

**INFLUENCE OF YOGA ON HORMONAL CHANGES, QUALITY OF LIFE,
AND MUSCULOSKELETAL FITNESS IN MENOPAUSAL WOMEN**

**M. L. SOPHIA VERZOSA
B.SC. (AGR), UNIVERSITY OF BRITISH COLUMBIA, 1988**

A Thesis
Submitted to the School of Graduate Studies
of the University of Lethbridge
in Partial Fulfillment of the
Requirements for the Degree

M.SC. EXERCISE SCIENCE

Department of Kinesiology
University of Lethbridge
LETHBRIDGE, ALBERTA, CANADA

©M. L. S. Verzosa, 2010

Dedication

*To my children, Theo and Stasha, whose independence, maturity, and self-sufficiency
attest to their contribution to this thesis*

and

Sarah Satchi Hargreaves, my first yoga teacher, who taught me to breathe

Abstract

Symptoms associated with menopause are known to negatively affect quality of life for many women. Moreover, concern about risks associated with hormone replacement therapy can prompt women to seek non-pharmacological approaches to symptom management. Claims exist that yoga can be useful in the management of menopausal symptoms, possibly through modification of endocrine function. This study used a randomized controlled design to examine the effect of yoga on sedentary menopausal women with regard to menopausal symptoms, circulating hormones, musculoskeletal fitness, heart rate, blood pressure, and body mass index. Women participating in a traditional walking program served as the control group. Results indicate that both types of activity were beneficial for perimenopausal women, although the differences between yoga and walking for improvement in menopause symptoms were not statistically significant. The effects do not appear to be associated with hormonal changes. Musculoskeletal fitness in sedentary women improved with activity despite weight gain.

Acknowledgements

I am indebted to the invaluable contributions of:

- My supervisor, Dr. Jennifer Copeland, whose expertise, enthusiasm, and humour made the process of inquiry both challenging and exhilarating
- The University of Lethbridge Sports and Recreational Services, for support and cooperation providing access to the facilities for the activities
- All the women who cheerfully volunteered their time and effort to participate as research subjects
- My husband Tim Lysyk, who asked one day: “since you like this stuff so much, why don’t you take a few courses at the university, then?” and patiently lived with the consequences

Table of Contents

Chapter 1: Introduction	1
Chapter 2: Literature review	7
Chapter 3: Influence of a yoga intervention on quality of life and hormone levels in menopausal women	30
3.1 Introduction	31
3.2 Materials and Methods	33
3.3 Results	39
3.4 Discussion.....	40
3.5 References	45
Chapter 4: Influence of a yoga intervention on musculoskeletal fitness, heart rate, blood pressure and BMI in menopausal women	53
4.1 Introduction	54
4.2 Materials and Methods	56
4.3 Results	61
4.4 Discussion.....	63
4.5 References	67
Chapter 5: Acute effects of a single session of yoga on adrenal androgens in menopausal women	76
5.1 Introduction	77
5.2 Materials and Methods	79
5.3 Results	81
5.4 Discussion.....	82
5.5 References	84
Chapter 6: Discussion and conclusions	89
Appendices	97

List of Figures

Figure 3.1: Schematic of experimental design

Figure 3.2: Menopause Specific Quality of Life Scores for four domains and summary score for subjects during the walking and yoga interventions

Figure 4.1: Schematic of experimental design

List of Tables

Table 3.1: Mean (S.D.) age, weight and BMI of subjects pre- and post- yoga and walking interventions.

Table 3.2: Mean (S.D.) serum concentrations of DHEA-S and FSH of subjects pre- and post- yoga and walking interventions.

Table 4.1: Mean (S.D.) age, weight and BMI of subjects pre- and post- yoga and walking interventions.

Table 4.2: Mean (S.D.) systolic and diastolic blood pressure and resting heart rate pre and post intervention.

Table 4.3: Mean (S.D.) upper body strength and flexibility pre and post intervention.

Table 4.4: Mean (S.D.) knee extensor and flexor isometric strength pre and post intervention.

Table 5.1: Mean (S.D.) salivary cortisol and serum DHEA-S pre and post session.

List of Abbreviations

BMI: body mass index

CAM: complementary and alternative medicine

CPAFLA: Canadian Physical Activity, Fitness, and Lifestyle Approach

CSEP: Canadian Society of Exercise Physiology

DBP: diastolic blood pressure

DHEA-S: dehydroepiandrosterone - sulfate

ELISA: Enzyme-linked immunosorbant assay

FSH: follicle stimulating hormone

HPA: hypothalamic-pituitary-adrenal

HPG: hypothalamic-pituitary-gonadal

HRmax: maximum heart rate

HRT: hormone replacement therapy

MENQOL: Menopause-specific Quality of Life questionnaire

METS: metabolic equivalents

PAR-Q: physical activity readiness questionnaire

RHR: resting heart rate

SBP: systolic blood pressure

SNS: sympathetic nervous system

Chapter 1: Introduction

1.1 Women, yoga and menopause

Women in Canada have a life expectancy of 81 years (Millar, 1995), approximately one third of which will be spent in the transition through menopause and the years following. The quality of life in these later years may be affected by hormonal status and the ability to enjoy activities unimpeded by disability or disease. Menopause signifies a transition in which hormonal changes bring on a host of disruptions that include symptoms such as hot flashes and sweating, muscle and joint pain, sleep disturbances, anxiety, and mood disturbances, any of which can significantly compromise quality of life. The practice of yoga for health benefits and overall wellness has long been promoted by leading yoga teachers and educators. This potential has recently been recognized by the general public and yoga has become a focus of attention as a potential alternative treatment for common conditions associated with women's health and the processes of menopause.

Hatha yoga, a branch of yoga emphasizing the performance of postures (*asanas*) that stretch and strengthen the body, has been growing in popularity since its relatively recent introduction to North America in the latter part of the 19th century, this growth becoming explosive after the Second World War (Singleton, 2010). In contrast, yoga has had a long tradition of practice in the Indian subcontinent, sharing its philosophical roots with Ayurveda, India's form of traditional medicine. It has thus had in that country long acceptance as a holistic health practice and an adjunct to medical treatment.

Encompassing not merely the physical postures of hatha yoga but other traditions such as philosophy and devotional practice, yoga was originally intended to address the

wholeness of the entire person and provide support in the human experience of journeying towards union with the Divine. In short, yoga may address multiple dimensions of wellness.

Within North America, interest tends to focus on the physical aspect of wellness, and yoga is practiced for relaxation, general conditioning, and overall health benefits. Typical hatha yoga classes also include some form of breath training, (*pranayama*), and a relaxation session in a supine position (*savasana*). This combination of physical exercise, paced respiration, and relaxation with a meditative approach may be beneficial to women coping with the symptoms that accompany midlife transition.

1.2 What is yoga?

Yoga originated in and was developed in the Indian subcontinent as a form of self-evolution, or development of the self as a fully-realized human being. Codified in the Yoga Sutras in approximately 300 BC by the sage Patanjali and passed down as oral tradition, the Sutras consist of 196 terse aphorisms that state the purpose of yoga in terms of spiritual, mental, emotional and physical growth. Ultimately, through the practice of yoga, the impurity and imperfection of the human condition is removed to allow the true self to be revealed (Bouanchaud, 1997).

From this philosophical and spiritual context, yoga in the West has developed into a physical recreational activity with expected benefits in strength, flexibility, balance and relaxation. Originally conceived as a means of addressing the entire self, it is increasingly also seen as a means of attaining holistic wellness, with physical benefits closely tied to mental and emotional benefits. In this context, revelation of the self for modern day practitioners can be interpreted as removal of sources of discomfort, disease, and physical

ailment. This modern day interpretation remains consistent with Patanjali's aphorism 1.30: "The inner obstacles that disperse the mind are sickness, mental inertia, doubt, haste, apathy, intemperance, errors in judgement of oneself, lack of perseverance, and the inability to stay at a level once reached." (Bouanchaud, 1997). In this view, yoga is regarded as having the potential to help address malfunctions or imbalances that manifest as physical symptoms of disease, in particular those related to the stressful and often sedentary nature of western lifestyles.

The World Health Organization recently redefined wellness as: "...the realization of the fullest potential of the individual physically, psychologically, socially, spiritually and economically, and the fulfillment of one's role expectations in the family, community, place of worship and other settings (World Health Organization, n.d.). Society has increasingly accepted the World Health Organization definition of wellness in a desire not only to feel well as individuals, but also to reduce health care costs to themselves and to society, and to feel empowered in their self-care and health choices. It is in this context of seeking a multidimensional approach to wellness that yoga has relevance to health in the modern world.

The yoga predominantly practiced in the west is largely derived from the postural yoga popularized by B.K.S. Iyengar which in turn has roots in the gymnastic tradition of Mysore Palace and the teachings of T. Krishnamacharya. Perhaps most accurately termed "transnational anglophone yoga" by Singleton (2010), this form of postural practice is best known in the west as "hatha yoga" or simply "yoga", and for the sake of simplicity these terms will be used throughout the thesis to refer to postural yoga that also incorporates breathwork and relaxation.

1.3 Yoga and women's health

Yoga practitioners in the west today are a diverse population. People from all ages and backgrounds are drawn to yoga classes offered in studios, health clubs, gyms, community recreational centres and educational institutions. Yoga may be of particular importance to mid-life women as a safe, accessible exercise option to those experiencing the effects of aging such as chronic use injury, movement limitations, and inability to participate in high impact or high intensity activities. Expected benefits may include increased fitness levels in the widely recognized components of flexibility, muscular strength and endurance and cardiovascular health. Health related and psychological benefits include relief from stress, relaxation, an overall feeling of well-being, and sense of “flow” – a sense of immersion and absorption in one's experience. Benefits of particular concern to women include relief from premenstrual syndrome, lower back pain, depression, respiratory disorders, or menopausal symptoms.

The possibility of yoga used therapeutically as a type of complementary and alternative medicine (CAM) is growing in importance as public demand drives health management organizations and health care providers to include various CAM therapies in their coverage (Pelletier, Marie, Krasner, & Haskell, 1997). As with other users of CAM therapies, yoga practitioners use yoga to supplement and support, rather than replace, conventional therapies (Jonas, 2001). However, health care providers have an interest in seeing more objective demonstration of clinical efficacy as well as cost effectiveness in determining whether to offer coverage for certain therapies (Pelletier et al., 1997).

While interest in the beneficial effects of yoga on fitness and health continues to grow, experimental evidence to support the benefits of yoga is limited in comparison to

other modes of exercise, and the purported influence of yoga on endocrine function and the associated benefits for postmenopausal women remains largely undocumented by scientific research. Studies on the effect of more conventional exercise regimes such as aerobic or resistance training on the hormonal status of aging women have begun only recently, and investigation of how mind-body exercise such as yoga affects the endocrine system is even more limited. With increasing numbers of women experiencing menopause-related issues and a subsequent decrease in quality of life, interest in safe, inexpensive, non-invasive management of symptoms emphasizes the need for evidence-based information about the physiological effects of yoga to enable women to make informed choices about their health.

This thesis begins with a review of available scientific literature on the physiological effects of yoga, particularly as it may relate to menopausal women's health, and compare it to the information on yoga to which women are exposed through popular (i.e., non-scholarly) literature and the media. The experimental research conducted as part of the thesis project will follow in three separate articles. Finally, a general discussion will conclude and summarize the result of the studies as a whole.

1.4 References

- Bouanchaud, B. (1997). *The Essence of yoga: reflections on the yogasutras of Patanjali*. Portland, OR: Rudra Press.
- Jonas, W. B. (2001). Advising Patients on the Use of Complementary and Alternative Medicine. *Applied Psychophysiology & Biofeedback*, 26(3), 205-214.
- Millar, W. J. (1995). *Life Expectancy of Canadians*. Retrieved from <http://www.statcan.gc.ca/studies-etudes/82-003/archive/1995/5018983-eng.pdf>.
- Pelletier, K. R., Marie, A., Krasner, M., & Haskell, W. L. (1997). Current trends in the integration and reimbursement of complementary and alternative medicine by managed care, insurance carriers, and hospital providers. *Am J Health Promot.* ,

12(2), 112-122.

Singleton, M. (2010). *Yoga Body: The Origins of Modern Posture Practice*: Oxford University Press, USA.

Chapter 2: Literature review

Yoga is increasingly promoted by yoga educators and in media as a beneficial practice with the potential to address the health concerns of women, in particular those tied to hormonal changes and the aging process. This review will examine the claims in the media and popular literature about the benefits of yoga for menopausal women and explore which of these claims are supported by clinical evidence.

2.1 Introduction

The number of women over the age of 50 is rising worldwide. Estimated to consist of 467 million in 1990 with 47 million new entrants each year, by 2030 the number of menopausal and postmenopausal women is expected to reach 1.2 billion (Hill, 1996). This trend is equally important in Canada, where the number of women over the age of 50 totaled 5.5 million at the time of the 2005 Canadian census, and is expected to increase to 6.9 million by 2016 and 7.9 million by 2026, at which point they will comprise 22%, or over one-fifth of the Canadian population (Desindes et al., 2006). With the average age of menopause remaining stable at 51 the number of women in Canada and throughout the world seeking relief from menopausal symptoms will also increase.

Menopause is defined as loss of menstrual cycles caused by decline in ovarian follicular activity. This is considered to be permanent after 12 consecutive months of amenorrhea, and thus can only be recognized in retrospect. The period of 2-8 years leading up to, and one year following the last menstrual cycle is considered to be perimenopause. Menopausal symptoms may be experienced at any point within these phases, and can range from negligible to severely problematic. Of the wide variety of possible symptoms, vasomotor symptoms are most widely reported, occurring in 85% of

women in Caucasian populations (Cheung, Chaudhry, Kapral, Jackevicius, & Robinson, 2003). Vasomotor symptoms appear to peak in the first two years following the last menstrual cycle, after which a decline is seen. (Desindes et al., 2006). Experience of vasomotor symptoms appears to increase the chance of reporting other symptoms, perhaps indicating that the process that triggers them is also the mechanism that drives all the rest. While vasomotor symptoms appeared to be tied to sympathetic nervous system (SNS) activity, the primary mechanism by which changes in hormonal status appear to elicit SNS arousal in symptomatic women is yet to be fully elucidated.

Hormone replacement therapy (HRT) was previously seen as the most effective treatment for menopausal symptoms, but use of HRT declined significantly around the world (Canadian Institute for Health Information [CIHI], 2008; Sievert et al., 2008) after the Women's Health Initiative study (Writing Group for the Women's Health Initiative Investigators, 2002) concluded that the overall risks to healthy post-menopausal women outweighed the benefits, contradicting previous assumption of cardioprotective benefits and affirming increased risk of certain types of cancers. The North American Menopause Society recently updated its position statement and now considers the benefit to risk ratio for HRT acceptable for short-term use only and no longer recommends HRT as a long term solution (North American Menopause Society [NAMS], 2010). Within Canada, use of HRT has declined and in five Canadian provinces was reduced by 30% in the two years following the release of the study and 17% per year thereafter. (CIHI, 2008).

Many women report fears of breast cancer and heart attack associated with using HRT (Twiss et al., 2007) prompting interest in alternative, non-pharmacological approaches to symptom management (Kronenberg & Fugh-Berman, 2002; Twiss et al.,

2007). Women are anxious to obtain accurate information, but opportunity to discuss treatment options with healthcare providers may be limited, leading many women to rely on the media for information related to menopause and HRT (Lewis, 2009; Maslow, 2003; Twiss et al., 2007) . While claims abound regarding benefits and risks of various interventions for menopause symptoms, there is far less research on the effectiveness and safety of complementary and alternative medicine (CAM) therapies compared to that available on HRT (Cheung et al., 2003; Maslow, 2003). This provides additional impetus to earlier recommendations by Cheung et al. (2003) in The Women’s Health Surveillance Report on Perimenopausal and Postmenopausal Health: that non-pharmacological alternatives for menopausal symptom treatment be investigated. Clearly, interest is demonstrated on the part of Canadian public health agencies as well as Canadians themselves, and yoga has the potential to play a part in the search for these alternatives.

Yoga falls into the top 10 of CAM therapies used, and a 2002 survey found that 8% of the 15.2 million respondents used yoga for health purposes (National Centre for Complementary and Alternative Medicine, 2008). A great deal of popular literature claims yoga will be beneficial to women’s health and provide relief from hot flashes, the most notorious of menopause-related issues. Experimental evidence to support the benefits of yoga for menopausal women remains largely undocumented by scientific research. The purpose of this review is to outline the many claims about yoga to which women are exposed, and to examine which of these claims, if any, are supported by clinical evidence.

2.2 Menopause and Hormones

Menopausal symptoms may be experienced as early as 8 years prior to the last

menstrual cycle, and can range from negligible to severely problematic. These may include vasomotor symptoms, mood disturbance, increased stress reactivity, cognitive difficulty, headaches and sleep disturbances (Twiss et al., 2007). These symptoms are presumed to be directly related to hormonal changes occurring at perimenopause, but the mechanism by which symptoms are elicited is unclear.

A relatively common pattern of hormone shifts during perimenopause can be observed, prominently characterized by a period of extreme fluctuation in estrogen levels followed by an overall decline that typically plateaus approximately 4-5 years postmenopause (Rannevik et al., 1995). Consequently, other reproductive hormone levels are altered due to changes in various feedback pathways, including declining levels of progesterone and elevated levels of follicle stimulating hormone (FSH) and luteinizing hormone (LH). Small decreases in circulating levels of testosterone, androstenedione and sex-hormone binding globulin have also been observed (Rannevik et al., 1995). In addition to effects on the hypothalamic-pituitary-gonadal axis, there is evidence that menopause is associated with increases in SNS activity as well as increased adrenocortical reactivity to stress (Lindheim et al., 1992; Vongpatanasin, 2009).

For many years it was assumed the decline in estrogen levels combined with the elevated levels of FSH were responsible for vasomotor symptoms such as hot flashes and night sweats. A number of cross-sectional analyses have found that the prevalence and severity of hot flash symptoms is inversely related to circulating concentrations of estrogen and directly related to circulating FSH (Øverlie, Moen, Holte, & Finset, 2002; Randolph et al., 2005; Ratka, Miller, Brown, Jenschke, & Simpkins, 2009). Perhaps the most convincing evidence of a relationship between estrogen and vasomotor symptoms is

the fact that estrogen replacement significantly reduces hot flashes and is thus considered the most effective pharmacological treatment for vasomotor complaints (NAMS, 2010). Despite this relationship, it is now believed that estrogen changes alone can not fully explain the etiology of hot flashes and that other factors, namely central adrenergic activation, are involved.

Hot flashes result from dysfunction in the central thermoregulatory centres in the hypothalamus (Freedman & Blacker, 2002; Shanafelt, Barton, Adjei, & Loprinzi, 2002). Estrogens are potent neuromodulators as well as reproductive hormones, and estrogen receptors have been identified in regions of the hypothalamus associated with thermoregulation (Deecher & Dorries, 2007). It is hypothesized that estrogen withdrawal results in an increase in central norepinephrine release and disrupts the balance of serotonin and norepinephrine, two neurotransmitters crucial to temperature regulation. As a result, the thermoneutral zone or “set point” of the thermoregulatory centres is lowered so that even a small increase in core body temperature can trigger an exaggerated response to dissipate heat, including vasodilation and sweating (Freedman & Blacker, 2002; Freedman, Woodward, & Sabharwal, 1990; Shanafelt et al., 2002). Drugs that modulate the release and reuptake of neurotransmitters, such as antidepressants, may be effective in reducing hot flashes (Shanafelt et al., 2002) but possible side-effects must be considered.

Menopause is also associated with increased adrenocortical activity (Kajantie, 2008; Woods, Mitchell, & Smith-DiJulio, 2009). Estrogen is believed to play a role in physiological stress reactivity as evidenced by elevated salivary cortisol and plasma catecholamine responses to stress in postmenopausal women when compared to young

women or women on estrogen replacement. As a result, postmenopausal women may have a greater cardiovascular response to both physical and psychological stressors (Lindheim et al., 1992; Menozzi et al., 2000; Patacchioli et al., 2006). This heightened stress reactivity may result in sleep and mood disturbances (Landis & Moe, 2004) and increased risk for hypertension and cardiovascular disease (Frag, Bardwell, Nelesen, Dimsdale, & Mills, 2003; Kajantie, 2008; Vongpatanasin, 2009).

