ACCUMULATED WALKING: FOR HYPERTENSION RISK REDUCTION
IN POSTMENOPAUSAL WOMEN 50-70 WITH PREHYPERTENSION:
A LITERATURE REVIEW

By
Nancy Jean Sullivan

A Master’s Project Submitted to the Faculty of the
COLLEGE OF NURSING
In Partial Fulfillment of the Requirements
For the Degree of
MASTER OF SCIENCE
In the Graduate College
THE UNIVERSITY OF ARIZONA

2009
STATEMENT BY AUTHOR

This master’s project has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this master’s project are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: ________________________________________

Nancy Jean Sullivan

APPROVAL BY MASTER’S PROJECT DIRECTOR

This Master’s Project has been approved on the date shown below:

Dr. Catherine Johnson, PhD, APRN-BC, FNP, PNP
Title: Clinical Associate Professor

Date:
ACKNOWLEDGMENTS

I am exceedingly grateful to Dr. Catherine Johnson for accepting the position of chair for my master’s report committee. Words are not enough to express my appreciation for her expertise, guidance, support, and encouragement throughout these last challenging semesters in my graduate career. I am so thankful to my other committee member, Dr. Donna Velasquez, for giving of her time and her expert insight and advice during the writing process. I am so appreciative of my academic advisor, Dr. Ted Rigney, for his expert advice, and unwavering support and encouragement as I endeavored to complete my graduate education.

I would like to thank Debbie Hanks, FNP for helping me crystallize my project focus and for her continued support and encouragement. I am very grateful to all my preceptors for giving of their time and expertise to prepare me for my future practice.
DEDICATION

This master’s report is dedicated to my family. To my late father, John, and my mother, Vida, my sister, Trisha, and her husband, Bruce, my brother, Dr. Mike, and all my nieces and nephews, I love you and thank you for your steadfast love, for your prayers of support and strength, and for cheering me on to run the graduate study race and become a family nurse practitioner.
## Table of Contents

List of Tables ...................................................................................................................................7

Abstract ............................................................................................................................................8

Chapter One .....................................................................................................................................9
  Statement of Problem .....................................................................................................................11
  Purpose ...........................................................................................................................................11
  Background ....................................................................................................................................12
    Epidemiology of Prehypertension ........................................................................................12
    Prehypertension ....................................................................................................................12
    Treatment Recommendations ...............................................................................................14
    Exercise and Hypertension Reduction ................................................................................15
      Exercise and Blood Pressure ...............................................................................................15
    Summary of Meta-analysis Examining Walking on Blood Pressure ......................................18
    Accumulated Walking on Blood Pressure .............................................................................19
    Walking and Cardiovascular Disease Reduction in Postmenopausal Women .....................21
  Summary ........................................................................................................................................23

Chapter Two...................................................................................................................................24
  Literature Search Method ..............................................................................................................24
  Data Evaluation ..............................................................................................................................25
  Data Analysis ................................................................................................................................25
  Presentation ....................................................................................................................................25
    Walking as an Intervention ................................................................................................... 25
    Impact of Walking on Dependent Variables .........................................................................27
      Blood Pressure and Heart Rate ............................................................................................27
      Energy Expenditure and Aerobic Capacity on Blood Pressure .........................................28
      Plasma Lipids and Body Mass Index ....................................................................................29
    Physiologic Measurements of Walking and Related Variables ............................................30
  Summary of Findings .....................................................................................................................32
    Walking as an Intervention ................................................................................................... 32
    Impact of Walking on Dependent Variables .........................................................................32
    Physiologic Measurements of Walking and Related Variables ............................................33
  Gaps in Literature ..........................................................................................................................33

Chapter Three.................................................................................................................................35
  Conclusions ....................................................................................................................................35
    Pattern of Walking on Blood Pressure Reduction .............................................................35
    Walking Dose for Prehypertension Treatment ....................................................................35
    Application for Postmenopausal Women with Prehypertension .........................................36
  Research Recommendations .....................................................................................................37
Table of Contents – *Continued*

Significance to Advanced Practice Nursing .................................................................38

Report Limitations ...........................................................................................................38

Appendix A: Relevant Studies ............................................................................................40

References ..........................................................................................................................46
List of Tables

TABLE 1: Classification of Blood Pressure for Adults ................................................13
TABLE 2: Lifestyle Modifications for the Primary Prevention and Management of Hypertension .................................................................15
Abstract

Hypertension is one of the most important risk factors in the development of cardiovascular diseases. Blood pressure values ranging from 130–139/85–89 mmHg once considered “normal” have been reclassified “prehypertensive” and are associated with a more than two-fold increase in relative risk for cardiovascular disease. In postmenopausal women with prehypertension, the reduction of hypertension risk is of significant importance considering one in every two women die of cardiovascular disease. The JNC-7 (2003) treatment recommendation for prehypertension is lifestyle modification, such as regular brisk walking 30 minutes per day most days of the week. This is a summary of the evidence in an integrative literature review format using a modified Cooper’s framework regarding accumulated walking and its effect on hypertension risk reduction in postmenopausal women age 50 – 70 with prehypertension.
Chapter One

Hypertension is one of the most important risk factors in the development of cardiovascular diseases such as: ischemic heart disease, congestive heart failure, stroke, and renal disease (JNC-7, 2003; Chobanian et al., 2003). According to Healthy People 2010, hypertension affects about 50 million people in the U.S. and it is increasing with age (Centers For Disease Control And Prevention (CDC) & National Institutes Of Health (NIH), 2000). For every 20 mmHg systolic or 10 mmHg diastolic increase in blood pressure, there is a doubling of mortality from both ischemic heart disease and stroke in individuals ranging from 40 to 89 years of age (Lewington, Clarke, Qizilbash, Peto, & Collins, 2002). Therefore, the higher the blood pressure, the greater the risk for heart attack, heart failure, stroke, and kidney disease.

More than half of people 60–69 years of age and approximately three-fourths of those 70 years of age and older have hypertension (Wang & Wang, 2004). In women, data from the National Health and Nutrition Examination Survey (NHANES) for 1999-2000 surveys of 2526 women indicated hypertension increased from 5% in 18 to 39 year olds to 70% in those 60 years or older (NCHS & CDC, 2000).

In 2006, cardiovascular diseases accounted for the highest percentage of mortality in the United States at 33% (CDC, 2009). In a study to quantify the global burden of disease related to high blood pressure, Lawes, Hoorn, and Rodgers (2008) determined about 7.6 million (13.5%) of all deaths worldwide were attributable to high blood pressure that is referred to a systolic blood pressure greater than 115 mm Hg. Hypertension is having a devastating impact on global health and greater emphasis should be directed towards risk reduction through the prevention and treatment of this modifiable cardiovascular risk factor.
The lifetime risk of hypertension is reported to be approximately 90 percent for men and women who were nonhypertensive at 55 or 65 years according to the Framingham Heart Study (Vasan et al., 2002). These are ominous statistics that reinforce the importance of hypertension risk reduction. The study also indicated that blood pressure values ranging from 130–139/85–89 mmHg are associated with a more than two-fold increase in relative risk from cardiovascular disease as compared with blood pressure levels below 120/80 mmHg (Vasan et al., 2001). Numerous other studies have indicated prehypertension is associated with an increase risk of having a major cardiovascular event and/or the development of cardiovascular disease (Vasan et al., 2001; Liszka, Mainous, King, Everett & Egan, 2005; Kshirsagar, Carpenter, Bang, Wyatt, & Colindres, 2006; Sipahi et al., 2006; Hsia et al., 2007).

