)</td>
<td>75 (75.8)</td>
<td></td>
</tr>
<tr>
<td>No (%)</td>
<td>54</td>
<td>30 (16.2)</td>
<td>24 (24.2)</td>
<td>.11</td>
</tr>
<tr>
<td>Vigorous Activity (METs/wk)</td>
<td>157</td>
<td>108, 3,966.1 (12,053.8)</td>
<td>49, 2,581.5 (3,667.7)</td>
<td>.43</td>
</tr>
<tr>
<td>Yes (%)</td>
<td>236</td>
<td>156 (84.3)</td>
<td>80 (80.8)</td>
<td></td>
</tr>
<tr>
<td>No (%)</td>
<td>48</td>
<td>29 (15.7)</td>
<td>19 (19.2)</td>
<td>.51</td>
</tr>
<tr>
<td>Met WHO Recommendations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (%)</td>
<td>139</td>
<td>97 (52.4)</td>
<td>42 (42.4)</td>
<td></td>
</tr>
<tr>
<td>No (%)</td>
<td>145</td>
<td>88 (47.6)</td>
<td>57 (57.6)</td>
<td>.14</td>
</tr>
<tr>
<td>Sum of All Activity/wk (MET-min.)</td>
<td>267</td>
<td>176, 1,027.6 (1,703.5)</td>
<td>91, 737.4 (854.5)</td>
<td>.13</td>
</tr>
<tr>
<td>Sedentary Time (min.)</td>
<td>282</td>
<td>183, 275.4 (149.8)</td>
<td>99, 307.0 (196.9)</td>
<td>.17</td>
</tr>
</tbody>
</table>
Note. Min = minimum; Max = maximum; $M$ = mean; $SD$ = standard deviation; min. = minute(s); PA = physical activity; wk = week; MET(s) = metabolic equivalent of task; WHO = World Health Organization.

Work-related PA per day = (vigorous work activity minutes per week + moderate work activity minutes per week)/7
Recreation-related PA per day = (vigorous recreational activity minutes per week + moderate recreational activity minutes per week)/7

Vigorous Activity = vigorous work activity in minutes per week + vigorous recreational activity in minutes per week.

Comparisons for continuous variables by independent t-tests for log transformed values and for categorical variables by chi square tests.

$p$-value < .05 is considered significant. $p$-value < .15 is in bold; all significance values are 2-sided.

Differences in n for continuous and categorical data for vigorous activity are due to completion of GPAQ questionnaire; if questionnaire data for a variable was not completed the participant was excluded.
Hierarchical binary logistic regression was used to determine associations between variables of interest (pregnancy complications and PA) and elevated BP. See Table 5. After adjusting for covariates of age, WC, family history of high BP, and marital status category (Model A), women with pregnancy-related complications were 5 times more likely to have elevated BP. In Model B, when a participant was classified as meeting PA guidelines, there was no reduction in the risk of increased BP. Model C explored how addition of a continuous measure of PA, instead of a categorical measure, affected the relationship between having pregnancy complications and elevated BP. Model C also did not reveal a reduction in the risk of having higher BP, in working women who reported pregnancy-related complications.

Table 5
Logistic Regression Analysis: The Association Between Pregnancy Complications and BP

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model A</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Pregnancy Complication</td>
<td>266</td>
<td>5.0</td>
<td>2.4 - 10.6</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>2.1</td>
<td>1.5 - 2.9</td>
</tr>
<tr>
<td>WC</td>
<td></td>
<td>1.1</td>
<td>1.0 - 1.1</td>
</tr>
<tr>
<td>Family History Increased BP</td>
<td></td>
<td>1.7</td>
<td>0.9 - 3.2</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never Married</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Longer Married</td>
<td></td>
<td>0.8</td>
<td>0.2 - 2.6</td>
</tr>
<tr>
<td>Married</td>
<td></td>
<td>0.3</td>
<td>0.1 - 0.7</td>
</tr>
<tr>
<td><strong>Model B</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Pregnancy Complication</td>
<td>244</td>
<td>5.6</td>
<td>2.5 – 12.6</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>2.3</td>
<td>1.6 – 3.3</td>
</tr>
<tr>
<td>WC</td>
<td></td>
<td>1.1</td>
<td>1.0 - 1.1</td>
</tr>
<tr>
<td>Family History Increased BP</td>
<td></td>
<td>1.5</td>
<td>0.8 – 2.9</td>
</tr>
</tbody>
</table>
Table 5 continued