2.3 Yoga and Women's Health

Many women report using complementary and alternative medicine (CAM) to treat symptoms of menopause, including herbal preparations, chiropractic, acupuncture, and meditation, despite the lack of evidence to support their effectiveness (Kronenberg & Fugh-Berman, 2002; Lee, Shin, & Ernst, 2009). Behavioural interventions, including paced respiration, meditation, and exercise have shown potential to relieve hot flashes and improve quality of life (Elavsky & McAuley, 2005; Freedman, Woodward, 1992; Irvin, 1996; Ivarsson, Spetz, & Hammar, 1998; Lindh-Åstrand, Nedstrand, Wyon, & Hammar, 2004). Yoga thus holds promise as an intervention that combines several of these potentially useful behavioral techniques.

Yoga has been long accepted in the Indian subcontinent as a component of Ayurveda, India's form of traditional medicine and thus regarded as a holistic health practice in conjunction with medical treatment. Ayurveda regards health as a harmony of bodily functions, a well-balanced metabolism and a happy and poised state of the mind (G. Iyengar, 1990).

Modern day yoga is typically practiced in North America with the expectation of improved flexibility, muscular conditioning and stress relief. In addition to the physical

postures (*asana*) hatha yoga classes commonly include some form of breath training, (*pranayama*) and relaxation in a supine position (*savasana*). This combination of physical exercise, paced respiration, and meditative relaxation is seen as a means of attaining overall wellbeing with physical and psychological benefits. Thus, the potential for yoga practice to positively influence health and wellness has been recognized by the general public and yoga has gained attention as a complementary treatment for many health-related issues, augmenting conventional therapies (McCall, 2007).

Women are more frequent users of CAM therapies than men (Kronenberg & Fugh-Berman, 2002) and yoga is no exception; the vast majority (72%) of yoga practitioners are women ("Yoga in America Study," 2008). Furthermore, many of the claims about the health benefits about yoga are of particular interest to women, including stress relief and relaxation, improved flexibility, muscle tone without bulk, and relief from symptoms associated with premenstrual syndrome or menopause.

The public has access to an unprecedented number and variety of books, periodicals, websites, television programs, and other media sources from which to gain information on yoga. As is the case with much health and fitness information, the depth and accuracy of information varies, and due to the limited clinical evidence of effectiveness, health care professionals may have difficulty addressing questions from patients about potential benefits of yoga.

2.4 Benefits of yoga for women: Popular literature

For the purpose of this review, the works of well established yoga teachers were examined, focusing on that of B.K.S. Iyengar and his students. Iyengar yoga is one of the most widely practiced styles of hatha yoga around the world, in part because the use of

props allows poses to be adapted to practitioners of any age or fitness level, making it suitable for therapeutic use. Currently, the majority of available information on the health benefits of yoga is strongly Iyengar-influenced.

Along with the numerous health benefits ascribed to yoga, practices recommended specifically for women emphasize the beneficial effects on the neuroendocrine system, particularly SNS activation and hormonal stress response (G. Iyengar, 1990; Sparrowe & Walden, 2002). In turn, this effect is purported to lead to reduction of symptoms related to women's menopausal issues, including but not limited to hot flash symptoms. Yoga teacher and Ayurvedic doctor G. Iyengar suggests that the hormonal shifts accompanying menopause can be ameliorated through the practice of yoga asanas (postures), due to their effects on the endocrine as well as the nervous system, as it "calms the nervous system and brings equipoise" (G. Iyengar, 1990).

Poses are believed to exert their effects by improving circulation to the glands through compression and release of the surrounding tissue, creating a "squeeze and soak" effect (Raman, 1998). In this manner, forward bends and twists are purported to regulate function of the adrenal glands (Sparrowe & Walden, 2002). According to B.K.S. Iyengar, these poses also "quiet" the sympathetic nervous system (B. K. S. Iyengar, 1991).

Inverted poses have the additional effect of altering the position of the glands relative to surrounding organs. Inverting the body in a head down, body up position is maintained either by muscular effort alone or with the assistance of props. The entire musculoskeletal system is involved in maintenance of the pose, though use of props for restorative variations modifies the degree of effort expended. The weight of the abdominal and pelvic organs rests on the diaphragm, while the practitioner focuses on

relaxation and breathing. The head-down, body-up position is said to relieve strain on the heart and facilitate venous return, improving blood supply to the front of the throat and stimulating secretory activity of the thyroid and parathyroid glands, thereby improving metabolic function through stimulation of other glands (Moyer, 2006; Rele, 1958).

Sparrowe and Walden (2002) assert that this regulation of the activities of the hypothalamus, pituitary, thyroid and adrenal glands makes inversions of particular value to women. G. Iyengar (1990) states that shoulderstand is beneficial to women due to this improvement in thyroid function and its interactions with ovaries and adrenals.

Identical benefits are listed by Austin (2003) and Raman (1998). Francina (1997) relates anecdotes from her students who report that inverted postures such as headstand and shoulderstand alleviate their hot flashes and other menopausal symptoms, ascribed to the “quieting effect” shoulderstand produces on the brain and nervous system. Lasater (2003) emphasizes the benefits of improved balance and flexibility in shoulders and chest in addition to decreased blood pressure and general relaxation. The benefits of shoulderstand for relief of symptoms of menopause were featured in an article appearing in the magazine *Yoga Journal* ("Salamba sarvangasana (supported shoulderstand)," n.d.).

Authors of more recent books show greater reliance on clinical evidence and suggest that the relief yoga may bring from stress-related symptoms is tied not only to the physical changes that result from asana, but to the shift in autonomic nervous function brought about by the relaxation and paced respiration aspect of yoga practice (McCall, 2007; McGonigal, 2009) The pranayama (breathwork) and savasana (guided relaxation) intrinsic to yoga practice may moderate hyperarousal of the sympathetic nervous system (McGonigal, 2009) and mediate activity of the hypothalamic-pituitary-adrenal axis,

lowering the release of stress hormones such as cortisol (McCall, 2007). Browning Miller (2007) suggests that it is this amelioration of the effects of stressors experienced at the midlife transition that is a key factor in yoga's ability to alleviate the symptoms of menopause.

2.5 Benefits of yoga: clinical evidence

Although the validity of claims about yoga and health has been questioned (Foreman, 2004) the number of studies focusing on the psychological, musculoskeletal, cardiovascular, and autonomic nervous system effects of yoga continues to grow. Comprehensive reviews have examined indices of cardiovascular disease risk and improved musculoskeletal function (Innes, Bourguignon, & Taylor, 2005; Raub, 2002). A recent review comparing the benefits of yoga versus traditional exercise for a variety of health outcomes including blood lipids, blood glucose, heart rate variability and perceptions of stress, found that yoga is as effective, or better, than traditional exercise for improving many health-related outcomes (Ross & Thomas, 2010). On the other hand, another review focusing specifically on efficacy of yoga in menopausal symptom reduction concluded that there was insufficient evidence to recommend yoga as an intervention (Lee, Kim, Ha, Boddy, & Ernst, 2009). With regard to the benefits of yoga to menopausal women, studies that clearly demonstrate a relationship between yoga practice and hormonal changes are scarce.

Favorable outcomes were seen in a pilot trial investigating yoga as a potential treatment for hot flashes in postmenopausal women (Cohen et al., 2007). A series of restorative poses that included a supported version of shoulderstand was practiced weekly over the eight week trial. Subjects reported decreases in frequency and severity of hot

flushes and showed program adherence and satisfaction. Contrasting results were observed in a 10-week yoga program, in which no reduction was found for hot flash frequency or severity of hot flashes in 12 peri- and postmenopausal women (Booth-LaForce, Thurston, & Taylor, 2007). However, based on questionnaire data, the intensity of symptoms and daily interference was reduced, while sleep quality was enhanced. Furthermore, Mastrengelo, Galentino and Chaloupka (2005) reported that 5 out of 6 peri- and post-menopausal women who completed an 8 week yoga program demonstrated improved flexibility and increased quality of life as indicated by the Menopause Specific Quality of Life (MENQOL) survey. However, half of the women had prior yoga experience and 17% were on hormone replacement therapy. These limitations were acknowledged by Mastrengelo, Galentino and House (2007), who suggest that future studies incorporate a control condition, longer follow-up period and more comprehensive evaluation of appropriate outcome measures. In all of these studies the results were encouraging and underline the need for studies with larger subject numbers and a comparison group. Indeed, in 120 Indian women randomised to yoga and a control condition, significant reductions occurred for vasomotor symptoms and a non-significant trend towards reduction occurred for psychological symptoms, with greater reductions occurring in the yoga group (Chattha, Raghuram, Venkatram, & Hongasandra, 2008). Finding endocrine markers that reliably correlate with symptoms is inconclusive thus far. In a comparison of the acute effect of yoga on young female subjects, heart rate was reduced and mood state improved in the yoga group, with no change observed in a reading control group (Schell, Allolio, & Schonecke, 1994). Measurements of cortisol, prolactin, and growth hormone was identical between both groups. While it appears that

yoga provided stress reduction, this effect appears to be unrelated to hormonal shifts. However, the choice of hormones measured by Schell et al. (1994) may not be sufficiently inclusive to assess hormonal change as part of a stress response.

Hormonal effects of yoga postures, including inversions, were investigated in the 70's by Udupa, Singh and Settiwar (1975a, 1975b) who reported enhanced adrenocortical activity through increased plasma cortisol and reduced adrenal medulla activity through decreased plasma catecholamines in some poses. These results were interpreted as an indication that yoga practitioners were more "stress competent"; however small group sizes (two to six subjects) and the lack of statistical analysis places the validity of these conclusions in question. No further studies on the effects of inverted yoga poses on neuroendocrine function have provided convincing support that inversions influence hormonal stress responses, and the studies by Udupa et al. (1975a, 1975b) remain inconclusive due to lack of methodological rigour and small subject group size.

There may still be physiological bases that could explain the benefits experienced from inverted postures. The key components of shoulderstand, for instance, in which the head is placed lower than the rest of the body, the neck is flexed, and the whole body in isometric contraction, may interact to lead to alterations in fitness, autonomic nervous system function, and breathing patterns.

The head-down, body-up aspect of inverted poses may influence sympathetic nervous system activity through activation of the baroreceptor reflex. Reduced blood pressure, resting heart rate and blood catecholamines were seen in hypertensive male patients after three weeks of yoga practice that included inversions (Selvamurthy et al., 1998). Increased sensitivity of the baroreceptor reflex and reduced sympathetic nervous

system activity were suggested as primary mechanisms for these effects. Innes et al. (2005) also considered improved baroflex sensitivity indicative of decreased cardiovascular disease risk, a potentially important factor for menopausal women no longer experiencing the protective effects of estrogen. Konar, Latha, and Bhuvaneshwaran (2000) observed a decrease in resting heart rate following daily practice of shoulderstand, suggesting improved parasympathetic function. Although unlike Selvamurthy et al. (1998) no decline in blood pressure was observed, the study participants were younger with no existing hypertension, likely resulting in a floor effect in which no further reduction in blood pressure could be found.

The overall effects of inverted postures on localized blood pressure changes in regions of the body have yet to be studied in detail and are limited to those examining intraocular pressure during headstand (Baskaran et al., 2006). Information about local changes in blood pressure during the pose and effects on the baroreceptor reflex could lead to greater understanding about potential long term adaptations.

Another consideration is the effect of altered breathing patterns in inversions resulting from the abdominal organs resting upon the diaphragm, changing its relationship with the thoracic cavity to facilitate increased abdominal breathing and slower pace of respiration (Coulter, 2001). However, paced respiration in the form of pranayama is an integral part of yoga practice whether or not a pose is inverted. The practice of pranayama has been linked to improvements in autonomic function and a shift from sympathetic to parasympathetic dominance, possibly mediated by stretch receptors producing inhibitory signals and hyperpolarization currents (Jerath, Edry, Barnes, & Jerath, 2006; Pal, Velkumary, & Madanmohan, 2004). This shift in response to breathing

pattern may be a factor in the claim that certain inversions “calm” the nervous system.

While observations from these studies (Baskaran et al., 2006; Konar et al., 2000; Pal et al., 2004; Selvamurthy et al., 1998) suggest potential mechanisms by which benefits of yoga poses are elicited, the use of men as subjects limits generalisability of the findings to menopausal women, to whom the recommendation to practice yoga, particularly inversions is made. Recent research (Booth-LaForce et al., 2007; Chatta et al., 2008; Cohen et al., 2007; Mastrengeolo et al., 2007) has begun to address methodological problems seen in earlier studies, making use of female subjects, larger group sizes, and statistical analysis.

2.6 Musculoskeletal fitness, heart rate, blood pressure and body mass

The concept of prescribing exercise for general health and increased chronic disease risk reduction is well established, and the American College for Sports and Medicine (ACSM) guidelines for the general population advocates increased physical activity to enhance and preserve physical health (Haskell, 2007). However, compared to other modes of exercise, there may be limitations to the fitness benefits offered by yoga compared to traditional exercise (Ross & Thomas, 2010).

Concern about cardiovascular disease increases in midlife women as risk appears to accompany withdrawal of estrogen. While it is believed that estrogen withdrawal during menopause is a factor in the increased sympathoadrenal activity (Menozzi et al., 2000) and adrenergic sensitivity (Vongpatanasin, 2009) that results in increased blood pressure during the menopausal period, other investigators have shown that the increase in blood pressure is more related to increased body mass index (BMI) during menopause rather than estrogen withdrawal itself (Cifkova, Pitha, Lejskova, Lanska, & Zecova,

2008). The role of estrogen in protection against cardiovascular disease remains equivocal (Pérez-López, Chedraui, Gilbert, & Pérez-Roncero, 2009).

Increases in body weight during menopause is typical, with an average of 2.25 kg gained over three years in association with an increase in other coronary disease risk factor such as increased blood pressure and blood lipids (Wing, Matthews, Kuller, Meilahn, & Plantinga, 1991). Behavioural lifestyle interventions such as dietary changes and physical activity have been shown to mitigate this weight gain (Blanck et al., 2007; Evans & Racette, 2006; Krumm, Dessieux, Andrews, & Thompson, 2006; Simkin-Silverman, Wing, Boraz, & Kuller, 2003), indicating that adherence to long term physical activity is an important component to weight management in menopausal women, and suggesting that establishing the habit of physical activity is crucial to this population for weight management and reduction in co-morbid conditions that contribute to cardiovascular disease risk. Yoga practice has resulted in reduced body mass in one study (Yang, 2007) while having no effect in another (Tran, Holly, Lashbrook, & Amsterdam, 2001) and there is some indication that yoga practice may ameliorate the weight gain typically seen at menopause (Guarracino, 2007).

Several studies have shown that yoga practice may lead to reduction in systolic or diastolic blood pressure or both (Cowen & Adams, 2005; Damodaran, 2002; Guarracino, 2007; Selvamurthy et al., 1998; Yang, 2007) and lower resting heart rate (Konar et al., 2000; Selvamurthy et al., 1998). Even in a single session, yoga was shown to reduce systolic blood pressure when recovering from a psychological stressor (Sung, Roussanov, Nagubandi, & Golden, 2000).

Fitness parameters have been improved after yoga practice, including upper and

lower body muscular strength and lower body muscular endurance as well as joint flexibility and absolute and relative maximal oxygen uptake (Tran et al., 2001).

Improved upper body and trunk strength, endurance and flexibility were also observed by Cowen and Adams (2005) who further suggested that style of yoga influenced degree of benefit. Yoga is typically not as intense as conventional exercise and has been classified as mild to moderate in intensity, since the intermittent nature of the poses provides no sustained cardiovascular effect (Blank, 2006; Cowen & Adams, 2007). Yoga may not be of sufficient intensity to meet recommendations for cardiovascular improvement (Hagins, 2007) with the metabolic cost of only 2.5 METS (metabolic equivalents) and intensity of 49.4% HRmax (maximum heart rate) over a single yoga session, and it is possible that only vigorous styles such as ashtanga yoga may increase the heart rate sufficiently to improve cardiovascular fitness (Cowen & Adams, 2007).

Yoga is an increasingly popular recreational activity, particularly among women, who comprise 72% of the estimated 5.8 million practitioners in the US ("Yoga in America Study," 2008). A recent examination of National Health Interview Survey data showed that 61% of yoga users felt that their practice was important in maintaining health, particularly mental health and musculoskeletal conditions (Birdee et al., 2008). For mid-life women, yoga may provide a safe, accessible exercise option to those experiencing the effects of aging such as chronic use injury, movement limitations, and inability to participate in high impact or high intensity activities.

2.7 References

- Austin, M. (2003). *Cool Yoga Tricks*. Toronto, ON: Random House Publishing Group.
- Baskaran, M., Raman, K., Ramani, K. K., Roy, J., Vijaya, L., & Badrinath, S. S. (2006). Intraocular Pressure Changes and Ocular Biometry during Sirsasana (Headstand

- Posture) in Yoga Practitioners. *Ophthalmology*, 113(8), 1327-1332. doi: 10.1016.02.063.
- Birdee, G., Legedza, A., Saper, R., Bertisch, S., Eisenberg, D., & Phillips, R. (2008). Characteristics of Yoga Users: Results of a National Survey. *Journal of General Internal Medicine*, 23(10), 1653-1658. doi: 10.1007/s11606-008-0735-5.
- Blanck, H. M., McCullough, M. L., Patel, A. V., Gillespie, C., Calle, E. E., Cokkinides, V. E., . . . Serdula, M. K. (2007). Sedentary Behavior, Recreational Physical Activity, and 7-Year Weight Gain among Postmenopausal U.S. Women[ast]. *Obesity*, 15(6), 1578-1588.
- Blank, S. E. (2006). Physiological responses to Iyengar yoga performed by trained practitioners. *Journal of Exercise Physiology Online*, 9(1), 7-23.
- Booth-LaForce, C., Thurston, R. C., & Taylor, M. R. (2007). A pilot study of a Hatha yoga treatment for menopausal symptoms. *Maturitas*, 57(3), 286-295.
- Browning Miller, E. (2007). Yoga for Menopause. In T. McCall (Ed.), *Yoga as Medicine*. New York, NY: Bantam Books.
- Chattha, R., Raghuram, N., Venkatram, P., & Hongasandra, N. R. (2008). Treating the climacteric symptoms in Indian women with an integrated approach to yoga therapy: a randomized control study. *Menopause*, 15(5), 862-870
doi:10.1097/gme.1090b1013e318167b318902.
- Cheung, A. M., Chaudhry, R., Kapral, M., Jackevicius, C., & Robinson, G. (2003). The Women's Health Surveillance Report on Perimenopausal and Postmenopausal Health. Retrieved from <http://www.phac-aspc.gc.ca/publicat/whsr-rssf/index-eng.php>
- Cifkova, R., Pitha, J., Lejskova, M., Lanska, V., & Zecova, S. (2008). Blood pressure around the menopause: a population study. *Journal of Hypertension*, 26(10), 1976-1982 doi:10.1097/HJH.1970b1013e32830b32895c.
- Cohen, B. E., Kanaya, A. M., Macer, J. L., Shen, H., Chang, A. A., & Grady, D. (2007). Feasibility and acceptability of restorative yoga for treatment of hot flashes: A pilot trial. *Maturitas*, 56.
- Coulter, H. D. (2001). *Anatomy of hatha yoga*. . Honesdale, PA: Body and Breath, Inc.
- Cowen, V. S., & Adams, T. B. (2005). Physical and perceptual benefits of yoga asana practice: results of a pilot study. *Journal of Bodywork and Movement Therapies*, 9(3), 211-219.
- Cowen, V. S., & Adams, T. B. (2007). Heart rate in yoga asana practice: A comparison of

- styles. *Journal of Bodywork and Movement Therapies*, 11(1), 91-95.
- Damodaran, A., Malathi, A., Patil, N., Shah, N., Suryavanshi, Marathe, S. (2002). Therapeutic potential of Yoga practices in modifying cardiovascular risk profile in middle aged men and women. *50(MAY)*, 8.
- Deecher, D. C., & Dorries, K. (2007). Understanding the pathophysiology of vasomotor symptoms (hot flushes and night sweats) that occur in perimenopause, menopause, and postmenopause life stages, *Archives of Women's Mental Health: Springer Science & Business Media B.V.*
- Desindes, S., Bélisle, S., Blake, J., Basson, R., Graves, G., Grigoriadis, S., . . . Turek, M. (2006). Canadian Consensus Conference on Menopause, 2006 update. *Journal of Obstetrics and Gynaecology in Canada*, 28(S1), 7-94.
- Elavsky, S., & McAuley, E. (2005). Physical activity, symptoms, esteem, and life satisfaction during menopause. *Maturitas*, 52(3-4), 374-385.
- North American Menopause Society. (2010). Estrogen and progestogen use in postmenopausal women: 2010 position statement. *Menopause*, 17(2), 242-255. doi: 10.1097/gme.0b013e3181d0f6b9.
- Evans, E. M., & Racette, S. B. (2006). Menopause and Risk for Obesity: How Important Is Physical Activity? *Journal of Women's Health (15409996)*, 15(2), 211-213. doi: 10.1089/jwh.2006.15.211
- Farag, N. H., Bardwell, W. A., Nelesen, R. A., Dimsdale, J. E., & Mills, P. J. (2003). Autonomic responses to psychological stress: the influence of menopausal status. *Ann Behav Med*, 26(2), 134-138.
- Foreman, J. (2004). Scientific support for yoga is slim *Boston Globe*. Boston, MA.
- Francina, S. (1997). *The new yoga for people over 50*. Deerfield Beach, FL: Health Communications, Inc.
- Freedman, R. R., & Blacker, C. M. (2002). Estrogen raises the sweating threshold in postmenopausal women with hot flashes. [doi: DOI: 10.1016/S0015-0282(01)03009-6]. *Fertility and Sterility*, 77(3), 487-490.
- Freedman, R. R., Woodward, S., & Sabharwal, S. C. (1990). [alpha]2-Adrenergic Mechanism in Menopausal Hot Flushes. *Obstetrics & Gynecology*, 76(4), 573-578.
- Freedman, R. R., Woodward, S. (1992). Behavioural treatment of hot flushes. *American Journal of Obstetrics and Gynecology*, 167(2), 436-439.