In postmenopausal women with prehypertension, the reduction of hypertension risk is of significant importance. Cardiovascular disease is the number one killer of women in the U.S. (Sandmeier, 2007). One in every two women dies of cardiovascular disease. In 2004, there were 423,800 deaths from cardiovascular disease in women compared to 265,022 for all cancer types, and this includes breast cancer (Sandmeier, 2007). In women 40-60 yrs, the risk for cardiovascular disease rises. Women with prehypertension have increased risk of cardiovascular event, such as myocardial infarction, stroke, heart failure, and cardiovascular death, compared to normotensive women (Hsia et al., 2007). In a cohort study of the Women’s Health Initiative, Hsia et al. (2007) studied 60,758 postmenopausal women over 7.7 years. They found for every 1000 women with prehypertension, seven had first cardiovascular event per year compared to 14 with hypertension and 4 who were normotensive. These findings support early reduction in
blood pressure at the prehypertensive stage to reduce cardiovascular events in postmenopausal women.

Statement of Problem

The prevalence of prehypertension is a growing national and global health concern and is, therefore, a concern to health care providers. In women’s health, postmenopausal women with prehypertension are at significant risk for cardiovascular disease development and would benefit from early intervention. The health care industry is turning its focus on hypertension risk reduction through prevention and education, and key in the treatment of prehypertension is lifestyle modification, such as regular brisk walking at least 30 minutes per day most days of the week (JNC-7, 2003).

Purpose

This report will follow a modified Cooper’s framework for conducting an integrative literature review. This method begins with a well-defined problem and variables of interest the review is addressing followed by a clearly documented literature search process including search strategies, search terms, and databases used (Whittemore & Knafl, 2005). Data sources are evaluated based on the relevancy to the variables of interest and any inclusion and exclusion criteria. Data from the primary sources is extracted, divided into subgroups, compared, interpreted, and synthesized into the conclusion (Whittemore & Knafl).

The goal of the review will focus on literature regarding: (1) walking, either accumulated or continuous, and its effect on blood pressure reduction in postmenopausal women with prehypertension; (2) the minimum dose of walking needed to have a positive effect on blood pressure in postmenopausal women with prehypertension; and (3) how does this walking dose
compare to the JNC-7, 2003 guideline recommendations in the prevention and treatment of prehypertension with at least 30 minutes brisk walking daily most days of the week for lowering resting blood pressure in postmenopausal women with prehypertension.

Background

Epidemiology of Prehypertension

The prevalence of prehypertension in the U.S. is 31% (Wang & Wang, 2004). Among young adults, African Americans have the highest prevalence at 37.4% compared to whites and Mexican Americans, at 32.2% and 30.9% respectively. In adults aged 40-59 and 60 years and older, the pattern is reversed with a higher prevalence of prehypertension in whites and Mexican Americans than African Americans (Wang & Wang, 2004). According to the NHANES data, the prevalence of prehypertension in 2279 men to be 40% and in 2526 women to be 23% (NCHS & CDC, 2000). NHANES data also indicated only 66% of those surveyed were aware they had prehypertension or hypertension (NCHS & CDC, 2000). This means about one third of the individuals remain uninformed of their condition. Of those surveyed only 60% adopted lifestyle modifications or had taken prescriptions, and 31% had controlled their prehypertension or hypertension (NCHS & CDC, 2000). The NHANES results demonstrate that awareness does not always indicate control. These results clearly demonstrate a need for early detection, treatment, and patient education for prehypertensive and hypertensive individuals on the part of primary care providers.

Prehypertension

New data on lifetime risk of hypertension and the increase in the risk of cardiovascular complications associated with levels of blood pressure previously considered to be normal,
prompted the Joint National Committee On Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7) to introduce a new classification, “prehypertension”, for those with blood pressure ranging from 120–139 mmHg systolic and/or 80–89 mmHg diastolic (Table 1) (JNC-7, 2003; Chobanian et al., 2003). Prehypertension replaces the former categories of “high-normal”, “above-optimal”, and “borderline hypertension” (JNC-7; Chobanian et al., 2003; Svetkey, 2005).

Table 1 Classification of Blood Pressure for Adults

<table>
<thead>
<tr>
<th>Blood Pressure Classification</th>
<th>SBP mm Hg</th>
<th>DBP mm Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;120</td>
<td>and &lt;80</td>
</tr>
<tr>
<td>Prehypertension</td>
<td>120-139</td>
<td>or 80-89</td>
</tr>
<tr>
<td>Stage 1 Hypertension</td>
<td>140-159</td>
<td>or 90-99</td>
</tr>
<tr>
<td>Stage 2 Hypertension</td>
<td>&gt;160</td>
<td>or &gt;100</td>
</tr>
</tbody>
</table>

(Joint National Committee On Prevention, Detection, Evaluation, & And Treatment Of High Blood Pressure, JNC-7, 2003)

According to the JNC-7 (2003), prehypertension not considered a disease category. Its designation helps to identify those individuals in whom early intervention could reduce blood pressure, decrease the rate of progression of blood pressure to hypertensive levels, or prevent hypertension entirely.

A diagnosis of prehypertension is made when either a systolic blood pressure (SBP) of 120 to 139 mm Hg or a diastolic blood pressure (DBP) of 80 to 89 mm Hg is recorded on two or more properly measured seated auscultated blood pressure readings on each of two or more
office visits (Chobanian et al., 2003; Svetkey, 2005). If the SBP or the DBP fall into different categories, such as normal and prehypertensive, the category associated with the higher of the two pressures is applied to the diagnosis (JNC-7, 2003). For example, if an individual had an SBP of 117 and a DBP of 85 on two or more office visits, a diagnosis of prehypertension would be applied. Recommended follow-up for an individual diagnosed with prehypertension without compounding conditions and following recommended treatment is blood pressure recheck in one year (JNC-7, 2003). Considering adherence to treatment has been shown to be poor, a three-month follow-up would be warranted (Nesbitt, 2007).

Treatment Recommendations

The treatment recommendation for prehypertension without compounding conditions is early intervention and prevention through lifestyle modifications (JNC-7; Chobanian et al., 2003; Wexler & Aukerman, 2006; Svetkey, 2005). Recommended lifestyle modifications include weight reduction, Dietary Approaches to Stop Hypertension (DASH) eating plan, sodium intake reduction to 2.4 grams per day, regular aerobic physical activity such as brisk walking at least 30 minutes per day most days of the week, and only moderate alcohol consumption (See Table 2.) (JNC-7; Chobanian et al., 2003; Wexler & Aukerman, 2006; Svetkey, 2005).
Table 2. Lifestyle Modifications for the Primary Prevention and Management of Hypertension

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary sodium Reduction</td>
<td>Reduce dietary sodium intake to less than (2.4 g/d sodium)</td>
</tr>
<tr>
<td>Weight loss</td>
<td>Maintain healthy body weight: BMI* 18-25</td>
</tr>
<tr>
<td>Moderation of Alcohol</td>
<td>Limit alcohol consumption to &lt;2 drinks/d (1oz or 30 mL ethanol) in most men and no more than 1 drink/d in women and lightweight persons</td>
</tr>
<tr>
<td>Consumption</td>
<td></td>
</tr>
<tr>
<td>Physical activity</td>
<td>Engage in regular aerobic physical activity for at least 30 min/d, most days of week</td>
</tr>
<tr>
<td>Adopt DASH* Dietary plan</td>
<td>Consume a diet rich in fruits and veggies and low-fat dairy products with a reduced content of saturated and total fat</td>
</tr>
<tr>
<td>Dietary potassium Maintenance</td>
<td>Maintain adequate intake of potassium (3500 mg/d)</td>
</tr>
</tbody>
</table>

*BMI indicates body mass index; DASH, Dietary Approaches to Stop Hypertension (JNC-7, 2003)

Individuals with compounding conditions diagnosed with prehypertension would receive lifestyle modifications with drug intervention (JNC-7; Chobanian et al.; Wexler & Aukerman; Svetkey).