<table>
<thead>
<tr>
<th>Marital Status</th>
<th>n</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never Married (Reference)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Longer Married</td>
<td>0.5</td>
<td>0.1 - 1.9</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>0.3</td>
<td>0.1 - 0.7</td>
<td></td>
</tr>
<tr>
<td>Met WHO PA</td>
<td>1.0</td>
<td>0.5 - 1.9</td>
<td></td>
</tr>
</tbody>
</table>

Model C: 244

<table>
<thead>
<tr>
<th>Model C</th>
<th>n</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Pregnancy Complication</td>
<td>4.9</td>
<td>2.1 - 11.3</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>2.3</td>
<td>1.6 - 3.4</td>
<td></td>
</tr>
<tr>
<td>WC</td>
<td>1.1</td>
<td>1.0 - 1.1</td>
<td></td>
</tr>
<tr>
<td>Family History Increased BP</td>
<td>1.7</td>
<td>0.9 - 3.5</td>
<td></td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never Married (Reference)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Longer Married</td>
<td>0.4</td>
<td>0.1 - 1.7</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>0.2</td>
<td>0.1 - 0.6</td>
<td></td>
</tr>
<tr>
<td>Transformed Sum of All</td>
<td>0.9</td>
<td>0.4 - 1.7</td>
<td></td>
</tr>
</tbody>
</table>

Activity

Note. OR = odds ratio; CI = confidence interval; WC = waist circumference; BP = blood pressure.

Model A: $R^2 = .76$ (Hosmer & Lemeshow), .27 (Cox & Snell), .37 (Nagelkerke). Model $\chi^2 (6) = 82.1, p = .00$.

Model B: $R^2 = .76$ (Hosmer & Lemeshow), .27 (Cox & Snell), .37 (Nagelkerke). Model $\chi^2 (7) = 72.6, p = .00$.

Model C: $R^2 = .76$ (Hosmer & Lemeshow), .27 (Cox & Snell), .38 (Nagelkerke) Model $\chi^2 (7) = 71.0, p = .00$.

3.3 Comment

Emerging literature has identified that pregnancy-related complications are associated with an increased risk for future CVD (18-20). Results of our study further support this association between pregnancy-related complications, namely, preeclampsia, gestational hypertension, gestational diabetes,
and intrauterine growth restriction and the risk of increased BP. We found that a working adult woman with a history of a pregnancy complication was at least 5 times more likely to have indicators of increased BP. Other large cohort studies have found pregnancy complications are associated with increased CVD risk in the range of 2 to 4 times (21-23). Similar to the findings in a case-controlled investigation (24), our study did not find a significant association between a history of placental abruption and BP status. Contrary to the findings from two previous large cohort studies (5,25), we did not find an association between a history of preterm labour and elevated BP. Our non-significant results could have been due to small numbers of cases of placental abruption and preterm birth and shorter follow-up time. A large prospective cohort study \(n = 2,112\) found women with hypertensive disorders of pregnancy had close to 4 times the odds of having unidentified and unmanaged high BP (21).