- Guarracino, J. L. M. S., Susan MS; Edelstein, Sari PhD, RD (2007). Yoga Participation Is Beneficial to Obesity Prevention, Hypertension Control, and Positive Quality of Life. *Topics in Clinical Nutrition*, 21(1), 108-113.
- Hagins, M., Moore, W. & Rundle, A. (2007). Does practicing hatha yoga satisfy recommendations for intensity of physical activity which improves and maintains health and cardiovascular fitness? *BMC Complement Altern Med.* , 7(40). doi: 10.1186/1472-6882-7-40.
- Haskell, W. L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C.A., Heath, G.W., Thompson, P.D., Bauman, A. . (2007). Physical Activity and Public Health: Updated Recommendation for Adults from the American College of Sports Medicine and the American Heart Association. *Medicine and Science in Sports and Exercise*, 39(8), 1423-1434.
- Hill, K. (1996). The demography of menopause. *Maturitas*, 23(2), 113-127.
- Hormone replacement therapy: an analysis focusing on drug claims by female seniors, 2000 to 2007. (2008). Retrieved from http://secure.cihi.ca/cihiweb/products/HRT_AIB_web.pdf
- Innes, K. E., Bourguignon, C., & Taylor, A. G. (2005). Risk indices associated with the insulin resistance syndrome, cardiovascular disease, and possible protection with yoga: A systematic review. *Journal of the American Board of Family Practice*, 18(6), 491-519.
- Irvin, J. H., Domar, A.D., Clark, C., Zuttermeister P.C., and R. Friedman. (1996). The effects of relaxation response training on menopausal symptoms. [Journal]. *J. Psychom. Obstet. Gynecol.*, 17, 202-207.
- Ivarsson, T., Spetz, A.-C., & Hammar, M. (1998). Physical exercise and vasomotor symptoms in postmenopausal women. *Maturitas*, 29(2), 139-146. doi:10.1016/S0378-5122(98)00004-8.
- Iyengar, B. K. S. (1991). *Light on Yoga*. Hammersmith, London: Harper Collins.
- Iyengar, G. (1990). *Yoga, a Gem for Women*. Spokane, WA: Timeless Books.
- Jerath, R., Edry, J. W., Barnes, V. A., & Jerath, V. (2006). Physiology of long pranayamic breathing: Neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system. *Medical Hypotheses*, 67(3), 566-571.
- Kajantie, E. (2008). Physiological Stress Response, Estrogen, and the Male–Female Mortality Gap. *Current Directions in Psychological Science*, 17(5), 348-352. doi: 10.1111/j.1467-8721.2008.00604.x

- Konar, D., Latha, R., & Bhuvaneshwaran, J. S. (2000). Cardiovascular responses to head-down-body-up postural exercise (Sarvangasana). *Indian J Physiol Pharmacol.*, 44(4), 392-400.
- Kronenberg, F., & Fugh-Berman, A. (2002). Complementary and alternative medicine for menopausal symptoms: a review of randomized, controlled trials. *Ann Intern Med*, 137(10), 805-813.
- Krumm, E. M., Dessieux, O. L., Andrews, P., & Thompson, D. L. (2006). The Relationship between Daily Steps and Body Composition in Postmenopausal Women. *Journal of Women's Health*, 15(2), 202-210. doi:10.1089/jwh.2006.15.202
- Landis, C. A., & Moe, K. E. (2004). Sleep and menopause. *Nurs Clin North Am*, 39(1), 97-115. doi: 10.1016/j.cnur.2003.11.006 S0029646503001312
- Lasater, J. (2003). *30 Essential Yoga Poses*. Berkely, CA: Rodmell Press.
- Lee, M. S., Kim, J.-I., Ha, J. Y., Boddy, K., & Ernst, E. (2009). Yoga for menopausal symptoms: a systematic review. *Menopause*, 16(3), 602-608 doi:10.1097/gme.1090b1013e31818ffe31839.
- Lee, M. S., Shin, B. C., & Ernst, E. (2009). Acupuncture for treating menopausal hot flushes: a systematic review. *Climacteric*, 12(1), 16-25. doi: 10.1080/13697130802566980
- Lewis, V. (2009). Undertreatment of menopausal symptoms and novel options for comprehensive management. *Curr Med Res Opin*, 25(11), 2689-2698. doi: 10.1185/03007990903240519
- Lindh-Åstrand, L., Nedstrand, E., Wyon, Y., & Hammar, M. (2004). Vasomotor symptoms and quality of life in previously sedentary postmenopausal women randomised to physical activity or estrogen therapy. *Maturitas*, 48(2), 97-105.
- Lindheim, S. R., Legro, R. S., Bernstein, L., Stanczyk, F. Z., Vijod, M. A., Presser, S. C., & Lobo, R. A. (1992). Behavioral stress responses in premenopausal and postmenopausal women and the effects of estrogen. *Am J Obstet Gynecol*, 167(6), 1831-1836.
- Maslow, K. (2003). Problems in women's knowledge about menopause. [doi: DOI: 10.1016/0531-5565(94)90015-9]. *Experimental Gerontology*, 29(3-4), 351-353.
- Mastrangelo, M. A., Galantino, M. L., & E.C., C. (2005). Effects of yoga on quality of life and flexibility in perimenopausal and postmenopausal women. *Medicine and Science in Sport and Exercise*, 37(5), S75.

- Mastrangelo, M. A., Galantino, M. L., & House, L. (2007). Effects of Yoga on Quality of Life and Flexibility in Menopausal Women: A Case Series. *EXPLORE: The Journal of Science and Healing*, 3(1), 42-45.
- McCall, T. (2007). *Yoga as Medicine*. New York, NY: Bantam Books.
- McGonigal, K. (2009). *Yoga for Pain Relief*. Oakland, CA: New Harbinger Publications.
- Menzio, R., Cagnacci, A., Zanni, A. L., Bondi, M., Volpe, A., & Del Rio, G. (2000). Sympathoadrenal response of postmenopausal women prior and during prolonged administration of estradiol. *Maturitas*, 34(3), 275-281.
- Moyer, D. (2006). *Yoga, awakening the inner body*. Berkeley, CA: Rodmell Press.
- National Centre for Complementary and Alternative Medicine. (October 22, 2008). Retrieved from <http://nccam.nih.gov/health/yoga/>
- Øverlie, I., Moen, M. H., Holte, A., & Finset, A. (2002). Androgens and estrogens in relation to hot flushes during the menopausal transition. *Maturitas*, 41(1), 69-77.
- Pal, K., Velkumary, S., & Madanmohan. (2004). Effect of short-term practice of breathing exercises on autonomic functions in normal human volunteers. *Indian Journal of Medical Research*, 120(2), 115-121.
- Patacchioli, F. R., Simeoni, S., Monnazzi, P., Pace, M., Capri, O., & Perrone, G. (2006). Menopause, mild psychological stress and salivary cortisol: Influence of long-term hormone replacement therapy (HRT).]. *Maturitas*, 55(2), 150-155. doi: 10.1016/j.maturitas.2006.01.009.
- Pérez-López, F. R., Chedraui, P., Gilbert, J. J., & Pérez-Roncero, G. (2009). Cardiovascular risk in menopausal women and prevalent related co-morbid conditions: facing the post-Women's Health Initiative era. *Fertility and Sterility*, 92(4), 1171-1186. doi:10.1016/j.fertnstert.2009.06.032.
- Raman, K. (1998). *A Matter of Health: Integration of yoga and western medicine for prevention and cure*. Bangalore, India: Eastwest Books (Madras) Pvt. Ltd.
- Randolph, J. F., Jr, Sowers, M., Bondarenko, I., Gold, E. B., Greendale, G. A., Bromberger, J. T., . . . Matthews, K. A. (2005). The Relationship of Longitudinal Change in Reproductive Hormones and Vasomotor Symptoms during the Menopausal Transition. *J Clin Endocrinol Metab*, 90(11), 6106-6112. doi: 10.1210/jc.2005-1374.
- Rannevik, G., Jeppsson, S., Johnell, O., Bjerre, B., Laurell-Borulf, Y., & Svanberg, L. (1995). A longitudinal study of the perimenopausal transition: altered profiles of

- steroid and pituitary hormones, SHBG and bone mineral density. *Maturitas*, 21(2), 103-113. doi: 10.1016/0378-5122(94)00869-9.
- Ratka, A., Miller, V., Brown, K., Jenschke, M., & Simpkins, J. (2009). Association of Various Dimensions of Hot Flashes with Systemic Levels of Gonadal Steroids. *Exp. Biol. Med.*, 234(4), 395-402. doi: 10.3181/0811-rm-334
- Raub, J. A. (2002). Psychophysiological effects of Hatha Yoga on musculoskeletal and cardiopulmonary function: A literature review. *Journal of Alternative and Complementary Medicine*, 8(6), 797-812.
- Rele, V. G. (1958). *Yogic Asanas for health and vigour (a physiological exposition)*. Bombay, India: D.B. Taraporevala Sons & Co. Private Ltd.
- Ross, A., & Thomas, S. (2010). The health benefits of yoga and exercise: a review of comparison studies. *J Altern Complement Med*, 16(1), 3-12. doi: 10.1089/acm.2009.0044
- Salamba sarvangasana (supported shoulderstand). (n.d.). *Yoga Journal.com*.
- Schell, F. J., Allolio, B., & Schonecke, O. W. (1994). Physiological and psychological effects of Hatha-Yoga exercise in healthy women. *Int J Psychosom*, 41(1-4), 46-52.
- Selvamurthy, W., Sridharan, K., Ray, U. S., Tiwary, R. S., Hegde, K. S., Radhakrishnan, U., & Sinha, K. C. (1998). A new physiological approach to control essential hypertension. *Indian J Physiol Pharmacol*, 42(2), 205-213.
- Shanafelt, T. D., Barton, D. L., Adjei, A. A., & Loprinzi, C. L. (2002). Pathophysiology and Treatment of Hot Flashes. *Mayo Clinic Proceedings*, 77(11), 1207-1218. doi: 10.4065/77.11.1207
- Sievert, L. L., Saliba, M., Reher, D., Sahel, A., Hoyer, D., Deeb, M., & Obermeyer, C. M. (2008). The medical management of menopause: a four-country comparison care in urban areas. *Maturitas*, 59(1), 7-21. doi:10.1016/j.maturitas.2007.11.001.
- Simkin-Silverman, L., Wing, R., Boraz, M., & Kuller, L. (2003). Lifestyle intervention can prevent weight gain during menopause: Results from a 5-year randomized clinical trial. *Annals of Behavioral Medicine*, 26(3), 212-220. doi: 10.1207/s15324796abm2603_06
- Sparrowe, L., & Walden, P. (2002). *The Woman's Book of Yoga and Health*. Boston, MA: Shambala.
- Sung, B. H., Roussanov, O., Nagubandi, M., & Golden, L. (2000). Effectiveness of various relaxation techniques in lowering blood pressure associated with mental

- stress. *American Journal of Hypertension*, 13(4, Supplement 1), S185-S185.
- Tran, M. D., Holly, R. G., Lashbrook, J., & Amsterdam, E. A. (2001). Effects of Hatha Yoga Practice on the Health-Related Aspects of Physical Fitness. *Preventive Cardiology*, 4(4), 165-170.
- Twiss, J. J., Wegner, J., Hunter, M., Kelsay, M., Rathe-Hart, M., & Salado, W. (2007). Perimenopausal symptoms, quality of life, and health behaviors in users and nonusers of hormone therapy. *J Am Acad Nurse Pract*, 19(11), 602-613. doi: 10.1111/j.1745-7599.2007.00260.x
- Udupa, K. N., Singh, R. H., & Settiwar, R. M. (1975a). A comparative study on the effect of some individual yogic practices in normal persons. *Indian Journal of Medical Research*, 63(8), 1066-1071.
- Udupa, K. N., Singh, R. H., & Settiwar, R. M. (1975b). Physiological and biochemical studies on the effects of yogic and certain other exercises. *Indian Journal of Medical Research* 63(4), 620-624.
- Vongpatanasin, W. (2009). Autonomic regulation of blood pressure in menopause. *Semin Reprod Med*, 27(4), 338-345. doi: 10.1055/s-0029-1225262
- Wing, R. R., Matthews, K. A., Kuller, L. H., Meilahn, E. N., & Plantinga, P. L. (1991). Weight Gain at the Time of Menopause. *Arch Intern Med*, 151(1), 97-102. doi: 10.1001/archinte.1991.00400010111016
- Woods, N. F., Mitchell, E. S., & Smith-DiJulio, K. (2009). Cortisol levels during the menopausal transition and early postmenopause: observations from the Seattle Midlife Women's Health Study. *Menopause*, 16(4), 708-718 doi:10.1097/gme.1090b1013e318198d318196b318192.
- Writing Group for the Women's Health Initiative Investigators. (2002). Risks and Benefits of Estrogen Plus Progestin in Healthy Postmenopausal Women: Principal Results From the Women's Health Initiative Randomized Controlled Trial. *Jama*, 288(3), 321-333. doi: 10.1001/jama.288.3.321
- Yang, K. (2007). A Review of Yoga Programs for Four Leading Risk Factors of Chronic Diseases. *eCAM*, nem154. doi: 10.1093/ecam/nem154
- Yoga in America Study. (2008). Retrieved from www.yogajournal.com website: http://www.yogajournal.com/press/yoga_in_america

Chapter 3: Influence of a yoga intervention on quality of life and hormone levels in menopausal women

Abstract

Yoga is often recommended as a non-pharmacological approach for alleviating the wide range of symptoms associated with menopause. In popular literature it is suggested that the beneficial effects of yoga may result from changes in hormone levels, such as the adrenal androgen, DHEA-S and pituitary hormone FSH. The purpose of this study was to examine the effect of a 10 week yoga intervention on quality of life related to menopausal symptoms and to determine if there were associated changes in circulating DHEA-S and FSH. Volunteer participants were 17 inactive women between ages 45 and 60 experiencing menopause-related symptoms. Women were randomly assigned to either a 10 week Hatha yoga program (N= 10, age= 51.6±4.2, BMI= 27.2±5.8) or an active control group who completed a 10 week walking program (N=7, age= 53.1±4.1, BMI= 27.6±6.7). Both groups completed the Menopause Specific Quality of Life questionnaire (MENQOL) at week 0, 3,7, and 11 of the intervention to assess symptoms over four domains; vasomotor, psychosocial, physical, and sexual. Repeated measures ANOVA showed a trend for reduction in the vasomotor domain (p= 0.096) and summary score (p=0.066) for MENQOL in both groups. A trend towards reduction was seen for time (p= 0.066) and time by group (p= 0.074) for FSH. No changes in circulating DHEA-S were observed for either group. This suggests that 10 weeks of either yoga or walking will improve vasomotor symptoms of menopause, although this effect did not appear to be associated with changes in DHEA-S or FSH. An intervention longer than 10 weeks may be necessary to see changes in other domains of quality of life among menopausal

women.

3.1 Introduction

The practice of yoga for health benefits and overall wellness has long been promoted by leading yoga teachers and educators. More recently, interest has arisen in the purported benefits of yoga for women coping with the symptoms that accompany menopause.

Women in Canada have a life expectancy of 81 years (Millar, 1995), approximately one third of which will be spent in the transition through menopause and the years following. Menopause, defined as a decline in ovarian function leading to cessation of menstrual cycles, is associated with a host of disruptions including vasomotor symptoms such as hot flashes and sweating, sleep disturbances, anxiety, and mood disturbances, any of which can significantly compromise quality of life (Desindes et al., 2006).

The decline in estrogen that accompanies menopause (Rannevik et al., 1995) is presumed to be a factor in experience of symptoms, and one which may trigger fluctuations in adrenal and ovarian hormones such as DHEA-S and FSH. Higher levels of DHEA-S may protect against vasomotor symptoms (Øverlie et al., 2002) and is inversely associated with psychological distress and musculoskeletal pain (Finset, Øverlie, & Holte, 2004). The elevated levels of FSH associated with fluctuating estrogen, on the other hand, are associated with increased vasomotor symptoms (Freeman et al., 2007; Randolph et al., 2005) as well as cognitive, psychological and musculoskeletal symptoms (Freeman et al., 2007; Woods et al., 2007). While hormone replacement therapy (HRT) has been demonstrated to be an effective treatment for many symptoms of menopause,

use of HRT has declined significantly worldwide (Canadian Institute for Health Information [CIHI], 2008; Sievert, et al., 2008) after the Women's Health Initiative (WHI) study (Writing Group for the Women's Health Initiative Investigators, 2002) concluded that the overall risks to healthy post-menopausal women outweighed the benefits. Furthermore, the North American Menopause Society recently updated its position statement and now considers the benefit to risk ratio for HRT acceptable for short-term use only and no longer recommends HRT as a long term solution (North American Menopause Society [NAMS], 2010).

Fears of health risks such as breast cancer and heart attack associated with using HRT (Twiss, et al., 2007) have prompted interest in alternative, non-pharmacological approaches to symptom management (Kronenberg & Fugh-Berman, 2002; Twiss et al., 2007). While claims abound regarding the benefits and risks of various interventions for menopause symptoms, there is far less research on the effectiveness and safety of CAM therapies compared to that available on HRT (Cheung et al., 2003; Maslow, 2003).

Behavioural interventions, including paced respiration, meditation, and exercise have shown potential to relieve hot flashes and improve quality of life (Elavsky & McAuley, 2005; Freedman, 2005; Irvin, 1996; Ivarsson et al., 1998; Lindh-Åstrand et al., 2004). Yoga holds promise as an intervention that combines several of these potentially useful behavioural techniques. It has been suggested that yoga practice may modify hormonal function, thus leading to relief of symptoms in menopausal women (G. Iyengar, 1990; Sparrowe & Walden, 2002) but compared to other modes of exercise, experimental evidence to support the benefits of yoga is limited.