Exercise and Hypertension Reduction

*Exercise and Blood Pressure*

The lack of physical activity and exercise has been associated with an increased risk in high blood pressure and cardiovascular disease (JNC-7, 2003; Chobanian et al., 2003). In recent
decades, empirical and observational studies have demonstrated physical activity and exercise have been associated with reduction in blood pressure.

Whelton, Chin, Xin and He (2002) examined the effect of aerobic exercise on blood pressure. The meta-analysis included fifty-four randomized, controlled trials involving 2419 participants (hypertensive and normotensive) with mean ages ranging from 21 to 79 years from a wide range of geographic regions and ethnic populations. The intervention and control groups differed in aerobic exercise only. The researchers found that aerobic exercise was associated with a significant reduction in mean SBP and DBP of 3.84 mm Hg and 2.58 mm Hg respectively. In subgroup analysis, hypertensive participants had a mean SBP and DBP reduction of 4.94 mm Hg and 3.73 mm Hg while normotensive participants had a mean SBP and DBP reduction of 4.04 mm Hg and 2.33 mm Hg. Among the three ethnic groups represented, black participants had significantly greater reductions in SBP than Asian or white participants, and Asian participants had greater reductions in DBP than black or white participants (Whelton et al.).

Limitations of the subgroup analysis include the lack of differentiation between men and women, age groups, and geographic regions. Despite its limitations, the study results support the use of aerobic exercise as an important strategy for blood pressure reduction in the prevention and treatment of prehypertension and hypertension.

In a position stand from the American College of Sports Medicine (Pescatello et al., 2004) on exercise and hypertension, the pronouncement presented a categorized evidence-based review of what is currently known regarding exercise and hypertension with a focus on the blood pressure benefits from exercise and exercise recommendations. Evidence statements on exercise blood pressure benefits that ranked the highest include the following: aerobic training reduces
resting blood pressure in normotensive and hypertensive individuals, blood pressure reduction with aerobic-based activity is more pronounced and prolonged in hypertensive individuals, and regular endurance exercise, such as walking, jogging, running, or cycling, reduces blood pressure in older adults as it does in younger adults (Pescatello et al.). Evidence statements on exercise recommendations that ranked the highest include: individuals with high blood pressure should follow an exercise program that is aerobic-based, and resistance training can be an adjunct to an aerobic-based exercise (Pescatello et al.). The conclusions of this position paper are consistent with the previous findings discussed that aerobic exercise is effective therapy for the prevention, treatment, and control of prehypertension and hypertension.

In a systematic review and meta-analysis by Dickinson et al. (2006), the researchers wanted to quantify effectiveness of lifestyle interventions in patients with raised blood pressure. They categorized 105 randomized, controlled trials by type of intervention involving 6805 adult participants with a mean age of 50 years, 61% male, 58% white, and a mean blood pressure of 147/92 mm Hg that were a minimum of eight weeks duration. Of the ten-lifestyle interventions reviewed, the most robust statistically significant effects on blood pressure reduction were in the area of improved diet, aerobic exercise, alcohol and sodium restriction, and fish oil supplements with mean reduction in SBP of 5.0 mm Hg, 4.6 mm Hg, 3.8 mm Hg, 3.6 mm Hg, and 2.3 mm Hg, respectively (Dickinson et al., 2006). Limitations of the study included lack of equivalent data on women, various age groups, ethnic groups, cardiovascular risk factors, and use of English language studies only. Considering its limitations, the study findings support the recommended treatment of lifestyle modification in blood pressure reduction and the prevention and treatment of prehypertension and hypertension.
Summary of Meta-analysis Examining Walking on Blood Pressure

Walking is the most popular type of physical activity reported in the United States with approximately 39.4% of active men and 44.1% active women ages 18 or older reported participation in walking (U.S. Department of Health and Human Services, 1999). Among adults aged 45 – 74, walking has increased popularity ranging from 43.3-50.1% from both men and women. Brisk walking for lowering resting blood pressure is recommended by the JNC-7 in the prevention and treatment of prehypertension and hypertension (JNC-7, 2003). Over the past decades, studies have been conducted to examine the effects of walking on resting blood pressure in adults.

Kelley, Kelley and Tran (2001) conducted a meta-analysis of 11 randomized and 5 nonrandomized controlled trials in which walking was the only intervention used to examine the effects on resting systolic and diastolic blood pressure in adults. Study participants totaled 650, mostly sedentary, with approximately 38% men and 62% women represented, aged 48 to 68 years. Participants included normotensive, above normal (prehypertensive), and hypertensive individuals from six geographic regions worldwide. The overall results indicate walking exercise reduces resting SBP by 3 mm Hg and resting DBP by 2 mm Hg with a slightly larger decrease in hypertensive participant’s SBP of 5 mm Hg and DBP of 3 mm Hg and that these changes are independent of changes in body composition (Kelley et al.). An interesting finding of the analysis, though not a primary focus of the study was that walking can increase maximum oxygen consumption and decrease resting heart rate. No direct correlation between maximum oxygen consumption and blood pressure reduction or resting heart rate and blood pressure reduction were noted (Kelley et al.).
The study by Kelley and colleagues (2001) did not include the evaluation of the JNC-7 recommendation on 30 minutes of brisk walking most days of the week for blood pressure reduction. There are potential limitations to the study analysis since the studies were not entirely randomized and controlled and that incomplete reported data allowed for only single regression analysis. Some studies lacked information on race, alcohol consumption, diet, cigarette smoking, and use of antihypertensive medications. There was no subgroup analysis of data pertaining to sex, age, or ethnicity. Only about one third of the studies provided information on compliance with number of exercise sessions attended. Inclusion of this information allows for better judgment of study validity and applicability of its results.

In the final analysis, the modest blood pressure reductions observed in the study findings. Due to the popularity of walking among adults and the health benefits of lowered blood pressure, it would be logical to suggest a continued emphasis on walking and encourage more adult participation in this activity.

*Accumulated Walking on Blood Pressure*

One of the barriers frequently cited in meeting the JNC-7 recommendation of 30 minutes of aerobic activity, such as brisk walking most days of the week, is the lack of time. The benefits of reducing resting blood pressure with aerobic activity, such as walking, have been established. Recent studies examined whether the same health benefits are retained when a single continuous bout of exercise, like walking, is divided into shorter bouts of exercise accumulated over the entire day.

In a systematic review of empirical studies, Murphy, Blair and Murtagh (2009) compared the effects of accumulated versus continuous physical activity on a range of health outcomes,
such as fitness (maximum oxygen consumption), body mass, adiposity, blood pressure, blood lipids, and psychological outcomes (mood, well-being). Inclusion criteria focused on studies where the primary intervention was continuous compared to two or more accumulated bouts of exercise with at least one health outcome measured pre- and post intervention (Murphy et al.).

The researchers looked at 16 long-term training studies with interventions lasting a minimum of 4 to 20 weeks’ duration and 7 short-term training studies whose interventions only lasted 48 hours. Only the long-term studies contained data on blood pressure reduction and this is where the analysis will focus. Of the 16 long-term training studies, walking was the primary intervention exercise used in 12 of the studies. Subject participants totaled 836 with 75.3% women ranging in age from 18 to 71 years, and none of the subjects met the current physical activity guidelines of 30 minutes of physical activity, such as brisk walking, daily at the start of the study. The interventions involved total daily exercise durations of 20 to 40 minutes on 3-5 days per week with exercise intensity ranging from 50 to 80% maximum oxygen uptake (Murphy et al.). Accumulated exercise was prescribed in 2, 3, or 4 bouts of 10 to 15 minutes with at least 2 hours separation between exercise bouts.