Approximately one third of our sample met the classification for increased BP, which was measured as SBP \(\geq 120\) and/or DBP \(\geq 80\) mmHg. Five percent of participants had hypertension, which was measured as SBP \(\geq 140\) and/or DBP \(\geq 90\) mmHg and approximately 28% of the sample were pre-hypertensive, measured as SBP between 120-139 and/or DBP between 80-89 mmHg. Women in the increased BP category had a mean (SD) BP of 127(14.3)/80 (7.8). Our findings are consistent with Canadian (16) and international prehypertension rates (26,27) ranging from 15-31%. A cross-sectional Canadian study found 28% of female primary care patients without diagnosis of hypertension were found to be prehypertensive (28). Interestingly, only 10% of our participants reported taking medication for the management of hypertension; yet, 71% of women in the increased BP category reported they were not taking medication for BP control. The prevalence of potentially untreated or undetected increased BP in this adult working sample is concerning.

We know age is significantly associated with increased BP (26,29-31). The mean (SD) age in this sample of working women was 41.3 (11.2) years, an age distribution that is reflective of typical hospital (healthcare) workforces (32); thus many participants were either approaching menopause or
postmenopausal, a time when CVD risk is further increased (33). Furthermore, the presence of prehypertension in pre- or peri-menopausal women is of concern, as this suggests beginning atherosclerotic processes that will likely be enhanced following menopause. Regular assessment of BP, particularly in women with a history of pregnancy complications and other risk factors is an important CVD prevention strategy.

The majority of our sample were employed in full-time positions and work-related physical activity varied. Approximately 60% of participants reported sedentary-like jobs. A female shift worker study found that in a 24-hour period (7am-7am) the mean (± SD) MET-minutes of moderate to vigorous PA was 284 ± 649 for day shift and 206 ± 530 for night shift workers (32). Low intensity PA and sedentary PA for dayshift workers was 673 ± 658 and 858 ±297, respectively. Sedentary activity was high for workers on both shifts 858 ± 297 (dayshift) and 852 ± 267 (night shift) (32). Traditionally physically active jobs typically included manual labour (i.e., construction) and not hospital work. However, many participants in this study would have engaged in front-line patient care work, which is often perceived as physically demanding (34,35). There is limited research exploring effects of occupational-related PA on CVD risk in females (36); findings from a Finnish study (N = 26,643) with mean follow up time of 19.9 years, suggested moderate to high levels of occupational PA, leisure-time PA, and walking or cycling commuting to work were independently associated with reduced CVD mortality, particularly for hypertensive women who were initially free of CVD and type I diabetes at study initiation (37). Their participant data was obtained from six independent population surveys conducted in Finland between the years 1972 to 1997. Associations between PA and CVD related death were explored in multivariate analysis, which adjusted for covariates including: age, education, alcohol, smoking, BMI, SBP, cholesterol, use of antihypertensive at baseline or follow up, diabetes at baseline or follow up, and two other types of PA. Women (n = 12,244) who engaged in moderate and high levels of occupational PA (Hazard Ratio [HR] 0.85, 95% CI 0.74-0.98 and HR 0.84, 95% CI 0.73-0.96, respectively) or leisure time
PA (HR 0.78, 95% CI 0.70-0.87 and HR 0.76, 95% CI 0.60-0.97, respectively) had reduced risk of CVD mortality (37). Work related PA or demands vary, as seen in this study. Sedentariness and high levels of physically (and psychologically) demanding activity might have both a positive or negative effect, which requires further exploration.