With increasing numbers of women experiencing menopause-related issues and a

subsequent decrease in quality of life, there is an increased interest in safe, inexpensive, non-invasive management of symptoms. Many women are interested in the use of complementary and alternative medicine (CAM) to treat symptoms of menopause (Kronenberg & Fugh-Berman, 2002) , and yoga continues to hold appeal as a relatively inexpensive, accessible, and non-invasive therapeutic intervention. Among Canadian women, 91% of those surveyed report trying CAM therapies for relief of symptoms, with 57% trying relaxation techniques and 37.6% trying yoga/meditation (Lunny & Fraser, 2009). This emphasizes the need for evidence-based information about the physiological effects of yoga to enable women to make informed choices about their health. To our knowledge, no study has examined the effects of yoga on menopausal symptoms and the hormones associated with the experience of symptoms. Therefore, the purpose of this study was to evaluate the effects of a yoga intervention on quality of life in relation to menopausal symptoms and chronic hormonal responses in comparison to a more traditional exercise intervention, walking. Improvement in quality of life was expected in both groups in association with decreases in FSH and increases in DHEA-S, with a larger effect expressed in the yoga group.

3.2 Materials and Methods

3.2.1 Subject recruitment and screening

Women ages 45-60 experiencing menopausal symptoms living in the Lethbridge, Alberta area were invited to participate in the 10 week activity intervention study through posters, electronic notice boards, newspaper articles and newsletters. Recruitment began in July 2009 and continued through January 2010 with intervention periods taking place in the fall of 2009 and spring of 2010, for a total of two intervention periods. Subjects

were defined as perimenopausal or menopausal based on self-reported bleeding patterns, and symptoms included any that participants felt negatively influenced quality of life, including vasomotor, cognitive, physical, social and sexual symptoms. Prospective subjects were screened for any contraindications to physical activity participation using the PAR-Q questionnaire and a health screening form. Women were excluded on the basis of use of hormone replacement therapy or any other medication known to affect endocrine function, oophorectomy, history of severe health problems, osteoporosis or any acute musculoskeletal condition that impaired their ability to participate. Women were also excluded if they had participated in a structured exercise program or smoked in the previous 6 months, or if they were unwilling to accept random assignment and confine their exercise activities to that of their assigned intervention group.

Prior to beginning the intervention, resting heart rate and blood pressure were taken and to ensure that they met the safety criteria established by the Canadian Society for Exercise Physiology, excluding those with a resting heart rate of >100 beats per minute (bpm) and resting blood pressure of >144/95 mmHg.

All subjects provided written informed consent. Participation was completely voluntary and participants were free to withdraw from the experiment at any time. The primary incentive was the opportunity to participate in yoga classes or group exercise sessions free of charge, with the additional incentive of a 50% discount on either the walking or yoga program at the University of Lethbridge upon completion of data collection. The experimental protocol was reviewed and approved by the University of Lethbridge Human Subject Research Committee., protocol #752.

3.2.2 Data collection and experimental procedures

A schematic of the experimental protocol used is seen in Figure 3.1. Participants attended two testing sessions one week prior to beginning and one week following the end of the intervention. During the first session, resting heart rate and blood pressure, height and weight were taken and resting blood samples were drawn. The Menopause-Specific Quality of Life questionnaires was completed by participants on their first session and then again at weeks 3, 7, and during the post intervention blood sampling session.

3.2.3 Activity interventions: Yoga and walking

Both activities were conducted at the First Choice Centre for Sport and Wellness University of Lethbridge with consent and approval from facility managers.

The yoga intervention group attended one group hatha yoga class a week. The 10 week syllabus was based on the beginner's class taught for recreation services, modified for older sedentary women. All classes were 75 minutes long and began with 10-15 minutes of pranayama (paced breathing) followed by 50 minutes of asana (postures) and concluding with 10-15 minutes savasana, (guided relaxation). Poses were selected and sequenced to develop strength, flexibility, and balance. As well, restorative poses, particularly those specifically considered beneficial to mid-life women and recommended for alleviating menopausal symptoms, were included in each practice (Sparrowe & Walden, 2002; Iyengar, G., 1990). Poses therefore consisted of a variety of standing, supine, and prone poses, as well as preparation for inverted poses. Participants were asked to practice for an additional 75 minutes at home with the use of handouts, videos, and worksheets to support program adherence, and permitted to accumulate the 75 minutes in multiple sessions if needed to accommodate their schedules. Emphasis was

placed on choosing the pose sequences or practice duration according to their needs, level of ability, and comfort.

Poses became more challenging as students progressed. However, students were shown how to modify poses and encouraged to respect their own limits and perform the poses in a way that allowed them to maintain comfort and equanimity through the pose, and to take extra rest if necessary. Yoga blocks, blankets and straps were used to assist in modification. This manner of practice in which individuals are encouraged to adapt the manner and intensity of poses to their individual requirements is consistent with the underlying principles of yoga, and as such, are not considered sources of variability, but adherence to the fundamental intentions of yoga practice.

The walking group served as an active control for comparison with a more traditional exercise intervention and to minimize the attrition found in inactive control groups. Participants met weekly to at a 200 metre indoor track for a supervised walking session and asked to walk independently for at least one additional session at similar intensity to the supervised session. Participants were provided with a walking exercise prescription and progress chart with guidelines for weekly progression. Walking intensity and duration were prescribed according to guidelines of the Canadian Society for Exercise Physiology (CSEP, 2004). Target heart rate ranges were calculated using the heart rate reserve method and the Borg scale for Rate of Perceived Exertion (Borg, 1982) used to modify heart rate if necessary. For supervised sessions, a group exercise leader led the class in a warm-up and cool-down, and assisted participants in finding their appropriate level of exercise intensity. Participants started with an initial intensity of 40-50% heart rate reserve (HRR) and duration of 15-20 minutes, increasing over the 10

weeks to 50-70% HRR and 30-50 minute durations.

Participants in both groups were asked to continue everyday activities of daily living and intermittent recreational activity, but to avoid other structured physical activity during the duration of the intervention. Participants kept a daily log in order to record class attendance, home practice, and any incidental activities that have the potential to affect the experimental outcome (injuries, illness, unusual but sporadic physical activity). All logs were collected at the end of the activity interventions for use in data interpretation.

3.2.4 Blood sampling and collection

For all sampling sessions, participants refrained from strenuous exercise for 24 hrs, alcohol for 12 hrs, caffeine for 4 hrs and food for 3 hrs before the samples were drawn (Tremblay & Chu, 2000).

Resting pre- and post-intervention blood samples were collected by lab technicians or registered nurses certified in phlebotomy. 5ml of blood each were drawn into plasma and serum vials. Samples were centrifuged and the serum or plasma stored at -80C till assayed.

3.2.5 Menopausal symptom assessment

Participants completed the Menopause Specific Quality of Life (MENQOL) questionnaire (Lewis, Hilditch, & Wong, 2005) pre and post intervention as well as twice more within the 10 week period.

The MENQOL was developed on women between the ages 47 and 62 to measure health-related quality of life symptoms 2-7 years following the last menstrual period. The questionnaire consists of 29 questions about menopause-related symptoms, each question

answered on an 8-point Likert scale to rate symptoms in four domains: vasomotor, physical, psychosocial and sexual. Domain-specific scores are calculated and a summary score is calculated as the mean of the four domain-specific scores. (Hilditch et al., 1996; Lewis et al., 2005). Domain internal consistency for the four domains ranged between 0.82 and 0.89 (Cronbach's alpha) and test-retest reliability over a 28 day interval ranged from 0.69 to 0.81 (intraclass correlation coefficient) (Lewis et al., 2005).

3.2.6 Biochemical Analysis

Samples were analysed in duplicate and all samples from an individual were analysed in the same plate to minimize variability and reduce chance of drift. Serum FSH and serum DHEA-S were analysed using commercial test kits (Alpco Diagnostics, Salem, NH.) Samples were thawed, vortexed and centrifuged prior to assay. Interassay and intra-assay variability for DHEA-S assay was 5.0 and 5.1% respectively and for FSH, 5.4 and 7.1%.

For all assay`s, plates were washed using a Biotek ELx405 microplate washer and read with a ELx808 Absorbance Microplate Reader using Gen5 Microplate Data Collection & Analysis software version 2.8 (BioTek Instruments Inc, Winooski, Vermont).

3.2.7 Data Analysis

For statistical analysis, subjects from the fall and spring session were pooled and organized by their activity group, either walking or yoga. MENQOL questionnaire data was coded according to the Likert scale and entered by hand. Assay data was exported from Gen 5 to Microsoft Excel for tabulation and organization and statistical analysis performed using SPSS. Repeated measures ANOVA was performed to determine if there

was change in MENQOL scores over the 10 week activity intervention and whether this change differed according to activity. Repeated measures ANOVA was also performed to determine if the 10 week intervention or activity type influenced concentrations of the hormones DHEA-S and FSH. All statistical tests were performed using SPSS 17.0 and statistical significance set at $p < 0.05$. Wherever the test for sphericity was significant ($p < 0.05$), degrees of freedom was adjusted using Geisser-Greenhouse correction.

3.3 Results

3.3.1 Recruitment, participation and adherence

A total of 85 women from the Lethbridge area contacted the University of Lethbridge Physiology lab through telephone or e-mail. 64 were screened out due to unavailability during the class times, use of HRT, smoking, regularly exercising, or not wishing to adhere to only one type of exercise, resulting in initial recruitment of 11 women into the walking group and 10 into the yoga group. One woman dropped out of the walking group after the first test session due to not wishing to be restricted to the assigned activity, and two dropped out after the first exercise session for unknown reasons, leaving a total of eight participants. The remaining eight participants completed the 10 week walking program, six returned MENQOL questionnaires and completed the post interventions fitness assessment and seven provided post-intervention blood collection. Of the ten women recruited into the yoga group, all completed the yoga program. Ten completed fitness assessments and provided post-intervention blood samples, and nine returned MENQOL questionnaires.

Subject data is shown in Table 3.1. There were no significant differences between the two groups in age, weight, or BMI at the outset of the intervention.

3.3.2 Menopause Specific Quality of Life Questionnaire

Changes in MENQOL scores over four survey times are shown in Figure 3.2. Repeated measures ANOVA indicated that no significant changes occurred for any domain or summary score in either group. A modest decrease in MENQOL score over all time periods was observed for the vasomotor domain in the walking (3.6 ± 2.1 to 2.9 ± 1.8) as well as the yoga (4.5 ± 1.6 to 3.6 ± 2.0) group, although this change did not reach significance ($F=3.228$, $p=0.096$). The summary score also decreased over all time periods for both the walking (3.2 ± 0.9 to 2.8 ± 1.3) and yoga (3.6 ± 0.9 to 3.1 ± 1.0) group although this change did not reach significance ($F=4.022$, $p=0.066$). Overall, there was a tendency towards symptom reduction with changes over time consistent between the two groups. There were no significant group differences in any of the domains or the summary score.

3.3.3 Chronic effects of activity intervention on hormone concentrations

Resting serum concentrations of FSH and DHEA-S before and after the activity intervention are shown in Table 3.2. Repeated measures ANOVA was used to examine changes in hormone levels over time and compare groups. Concentrations of DHEA-S remained unchanged pre and post intervention. Concentrations of FSH, however, decreased from 62.74 ± 35.8 to 44.99 ± 30.67 IU/L in the walking group and 57.11 ± 35.88 to 56.82 ± 38.44 IU/L in the yoga group. The decrease in FSH was not significant, but there was a non-significant trend for reductions over time ($F=3.933$, $p=0.066$) and time by group ($F=3.694$, $p=0.074$), with the decrease being more pronounced for the walking group.

3.4 Discussion

The results of the present study support previous research that shows a trend towards vasomotor symptom reduction and improved quality of life after 8-10 weeks of yoga. A walking group acted as an “active control” to allow comparison to a more traditional exercise mode, and we expected that yoga would be more effective than walking in reducing menopausal symptoms and quality of life due to the purported effects of yoga on hormonal activity. We further anticipated that this reduction in menopausal symptoms would be accompanied by an increase in DHEA-S and decrease in FSH levels, and that these changes would be more pronounced in the yoga group.

Results showed that both interventions produced minor reductions in MENQOL scores for all domains, but that the reductions were not significant; however, non-significant trends towards vasomotor symptom reduction and summary score were encouraging. Changes over time for MENQOL scores were similar between the two types of activity, and there was no evidence that yoga was more beneficial than walking in reduction of menopausal symptoms. It is possible that activity in general may provide beneficial effects to sedentary midlife women.

Results of the present study are similar to several that have shown favorable outcomes from yoga practice. An eight week intervention of restorative poses practiced weekly decreased the frequency and severity of hot flashes, with subjects showing program adherence and satisfaction (Cohen et al., 2007) and although a 10 week yoga program resulted in no reduction in the frequency or severity of hot flashes in 12 peri- and postmenopausal women (Booth-LaForce et al., 2007), intensity of symptoms and daily interference was reduced and sleep quality enhanced. Five out of six peri- and postmenopausal women who completed an 8 week yoga program had improved flexibility

and quality of life as indicated by the Menopause Specific Quality of Life (MENQOL) survey (Mastrangelo et al., 2007). The present study confirms these encouraging results and underlines the need for further research with larger subject numbers and comparison groups. Indeed, in 120 Indian women, greater reductions occurred for vasomotor symptoms and there was a larger, albeit non-significant, trend towards reduction of psychological symptoms in a yoga group compared with a control group (Chattha et al., 2008).

We were, however, unable to refute the assertion that there is insufficient evidence to recommend yoga as an intervention (Lee et al., 2009), and with regard to the benefits of yoga to menopausal women, studies that clearly demonstrate a relationship between yoga practice and hormonal changes remain scarce.

The relatively short duration of the intervention, 10 weeks of yoga practice or walking, may be inadequate to stimulate changes in the hormonal profiles of menopausal women. In particular, the time taken to achieve proficiency in all aspects of yoga practice – breathwork, postures, and relaxation – may have placed yoga participants at a disadvantage in comparison to the walking participants and limited the ability of yoga participants to benefit comparably from their practice within the same time frame. By the end of the 10 week intervention, yoga participants were still learning to effectively engage the musculoskeletal system in poses and to fully relax at the end of class. It is of note that inversions, regarded as among the most beneficial types of yoga poses for women, could not be performed during this time span, although modifications and preparations for inversions were practiced. In contrast, the walking participants were fully able to engage in their activity from the beginning of the intervention, progressing

in intensity and duration. It is possible that a longer intervention period, allowing the learning process to progress further, is necessary to determine whether the two modes of activity exert different effects on menopausal symptoms and associated hormones.

The change in FSH levels in the walking group is difficult to interpret. Despite the more marked decline in FSH levels in the walking group, the decrease in vasomotor symptoms associated with FSH levels was consistent between the two groups. The mechanism by which FSH may exert an influence on vasomotor symptoms is not understood, nor is it known whether elevated FSH is itself a cause or merely a marker of other changes leading to symptoms. Furthermore, changes in circulating hormone concentrations may not necessarily result in changes in physiological function at a cellular level (Tremblay & Chu, 2000) and thus the observed alterations in circulating FSH level were not closely tied to symptom expression. Similarly, the lack of any change in DHEA-S levels despite trends towards decreasing symptoms suggest that circulating hormone levels may not be directly related to physiological changes that lead to reduced symptoms .

The study demonstrates possible outcomes for sedentary menopausal women becoming moderately active. Participants from both activity groups showed good adherence, attending at least 7 out of 10 weeks of the group sessions. The social aspect of group exercise appeared to be important to the participants and several reported that this was a motivating factor in attending classes. Both exercise modes were well tolerated and participants found them enjoyable. Some yoga participants indicated they would have preferred more class times offered for flexibility of schedule, and would attend twice a week if possible. This gave an advantage to the walking group compared to the yoga

group, who reported that they found it challenging to find time and motivation to practice at home. In comparison, walking group participants either came to a second group session at the track or walked with a friend.

The generalisability of the results may be limited by the self-selected nature of the volunteer participants. All women who participated were of sufficient socio-economic status and flexible working hours that they were available to attend group classes. Thus, women with more restrictive employment or economic conditions were not included in the study. Excluding women on hormone replacement therapy may have eliminated the segment of the menopausal population whose symptoms were most severe, and those who participated in the study rarely reported symptoms being more than moderately bothersome in nature, perhaps resulting partially in a floor effect in terms of symptom reduction.

Potential confounders arose during the intervention that may have diluted measurable effects, such as substitution of exercise mode or problems adhering to the assigned activity. For example, one participant was injured in an accident at home and substituted cycling for walking for two weeks in order to maintain the prescribed exercise intensity. While larger subject numbers would be preferable, limitations exist in subject numbers for yoga intervention studies, particularly in sedentary populations with no yoga experience. In order to provide sufficiently detailed instruction, modify poses for participants, and ensure their safety, smaller class sizes are more feasible. In order to conduct studies of sufficient subject numbers and with sufficient power to detect changes, it would be necessary to conduct multiple cohorts. Longer terms of participation would give information on whether benefits become more pronounced with time and also if

yoga offers advantages over more traditional forms of physical activity.

The clinical significance of the present study is unclear. It appears that either walking or yoga as a physical intervention may have the potential to reduce vasomotor symptoms in previously sedentary menopausal women, although this may not be accompanied by changes in hormone levels. It also appears that in menopausal women, 10 weeks is too short a duration of physical activity to effect pronounced and significant changes to either menopausal symptoms across all domains of the MENQOL or levels of hormone associated with those symptoms.

The present study, while adding to the encouraging results seen in previous studies, does not definitively confirm the effectiveness of yoga as a treatment for menopausal symptoms, and points to the need for further research. The strength of this study lies in the use of randomization and a comparison group, along with analysis of blood hormones associated with menopausal symptoms and detailed statistical analysis. It suffers from the same limitations as other studies in terms of subject selection bias, lack of control for confounding factors, and small group sizes.

Despite the challenges posed by undertaking research on yoga, the fact that positive outcomes were seen in this and several previous studies indicates numerous avenues for further research, which may include other forms of comparison groups such as a sedentary control, yoga in combinations with other modes of activity, and investigation of other hormones known to be affected by the menopausal transition.

3.5 References

Booth-LaForce, C., Thurston, R. C., & Taylor, M. R. (2007). A pilot study of a Hatha yoga treatment for menopausal symptoms. *Maturitas*, 57(3), 286-295.

Borg, G. A. V. (1982). Psychophysical bases of perceived exertion. *Medicine & Science*

in Sports & Exercise, 14(5), 377-381.