Six of the studies measured resting SBP and DBP before and after the exercise interventions, and all of them used walking as the primary intervention exercise. Study participants totaled 230 with 81% women ranging in age from 18 to 58 years containing both normotensive and hypertensive individuals. Five of the studies reported statistically significant blood pressure reduction pre-post intervention but observed no differences between the two patterns of exercise, accumulated or single continuous (Murphy et al.). The five studies lasted, on average, 12 weeks and involved total daily exercise durations of 30 minutes, 5 days a week.
with a maximum heart rate of 70-80%, comparing one continuous bout of walking to either 2 – 15 minute bouts or 3 – 10 minute bouts of walking. The single study that did not report significant blood pressure reduction lasted 12 weeks and involved a total daily exercise duration of 20 minutes walking, 3 days a week with a maximum heart rate approximately 73%, comparing one 20 minute bout of walking to 2 – 10 minute bouts of walking (Murphy et al.). Interestingly, none of the health outcomes measured in this one study reported any significant difference pre-post intervention. These findings indicate 20 minutes of walking 3 days a week is not sufficient in changing health outcomes to effect a health benefit.

Limiting the review analysis was the low subject numbers (< 60 subjects per intervention group), and the study subjects were predominantly middle-aged women with relatively low levels of cardiovascular fitness, so it is difficult to apply these conclusions for males or females with average or above-average fitness levels. There is incomplete information on ethnic minorities or older people in the study subjects that makes application of the conclusions difficult.

The study findings regarding blood pressure reduction with accumulated or continuous walking totaling 30 minutes daily, 5 days a week supports the JNC-7 recommendation for the prevention and treatment of prehypertension and hypertension. Individuals can perform shorter bouts of walking throughout the day and still gain health benefits such as blood pressure reduction.

Walking and Cardiovascular Disease Reduction in Postmenopausal Women

Walking is the most popular type of physical activity in women age 45 to 74 with 50.1% of women reporting they participate in walking (U.S. Department of Health and Human Services,
1999). As stated in previous finding discussed, physical activity has been associated with cardiovascular risk reduction. Yet, there is a lack of data for women, in general, and for women in minority and/or ethnic groups regarding cardiovascular risk reduction associated with physical activity either through walking or vigorous exercise.

In a systematic review by Asikainen, Kukkonen-Harjula, and Miilunpalo (2004), the researchers evaluated exercise-training studies that referenced improving health-related fitness in early postmenopausal women aged 50 – 65 years. There were nine fitness components with corresponding outcome measure examined, but for this paper, we will look at the cardiovascular fitness component and blood pressure outcome measure. A total of 26 randomized controlled studies were analyzed from European nations and the United States in the entire review with 7 studies focused on cardiovascular fitness with blood pressure as its outcome measure. In these 7 studies, 976 normotensive and hypertensive women participated for 12 – 15 weeks of exercise training with a pre-post intervention evaluation of resting blood pressure (Asikainen et al.). All 7 studies used walking as their primary exercise training, though its intensity, duration, or whether it was continuous or accumulated varied between studies. In the studies, participants walked 30 minutes, either continuous or accumulated, 5 days a week, at a minimum of 65% maximal oxygen uptake to observe SBP and DBP reductions (Asikainen et al.). The studies with less than 5 days of exercise training or less than 65% maximal oxygen uptake found blood pressure reductions were not statistically significant. In studies with hypertensive subjects, a larger blood pressure reduction was observed compared to the normotensive subjects. There are acknowledged limitations with the small study numbers and researchers recommended more
studies are needed to evaluate the effects of exercise on early postmenopausal women with hypertension.

The results of this study are consistent with the previously mentioned study and the JNC-7 recommendation that moderate-intensity walking 30 minutes daily, most days of the week reduces resting blood pressure can be beneficial in postmenopausal women.

Summary

Prehypertension and hypertension are associated with an increased risk for cardiovascular events and disease. Both pose a serious health problem in the United States and around the world. In women’s health, especially postmenopausal women, the health risks from prehypertension and hypertension are significant since cardiovascular disease is the number one killer of women.

Since the new JNC-7 designation for prehypertension has broadened the target population for hypertensive risk reduction, the control of prehypertension and hypertension has, unfortunately, remained poor. The recommended treatment guidelines have included lifestyle modifications, like regular aerobic activity, such as brisk walking, 30 minutes daily most days of the week (JNC-7, 2003). Walking continues to be one of the most popular physical activities among U.S. adults, but lack of time has been given as one reason for being unable to attain 30 minutes of brisk walking daily. Recent literature findings have established similar health benefits for single continuous or accumulated aerobic activity, such as walking, for reduction of blood pressure and cardiovascular risk in adults.
Chapter Two

Literature Search Method

In accordance with Cooper’s Framework for an integrative literature review, the literature is focused on walking and its effect on hypertension risk reduction in postmenopausal women age 50 – 70 with prehypertension. The literature search process should be “clearly documented in the method section including the search terms, the databases used, additional search strategies, and the inclusion and exclusion criteria for determining relevant primary sources (Whittemore & Knafl, 2005, p. 549).

A search of the literature was conducted using electronic databases including MEDLINE (PubMed), CINAHL (EBSCO) and EBM (Evidence-Based Medicine). The search was limited to full text, English studies on human subjects from 2000 to 2009. The limitation for “full text” was used to eliminate any incomplete articles so only articles available in full were reviewed. The limitation “English studies” was applied due to the language limitations of the reviewer, and the limitation for “human subjects” was used to ensure only studies involving human subjects was collected. The terms used in the search were “women”, “postmenopausal women”, “prehypertension”, “borderline hypertension”, “above normal blood pressure”, “walking”, and “accumulated”. Combinations of terms were used during the searches, such as “postmenopausal women and either prehypertension, above normal blood pressure, or borderline hypertension”, “women and either prehypertension, above normal blood pressure, or borderline hypertension”, “postmenopausal women and walking”, “prehypertension and walking”, and “walking and accumulated”. The search generated a total of 208 results. The limitations of 2000 to 2009, full
text, English, and human subjects were applied and narrowed the result down to 56 complete articles to be reviewed.

Data Evaluation

Evaluation of the abstracts or introductions for the 56 articles generated in the electronic database search was conducted based on its relevancy to the subject matter of this report. Relevant information included two or more of the following terms: postmenopausal women, women, prehypertension, walking, exercise, and accumulated walking or steps. From the 56 articles generated, 11 articles were relevant to this report. The research articles included experimental, correlational, and prospective studies (See Appendix A).

Data Analysis

Following Cooper’s framework, data from primary sources were extracted for comparison and divided into subgroups, patterns, themes, and relationships. The subgroups identified from the data are ‘walking as an intervention’, ‘impact of walking on dependent variables’, and ‘physiologic measurement of walking and related variables’. The extracted data was displayed via chart for easy cross comparison of patterns and relationships (See Appendix A). Data is compared, interpreted, and synthesized for each subgroup and integrated into the conclusion (Whittemore & Knafl, 2005).

Presentation

Walking as an Intervention

Walking was listed as an intervention in eight out of the 11 research studies. In the other three studies listing physical activity as the intervention (Church, Earnest, Skinner & Blair, 2007;
Kokkinos et al., 2006; Padilla, Wallace & Park, 2005), walking was implied in the global term of “physical activity”, but not measured separately from other forms of physical activity.