Physical activity measurement is complex and challenging, particularly for women who work in non-regular schedules, such as shift work. A systematic review of PA evidence, which was used to inform the adult Canadian PA guidelines, supports the inverse associations between PA and CVD and/or hypertension (36). Among 12 studies investigating the relationship between PA and hypertension, there was conflicting evidence supporting the association between PA and hypertension in women, yet, the research clearly supported consistent inverse associations for men, particular Caucasian males. Three articles, which found protective effects of PA for women were mostly based on leisure PA. In our study, working women classified as meeting WHO PA recommendations (38) were younger, mean (SD) 39-years (10.8) and had smaller WCs, mean (SD) 84cm (13.0), and BMI (kg/m²), mean (SD) 26.6 (4.9) compared to participants who were not classified as meeting recommendations (43-years [10.4] and 89cm [17.8], and 29.5 [7.2], respectively). Our results were consistent with findings of an American study, which found inverse associations between abdominal obesity and PA, particularly when PA recommendations were achieved outside of sedentary work environments (39). The use of self-report measures for PA has limitations. Self-reporting of PA is subject to recall and social desirability biases (40); but, because of ease of data collection and reported reliabilities of tools, such as the GPAQ, studies continue to use self-report data to assess PA and sedentary activity (41-43). In our sample there were wide ranges and variation in activity levels, limiting our ability to accurately determine a precise estimate of PA levels. However, while not significant, there were a higher proportion of women with higher levels of PA in the normal BP group compared to the increased BP group, supporting the trend. Women’s
interpretation of both work and nonwork related activity levels requires validation with objective measurement of PA.

### 3.4 Conclusion

Our study further supports important associations between pregnancy-related complications and increased risk for hypertensive disorders in a working adult population. We were not able to determine that health-enhancing levels of PA influenced this risk; however, this requires further exploration with objective PA measures and within larger samples. Importantly, given that approximately one third of this sample had indicators of increased BP supports the need for early primary care assessment of risk and nursing implementation of health promotion and disease prevention strategies, through patient health education targeting modifiable risk factors such as PA, nutrition, and smoking cessation (if applicable).

### 3.5 Acknowledgements

The authors would like to acknowledge the healthcare facility for granting permission to conduct our study in their setting. Acknowledgement is also given to members of the research team, in particular C. Kelly and R. Corbin, Research Coordinators for the project. The Canadian Institutes of Health Research funded the original cohort study.

### 3.6 Conflicts of Interest

There were no conflicts of interest with any of the participating authors of this study.
3.7 References


(2) Dahlöf B. Cardiovascular Disease Risk Factors: Epidemiology and Risk Assessment. Am J Cardiol 2010;105[suppl]:3A-9A.


Chapter 4

General Discussion

4.1 Summary of Findings

The overall purpose of this thesis project was to explore whether work and non-work physical activity (PA) levels modify the relationship between pregnancy-related complications and future cardiovascular disease (CVD). The Global Physical Activity Questionnaire – Version 2 (GPAQ) provided measurement of physical activity. The outcome of interest was increased blood pressure (BP), which was defined as SBP ≥ 120 and/or DBP ≥ 80 mmHg or currently taking antihypertensive medication for BP control.

The first objective was to compare the demographic, lifestyle, and work characteristics, as well as the self-reported history of pregnancy-related complications in working women with normal and increased BP. Participants classified as having increased BP were older, had larger waist circumferences (WCs) and body mass indexes (BMIs), were no longer married (widowed, separated, and divorced), had a family history of increased BP, and had a history of pregnancy complications compared to women in the normal BP group. Our findings of significant associations between age, WC, BMI, family history of increased BP, and pregnancy complications and increased BP are consistent with existing literature (1-12). The prevalence of pregnancy complications in our sample of working women was 19%, which is similar to rates found in the United States and Denmark (13-15) and which approaches the prevalence rate found in Ontario, 21% (16). Although the majority of women were in full-time, permanent positions and 64% of the participants were in positions that involved shift work, there were no significant differences in these characteristics between the women with normal and increased BP. Additionally, we found no significant associations between work characteristics, such as shift work and BP status, which is consistent with a
prospective population-based study ($N = 20,142$), from Finland where 52% of the participants were female (17).