- Chattha, R., Raghuram, N., Venkatram, P., & Hongasandra, N. R. (2008). Treating the climacteric symptoms in Indian women with an integrated approach to yoga therapy: a randomized control study. *Menopause, 15(5), 862-870.* doi: 10.1097/gme.1090b1013e318167b318902.
- Cheung, A. M., Chaudhry, R., Kapral, M., Jackevicius, C., & Robinson, G. (2003). The Women's Health Surveillance Report on Perimenopausal and Postmenopausal Health. Retrieved from <http://www.phac-aspc.gc.ca/publicat/whsr-rssf/index-eng.php>
- Cohen, B. E., Kanaya, A. M., Macer, J. L., Shen, H., Chang, A. A., & Grady, D. (2007). Feasibility and acceptability of restorative yoga for treatment of hot flashes: A pilot trial. *Maturitas, 56.*
- Elavsky, S., & McAuley, E. (2005). Physical activity, symptoms, esteem, and life satisfaction during menopause. *Maturitas, 52(3-4), 374-385.*
- North American Menopause Society. (2010). Estrogen and progestogen use in postmenopausal women: 2010 position statement of The *Menopause, 17(2), 242-255.* doi: 10.1097/gme.0b013e3181d0f6b9
- Finset, A., Øverlie, I., & Holte, A. (2004). Musculo-skeletal pain, psychological distress, and hormones during the menopausal transition. [doi: DOI: 10.1016/S0306-4530(02)00134-8]. *Psychoneuroendocrinology, 29(1), 49-64.*
- Freedman, R. R. (2005). Hot flashes: behavioral treatments, mechanisms, and relation to sleep. *The American Journal of Medicine, 118(12, Supplement 2), 124-130.*
- Freeman, E. W., Sammel, M. D., Lin, H., Gracia, C. R., Pien, G. W., Nelson, D. B., & Sheng, L. (2007). Symptoms Associated With Menopausal Transition and Reproductive Hormones in Midlife Women. *Obstetrics & Gynecology, 110(2, Part 1), 230-240.* doi:10.1097/1001.AOG.0000270153.0000259102.0000270140.
- Hilditch, J. R., Lewis, J., Peter, A., van Maris, B., Ross, A., Franssen, E., . . . Dunn, E. (1996). A menopause-specific quality of life questionnaire: development and psychometric properties. *Maturitas, 24(6), 161-175.*
- Hormone replacement therapy: an analysis focusing on drug claims by female seniors, 2000 to 2007. (2008). Retrieved from http://secure.cihi.ca/cihiweb/products/HRT_AIB_web.pdf
- Irvin, J. H., Domar, A.D., Clark, C., Zuttermeister P.C., and R. Friedman. (1996). The effects of relaxation response training on menopausal symptoms. [Journal]. *J. Psychom. Obstet. Gynecol., 17, 202-207.*

- Ivarsson, T., Spetz, A.-C., & Hammar, M. (1998). Physical exercise and vasomotor symptoms in postmenopausal women. *Maturitas*, 29(2), 139-146. doi: 10.1016/S0378-5122(98)00004-8.
- Iyengar, G. (1990). *Yoga, a Gem for Women*. Spokane, WA: Timeless Books.
- Kronenberg, F., & Fugh-Berman, A. (2002). Complementary and alternative medicine for menopausal symptoms: a review of randomized, controlled trials. *Ann Intern Med*, 137(10), 805-813.
- Lee, M. S., Kim, J.-I., Ha, J. Y., Boddy, K., & Ernst, E. (2009). Yoga for menopausal symptoms: a systematic review. *Menopause*, 16(3), 602-608 doi: 10.1097/gme.1090b1013e31818ffe31839.
- Lewis, J. E., Hilditch, J. R., & Wong, C. J. (2005). Further psychometric property development of the Menopause-Specific Quality of Life questionnaire and development of a modified version, MENQOL-Intervention questionnaire. *Maturitas*, 50(3), 209-221.
- Lindh-Åstrand, L., Nedstrand, E., Wyon, Y., & Hammar, M. (2004). Vasomotor symptoms and quality of life in previously sedentary postmenopausal women randomised to physical activity or estrogen therapy. *Maturitas*, 48(2), 97-105.
- Lunny, C. A., & Fraser, S. N. (2009). The Use of Complementary and Alternative Medicines Among a Sample of Canadian Menopausal-Aged Women.. *Journal of Midwifery & Women's Health*, 55(4), 335-343. doi: 10.1016/j.jmwh.2009.10.015
- Maslow, K. (2003). Problems in women's knowledge about menopause. [doi: DOI: 10.1016/0531-5565(94)90015-9]. *Experimental Gerontology*, 29(3-4), 351-353.
- Mastrangelo, M. A., Galantino, M. L., & House, L. (2007). Effects of Yoga on Quality of Life and Flexibility in Menopausal Women: A Case Series. *EXPLORE: The Journal of Science and Healing*, 3(1), 42-45.
- Millar, W. J. (1995). *Life Expectancy of Canadians*. Retrieved from <http://www.statcan.gc.ca/studies-etudes/82-003/archive/1995/5018983-eng.pdf>.
- Øverlie, I., Moen, M. H., Holte, A., & Finset, A. (2002). Androgens and estrogens in relation to hot flushes during the menopausal transition. *Maturitas*, 41(1), 69-77.
- Randolph, J. F., Jr, Sowers, M., Bondarenko, I., Gold, E. B., Greendale, G. A., Bromberger, J. T., . . . Matthews, K. A. (2005). The Relationship of Longitudinal Change in Reproductive Hormones and Vasomotor Symptoms during the Menopausal Transition. *J Clin Endocrinol Metab*, 90(11), 6106-6112. doi: 10.1210/jc.2005-1374

- Rannevik, G., Jeppsson, S., Johnell, O., Bjerre, B., Laurell-Borulf, Y., & Svanberg, L. (1995). A longitudinal study of the perimenopausal transition: altered profiles of steroid and pituitary hormones, SHBG and bone mineral density.. *Maturitas*, 21(2), 103-113. doi: 10.1016/0378-5122(94)00869-9
- Sievert, L. L., Saliba, M., Reher, D., Sahel, A., Hoyer, D., Deeb, M., & Obermeyer, C. M. (2008). The medical management of menopause: a four-country comparison care in urban areas. *Maturitas*, 59(1), 7-21. doi: 10.1016/j.maturitas.2007.11.001
- Sparrowe, L., & Walden, P. (2002). *The Woman's Book of Yoga and Health*. Boston, MA: Shambala.
- Tremblay, M. S., Chu, S.Y. (2000). Hormonal response to exercise: methodological considerations. In M. P. Warren, Constantini, (Ed.), *Sports Endocrinology* (pp. 1-30). NJ: Humana Press.
- Twiss, J. J., Wegner, J., Hunter, M., Kelsay, M., Rathe-Hart, M., & Salado, W. (2007). Perimenopausal symptoms, quality of life, and health behaviors in users and nonusers of hormone therapy. *J Am Acad Nurse Pract*, 19(11), 602-613. doi: 10.1111/j.1745-7599.2007.00260.x
- Woods, N. F., Smith-DiJulio, K., Percival, D. B., Tao, E. Y., Taylor, H. J., & Mitchell, E. S. (2007). Symptoms during the Menopausal Transition and Early Postmenopause and Their Relation to Endocrine Levels over Time: Observations from the Seattle Midlife Women's Health Study. *Journal of Women's Health (15409996)*, 16(5), 667-677. doi: 10.1089/jwh.2006.0138
- Writing Group for the Women's Health Initiative Investigators. (2002). Risks and Benefits of Estrogen Plus Progestin in Healthy Postmenopausal Women: Principal Results From the Women's Health Initiative Randomized Controlled Trial. *Jama*, 288(3), 321-333. doi: 10.1001/jama.288.3.321

Table 3.1: Mean (S.D.) age, weight and BMI of subjects pre- and post- yoga and walking interventions .

Group	n	Age (yrs)	Mass (kg)		BMI (kg/m ²)	
			pre	post	pre	post
Walk	8	52.6 (4.1)	72.4 (16.6)	73.0 (17.4)	27.1 (6.4)	27.3 (6.8)
Yoga	10	51.9 (4.3)	75.0 (15.3)	76.3 (15.7)	27.6 (5.9)	28.1 (6.0)

Table 3.2: Mean (S.D.) serum concentrations of DHEA-S and FSH of subjects pre- and post- yoga and walking interventions .

Group	n	DHEA-S ($\mu\text{g/ml}$ blood)		FSH (IU/L blood)	
		pre	post	pre	post
Walk	7	1.533 (0.695)	1.569 (0.695)	62.74 (35.80)	43.99 (30.67)*
Yoga	10	1.148 (0.459)	1.284 (0.690)	57.11 (35.88)	56.82 (38.44)*

DHEA-S: dehydroepiandrosterone sulfate, FSH: follicle stimulating hormone

*p=0.066 for time, p=0.074 for time by group

Figure 3.1: Schematic of experimental design

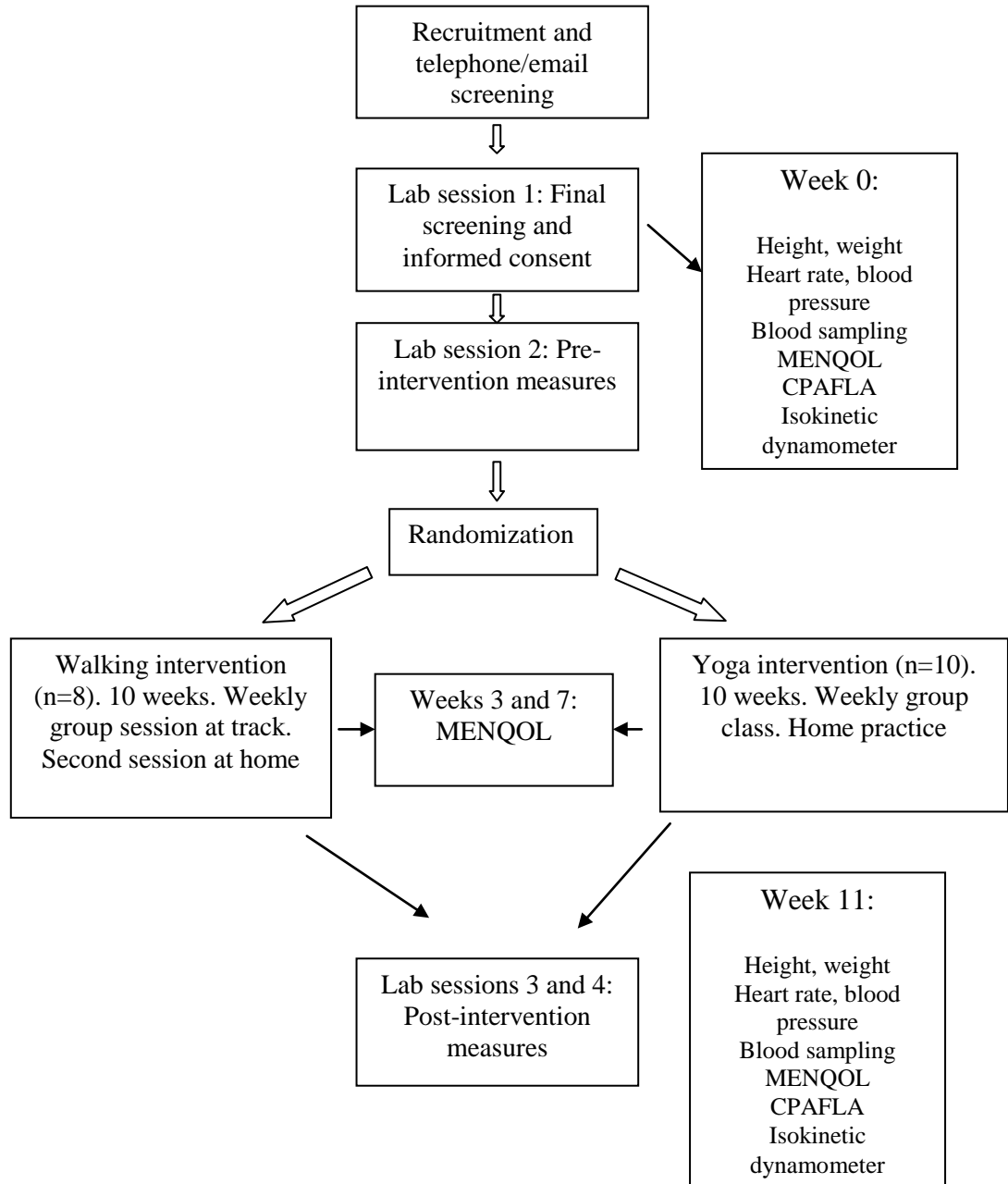
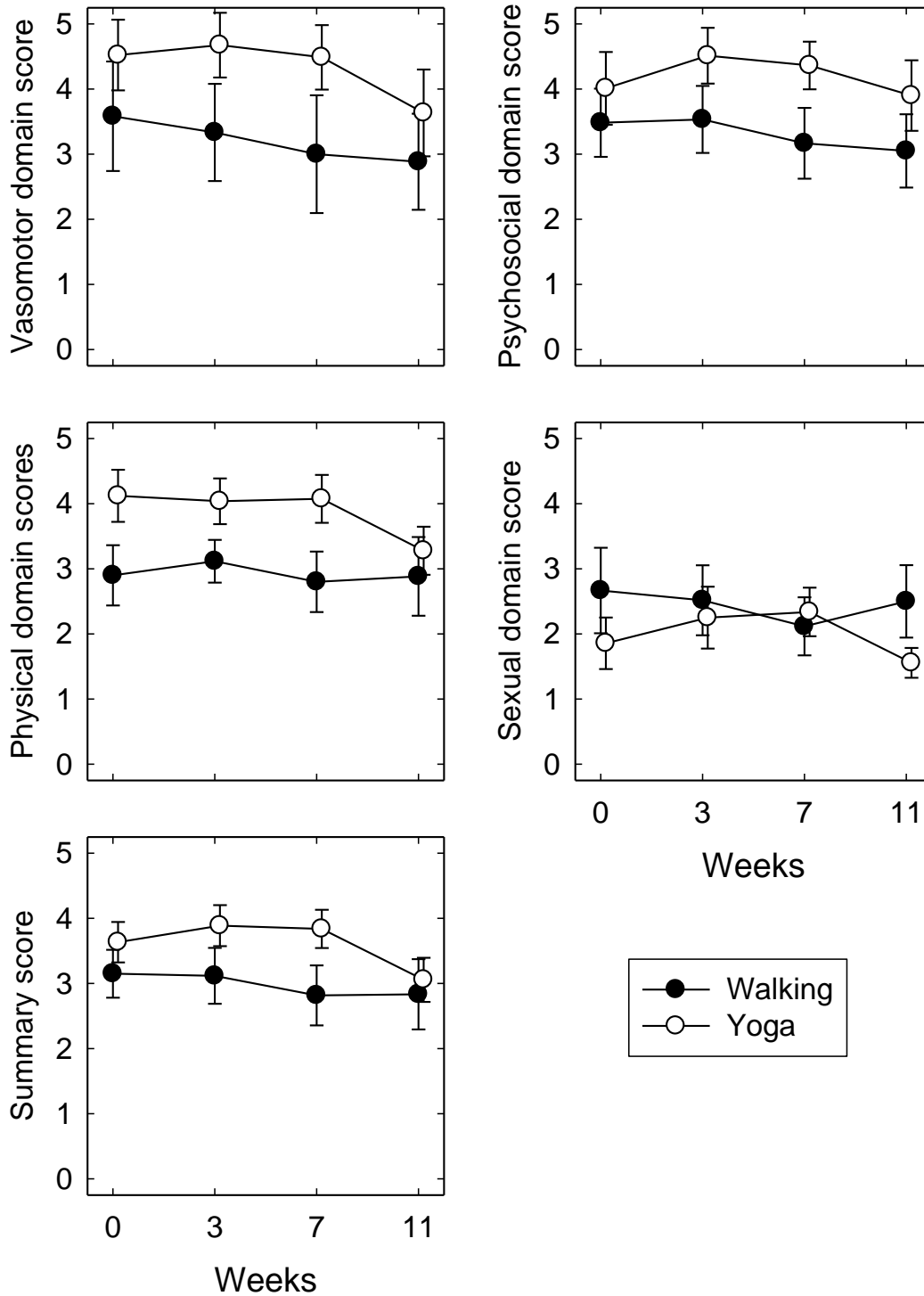


Figure 3.2: Menopause Specific Quality of Life Scores for four domains and summary score for subjects during the walking and yoga interventions. Vasomotor domain score $p=0.096$ for time, summary score $p=0.066$ for time.



Chapter 4: Influence of a yoga intervention on musculoskeletal fitness, heart rate, blood pressure and BMI in menopausal women

Abstract

Yoga is often recommended as a holistic approach to wellness of particular value to women undergoing menopause. In addition to the challenges posed by menopausal symptoms that may affect quality of life, the hormonal shifts and lifestyle changes that accompany the menopausal transition may lead to negative changes in physical fitness and health. The purpose of this study was to examine the effect of a 10 week yoga intervention on physiological and musculoskeletal fitness parameters. Volunteer participants were 18 inactive women between ages 45 and 60 experiencing menopause-related symptoms. Women were randomly assigned to either a 10 week Hatha yoga program (N= 10, age= 51.9±4.3, BMI= 27.6±5.9) or an active control group who completed a 10 week walking program (N=8, age= 52.6±4.1, BMI= 27.1±6.4). Before and after the intervention, both groups completed musculoskeletal fitness assessments, and resting heart rate, blood pressure, height and body mass were recorded. Upper body and trunk endurance were improved in both groups, as was leg extensor strength and trunk-forward flexibility. Grip strength and leg flexor strength, and extensor/flexor ratio remained unchanged. No changes were seen for systolic or diastolic blood pressure or resting heart rate. Body mass index significantly increased over time for both walking and yoga groups. Ten weeks of yoga or walking improved musculoskeletal fitness parameters in sedentary perimenopausal women. Additional activity or lifestyle changes may be required to prevent weight gain, and longer term activity participation may be necessary to see differences between the two modes of activity.

4.1 Introduction

The practice of yoga for health benefits and overall wellness has long been promoted by leading yoga teachers and educators. More recently, interest has arisen in the purported benefits of yoga for women coping with the changes that accompany menopause.

Women in Canada have a life expectancy of 81 years (Millar, 1995), approximately one third of which will be spent in the transition through menopause and the years following. The quality of life in these later years may be affected by hormonal status and the ability to enjoy activities unimpeded by disability or disease. Menopause, defined by a decline in ovarian function and cessation of menstrual periods, may bring on host of disruptions that include hot flashes, musculoskeletal and joint pain, sleep disturbances, and reduced energy levels, any of which can significantly compromise quality of life. With the decline in estrogen that accompanies ovarian failure, women have increasing concerns about risk of cardiovascular disease and tendency towards weight gain. While the role of estrogen in protection against cardiovascular disease remains equivocal (Pérez-López et al., 2009), estrogen withdrawal appears to be a factor in increased sympathoadrenal activity (Menozzi et al., 2000) and adrenergic sensitivity (Vongpatanasin, 2009) that may result in increased blood pressure during the menopausal period. Furthermore, it appears that weight management remains an important component in reducing cardiovascular risk, and that increased blood pressure during menopause is more closely related to increased body mass index (BMI) than to estrogen withdrawal itself (Cifkova et al., 2008).

There is growing evidence to support the beneficial effects of yoga on fitness and

health, including factors of particular concern to women at midlife such as musculoskeletal fitness and chronic disease risk. Yoga may be of particular importance to women in menopause as a safe, accessible exercise option to those experiencing the effects of aging such as chronic use injury, movement limitations, and inability to participate in high impact or high intensity activities.

Comprehensive reviews have shown strong indications that yoga practice can lead to improvements in cardiovascular disease indices (Innes et al., 2005) and musculoskeletal conditions (Raub, 2002), and yoga has been found to improve fitness parameters including strength and flexibility (Cowen & Adams, 2005; Tran et al., 2001). While typically not as intense as conventional exercise, yoga is an increasingly popular recreational activity, particularly among women who comprise 72% of the estimated 5.8 million practitioners in the US ("Yoga in America Study," 2008). Originally intended to address multiple aspects of wellness including mental, emotional and spiritual dimensions, yoga in the west has gained popularity as a physical exercise for stress relief, fitness, and overall health and wellness. Prescribing exercise for general health and for reducing the risk of chronic disease is well established, and the American College of Sports and Medicine (ACSM) advocates increased physical activity to enhance and preserve physical health in the general population (Haskell, 2007). However, compared to other modes of exercise, there may be limitations to the benefits offered by yoga, and it is unknown whether yoga provides sufficient physical activity to induce health benefits for menopausal women.

To our knowledge, no study has focused on the cardiovascular health and musculoskeletal fitness effects of yoga in otherwise healthy menopausal women.

Therefore, the purpose of this study was to evaluate the effects of a 10 week yoga intervention on musculoskeletal fitness, blood pressure and heart rate in perimenopausal women using a more traditional exercise intervention, walking, as an “active control”. Both groups were expected to improve in musculoskeletal fitness, with yoga participants showing greater upper body strength gains and walking participants showing greater improvements in lower body strength. Both groups were expected to improve flexibility and show decreased resting blood pressure and resting heart rate, with a greater effect seen in the yoga group, and weight loss seen in the walking group.