In the previously mentioned eight studies, the interventions included only accumulated walking (Manson et al., 2002; Moreau et al., 2001; Park, Rink & Wallace, 2008), only continuous walking (Seals et al., 2001), or accumulated versus single continuous walking (Murtagh, Boreham, Nevill, Hare, & Murphy, 2005; Nemoto, Gen-No, Masuki, Okazaki, & Nose, 2007; Park, Rink, & Wallace, 2006; Quinn, Klooster, & Kenefick, 2006).

Most of the walking studies reviewed provided positive support for blood pressure reduction. Walking a minimum of 30 minutes daily, either accumulated or continuous, for at least 5 days a week was shown in seven of the 8 studies to benefit blood pressure (Manson et al., 2002; Moreau et al., 2001; Nemoto et al., 2007; Park et al., 2006; Park et al., 2008; Quinn et al., 2006; Seals et al., 2001). In Murtagh et al. (2005), study results showed that continuous or accumulated walking for 20 minutes 3 days a week had no improvement on blood pressure.

In the three studies where walking was included in the global variable of physical activity, all of the studies provided positive support for blood pressure reduction (Church et al., 2007; Kokkinos et al., 2006; Padilla et al., 2005).

Study samples included men and women, age 45-79 years old, with 80% of the studies indicating blood pressure in the prehypertensive range. A majority of sample sizes were small, except for Manson et al. (2002) who studied 73,743 postmenopausal women enrolled in the Women’s Health Initiative Observational Study, Kokkinos et al. (2006) who examined 407 men and 243 women, and Church et al. (2007) who studied 464 postmenopausal women.
Forty-five percent of the studies used treadmills and exercise was monitored under laboratory conditions. The studies reviewed were varied and generally provided support for blood pressure reduction without preference to single continuous or accumulated walking pattern.

In summary, walking and/or physical activity either accumulated or continuous seems to provide support for blood pressure reduction in adults with prehypertension, including postmenopausal women. Walking and/or physical activity of at least 30 minutes daily either accumulated or continuous for 5 days a week has shown a benefit in blood pressure reduction. Though most of the study sample sizes were small, twenty-seven percent of the study samples were robust and included a majority of postmenopausal women. Forty-five of the studies monitored exercise under laboratory conditions.

Impact of Walking on Dependent Variables

Blood Pressure and Heart Rate

Of the studies that investigated the relationship of walking, accumulated or continuous, to blood pressure, six studies showed an inverse relationship (Moreau et al., 2001; Nemoto et al., 2007; Padilla et al., 2005; Park et al., 2006; Park et al., 2008; Quinn et al., 2006). Each of these studies involved walking at least 30 minutes daily most days of the week. The Murtagh et al., 2005 study showed no relationship to blood pressure and was the only study to investigate walking less than 30 minutes daily 3 days a week. The study by Seals et al. (2001) comparing the effect of daily walking versus dietary sodium restriction on blood pressure, both showed an inverse relationship, but sodium restriction was significantly greater than daily walking in blood pressure reduction. All three studies examining the relationship of physical activity, either
accumulated or continuous, to blood pressure showed an inverse relationship to blood pressure and involved a minimum of 30 minutes of physical activity most days of the week (Church et al., 2007; Kokkinos et al., 2006; Padilla et al., 2005).

Each of the seven studies that evaluated the relationship of pulse rate to walking found a decrease in heart rate with either single continuous or accumulated walking (Moreau et al., 2001; Nemoto et al., 2007; Padilla et al., 2005; Park et al., 2006; Park et al., 2008; Quinn et al., 2006). One of the three studies on physical activity examined its relationship to pulse rate and found a decrease in heart rate with physical activity (Church et al., 2007).

To summarize, walking and/or physical activity, either accumulated or continuous, shown to lower blood pressure in adults, including postmenopausal women. The data showed a minimum of 30 minutes daily walking and/or physical activity most days of the week was needed to reduce blood pressure. Limited data from a study (Seals et al., 2001) comparing daily walking to sodium restriction on blood pressure noted both had an inverse relationship to blood pressure, but sodium restriction was significantly greater in postmenopausal women. Heart rate decreased in adults and postmenopausal women with either accumulated or continuous walking and/or physical activity.

Energy Expenditure and Aerobic Capacity on Blood Pressure

In two of the physical activity studies investigating the relationship of energy expenditure and blood pressure, an inverse relation was found between systolic blood pressure (SBP) and energy expenditure with physical activity in the Church et al., 2007 study, but no relation was found between energy expenditure and blood pressure in the Padilla et al. (2005) study. In two of the walking studies examining the relationship of energy expenditure to blood pressure,
neither of the studies found a relation between energy expenditure and blood pressure (Park et al., 2006 & 2008). The study by Manson et al. (2002) comparing the relationship of energy expenditure with walking to energy expenditure with vigorous exercise in terms of cardiovascular events found an inverse relation with energy expenditure and cardiovascular events with both, walking and vigorous exercise, in postmenopausal women. The data sample is large and, therefore, significant. Nemoto et al. (2007) and Quinn et al. (2006) found an inverse relation between aerobic capacity and blood pressure with high-intensity interval walking.

In summary, the relationship between energy expenditure and blood pressure during walking and/or physical activity is inconsistent in adults and postmenopausal women. Not enough data was found in the literature reviewed to establish a relationship either positively or negatively. There is an inverse relationship found between energy expenditure and cardiovascular events with walking and/or vigorous exercise in postmenopausal women. Increased energy expenditure with walking and/or vigorous exercise lowers cardiovascular events in postmenopausal women. This finding is significant considering the data from this study is so robust. For aerobic capacity and blood pressure, the limited data shows increased aerobic capacity with high-intensity interval walking lowers blood pressure in adults and postmenopausal women.

*Plasma Lipids and Body Mass Index*

Some of the studies used other cardiac risk factors besides blood pressure and heart rate as dependent variables. The most common have been lipid levels and body mass index (BMI). Two of the 8 walking intervention studies addressed the effects of walking on total cholesterol (TC), high-density lipoproteins (HDL), low-density lipoproteins (LDL), or triglycerides (TG)
levels. Neither of the studies demonstrated any improvement in lipid levels with walking (Murtagh et al., 2005; Seals et al., 2001). One of the three physical activity studies examined the effects of physical activity on TC, HDL, LDL, and TG levels and found no improvement in the lipid levels with physical activity (Church et al., 2007).

Of the two studies investigating the effects of walking on BMI, no significant difference was observed (Murtagh et al., 2005; Seals et al., 2001). In the case of Church et al., 2007 comparing physical activity to BMI, no significant difference was noted. Reasons for the lack of beneficial effect of either walking or physical activity on plasma lipids or BMI could be due to duration of intervention, lack of control for dietary factors, and cross-sectional research designs.

In summary, some studies using other cardiac risk factors besides blood pressure and heart rate as dependent variables, such as plasma lipids and body mass index (BMI), found no improvement in plasma lipids or BMI with either walking and/or physical activity in adults and postmenopausal women. Lack of beneficial effect could be due to the duration of the intervention is too short to note a change, the use of cross-sectional research design, or lack of controlling extraneous variables, such as dietary factors.