The second objective of this study was to describe and compare levels of work and non-work related PA between normotensive participants and those classified as having increased BP. There were no significant differences in reported work-related, travel-related, and recreation-related PA between the two groups. We did find that a higher proportion of women with normal BP reported engaging in the different classifications of PA compared to women who were classified as having increased BP. Likewise, 52% of women with normal BP met the WHO’s PA recommendations compared to 42% of women classified as having elevated BP. The overall rate of our participants meeting PA recommendations (49%) is similar to the rate found in a German study, $n = 1,171$ (52%, females), which also used the GPAQ to assess the different domains of PA (18). Similarly, an American longitudinal cohort study of female healthcare workers ($n = 99$) found that 59% of their participants met the recommended PA level, outside of the workplace (19). Physical activity recommendations for the US study was defined as participating in at least 150 minutes of moderate or vigorous PA per week or 120 minutes of vigorous PA per week (19).

The last objective addresses the overall goal of this thesis project, which was to explore the potential moderating effect of health enhancing PA levels for both work and non-work on the relationship between pregnancy-related complications and increased BP, while controlling for important covariates (e.g., age, WC, marital status, and family history of increased BP). Women who reported having a pregnancy-related complication had 5 times the risk of having increased BP. Stepwise binary logistic regression was used to explore these associations. There was no reduction in the association between pregnancy-related complication and risk of increased BP, regardless of the measure used for PA (i.e., categorical versus continuous). Thus, we were unable to determine whether self-reported PA moderated the relationship between a history of pregnancy complications and future CVD in working women.
4.2 Strengths and Limitations

Our study findings contribute to the literature, which identifies associations between pregnancy-related complications and increased risk of CVD. The proportion of participants reporting at least one pregnancy-related complication (19%) is within the percentage found in previous research (15-24%) (13-15). Further, our study adds to the limited research investigating the associations between work and non-work PA and risk for increased BP in the female population. Use of the validated GPAQ provided measurement for the different domains of PA (i.e., occupation, transportation, and leisure), as well as measurement of sedentary behaviour.

A major limitation of our study is the use of self-reported measures of PA and pregnancy complications, which is subject to recall bias. Ideally pregnancy complications would have been verified via medical record review. Recall of PA is also subject to social desirability bias, which involves over reporting of PA estimation and duration (20); GPAQ was found to have a moderate correlation ($r = .48$) with objectively measured moderate to vigorous PA (21). The retrospective, cross-sectional observational design of the study limits our ability to determine causal associations between the variables of interest. Moreover, the nonrandom selection of participants from a setting at one healthcare facility limits our ability to generalize our findings to women working in other settings. The work characteristics of our sample are similar to those found in other hospital settings.

4.3 Implications

The rising trend of elevated BP in Ontario women is concerning. Since pregnancy is now recognized as an opportunity to screen women for CVD risk, this thesis project further supports the relevance for the development of “Maternal Health Clinics” to follow postpartum women considered at risk. There is currently one such clinic in Kingston, Ontario, which was organized by Dr. G. Smith (22). Early nursing health promotion interventions, targeting modifiable CVD risk factors, e.g., PA, nutrition, and smoking
cessation (if applicable) could have beneficial effects for this population of women. We examined different domains of PA, particularly work and non-work related activity and sedentary behaviour in working women; however, we were unable to determine a moderating effect of PA on the relationship between pregnancy-related complications and future increased BP. Future research in larger sample sizes, taking place in various work settings, and using objective measures of PA and sedentary behaviour are needed in order to help develop health promotion and disease prevention strategies for women identified as at risk for CVD due to pregnancy complications.
4.4 References


Appendix A

Pregnancy-Related Indicators

Please fill in the below table regarding any pregnancy related conditions you may have experienced during all of your pregnancies.