4.2 Materials and Methods

4.2.1 Subject recruitment and screening

Women ages 45-60 experiencing menopausal symptoms were invited to participate in the 10 week activity intervention study through posters, electronic notice boards, newspaper articles and newsletters. Recruitment began in July 2009 and continued through January 2010 for a total of two intervention periods. Subjects were defined as perimenopausal or menopausal based on self-reported bleeding patterns. Women were excluded on the basis of use of hormone replacement therapy or any other medication known to affect endocrine function, oophorectomy, history of severe health problems, osteoporosis or any acute musculoskeletal condition that impaired their ability to participate. Women were also excluded if they had participated in a structured exercise program or smoked in the previous 6 months, or if they were unwilling to accept random assignment and confine their exercise activities to that of their assigned intervention group.

Prospective subjects were screened for any contraindications to physical activity

participation using the PAR-Q questionnaire and a health screening form. Prior to beginning the intervention, resting heart rate and blood pressure were taken and to ensure that they met the safety criteria established by the Canadian Society for Exercise Physiology, excluding those with a resting heart rate of >100 beats per minute (bpm) and blood pressure of >144/95 mmHg.

All subjects provided written informed consent. Participation was completely voluntary and participants were free to withdraw from the experiment at any time. The primary incentive was the opportunity to participate in yoga classes or group exercise sessions free of charge, with the additional incentive of a 50% discount on either the walking or yoga program at the University of Lethbridge Sports and Recreational Services upon completion of data collection. The experimental protocol was reviewed and approved by the University of Lethbridge Human Subject Research Committee, protocol #752.

4.2.2 Data collection and experimental procedures

A schematic of the experimental protocol used is seen in Figure 4.1. Participants attended two testing sessions one week prior to beginning and one week following the end of the intervention. During the first session, resting heart rate and blood pressure, height and weight were taken. Participants were familiarized with the use of the HUMAC isokinetic dynamometer for isometric knee extension and flexion. Musculoskeletal fitness tests from the Canadian Physical Activity and Lifestyle Approach (CPAFLA) were administered in the second session and isometric leg strength for knee extension and flexion was assessed. Measurements were taken in an identical fashion at the end of the 10 week intervention. All testing sessions took place in the University of Lethbridge

Exercise Physiology Lab.

4.2.2 Activity interventions: yoga and walking

Both activities were conducted at the First Choice Centre for Sport and Wellness at the University of Lethbridge with consent and approval from facility managers. The yoga intervention group attended one group hatha yoga class a week. The 10 week syllabus was based on beginner classes taught for University of Lethbridge Sports and Recreation Services, modified for older sedentary women. All classes were 75 minutes long and began with 10-15 minutes of pranayama (paced breathing) followed by 50 minutes of asana (postures) and concluding with 10-15 minutes savasana, (guided relaxation). Poses were selected and sequenced to include those traditionally considered beneficial to mid-life women and to develop strength, flexibility, and balance. As well, restorative poses, particularly those specifically recommended for alleviating menopausal symptoms, were included in each practice. Poses therefore consisted of a variety of standing, supine, and prone poses, as well as preparation for inverted poses. Participants were asked to practice for an additional 75 minutes at home with the use of handouts, videos, and worksheets to support program adherence, and permitted to accumulate the 75 minutes in multiple sessions if needed to accommodate their schedules. Emphasis was placed on choosing the pose sequences or practice duration according to their needs, level of ability, and comfort.

Poses became more challenging as students progressed. However, students were shown how to modify poses and encouraged to respect their own limits and perform the poses in a way that allowed them to maintain comfort and equanimity through the pose, and to take extra rest if necessary. Yoga blocks, blankets and straps were used to assist in

modification. This manner of practice in which individuals are encouraged to adapt the manner and intensity of poses to their individual requirements is consistent with the underlying principles of yoga, and as such, are not considered sources of variability, but adherence to the fundamental intentions of yoga practice.

The walking group served as an active control for comparison with a more traditional exercise intervention and to minimize the attrition found in inactive control groups. Participants met at a 200 m indoor track at the university for a supervised walking session and asked to walk independently for at least one additional session at similar intensity to the supervised session. Participants were provided with a walking exercise prescription and progress chart with guidelines for weekly progression. Walking intensity and duration were prescribed according to the recommendations of the Canadian Society for Exercise Physiology (CSEP, 2004). Target heart rate ranges were calculated for each participant using the Karvonen method, and the Borg scale for Rate of Perceived Exertion (Borg, 1982) used to modify heart rate if necessary. For supervised sessions, a group exercise leader led the class in a warm-up and cool-down, and assisted participants in finding their appropriate level of exercise intensity. Participants began the program at an intensity of 40-50% heart rate reserve (HRR) and increased intensity over the 10 weeks to 50-70% HRR.

Participants in both groups were asked to continue everyday activities of daily living and intermittent recreational activity, but to avoid other structured physical activity during the duration of the intervention. Participants kept a daily log in order to record class attendance, home practice, and any incidental activities that have the potential to affect the experimental outcome (injuries, illness, unusual but sporadic physical activity).

All logs were collected at the end of the activity interventions for use in data interpretation.

4.2.3 Heart rate, blood pressure, body mass index

Resting heart rate was taken via palpation of the radial artery and recorded as beats per minute. Blood pressure was measured via auscultation. Both heart rate and blood pressure were taken three times during each test session and the lowest results used. Height and weight were taken and Body Mass Index (BMI) calculated using the formula $BMI = \text{kg}/\text{m}^2$.

4.2.4 Musculoskeletal fitness assessment

Participants performed a light 3-5 minute warmup on the stationary cycle with no resistance prior to musculoskeletal fitness testing. Three tests were chosen from the CPAFLA test battery: pushups and partial curls for upper body and trunk endurance and the sit and reach test for trunk-forward flexibility. Tests were administered as specified for women in the CPAFLA (CSEP, 2004).

Lower body strength was measured for isometric knee extension and flexion using the HUMAC Isokinetic dynamometer (HUMAC, Stoughton, MA) at a joint angle of 90 degrees. Participants were familiarized with the dynamometer and test protocol in their first session and there was a minimum of 24 hours between the familiarization and test sessions. The test protocol consisted of maximal effort at knee extension followed by maximal effort at knee flexion. One practice trial followed by three test trials were made, separated by 60 seconds of rest. All tests took place on the right side of the participant with the exception of one woman who was measured on the left side due to a malformed patella of the right leg.

4.2.5 Data Analysis.

An independent t-test was used to determine if any significant differences existed between groups at the start of the intervention for age, body mass, and body mass index. Repeated measures ANOVA was performed to determine if there was change in musculoskeletal fitness parameters over time and whether this change was different between groups. Repeated measures ANOVA was also performed to determine if time or activity type influenced resting heart rate, blood pressure, or body mass index (BMI). All statistical tests were performed using SPSS 17.0 and statistical significance set at $p < 0.05$. Wherever the test for sphericity was significant ($p < 0.05$), degrees of freedom was adjusted using Geisser-Greenhouse correction.

4.3 Results

4.3.1 Recruitment, participation and adherence

A total of 85 women from the Lethbridge area contacted the University of Lethbridge Physiology lab through telephone or e-mail. 64 were screened out due to unavailability during the class times, use of HRT, smoking, regularly exercising, or not wishing to adhere to only one type of exercise, resulting in initial recruitment of 11 women into the walking group and 10 into the yoga group. One woman dropped out of the walking group after the first test session due to not wishing to be restricted to the assigned activity, and two dropped out after the first exercise session for unknown reasons, leaving a total of eight participants. Of the remaining eight participants who completed the 10 week walking program, seven completed the CPAFLA test assessment and eight completed isokinetic dynamometry and had their heart rate, blood pressure, and BMI measured. Of the ten women recruited into the yoga group, all completed the yoga

program, and the fitness assessments.

Subject data is shown in Table 4.1. There were no significant differences between the two groups in age, weight, or BMI at the beginning of the intervention.

4.3.2 Musculoskeletal fitness

Musculoskeletal fitness assessments from CPAFLA are shown in Table 4.2 and lower body isometric strength measured through isokinetic dynamometry in Table 4.3. Both groups demonstrated significant improvements over time in upper body and trunk endurance ($F=6.209$, $p=0.025$ and $F=4.638$, $p=0.048$ respectively, Table 4.2), trunk-forward flexion ($F=25.686$, $p<0.0001$, Table 4.2), and isometric knee extensor strength ($F=4.923$, $p=0.041$, Table 4.4). The number of pushups performed increased by two repetitions in both the walking and yoga group, and partial curls increased by three and four repetitions in the walking and yoga groups respectively. Trunk-forward flexion measured by the sit and reach test increased by 4.7 cm for the walkers and 4.7 cm in the yoga group. Combined hand grip strength remained unchanged over time for both groups, and no interaction effects between time and group were observed.

Isometric lower body strength was improved over time in both groups for knee extension. Although the yoga group experienced a more marked increase in peak torque than the walking group, 13 vs 5Nm, the difference between the groups was not significant. Knee flexor strength and the extensor/flexor ratio remained unchanged.

Overall, improvements in musculoskeletal fitness were seen in both groups, with neither activity providing an advantage over the other in the parameters measured.

4.3.3 Resting heart rate, blood pressure, and body mass

Body weight and body mass index (BMI) pre and post intervention are shown in

Table 4.1, and systolic and diastolic blood pressure, and resting heart rate are shown in Table 4.4. No changes occurred over time for either group in blood pressure or resting heart rate, but both weight ($F=10.019$, $p=0.006$) and BMI ($F=10.297$, $p=0.005$) increased significantly in both groups over time. The walking group experienced a minor weight gain of 0.6 kg while the yoga group experienced a somewhat larger weight gain of 1.3 kg; however, neither increases in weight or BMI were significantly different between the groups.

4.4 Discussion

With increasing numbers of menopausal women seeking to improve musculoskeletal fitness and reduce chronic disease risk while coping with the reduced energy levels, weight gain and other physical symptoms of menopause, there is need for evidence-based information about the effects of yoga to enable women to make informed choices about their activity. We hypothesized that both walking and yoga would improve musculoskeletal fitness parameters, but that walkers would have greater gains in lower body strength while yoga participants would have greater gains in upper body and trunk strength, and that both groups would improve in trunk forward flexion. We also hypothesized that both types of activity would be associated with decreases in resting heart rate and systolic and diastolic blood pressure, and that walking would result in weight loss.

The results of the present study show that 10 weeks of either yoga or walking improves musculoskeletal fitness, but is not adequate to produce significant changes in blood pressure or heart rate. Neither yoga nor walking appeared to be sufficient to prevent weight gain in either group, and although the average weight gain of the yoga

participants was greater than that of walkers, this difference was not statistically significant.

Results support previous research in which yoga has been found to improve fitness parameters (Tran et al., 2001) such as upper and lower body muscular strength and lower body muscular endurance as well as joint flexibility. Improved upper body and trunk strength, endurance and flexibility was also observed by Cowen and Adams (2005) who further suggest that style of yoga will influence the degree and type of benefit.

Despite the differences in the two modes of activity, similar improvements were observed in upper and lower body strength. It is possible that greater core activation, increased proprioception, and improved body awareness assisted walkers in performance of upper body and trunk tests, and that the isometric nature of standing yoga postures allowed yoga participants to develop comparable knee extensor strength. The flexibility improvements in both groups were expected due to the leg stretches incorporated into yoga and the stride development and leg stretches included in the cool down for the walkers.

There was no evidence that yoga may play a role in weight management. Reduced body mass has previously been observed in one study (Yang, 2007) while remaining unchanged in another (Tran et al., 2001). There is some evidence that yoga practice may ameliorate the weight gain typically seen at menopause (Guarracino, 2007), but since the present study did not include a sedentary control group we were unable to determine whether yoga or walking modified potential weight gain in comparison to complete inactivity.

The observed weight gain in both groups may indicate that both interventions

were of insufficient intensity to create a neutral or negative energy balance. The greater weight gain in the yoga group, although not significant, may be the result of lower exercise intensity relative to walking. Increase in body weight during menopause is typical, with an average of 2.25 kg gained over three years in association with an increase in other coronary disease risk factor such as increased blood pressure and blood lipids (Wing et al., 1991). Behavioural lifestyle interventions such as dietary changes and physical activity have been shown to mitigate this weight gain (Blanck et al., 2007; Krumm et al., 2006; Simkin-Silverman et al., 2003), indicating that long term physical activity is an important component to weight management in menopausal women, and that habitual physical activity is crucial to this population for weight management and avoidance of co-morbid conditions that contribute to cardiovascular disease risk. On the other hand, it is also possible that both groups gained a small amount of muscle mass, resulting in weight gained without the addition of body fat. At this time, however, the effect of yoga on weight management remains equivocal.

No reductions were observed in systolic or diastolic blood pressure or resting heart rate. We were thus unable to confirm the findings of previous studies in which several weeks of yoga practice led to reduction in systolic or diastolic blood pressure or both (Cowen & Adams, 2005; Damodaran, 2002; Guarracino, 2007; Selvamurthy et al., 1998; Yang, 2007) and lower resting heart rate (Konar et al., 2000; Selvamurthy et al., 1998). This may again be the result of insufficient exercise intensity from either walking or yoga to stimulate changes in cardiovascular function. Blood pressure at the beginning of the intervention was already within normal range, potentially causing a floor effect in which little further reduction could be expected.

Yoga has been classified as mild to moderate in intensity, since the intermittent nature of the poses provides no sustained cardiovascular effect (Blank, 2006; Cowen & Adams, 2007). With a metabolic cost of only 2.5 METS and intensity of 49.4% maximum heart rate over a single yoga session, yoga may not meet recommendations for cardiovascular improvement (Hagins, 2007) and it is possible that only vigorous styles such as ashtanga yoga may increase the heart rate sufficiently to improve cardiovascular fitness (Cowen & Adams, 2007). However, this does not explain the lack of improvement in the walking group, as participants followed aerobic exercise guidelines in which both exercise intensity and duration increased during the 10 week intervention. The results are difficult to interpret. It may be that the recommended intensity was not reached during unsupervised walking sessions, and that twice weekly sessions are not frequent enough for improvement in this population. Our study showed no improvements in either group for cardiovascular fitness through resting heart rate or resting blood pressure despite improvements in musculoskeletal fitness.

Yoga continues to be perceived as a mode of activity leading to health benefits. A recent examination of National Health Interview Survey data showed that 61% of yoga users felt that their practice was important in maintaining health, particularly mental health and musculoskeletal conditions (Birdee et al., 2008) and yoga is promoted in popular literature as a means of augmenting conventional therapies (McCall, 2007). Although in a recent review (Ross & Thomas, 2010), traditional exercise appeared to be better than yoga for physical fitness, yoga was found to be as effective or better for other health outcomes such as blood lipids, blood glucose, heart rate variability and perceptions of stress, and thus continue to be of value in reduction of chronic disease risk. While our

results showed that in menopausal women, yoga may be as effective as traditional exercise for musculoskeletal fitness, this is only one component in a whole range of potential measures for health and wellness. Further studies in this population using longer intervention times, greater frequency of practice, sedentary comparison groups, and additional measurement criteria such as food intake and body fat percentage would increase knowledge of the effect of yoga in menopausal women.

Though not the primary aim of the study, it appeared to be successful in engaging sedentary women in physical activity during a period in which the role of activity in health management is crucial. Participants reported that they enjoyed the activity and group environment and several indicated that they would be interested in continuing either activity after the intervention was over. Both activities were mild to moderate in intensity, well tolerated and enjoyed by the participants, and thus have the potential to introduce sedentary women to habitual physical activity that may be adopted as a long term lifestyle change, and ultimately lead to the health benefits not realized in the short term of this study.

4.5 References

- Birdee, G., Legedza, A., Saper, R., Bertisch, S., Eisenberg, D., & Phillips, R. (2008). Characteristics of Yoga Users: Results of a National Survey. *Journal of General Internal Medicine*, 23(10), 1653-1658. doi: 10.1007/s11606-008-0735-5
- Blanck, H. M., McCullough, M. L., Patel, A. V., Gillespie, C., Calle, E. E., Cokkinides, V. E., . . . Serdula, M. K. (2007). Sedentary Behavior, Recreational Physical Activity, and 7-Year Weight Gain among Postmenopausal U.S. Women[ast]. *Obesity*, 15(6), 1578-1588.
- Blank, S. E. (2006). Physiological responses to Iyengar yoga performed by trained practitioners. *Journal of Exercise Physiology Online*, 9(1), 7-23.
- Borg, G. A. V. (1982). Psychophysical bases of perceived exertion. *Medicine & Science*

in Sports & Exercise, 14(5), 377-381.

The Canadian Physical Activity, Fitness, and Lifestyle Approach: CSEP – Health and Fitness Program's Health-Related Appraisal and Counselling Strategy (2004). (3rd ed.). Ottawa, ON: Canadian Society for Exercise Physiology.

Cifkova, R., Pitha, J., Lejskova, M., Lanska, V., & Zecova, S. (2008). Blood pressure around the menopause: a population study. *Journal of Hypertension, 26(10)*, 1976-1982. doi:10.1097/HJH.1970b1013e32830b32895c.

Cowen, V. S., & Adams, T. B. (2005). Physical and perceptual benefits of yoga asana practice: results of a pilot study. *Journal of Bodywork and Movement Therapies, 9(3)*, 211-219.

Cowen, V. S., & Adams, T. B. (2007). Heart rate in yoga asana practice: A comparison of styles. *Journal of Bodywork and Movement Therapies, 11(1)*, 91-95.

Damodaran, A., Malathi, A., Patil, N., Shah, N., Suryavanshi, Marathe, S. (2002). Therapeutic potential of Yoga practices in modifying cardiovascular risk profile in middle aged men and women. *50(MAY)*, 8.

Guarracino, J. L. M. S., Susan MS; Edelstein, Sari PhD, RD (2007). Yoga Participation Is Beneficial to Obesity Prevention, Hypertension Control, and Positive Quality of Life. *Topics in Clinical Nutrition, 21(1)*, 108-113.

Hagins, M., Moore, W. & Rundle, A. (2007). Does practicing hatha yoga satisfy recommendations for intensity of physical activity which improves and maintains health and cardiovascular fitness? *BMC Complement Altern Med. , 7(40)*. doi: doi: 10.1186/1472-6882-7-40.

Haskell, W. L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C.A., Heath, G.W., Thompson, P.D., Bauman, A. . (2007). Physical Activity and Public Health: Updated Recommendation for Adults from the American College of Sports Medicine and the American Heart Association. *Medicine and Science in Sports and Exercise, 39(8)*, 1423-1434.

Innes, K. E., Bourguignon, C., & Taylor, A. G. (2005). Risk indices associated with the insulin resistance syndrome, cardiovascular disease, and possible protection with yoga: A systematic review. *Journal of the American Board of Family Practice, 18(6)*, 491-519.

Konar, D., Latha, R., & Bhuvaneshwaran, J. S. (2000). Cardiovascular responses to head-down-body-up postural exercise (Sarvangasana). *Indian J Physiol Pharmacol. , 44(4)*, 392-400.

Krumm, E. M., Dessieux, O. L., Andrews, P., & Thompson, D. L. (2006). The

Relationship between Daily Steps and Body Composition in Postmenopausal Women. *Journal of Women's Health*, 15(2), 202-210.
doi:10.1089/jwh.2006.15.202

McCall, T. (2007). *Yoga as Medicine*. New York, NY: Bantam Books.

Menozzi, R., Cagnacci, A., Zanni, A. L., Bondi, M., Volpe, A., & Del Rio, G. (2000). Sympathoadrenal response of postmenopausal women prior and during prolonged administration of estradiol. *Maturitas*, 34(3), 275-281.

Millar, W. J. (1995). *Life Expectancy of Canadians*. Retrieved from <http://www.statcan.gc.ca/studies-etudes/82-003/archive/1995/5018983-eng.pdf>.