Physiologic Measurement of Walking and Related Variables

There were two studies that attempted to quantify walking using physiologic measures. Church et al. (2007) and Moreau et al. (2001) measured accumulated walking in their study participants using a Yamax Digi-Walker SW-200 pedometer. The digital pedometer is attached daily, from waking to bedtime, to waistband or belt in alignment with the right mid-thigh. Study participants recorded total accumulated steps at the end of each day. The Yamax Digi-Walker SW-200 has been shown to be accurate and reliable (Schneider, Crouter, Lukajic & Bassett,
Nemoto et al. (2007) study used pedometers in both of their walking groups, but in the moderate-intensity continuous walking group, it was used to measure exercise intensity. There is not enough data in the literature reviewed to determine its accuracy for exercise intensity.

Nemoto et al. (2007), Padilla et al. (2005), and Park et al. (2006) measured energy expenditure during walking using a RT3 accelerometer. The instrument is worn at the waist on the hip at the anterior axillary line of the dominant leg and measures motion as acceleration of the body. Information obtained is used to calculate kilocalories expended. The RT3 accelerometer has been shown to be accurate and reliable in quantifying energy expenditure (Rowlands, Thomas, Estonq & Topping, 2004). The Nemoto et al. study used accelerometers and pedometers to quantify walking in one of their three study groups, the high-intensity interval-walking group. There is not enough data in the literature reviewed to determine what affect both instruments had on the actual amount of walking by the participants.

There were four studies that quantified 24-hour blood pressure using physiologic measures. Kokkinos et al. (2006), Padilla et al. (2005), and Park et al. (2006 & 2008) measured arterial blood pressure for 24 hours using a noninvasive Accutraker II ambulatory monitor. The monitor is placed on the nondominant arm and was programmed to take measurements every 15 minutes for daytime hours (0600 to 2200) and every 30 minutes for nighttime hours (2200 to 0600). Readings were downloaded to a computer for analysis. Though the data is limited, 24 hour ambulatory monitoring showed reduction in blood pressure over a 24-hour period was greater with increased physical activity, like walking.
In summary, the physiologic measurement of walking and related variables varied between studies. Two studies attempted to quantify walking using the Yamax Digi-Walker SW 200 pedometer. This pedometer has shown to be accurate and reliable for quantitative walking, though data is lacking on its accuracy for exercise intensity. Three studies measured energy expenditure during walking with the RT3 accelerometer. This accelerometer has shown to be accurate and reliable in quantifying energy expenditure. Four studies quantified 24-hour arterial blood pressure using the Accutraker II ambulatory monitor. Limited data showed greater blood pressure reduction over a 24-hour period with increased walking and/or physical activity. Forty percent of the instruments used relied on some form of self-report measures for data collection. It is unclear whether there was similarity between self-report of walking and/or physical activity and actual walking and/or physical activity in those studies.

Summary of Findings

Walking as an Intervention

Walking and/or physical activity either accumulated or continuous for a minimum of 30 minutes daily 5 days a week or more has a positive effect on blood pressure reduction and resting heart rate in adults with prehypertension, including postmenopausal women. In 24-hour arterial blood pressure analysis, limited data shows the blood pressure lowering effect appears to last longer over a 24-hour period with increased walking and/or physical activity.

Impact of Walking on Dependent Variables

The effect of walking and/or physical activity on other dependent variables besides blood pressure and heart rate in adults and postmenopausal women vary. Though the relationship of energy expenditure to blood pressure during walking and/or physical activity is inconsistent,
there is a definite inverse relationship of energy expenditure and cardiovascular events with walking and/or vigorous exercise found with postmenopausal women. There is limited data showing an inverse relation between aerobic capacity and blood pressure with high-intensity interval walking. Plasma lipids and BMI showed no significant improvement with either walking or physical activity and could have been limited by the study design.

Physiologic Measurement of Walking and Related Variables

The physiologic measurement of walking and related variables varied between studies. Studies measuring quantitative walking found reliable and accurate measure with the Yamax Digi-Walker SW 200 pedometer. Those studies measuring energy expenditure with walking and/or physical activity found reliable and accurate measure with the RT3 accelerometer. Studies measuring 24-hour arterial blood pressure found accurate and reliable measure using the Accutraker II ambulatory monitor. Forty percent of the instruments used relied on some form of self-report measures for data collection and it is unclear the similarity of data between self-report walking and/or physical activity and actual walking and/or physical activity in the studies.

Gaps in the Literature

Of the eleven studies reviewed, only three tested the JNC-7 guidelines recommendation of at least 30 minutes brisk walking and/or physical activity daily most days of the week (Church et al., 2007; Moreau et al., 2001; Quinn et al., 2006). Though all three studies involved incorporated women between the age 50-70, only Church et al. and Moreau et al. specified postmenopausal women. All three studies included baseline blood pressures in the prehypertensive range, though none them were specifically designed to test the JNC-7 guideline recommendations on postmenopausal women with prehypertension. The remaining eight studies
reviewed either referred to the JNC-7 guideline recommendations in their introduction and/or their discussion section of their study, but did not actually test the recommendations in their intervention design.

Of the eleven studies reviewed, only the Church et al. (2007) and Manson et al. (2002) listed a multi-ethnic sample of postmenopausal women. Though Manson et al. had a robust sample; the researchers did not test the JNC-7 guideline recommendations as it applies to postmenopausal women.
Chapter Three

Conclusions

Pattern of Walking on Blood Pressure Reduction

The studies reviewed incorporated accumulated and/or continuous walking and/or physical activity as interventions. Based on the data presented, there seems to be support that either accumulated or continuous walking and/or physical activity have a positive effect on blood pressure reduction in adults and specifically, postmenopausal women with prehypertension. The studies reviewed showed 2, 3, or 4 accumulated bouts of walking and/or physical activity had the same effect on blood pressure reduction as performing single continuous walking and/or physical activity. In the case of accumulated walking, individuals with prehypertension could perform shorter bouts of walking throughout the day and still benefit from blood pressure reduction.

A variety of valid and reliable methods to measure walking and/or physical activity were used in the studies reviewed and their different measures made it somewhat difficult to standardize what was considered to be sedentary, mild, moderate, and vigorous walking and/or physical activity. Only forty percent of the reviewed studies conducted the walking/physical activity interventions under controlled conditions. It is unclear whether there was similarity between the actual walking and/or physical activity data of these studies and those using self-report of walking and/or physical activity data.

Walking Dose for Prehypertension Treatment

There appears to be positive support from the studies reviewed for a dose-related response of a minimum of 30 minutes brisk walking or moderate-intensity physical activity, either accumulated or continuous, most days of the week for blood pressure reduction in adults and
postmenopausal women with prehypertension. These findings would seem to support the JNC-7 2003 guideline recommendations in the prevention and treatment of prehypertension through lifestyle modifications, including at least 30 minutes brisk walking and/or physical activity daily most days of the week for lowering resting blood pressure. Unfortunately, less than thirty percent of the studies reviewed actually tested the JNC-7 guideline recommendations in their intervention design. These studies only implied the prehypertensive blood pressure range but did not specifically state it in their design description. Intervventional studies testing the JNC-7 guideline recommendations on populations of prehypertensive adults and postmenopausal women are still lacking.

Application for Postmenopausal Women with Prehypertension

For postmenopausal women with prehypertension, the reviewed studies seem to support either accumulated or continuous walking and/or physical activity having a positive effect on blood pressure reduction. Yet, there is little research exploring the differences and patterns of walking and/or physical activity among multi-cultural and racial groups of postmenopausal women. There seems to be positive support for the application of the JNC-7 guideline recommendations in the prevention and treatment of prehypertension in postmenopausal women through lifestyle modifications including a minimum of 30 minutes brisk walking and/or physical activity daily most days of the week for blood pressure reduction. Unfortunately, it is unclear whether this is effective in all ethnic cultures and races of prehypertensive postmenopausal women.