Please state the date of birth (DOB) as Year/Month/Date (i.e. 75/08/26)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Number of Pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&gt;4</td>
</tr>
<tr>
<td></td>
<td>(please indicate # of pregnancy in 2nd column)</td>
</tr>
<tr>
<td></td>
<td>DOB</td>
</tr>
<tr>
<td></td>
<td>DOB</td>
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<td></td>
<td>DOB</td>
</tr>
<tr>
<td></td>
<td>DOB</td>
</tr>
<tr>
<td></td>
<td>DOB(s)</td>
</tr>
</tbody>
</table>

Preeclampsia

Gestational Hypertension (hypertension during pregnancy)

Gestational Diabetes or Gestational Impaired Glucose Tolerance

Placental Abruption

Pre-term Birth (< 37 weeks)

Intrauterine growth restriction (your baby weighed much less than expected for their gestational age. i.e., < 2500 gms for a term birth)
Appendix B

Literature Review Methodology

The literature review protocol from *Nursing Research Generating and Assessing Evidence for Nursing Practice*, (2012) 9th Ed. by D.F. Polit and C.T. Beck was utilized to assess and select relevant articles.
Appendix C

Ethics Approval

QUEEN'S UNIVERSITY HEALTH SCIENCES & AFFILIATED TEACHING HOSPITALS RESEARCH ETICS BOARD-DELEGATED REVIEW
January 31, 2014

Ms. Jane van de Ven-Dantes
School of Nursing
Queen's University

Dear Ms. van de Ven-Dantes

Study Title: NURS-319-14 The Associations Between Physical Activity, Pregnancy-Related Complications and Elevated Blood Pressure in Female Hospital Employees.
File # 6011134

Co-Investigator: Dr. J. Tranmer

I am writing to acknowledge receipt of your recent ethics submission. We have examined the protocol for your project (as stated above) and consider it to be ethically acceptable. This approval is valid for one year from the date of the Chair's signature below. This approval will be reported to the Research Ethics Board. Please attend carefully to the following listing of ethics requirements you must fulfill over the course of your study:

Reporting of Amendments: If there are any changes to your study (e.g. consent, protocol, study procedures, etc.), you must submit an amendment to the Research Ethics Board for approval. Please use event form: HSREB Multi-Use Amendment/Full Board Renewal Form associated with your post review file # 6011134 in your Researcher Portal (https://reservices.queensu.ca/romeo_researcher)

Reporting of Serious Adverse Events: Any unexpected serious adverse event occurring locally must be reported within 2 working days or earlier if required by the study sponsor. All other serious adverse events must be reported within 15 days after becoming aware of the information. Serious Adverse Event forms are located with your post-review file 6011134 in your Researcher Portal (https://reservices.queensu.ca/romeo_researcher)

Reporting of Complaints: Any complaints made by participants or persons acting on behalf of participants must be reported to the Research Ethics Board within 7 days of becoming aware of the complaint. Note: All documents supplied to participants must have the contact information for the Research Ethics Board.

Annual Renewal: Prior to the expiration of your approval (which is one year from the date of the Chair's signature below), you will be reminded to submit your renewal form along with any new changes or amendments you wish to make to your study. If there have been no major changes to your protocol, your approval may be renewed for another year.

Yours sincerely,

[Signature]
Chair, Health Sciences Research Ethics Board
January 31, 2014

Investigators please note that if your trial is registered by the sponsor, you must take responsibility to ensure that the registration information is accurate and complete.
QUEEN'S UNIVERSITY HEALTH SCIENCES & AFFILIATED TEACHING HOSPITALS RESEARCH ETHICS BOARD

The membership of this Research Ethics Board complies with the membership requirements for Research Ethics Boards and operates in compliance with the Tri-Council Policy Statement; Part C Division 5 of the Food and Drug Regulations, OHRP, and U.S. DHHS Code of Federal Regulations Title 45, Part 46 and carries out its functions in a manner consistent with Good Clinical Practices.