Pérez-López, F. R., Chedraui, P., Gilbert, J. J., & Pérez-Roncero, G. (2009). Cardiovascular risk in menopausal women and prevalent related co-morbid conditions: facing the post-Women's Health Initiative era. *Fertility and Sterility*, 92(4), 1171-1186. doi: 10.1016/j.fertnstert.2009.06.032

Raub, J. A. (2002). Psychophysiological effects of Hatha Yoga on musculoskeletal and cardiopulmonary function: A literature review. *Journal of Alternative and Complementary Medicine*, 8(6), 797-812.

Ross, A., & Thomas, S. (2010). The health benefits of yoga and exercise: a review of comparison studies. *J Altern Complement Med*, 16(1), 3-12. doi: 10.1089/acm.2009.0044

Selvamurthy, W., Sridharan, K., Ray, U. S., Tiwary, R. S., Hegde, K. S., Radhakrishnan, U., & Sinha, K. C. (1998). A new physiological approach to control essential hypertension. [Journal article]. *Indian J Physiol Pharmacol*, 42(2), 205-213.

Simkin-Silverman, L., Wing, R., Boraz, M., & Kuller, L. (2003). Lifestyle intervention can prevent weight gain during menopause: Results from a 5-year randomized clinical trial. *Annals of Behavioral Medicine*, 26(3), 212-220. doi: 10.1207/s15324796abm2603_06

Tran, M. D., Holly, R. G., Lashbrook, J., & Amsterdam, E. A. (2001). Effects of Hatha Yoga Practice on the Health-Related Aspects of Physical Fitness. *Preventive Cardiology*, 4(4), 165-170.

Vongpatanasin, W. (2009). Autonomic regulation of blood pressure in menopause. *Semin Reprod Med*, 27(4), 338-345. doi: 10.1055/s-0029-1225262

Wing, R. R., Matthews, K. A., Kuller, L. H., Meilahn, E. N., & Plantinga, P. L. (1991). Weight Gain at the Time of Menopause. *Arch Intern Med*, 151(1), 97-102. doi: 10.1001/archinte.1991.00400010111016

Yang, K. (2007). A Review of Yoga Programs for Four Leading Risk Factors of Chronic Diseases. *eCAM*, nem154. doi: 10.1093/ecam/nem154

Yoga in America Study. (2008). Retrieved from www.yogajournal.com website:
http://www.yogajournal.com/press/yoga_in_america

Table 4.1: Mean (S.D.) age, weight and BMI of subjects pre- and post- yoga and walking interventions .

Group	n	Age (yrs)	Mass (kg)		BMI (kg/m ²)	
			pre	post	pre	post
Walk	8	52.6 (4.1)	72.4 (16.6)	73.0 (17.4)*	27.1 (6.4)	27.3 (6.8)**
Yoga	10	51.9 (4.3)	75.0 (15.3)	76.3 (15.7)*	27.6 (5.9)	28.1 (6.0)**

BMI: body mass index. *p=0.005 for time, **p=0.006 for time

Table 4.2: Mean (S.D.) systolic and diastolic blood pressure and resting heart rate pre and post intervention.

	Walk (n=8)		Yoga (n=10)	
	Pre	Post	Pre	Post
SBP	111.3 (10.0)	110.3 (8.5)	113.4 (12.9)	114.0 (14.3)
DBP	69.8 (9.3)	69.8 (7.4)	72.6 (10.3)	73.6 (13.6)
RHR	63.5 (4.0)	63.5 (4.0)	61.6 (6.0)	60.0 (5.0)

SBP: systolic blood pressure, DBP: diastolic blood pressure, RHR: resting heart rate

Table 4.3: Mean (S.D.) upper body strength and flexibility pre and post intervention.

	Walk (n=7)		Yoga (n=10)	
	Pre	Post	Pre	Post
Pushup (reps)	7.9 (6.0)	9.7 (6.0)*	6.4 (6.2)	8.5 (8.7)*
Sit and reach (cm)	27.6 (10.2)	31.7 (8.7)**	25.4 (12.2)	30.1 (10.7)**
Partial curl (reps)	2.9 (5.9)	7.4 (7.3)†	5.8 (6.0)	11.1 (15.7)†
Hand grip (kg)	31.1 (2.7)	31.5 (1.6)	30.4 (5.4)	32.1 (4.4)

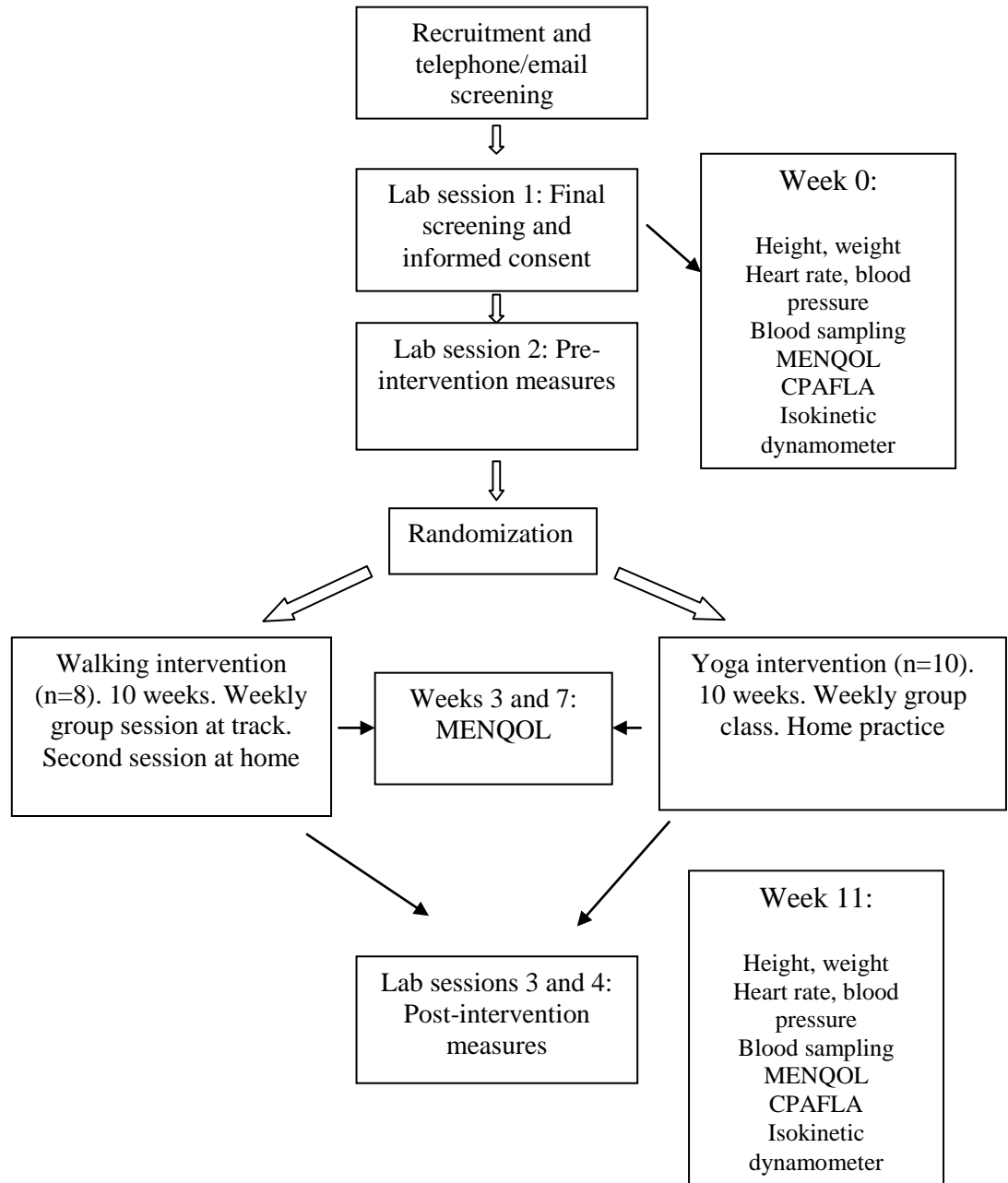
*p=0.025, **p<0.001, †p=0.048

Table 4.4: Mean (S.D.) knee extensor and flexor isometric strength pre and post intervention.

Peak Torque (Nm)	Walk (n=8)		Yoga (n=10)	
	Pre	Post	Pre	Post
Extension	140.3 (26.2)	145.0 (27.8)*	150.5 (33.4)	163.0 (27.8)*
Flexion	52.0 (15.4)	57.1 (13.5)	60.6 (25.9)	63.5 (18.2)
Ratio	36.6 (7.9)	40.1 (10.5)	40.1 (13.9)	38.9 (8.0)

*p=0.041

Figure 4.1: Schematic of experimental design



Chapter 5: Acute effects of a single session of yoga on adrenal androgens in menopausal women

Abstract

Yoga is often recommended to women undergoing menopause, particularly in coping with menopausal symptoms and the stress of midlife transition. In popular literature it is suggested that yoga may relieve stress by modifying neuroendocrine activity. Some studies suggest this effect may be mediated via the hypothalamus-pituitary-adrenal (HPA) axis, resulting in changes in hormones associated with the stress response. Few studies on the hormonal response to yoga have been conducted on midlife women, to whom yoga is frequently recommended. Thus, the objective of this study was to investigate the effect of a yoga session on two adrenal hormones associated with hypothalamic-pituitary-adrenal function: cortisol and dehydroepiandrosterone-sulfate (DHEA-S). Fourteen women aged 45-60 with at least 10 weeks yoga experience participated in a guided hatha yoga session. The same women also participated in a separate control session at the same time of day, during which they rested in the laboratory. Saliva and blood samples were collected before and after each session and analysed using ELISAs. Repeated measures ANOVA demonstrated that no changes occurred for salivary cortisol or serum DHEA-S over time, nor were there differences between the control or yoga session. No evidence was found that a single session of yoga modified neuroendocrine function by altering levels of hormones associated with the HPA axis.

5.1 Introduction

Women in Canada have a life expectancy of 81 years (Millar, 1995), approximately one third of which will be spent in the transition through menopause and the years following. Due to the increasing age of the population an unprecedented number of women will experience the transition to menopause in the coming decades. Menopause, defined as a decline in ovarian function leading to cessation of menstrual cycles, is associated with a host of disruptions such as hot flashes and sweating, musculoskeletal pain, sleep disturbances, anxiety, and mood disturbances, any of which can significantly compromise quality of life.

While the underlying mechanisms for the development of these symptoms are poorly understood, there is evidence that withdrawal of estrogen accompanying ovarian failure leads to increases in sympathetic nervous system activity as well as increased adrenocortical reactivity to stress (Lindheim et al., 1992; Vongpatanasin, 2009). Other pituitary, adrenal, and gonadal hormones may be altered along with estrogen withdrawal and are associated with the experience of menopausal symptoms. There is some evidence that higher levels of the adrenal androgen dehydroepiandrosterone-sulfate (DHEA-S), which becomes the main source of estrogen in women post-menopause, may protect against some menopausal symptoms (Finset, Øverlie, & Holte, 2004; Øverlie, Moen, Holte, & Finset, 2002) although this has not been universally observed (Randolph et al., 2005).

Menopausal women may thus benefit from therapies that modulate levels of ovarian, adrenal, and pituitary hormones. While hormone replacement therapy (HRT) is indeed effective, concerns about health risk associated with HRT use has led to attention

turning towards non-pharmacological strategies such as behavioral interventions. Exercise, meditation, and controlled breathing have shown potential for reducing menopausal symptoms (Elavsky & McAuley, 2005; Freedman, 1992; Irvin, 1996; Ivarsson, Spetz, & Hammar, 1998) and hatha yoga represents a combination of all of these behavioural strategies. The practice of yoga for health benefits and overall wellness has long been promoted by leading yoga teachers and educators and more recently, interest has arisen in the purported benefits of yoga for women coping with the symptoms that accompany menopause. The health benefits ascribed to yoga are numerous, and practices recommended for women emphasize the beneficial effects on the neuroendocrine system, particularly the effect on stress responses mediated through the sympathetic nervous system and hypothalamic-pituitary-adrenal (HPA) axis (Browning Miller, 2007; G. Iyengar, 1990; McCall, 2007; Sparrowe, 2002). Through compression and release of the surrounding tissue, circulation to the glands is believed to be enhanced (Raman, 1998), and certain poses are said to regulate function of the adrenal glands and thus “quiet” the sympathetic nervous system (B. K. S. Iyengar, 1991). Furthermore, the pranayama (breathwork) and savasana (guided relaxation) that are intrinsic to yoga practice may mediate hyperarousal of the sympathetic nervous system (McGonigal, 2009) and moderate activity of the hypothalamic-pituitary-adrenal axis, lowering the release of stress hormones such as cortisol (McCall, 2007). However, DHEA-S is also responsive to HPA activity and the response of this hormone to yoga is unknown.

There has been limited research to assess the effects of yoga on hormonal responses in menopausal women and to our knowledge, no study has examined the acute effects of a single session of yoga on hormones of the hypothalamic-pituitary-adrenal

axis in this population. Therefore, the purpose of this study was to evaluate the effects of a single session of yoga on circulating levels of cortisol and DHEA-S in comparison to a rest session. We anticipated that yoga would result in decreased circulating cortisol beyond that found in normal diurnal variation, and increased levels of DHEA-S.

5.2 Materials and Methods

5.2.1 Subject recruitment and screening

Women with a minimum of 10 weeks yoga experience aged 45-60 and experiencing menopausal symptoms were invited to participate in the study through notice boards, flyers, and local yoga teachers. Women were defined as menopausal based on self-reported bleeding patterns and included if they had sufficient yoga experience to be familiar with basic yoga postures, relaxation, and breathing techniques. Prospective subjects were screened for any contraindications to physical activity participation using the PAR-Q questionnaire and a health screening form. Resting heart rate and blood pressure were taken to ensure that they met the safety criteria established by the Canadian Society for Exercise Physiology, excluding those with a resting heart rate of >100 beats per minute (bpm) and blood pressure of >144/95 mmHg. All subjects provided written informed consent. Participation was voluntary and participants were free to withdraw from the experiment at any time. Participants were offered a \$15 gift certificate to a local yoga clothing store as incentive. The experimental protocol was reviewed and approved by the University of Lethbridge Human Subject Research Committee, protocol #752.

5.2.2 Acute hormone responses to yoga: Blood and saliva sampling and collection

For both yoga and rest sessions, participants refrained from strenuous exercise for 24 hrs, alcohol for 12 hrs, caffeine for 4 hrs and food for 3 hrs before the sessions were

held. Pre- and post-session blood samples were collected by venipuncture and 5ml of blood from each participant was drawn into serum vials. Samples were centrifuged and the serum stored at -80C till assayed. For salivary cortisol, saliva was collected by having participants passively allow saliva to pool in the mouth, then drop through a drinking straw into a .5 ml microcentrifuge vial. Saliva samples were also stored at -80C till assayed.

Each participant served as their own control in order to assess the diurnal changes in hormones. During the yoga session, saliva and blood samples were collected immediately before and after a 75 minute guided class that included pranayama (controlled breathing) asana (physical postures) and savasana (guided relaxation). During the control session, blood and saliva samples were collected before and after participants sat quietly reading for the 75 minutes. The two sessions were completed at the same time of day in random order 48 hours apart.

5.2.3 Biochemical Analysis

Samples were analysed in duplicate and all samples from an individual were analysed in the same plate to minimize variability and reduce chance of drift. Serum DHEA-S and salivary cortisol were analysed using commercial test kits (Alpco Diagnostics, Salem, NH, Salimetrics) Samples were thawed, vortexed and centrifuged prior to assay. Interassay and intra-assay variability for DHEA-S assay was 5 and 5.1% respectively and for cortisol, 3.4 and 5.5%.

For all assays, plates were washed using a Biotek ELx405 microplate washer and read with a ELx808 Absorbance Microplate Reader using Gen5 Microplate Data Collection & Analysis software version 2.8 (BioTek Instruments Inc, Winooski,

Vermont).

5.2.4 Data Analysis

For statistical analysis, assay data was exported from Gen 5 to Microsoft Excel for tabulation and organization and statistical analysis performed using SPSS. Repeated measures ANOVA was used to determine whether levels of salivary cortisol, or serum DHEA-S changed over the 75 minute session, and if differences in hormone levels existed between the yoga and rest session. All statistical tests were performed using SPSS 17.0 and statistical significance set at $p < 0.05$. Wherever the test for sphericity was significant ($p < 0.05$), degrees of freedom was adjusted using Geisser-Greenhouse correction.

5.3 Results

5.3.1 Subject participation and data treatment.

A total of 14 women participated in the acute session, 9 who had completed a 10 week yoga intervention, and an additional 5 who were recruited in April 2010. The average age was 52.8 ± 3.9 and body mass index (BMI) was 25.3 ± 5.1 . Three out of the 14 women were on hormone replacement therapy and all had a minimum of 10 weeks yoga experience. One woman experienced discomfort and stress during the blood sampling in the final session, and for this reason, her data were excluded, leaving data from 13 women for statistical analysis.

5.3.2 Cortisol and DHEA-S

There was no significant change in salivary cortisol or serum DHEA-S in either the control (rest) or yoga session over time, as can be seen in Table 1. Although there was a negligible rise in cortisol levels for the yoga session, and a modest decrease over time

in the control session, this difference was not significant. The control session cortisol levels were within normal range for evening cortisol (Salimetrics, State College, PA 2009). DHEA-S remained unchanged over time in both rest and yoga sessions.

5.4 Discussion

We hypothesized that a single session of yoga would result in a significant reduction in cortisol beyond that of normal diurnal variation, and in a significant increase in DHEA-S. Results showed that a 75 minute yoga session did not result in significant changes in cortisol or DHEA-S, and thus no support was found for the claim seen in popular literature that yoga exerts an effect on the neuroendocrine system.

The results add to the already contradictory evidence on the effects of yoga on hormones of the HPA axis. Cortisol has been found to both increase and decrease as a result of yoga practice, but this may in part be due to differences in sampling times and methods (Innes, Bourguignon, & Taylor, 2005). While a single bout of yoga in younger women appeared to result in lowered cortisol, there was no control for diurnal variation (Michalsen et al., 2005). Another study using a reading control group showed no change in cortisol levels for either the yoga or reading group (Schell, Allolio, & Schonecke, 1994). Reductions in cortisol were seen in a younger, mixed population performing a single yoga posture, but the DHEA-S response was variable (Minvaleev, 2004). However, this suggests that it is possible for levels of cortisol and DHEA-S to change in different directions, possibly due to different mechanisms. It is possible that degree of yoga experience may influence either intensity of practice, or the ability to perform postures such that other mechanisms, such as stimulation of autonomic nerves as suggested by Minvaleev (2004) are elicited.

The clinical significance of the results is difficult to interpret. Changes in cortisol and DHEA-S imply modification in hypothalamus-pituitary-adrenal activity, but opinion varies as to what constitutes healthful change. Since the primary role of cortisol is to mobilize stored energy, transient increases in cortisol due to exercise is a normal response to the need to supply necessary fuel to active muscle and thus an essential part of a healthful stress response. However, since the hypothalamus receives input from higher centres, the HPA axis is subject to emotional and mental as well as physical stress, which may also result in increased levels of cortisol. Constant unrelieved stress thus challenges the ability of the negative feedback loop to maintain homeostasis, and chronically elevated cortisol may be the result. Higher levels of salivary cortisol has been linked to psychological stress (Powell et al., 2002). Chronically high levels of cortisol have been linked to depression, cardiovascular disease risk (Walker, 2007), and insulin resistance (Smith et al., 2005). On the other hand, elevated levels of cortisol have also been associated with improved mood and psychological states (Brandstadter, 1991; Zorrilla, DeRubeis, & Redei, 1995), and a recent comparison of experienced yoga practitioners to a control group showed increased cortisol associated with improved sleep (Vera et al., 2009).

Increased acute post-exercise levels of dehydroepiandrosterone (DHEA) and cortisol have previously been observed for resistance training in women with 13 weeks experience (Copeland & Tremblay, 2004) but it appears that 10 weeks of yoga experience may be too short to stimulate changes in the hormonal profiles of menopausal women, or that yoga lacks the intensity required to provoke a similar increase. On the other hand, it has been previously observed that older, unfit women typically have a greater cortisol

response to behavioural stress than younger, fitter women (Traustadóttir, Bosch, & Matt, 2005), and it may have been expected that the physical stress of exercise may have had the same result in our subjects, but this was not observed in the present study.