Most of the walking/physical activity intervention studies reviewed included postmenopausal women age 50 – 70 in their study sample, but only twenty-seven percent of
them specified postmenopausal women in their study design. A majority of the intervention studies reviewed contained small sample sizes and threatens their ability to generalize results to the broader population of postmenopausal women.

Some of the studies reviewed examined the relationship between walking and/or physical activity and other cardiovascular risk factors besides blood pressure and heart rate in postmenopausal women with prehypertension. The results are inconclusive. Yet, there is robust evidence from the study by Manson et al., 2002 that brisk walking and/or vigorous exercise is associated with cardiovascular event reduction in multi-ethnic and racial groups of postmenopausal women.

Research Recommendations

Based on the studies reviewed, there is need for larger, longitudinal clinical trials that are well defined and well controlled to evaluate the effectiveness of walking, accumulated and continuous, and other lifestyle modifications, such as sodium restriction and DASH diet on blood pressure reduction in prehypertensive postmenopausal women across ethnic cultures and races. There is a need for qualitative studies related to walking and/or physical activity in diverse populations of postmenopausal women in order to understand the norms and values of the different cultures to promote positive lifestyle changes. It would be beneficial to understand the relationship of walking and/or physical activity and other cardiovascular risk factors in postmenopausal women with prehypertension through larger and longer clinical trials to measure the effectiveness of walking, accumulated and continuous, for cardiovascular risk reduction.
Significance to Advanced Practice Nursing

Advanced practice nurses have proven their effectiveness in disease management and prevention in helping to better hypertension control (JNC-7). These same skills can be applied to the management of prehypertension. Advance practice nurses are trained in direct clinical practice and the art of expert coaching and guiding to address the emerging public health significance of prehypertension. The current treatment guidelines for prehypertension management are lifestyle modifications. Implementing lifestyle modifications involves public health education and clinical strategies to which the advance practice nurse is uniquely suited. In the primary care setting, nurse practitioners follow a holistic approach to health and wellness promotion and disease prevention and management by establishing clinician-client partnerships collaborating with clients in forming their health goals. The nurse practitioner can assess for understanding of prehypertension and the risk for cardiovascular disease development, provide education of the condition and lifestyle modifications, and assess for challenges and barriers to successful treatment. By incorporating their cultural beliefs, nurse practitioners individualize management strategies to empower clients to adhere to intervention therapies and achieve their goals.

Report Limitations

Though this report followed Cooper’s Framework for integrative literature review, only one of the literature search methods, computerized database search, was applied to this report. Multiple literature search methods, such as ancestry searching, journal hand searching, networking, and searching research registries are incorporated in the usual Cooper’s Framework (Whittemore & Knafl, 2005). Accepting only full text articles from the computerized database
search has also limited this review. Articles may be mislabeled by the computerized database and through hand searching, the full text article may be found. Therefore, the lack of diversity in search methods have biased this report since there may be many studies in existence relevant to the subject matter that have not been reviewed.
Appendix A

Relevant Studies
### Relevant Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose</th>
<th>Method</th>
<th>Intervention</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Church et al., 2007</td>
<td>To examine the effect of 50%, 100%, and 150% of the recommended physical activity recommendation on cardiovascular fitness in sedentary, overweight or obese postmenopausal women with elevated blood pressure.</td>
<td>Prospective study of the randomized, controlled exercise DREW (dose-response to exercise in postmenopausal women) trial; multi-racial sample; analysis with Tukey test, multiple regression of BP, HR, BMI, waist circum., body fat, VO2, lipids</td>
<td>464 postmenopausal women, age 45-75, sedentary, BP range from 120-159.9 mm Hg; control group and 3 exercise groups expending 4, 8, or 12 kcal/kg per week; 3-4 training session each week for 6 months; used treadmill walking or cycle ergometers</td>
<td>12 kcal group had greatest increased VO2, reduced waist circum., reduced HR, and decreased SBP compared to other groups. No change in BMI, body fat, lipids in any of the groups. 12 kcal group similar to 30 min brisk walking daily.</td>
</tr>
<tr>
<td>Kokkinos et al., 2006</td>
<td>Assess relationship between fitness and 24-hr ambulatory BP in prehypertensive men and women.</td>
<td>Cross-sectional, non-randomized, no control, comparison at baseline; used multiple regression analysis of 24-hr BP at 20 min intervals</td>
<td>407 men (age 51 +/- 11 yrs) and 243 women (age 54 +/- 10 yrs) with resting BP in prehypertensive range placed in fitness category (low, moderate, high) per exercise time and age; kept log of activity</td>
<td>Fitness status inversely associated with ambulatory BP in both men and women. Lowest fitness had significantly higher 24-hr BP, day and night. Moderate physical activity promotes lower BP in 24-hr period in prehypertensive men and women.</td>
</tr>
<tr>
<td>Manson et al., 2002</td>
<td>Role of walking compared to vigorous exercise in cardiovascular disease in postmenopausal women</td>
<td>Prospective cohort study from Women’s Health Initiative Observational Study; postmenopausal women, multi-ethnic sample; analysis of MET score for each type of physical activity</td>
<td>73,743 women age 50-79 yrs completed detailed questionnaires about physical activity; given MET for walking and for exercise; 5.9 yr follow up</td>
<td>Cardiovascular events inversely associated with energy expenditure. Walking briskly and vigorous exercise associated with reduced cardiovascular events</td>
</tr>
</tbody>
</table>

**MET**—metabolic equivalent score  
**BP**—blood pressure  
**VO2**—maximal oxygen uptake  
**BMI**—body mass index  
**HR**—heart rate  
**SBP**—systolic blood pressure  
**DBP**—diastolic blood pressure
<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose</th>
<th>Method</th>
<th>Intervention</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moreau et. al., 2001</td>
<td>Test 30 minutes of walking every day would lower BP in postmenopausal women with high BP</td>
<td>Randomized controlled; pre-post intervention BP, Body fat, HR, Insulin levels, and Glucose at 12 wks and 24 wks.</td>
<td>24 women age 54 yrs with SBP of 130-159 and DBP of 85-99; used pedometers to measure accumulated steps; with EX group walking 4300 more steps/day than CON group; kept daily log of steps.</td>
<td>Resting SBP reduced in EX group by 5 – 11 mm Hg; no change in DBP, body fat, insulin, or glucose. Walking briskly 30 min daily lowers BP in postmenopausal women with high BP.</td>
</tr>
<tr>
<td>Murtagh et. al., 2005</td>
<td>Test effect of 20 minutes, of walking, continuous or accumulated, 3 days a week on fitness and cardiovascular disease risk</td>
<td>Randomized, controlled; conducted in Ireland; two-way ANOVA analysis of VO₂, BMI, waist-hip measurements, BP, HR, lipid panel pre-post intervention for 12 wks.</td>
<td>17 men and 31 women age 45.7 +/- 9 yrs with resting BP &lt; 140/90 mm Hg and BMI &gt; 30 kg/m²; no training group, 20 min continuous brisk walk 3 days a week, or 2 bouts of 10 min brisk walks 3 days a week; done on treadmills</td>
<td>All outcome measures showed no significant difference, except HR. Neither 20 mins brisk walking, continuous or accumulated, 3 days a week improved cardiovascular risk.</td>
</tr>
<tr>
<td>Nemoto et. al., 2007</td>
<td>To examine whether high-intensity interval walking compared to moderate-intensity continuous walking increases peak aerobic capacity, thigh muscle strength, and reduces BP</td>
<td>Randomized controlled; conducted in Japan; used 2-way analysis for variance on pre-post intervention energy expenditure with accelerometer for interval group and pedometers used in both walking groups, HR, BP, aerobic capacity, isometric knee flexion and extension force</td>
<td>60 men and 186 women age 63 +/- 6 yrs, prehypertensive and Stage 1 hypertension; had no walking group, moderate walking group (&gt;8000 steps) used pedometers, kept step log; and high interval group (5 sets of 3 min fast, 3 min slow) used accelerometers and pedometers; 4 days/wk for 20 wks.</td>
<td>BP reduction occurred in both moderate and high walking groups, but greatest in high-intensity interval group for both men and women along with aerobic capacity and thigh muscle strength.</td>
</tr>
</tbody>
</table>