Federalwide Assurance Number: #FWA00004184, #IRB00001173

Current 2014 membership of the Queen's University Health Sciences & Affiliated Teaching Hospitals Research Ethics Board:

Dr. A.F. Clarke, Emeritus Professor, Department of Biomedical and Molecular Sciences, Queen's University (Chair)

Dr. H. Abdollah, Professor, Department of Medicine, Queen's University

Dr. R. Brison, Professor, Department of Emergency Medicine, Queen's University

Dr. C. Cline, Assistant Professor, Department of Medicine, Director, Office of Bioethics, Queen's University, Clinical Ethicist, Kingston General Hospital

Dr. M. Evans, Community Member

Ms. J. Hudacin, Community Member

Mr. D. McNaughton, Community Member

Ms. P. Newman, Pharmacist, Clinical Care Specialist and Clinical Lead, Quality and Safety, Pharmacy Services, Kingston General Hospital

Ms. S. Rohland, Privacy Officer, ICES-Queen's Health Services Research Facility, Research Associate, Division of Cancer Care and Epidemiology, Queen's Cancer Research Institute

Dr. A. Singh, Professor, Department of Psychiatry, Queen's University

Dr. J. Walia, Assistant Professor and Clinical Geneticist, Department of Pediatrics, Queen's University and Kingston General Hospital

Ms. K. Weisbaum, LL.B. and Adjunct Instructor, Department of Family Medicine (Bioethics)
QUEEN'S UNIVERSITY HEALTH SCIENCES & AFFILIATED TEACHING HOSPITALS RESEARCH ETHICS BOARD

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Ms. K. Weisbaum, LL.B. and Adjunct Instructor, Department of Family Medicine (Bioethics)
### Appendix D

**Table 6**

<table>
<thead>
<tr>
<th>Transformed Variables</th>
<th>Total N</th>
<th>Blood Pressure Status</th>
<th></th>
<th></th>
<th></th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Normal</strong></td>
<td><strong>Increased</strong></td>
<td><strong>Normal</strong></td>
<td><strong>Increased</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>n, M (SD)</strong></td>
<td><strong>Min, Max</strong></td>
<td><strong>n, M (SD)</strong></td>
<td><strong>Min, Max</strong></td>
<td></td>
</tr>
<tr>
<td>Work-related PA per day (min.)</td>
<td>114</td>
<td>73, 1.6 (.4)</td>
<td>.3, 2.0</td>
<td>41, 1.6 (.3)</td>
<td>.7, 2.0</td>
<td>.62</td>
</tr>
<tr>
<td>Transport-related per day (min.)</td>
<td>154</td>
<td>104, 1.4 (.4)</td>
<td>.3, 2.8</td>
<td>50, 1.4 (.4)</td>
<td>.7, 2.4</td>
<td>.23</td>
</tr>
<tr>
<td>Recreation-related per day (min.)</td>
<td>230</td>
<td>155, 1.6 (.4)</td>
<td>.6, 3.4</td>
<td>75, 1.6 (.4)</td>
<td>.6, 2.4</td>
<td>.51</td>
</tr>
<tr>
<td>Vigorous Activity (METs/wk)</td>
<td>157</td>
<td>108, 3.3 (.4)</td>
<td>2.4, 5.1</td>
<td>49, 3.2 (.4)</td>
<td>2.3, 4.4</td>
<td>.36</td>
</tr>
<tr>
<td>Sum of All Activity/wk (MET-min.)</td>
<td>267</td>
<td>176, 2.7 (.5)</td>
<td>1.7, 4.2</td>
<td>91, 2.6 (.5)</td>
<td>1.5, 3.7</td>
<td><strong>.10</strong></td>
</tr>
<tr>
<td>Sedentary Time (min.)</td>
<td>282</td>
<td>183, 2.4 (.3)</td>
<td>1.8, 2.9</td>
<td>99, 2.4 (.3)</td>
<td>1.3, 3.0</td>
<td>.69</td>
</tr>
</tbody>
</table>

Note. Min = minimum. Max = maximum. SD = standard deviation. min. = minute(s). PA = physical activity. MET(s) = metabolic equivalent of task. wk = week.

Comparison by Independent t-test. *p*-value < .05 considered significant. *p*-value < .15 is in **bold**.