MET—metabolic equivalent score  
BP—blood pressure  
VO₂—maximal oxygen uptake  
BMI—body mass index  
HR—heart rate  
SBP—systolic blood pressure  
DBP—diastolic blood pressure  
EX—exercise group  
CON—control group
<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose</th>
<th>Method</th>
<th>Intervention</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Padilla et. al., 2005</td>
<td>Investigated the magnitude and duration of ambulatory BP reduction after 1 day lifestyle physical activity in normotension, prehypertension, and hypertension; determine energy expenditure relation to BP reduction</td>
<td>Quasiexperimental, equivalent control; ANOVA variance analysis; pre-post intervention energy expenditure (kcal/min) measured with RT-3 accelerometer, and ambulatory SBP; Two treatments for 24 hrs, 2-7 days apart; control treatment day—no additional physical activity; treatment day—with 3 accumulated activities included (walking, yard work, etc); kept log of physical activities</td>
<td>4 men and 4 women, age 38-46 yrs in normotensive group; 4 men and 6 women age 47-55 yrs with BP 125/82 approx. in prehypertensive group; 8 men and 2 women age 61-66 yrs with BP 140/85 approx. in hypertensive group; 24 hr recording at 15 min interval during day, and 30 min at night.</td>
<td>No significant BP difference in normotensive group. Significant reduction in SBP after accumulated physical activity in pre- and hypertensive groups. No correlation found between BP reduction and energy expenditure.</td>
</tr>
<tr>
<td>Park et. al., 2006</td>
<td>To compare the duration and magnitude of BP reduction after accumulated physical activity with a single session of continuous physical activity in prehypertensive adults; investigate sympathetic modulation as possible mechanism for BP reduction</td>
<td>Randomized cross-over design; analysis with descriptive statistics, paired t-tests and ANOVA variance; pre-post intervention after 12 hrs on energy expenditure (kcal/min) measured with RT-3 accelerometer, ambulatory BP, Holter monitoring for heart rate variability; 2 treatment days and one control day, 3 days apart</td>
<td>15 men and 5 women ages 44 – 50 yrs with prehypertension; control day—normal activity for 12 hrs; Single continuous treatment—40 min walking at 50% VO₂ plus 12 hr monitoring; Accumulated treatment—4 bouts of 10 min walking at 50% VO₂ spaced 1 hr apart plus 12 hr monitoring; walking done on treadmills</td>
<td>No correlation between energy expenditure and BP observed. SBP reduction greatest and for the longest duration post treatment in accumulated walking. Sympathetic modulation (decrease in sympathetic tone, increase in parasympathetic tone) correlated to BP reduction.</td>
</tr>
</tbody>
</table>

**MET**—metabolic equivalent score  
**BP**—blood pressure  
**VO₂**—maximal oxygen uptake  
**BMI**—body mass index  
**HR**—heart rate  
**SBP**—systolic blood pressure  
**DBP**—diastolic blood pressure
<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose</th>
<th>Method</th>
<th>Intervention</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park et al., 2008</td>
<td>Investigate BP reduction during rest periods following 3 successive 10-min walking sessions accumulated over 3-hr period in prehypertensive adults; To observe the role of autonomic modulation during rest periods following walking sessions.</td>
<td>Substudy from previous study done by authors in 2006; analysis with descriptive statistics, paired t-tests and ANOVA variance; ambulatory BP, Holter monitoring for heart rate variability; single treatment day</td>
<td>15 men and 5 women ages 44 – 50 yrs with prehypertension; Accumulated treatment—Baseline BP and 3 bouts of 10 min walking at 50% VO\textsubscript{2} spaced 50 mins apart; BP recorded every 15 min; walking done on treadmills</td>
<td>Significant reduction in SBP following third 10-min walking session, but no difference in DBP or autonomic modulation compared to baseline. Three 10-min walking sessions were effective in SBP reduction (4 mm Hg) in prehypertension.</td>
</tr>
<tr>
<td>Quinn et al., 2006</td>
<td>Determine whether a 12-wk intermittent (2 bouts of 15 min/day) exercise program yields similar improvements in cardiovascular health and fitness compared to the traditional 12-wk, 30 min continuous exercise program; determine effects of switching exercise programs and continuing for additional 12-wks.</td>
<td>Randomized, cross-over design; ANOVA 2 x 3 repeated measures analysis, Tukey post hoc tests; pre-post intervention after 2-12 wk training periods on VO\textsubscript{2}max, HR, BP, treadmill time, BMI, lipid panel.</td>
<td>17 men and 20 women age 50.5 +/- 7 yrs with BP &lt; 140/90; CON exercise program was 30 min walking at 70%HHR, 4 days/wk for 12 wks; then INT exercise program was 2 bouts of 15 min walking, 4 hours apart, 4 days/wk for 12 wks; walking done on treadmills</td>
<td>Exercise BP and HR decreased in both groups, but greater during INT exercise program. Maximum exercise capacity increased in both groups, but higher levels were observed in the INT exercise program compared to the CON exercise program. Accumulated exercise program yields significant cardiovascular fitness and health improvements.</td>
</tr>
</tbody>
</table>

BP—blood pressure  
VO\textsubscript{2}—maximal oxygen uptake  
BMI—body mass index  
HR—heart rate  
SBP—systolic blood pressure  
DBP—diastolic blood pressure  
HHR—heart rate reserve  
CON—control group  
INT—interval group
<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose</th>
<th>Method</th>
<th>Intervention</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seals et al., 2001</td>
<td>Determine the relative efficacy of daily walking and moderate dietary sodium restriction for reducing SBP and pulse pressure (PP) in postmenopausal women with elevated SBP; potential role of SBP reductions in large artery stiffness.</td>
<td>Parallel group design with active treatment control group; ANOVA analysis of variance; pre-post intervention on body mass, body fat, BMI, waist circumference, waist-hip ratio, fibrinogen, lipid panel; serum insulin, glucose, and plasma; BP, HR, VO_{2max}, sodium intake, urinary sodium, carotid AI, PWV</td>
<td>35 postmenopausal women age 59 – 75 with SBP between 130-159; EX group—walking 40-45 min at 70% maximal HR approx 6 days/wk for 3 months; SR group—sodium restriction of &lt;2.4 g sodium or &lt;6g sodium chloride without altering caloric intake daily for 3 months; kept activity log in EX group, and sodium intake log in SR group.</td>
<td>SR group lowered resting SBP and PP more than EX group (15.6 vs. 5 mm Hg) and (9.6 vs. 2 mm Hg), respectively. No significant changes in other outcome measures. SR group significantly reduced carotid AI and PWV, measures of central arterial stiffness, but no changes in EX group.</td>
</tr>
</tbody>
</table>

BP—blood pressure  
VO_{2max}—maximal oxygen uptake  
PP—pulse pressure  
BMI—body mass index  
HR—heart rate  
AI—augmentation index  
PWV—pulse wave velocity  
BP—systolic blood pressure  
DBP—diastolic blood pressure  
EX—exercise group  
SR—sodium restriction group
References