The lack of changes in cortisol levels over a single session of yoga also implies the relaxation response did not modify HPA activity to the extent that a decrease in cortisol was observed. Furthermore, it is important to distinguish between the effects of transient increases in cortisol as an exercise response and chronic elevation as the result of lifestyle stress. All women in the study had pre-session cortisol levels within normal diurnal reference ranges for women 51-70 years old (Salimetrics, 2009). It is possible that yoga may have negligible effect on cortisol levels unless they are already higher than normal. Exercise intensity was insufficient to cause an increase in DHEA-S, and it is unknown whether additional training would affect ability of women to elicit changes in this hormone. Further studies in older yoga practitioners with longer term experience with both the ability to perform postures and evoke the relaxation response would increase knowledge of HPA axis and adrenal androgen responses to yoga in menopausal women.

5.5 References

- Brandstadter, J., Baltes, G.B., Kirschbaum, C. and Hellhammer, D. . (1991). Developmental and personality correlates of adrenocortical activity as indexed by salivary cortisol: observations in the age range of 35 to 65 years. *Journal of Psychosomatic Research*, 35(2-1), 173-185.
- Browning Miller, E. (2007). Yoga for Menopause. In T. McCall (Ed.), *Yoga as Medicine*. New York, NY: Bantam Books.
- Copeland, J. L., & Tremblay, M. S. (2004). Effect of HRT on hormone responses to resistance exercise in post-menopausal women. *Maturitas*, 48(4), 360-371.
- Elavsky, S., & McAuley, E. (2005). Physical activity, symptoms, esteem, and life

- satisfaction during menopause. *Maturitas*, 52(3-4), 374-385.
- Finset, A., Øverlie, I., & Holte, A. (2004). Musculo-skeletal pain, psychological distress, and hormones during the menopausal transition. doi: 10.1016/S0306-4530(02)00134-8]. *Psychoneuroendocrinology*, 29(1), 49-64.
- Freedman, R. R., Woodward, S. (1992). Behavioural treatment of hot flushes. [Journal]. *American Journal of Obstetrics and Gynecology*, 167(2), 436-439.
- Innes, K. E., Bourguignon, C., & Taylor, A. G. (2005). Risk indices associated with the insulin resistance syndrome, cardiovascular disease, and possible protection with yoga: A systematic review. *Journal of the American Board of Family Practice*, 18(6), 491-519.
- Irvin, J. H., Domar, A.D., Clark, C., Zuttermeister P.C., and R. Friedman. (1996). The effects of relaxation response training on menopausal symptoms. *J. Psychom. Obstet. Gynecol.*, 17, 202-207.
- Ivarsson, T., Spetz, A.-C., & Hammar, M. (1998). Physical exercise and vasomotor symptoms in postmenopausal women. *Maturitas*, 29(2), 139-146. doi:10.1016/S0378-5122(98)00004-8.
- Iyengar, B. K. S. (1991). *Light on Yoga*. Hammersmith, London: Harper Collins.
- Iyengar, G. (1990). *Yoga, a Gem for Women*. Spokane, WA: Timeless Books.
- Lindheim, S. R., Legro, R. S., Bernstein, L., Stanczyk, F. Z., Vijod, M. A., Presser, S. C., & Lobo, R. A. (1992). Behavioral stress responses in premenopausal and postmenopausal women and the effects of estrogen. *Am J Obstet Gynecol*, 167(6), 1831-1836.
- McCall, T. (2007). *Yoga as Medicine*. New York, NY: Bantam Books.
- McGonigal, K. (2009). *Yoga for Pain Relief*. Oakland, CA: New Harbinger Publications.
- Michalsen, A., Grossman, P., Acil, A., Langhorst, J., Ludtke, R., Esch, T., . . . Dobos, G. J. (2005). Rapid stress reduction and anxiolysis among distressed women as a consequence of a three-month intensive yoga program. *Med Sci Monit*, 11(12), CR555-561.
- Millar, W. J. (1995). *Life Expectancy of Canadians*. Retrieved from <http://www.statcan.gc.ca/studies-etudes/82-003/archive/1995/5018983-eng.pdf>.
- Minvaleev, R. S., A. D. Nozdrachev, V. V. Kir'yanova and A. I. Ivanov. (2004). Postural Influences on the Hormone Level in Healthy Subjects: I. The Cobra Posture and Steroid Hormones *Human Physiology*, Volume 30 (4), 452-456.

- Øverlie, I., Moen, M. H., Holte, A., & Finset, A. (2002). Androgens and estrogens in relation to hot flushes during the menopausal transition. *Maturitas*, *41*(1), 69-77.
- Powell, L. H., Lovallo, W. R., Matthews, K. A., Meyer, P., Midgley, A. R., Baum, A., . . . Ory, M. G. (2002). Physiologic Markers of Chronic Stress in Premenopausal, Middle-Aged Women. *Psychosom Med*, *64*(3), 502-509.
- Raman, K. (1998). *A Matter of Health: Integration of yoga and western medicine for prevention and cure*. Bangalore, India: Eastwest Books (Madras) Pvt. Ltd.
- Randolph, J. F., Jr, Sowers, M., Bondarenko, I., Gold, E. B., Greendale, G. A., Bromberger, J. T., . . . Matthews, K. A. (2005). The Relationship of Longitudinal Change in Reproductive Hormones and Vasomotor Symptoms during the Menopausal Transition. *J Clin Endocrinol Metab*, *90*(11), 6106-6112. doi: 10.1210/jc.2005-1374.
- Schell, F. J., Allolio, B., & Schonecke, O. W. (1994). Physiological and psychological effects of Hatha-Yoga exercise in healthy women. *Int J Psychosom*, *41*(1-4), 46-52.
- Smith, G. D., Ben-Shlomo, Y., Beswick, A., Yarnell, J., Lightman, S., & Elwood, P. (2005). Cortisol, Testosterone, and Coronary Heart Disease: Prospective Evidence From the Caerphilly Study. *Circulation*, *112*(3), 332-340. doi: 10.1161/circulationaha.104.489088.
- Sparrowe, L. W., P. (2002). *The Woman's Book of Yoga and Health*. Boston, MA: Shambala.
- Traustadóttir, T., Bosch, P. R., & Matt, K. S. (2005). The HPA axis response to stress in women: effects of aging and fitness. *Psychoneuroendocrinology*, *30*(4), 392-402.
- Vera, F. M., Manzanque, J. M., Maldonado, E. F., Carranque, G. A., Rodriguez, F. M., Blanca, M. J., & Morell, M. (2009). Subjective Sleep Quality and hormonal modulation in long-term yoga practitioners. *Biological Psychology*, *81*(3), 164-168. doi: 10.1016/j.biopsycho.2009.03.008.
- Vongpatanasin, W. (2009). Autonomic regulation of blood pressure in menopause. *Semin Reprod Med*, *27*(4), 338-345. doi: 10.1055/s-0029-1225262 .
- Walker, B. R. (2007). Glucocorticoids and Cardiovascular Disease. *Eur J Endocrinol*, *157*(5), 545-559. doi: 10.1530/eje-07-0455
- Zorrilla, E. P., DeRubeis, R. J., & Redei, E. (1995). High self-esteem, hardiness and affective stability are associated with higher basal pituitary-adrenal hormone levels. *Psychoneuroendocrinology*, *20*(6), 591-601. doi: 10.1016/0306-

4530(95)00005-9.

Table 5.1: Mean (S.D.) salivary cortisol and serum DHEA-S pre and post session.

n=13	<u>Control</u>		<u>Yoga</u>	
	Pre	Post	Pre	Post
Cortisol ($\mu\text{g/dL}$)	0.12 (0.04)	0.09 (0.03)	0.11 (0.05)	0.14 (0.12)
DHEA-S ($\mu\text{g/mL}$)	1.53 (0.76)	1.49 (0.71)	1.46 (0.70)	1.41 (0.65)

No significant changes occurred for group or time for either cortisol or dehydroepiandrosterone-sulfate (DHEA-S)

Chapter 6: Discussion and conclusions

6.1 Overview

As women approach the challenges of the menopausal transition, finding ways to successfully manage the aging process, optimize quality of life and ameliorate changes associated with stressful and sedentary lifestyles becomes increasingly important.

Situated in the larger context of women's health, the studies encompassed by this thesis contribute to the growing body of information that yoga can play an important role in maintaining health through the aging process.

The study addressed the limited base of knowledge on whether yoga exerts beneficial effects through modification of glandular activity and the stress response, particularly through the hypothalamic-pituitary-adrenal and hypothalamic-pituitary-gonadal axis. It explored a number of aspects of concern to mid-life women, primarily menopausal symptoms, related hormonal function, and musculoskeletal fitness. The study on quality of life and hormonal changes demonstrated that physical activity such as yoga or walking has the potential to reduce menopausal symptoms, especially in the vasomotor domain, but that within the limited time frame of the activity intervention, this effect was small. Significant increases in musculoskeletal fitness were observed in both the walking and yoga participants, demonstrating that both modes of physical activity can result in relatively rapid improvements for otherwise healthy, sedentary menopausal women. Strengths of the study included the use of a randomization, strict selection criteria, a comparison group, measurement of hormones associated with menopausal symptoms and HPA axis activity, and detailed statistical analysis. However, the conclusions must remain tentative due to small group sizes and confounding factors such as lack of control

for stage of menopausal transition, stage of cycle for women still sporadically menstruating, and degree of adherence to the intervention.

6.2 Major findings of the study

6.2.1 Menopause specific quality of life

The Menopause-specific Quality of Life (MENQOL) questionnaire was used to assess whether changes occurred over the 10 weeks in four symptom domains: vasomotor, psychosocial, physical, and sexual. While reductions were seen in all domains, only the changes in the vasomotor domain ($p=0.096$) and summary score ($p=0.066$) approached statistical significance. Similar improvements in menopause symptoms occurred between the walking and yoga groups and if there was any difference in mode of action or relief of symptoms between the two types of activity, it was not apparent from this study.

6.2.2 Chronic changes in circulating hormones

The hormones of primary interest in this study were follicle stimulating hormone (FSH) and dehydroepiandrosterone-sulfate (DHEA-S), chosen for their association with menopausal symptoms across all the domains. It was hypothesized that changes in menopausal symptoms would be accompanied by changes in circulating hormone levels, with reduction in symptoms associated with decreases in FSH and increases in DHEA-S. While no changes occurred for DHEA-S, a non-significant reduction was found for FSH ($p=0.066$) and this effect appeared to differ between groups ($p=0.074$), with the reduction being much greater in the walking group. As both groups had similar reductions in vasomotor symptoms and the summary score for MENQOL, it does not appear that levels of FSH were strongly tied to symptoms in this study.

6.2.3 Musculoskeletal fitness

Both groups improved significantly in upper body strength ($p=0.025$), trunk strength ($p=0.048$), knee extension ($p=0.041$), and trunk forward flexion ($p<0.0001$). Despite the differences in type of activity and muscles engaged between the two groups, both the walking and yoga participants improved equally. It appears that rapid whole body improvements can be expected when sedentary middle aged women begin an activity they can adhere to consistently for at least 10 weeks, and perhaps even that these two forms of mild to moderate intensity exercise with a social component and low risk of injury can help women adopt long term habitual activity and continue to experience strength and flexibility benefits.

6.2.4 Heart rate, blood pressure, and body mass index

Resting heart rate and systolic and diastolic blood pressure remained unchanged from the 10 week activity intervention in both groups, but this was perhaps not surprising as all women were in normal ranges for all measures. Small but significant increases occurred for body weight ($p=0.006$) and body mass index ($p=0.005$) in both groups. While increased body fat is among the contributing factors to chronic disease risk later in life, the increase in body weight or BMI could also have been the result of increased muscle mass rather than body fat, particularly since strength gains were observed. Without more accurate measurements of body composition, no conclusions can be drawn as to changes in susceptibility to, or protection against, disease risk. If body fat did indeed increase, it is also possible that in comparison to sedentary women, weight gain was mitigated, but this could not be verified through this study, which did not include an inactive comparison group.

6.2.5 Acute effects of a single yoga session on hormones

The adrenal androgens cortisol and dehydroepiandrosterone-sulfate (DHEA-S) were chosen as indicators of hypothalamic-pituitary-adrenal (HPA) axis activity. The comparison of the active yoga session with the resting control session showed that yoga had no effect on the circulating levels of these hormones. It is difficult to interpret whether this implies that yoga has no action on glandular activity itself, or whether the hormones of interest are unreliable indicators of long-term HPA sensitivity when measured in an acute session.

6.3 Popular literature vs. clinical evidence: implications

No evidence was found to support the claims propagated through popular literature and by yoga educators that yoga calms the glands or indeed has any effect at all on the endocrine system in relation to the hormones we measured: FSH, DHEA-S, and cortisol. Despite the favorable outcomes seen in reduction of vasomotor and overall symptoms, the study demonstrated that if glandular activity was modified, it was not reflected through levels of circulating hormones as measured by techniques available to us. Where changes in hormone level occurred, as in FSH, this did not appear to be closely related to subjective experience of symptoms for either activity, even less so for the yoga participants who experienced reductions in symptoms without a concurrent reduction in FSH. No basis, therefore, was found for the purported mechanisms by which yoga is believed to exert an effect on the neuroendocrine system as described by prominent yoga teachers, particularly those from the lineage of B.K.S. Iyengar. This may be of limited relevance to teachers and students who practice yoga for pleasure and overall wellness, but may remain a concern for clinicians and patients who seek complementary and

alternative interventions for health issues. In particular, health care providers seeking to assist women managing hormonal related symptoms associated with menopause may require more objective evidence that yoga practice may offer relief.

Yoga presents unique difficulties in obtaining experimental evidence, particularly because poses are always practiced within a sequence with other poses, making isolation of the effects of a particular pose difficult, if not impossible. In addition, yoga poses are intended to be modified to the needs of the individual practicing it, and methodology with protocols requiring individuals to practice standardized versions of poses would be contrary to the fundamental tenets of yoga, and could negate the benefits that come from individualized practice. Studies that focus on measuring individual components of physiological responses may not adequately evaluate a practice that was never intended merely as a form of physical exercise, but as a complete practice intended to address all aspects of the human condition. The benefits experienced by practitioners may not be subject to reduction to its component parts, and it is possible that studies of this nature could be complemented by the inclusion of a qualitative component to examine the lived experience of yoga practice, and outcomes that could not be measured in our study.

It is of note that a vast majority of anecdotal information on yoga and menopause comes from teachers of the Iyengar lineage and relies on case histories and observations of their own students (Austin, 2003 ; Francina, 1997; Iyengar, 1990; Sparrowe, 2002). The paucity of research in support of this relationship compared to its abundance in popular literature suggests that oral tradition may have played a part. This remains compatible with the traditional yogic process of acquiring knowledge through the teacher-student relationship, personal communication and direct experience, and may

carry more weight than scientific evidence to practitioners with similar philosophical alignment. It may partially explain the prevalence of information that is not objectively substantiated by this and many other studies.

A tension may thus be discerned between the different ways of gathering, evaluating, and transmitting information as well as between the yogic and western definitions of research. While yoga leaders and educators consider research to be the accumulation of case studies that result from one-on-one work between a teacher and student (McCall, 2003), the western model of scientific research relies on quantitative measurements obtained through randomized controlled trials and standardized procedures. In a world where women and their health care providers have access to information disseminated through a wide variety of sources, from the lay literature to peer-reviewed articles, confusion may result as to which research approach best informs the health care choices that women make. It may be that both approaches are useful, and points to the need to continue investigations into the measurable components of yoga practice through modern scientific research methods.

6.4 Clinical application and generalisability:

Women appear to benefit from either walking or yoga within a relatively short period of activity, but longer term adherence, perhaps combined with greater frequency of practice, may be required to produce further benefits. Women seeking the most effective exercise intervention for relief of menopausal symptoms or improved musculoskeletal fitness could choose between either activity depending on availability and preference and expect similar outcomes. Both activities are typically easy to access, and depending on facilities, may be similar in cost. Both forms of activity pose little risk

of injury and may also have a social aspect that could improve adherence. Yoga, however, may have an advantage long term as it is adaptable through many stages of life and movement limitations, which may not be true to the same extent for walking.

The design of the study required that participants limit their activity to their assigned intervention, and it is possible that combining the activities could have an additive or synergistic effect. More research would be required to verify whether this might be the case. Regardless of the activity chosen, beginning physical activity for the short-term relief of menopausal symptoms may have long-term implications if activity is enjoyable enough to adopt as a permanent lifestyle change. Continuing physical activity into the years post-menopause even when symptoms have become negligible may decrease chronic disease risk, and maintain or improve physical fitness to enable longer periods of independent living.

6.5 Conclusion

The results of this thesis project support the claim that yoga may be beneficial to the health of menopausal women but that within 10 weeks, those benefits do not differ from those provided by walking, nor do the benefits appear to be derived through changes in the circulating levels of the hormones examined. The mind-body aspect of yoga, with its combination of physical exercise and relaxation is the manner by which yoga is differentiated from other types of exercise, and 10 weeks did not appear to be sufficient for participants to learn how to deeply experience the relaxation and meditative aspects of the practice. A longer time frame would be needed to fully evaluate the potential effects of the relaxation and meditation aspect of yoga practice and compare it to traditional exercise. The link between yoga practice, hormonal function, and

management of menopausal symptoms in midlife women remains to be verified.

Nevertheless, the study demonstrates that there are still benefits to be derived from yoga practice.

6.6 References

Austin, M. (2003). *Cool Yoga Tricks*. Toronto, ON: Random House Publishing Group.

Francina, S. (1997). *The new yoga for people over 50*. Deerfield Beach, FL: Health Communications, Inc.

Iyengar, G. (1990). *Yoga, a Gem for Women*. Spokane, WA: Timeless Books.

Sparrowe, L. W., P. (2002). *The Woman's Book of Yoga and Health*. Boston, MA: Shambala.

Appendices

Health Questionnaire

Informed consent

PAR-Q

Menopause Specific Quality of Life Questionnaire

Health and physical activity information form

The purpose of this form is to get some information about your general health and physical activity. Because hormonal response to physical activity may vary due to health and physical activity history and experience, this background information may assist interpretation of the results.

Name : _____ Date: _____
Date of birth: _____

1. What was the date of your last menstrual period?
2. Are you currently taking any supplemental hormones or undergoing hormone therapy of any kind, including bioidentical or natural hormone creams?
3. Are you on any other kind of medication, including blood pressure medication or beta blockers? Please list all medication you are currently taking:
4. Do you smoke? If so, how much?
5. Do you have any significant health issues or conditions that could influence your participation in this study?
6. Do you have any current or chronic musculoskeletal injuries and/or conditions that may affect your ability to participate in physical activity or testing? If so, please describe briefly:
7. This study is intended for women who have not had regular, structured physical activity within the last six months. However, you may have been active in the past. If so, please indicate what activities you have participated in and how long ago

Aerobic (walking, running, cycling) _____

Resistance (weight training, power yoga) _____

Flexibility and postural control (yoga, pilates, fusion) _____

Other (please describe): _____



“Moving Through Menopause”

Effects of Physical Activity on Fitness and Endocrine Function in Peri-menopausal Women.

We are inviting you to participate in a study to assess the effects of yoga practice and regular walking on muscular fitness, quality of life, menopause symptoms and hormone levels in women. Our goal is to gather data that may show some significant benefits of activity for women’s health.

Participation in this study involves participating in a 10 week supervised program of either walking or yoga. You will be randomly assigned to one program or the other and there will be no charge for these classes. In addition to attending your activity class for the 10 week period you will attend the Exercise physiology lab for two sessions before and after the 10 week program (4 visits in total) and each session should last approximately 30 minutes. Participation will include the following:

1. Completing two brief questionnaires about your health status and medical history. This is to ensure that it is safe for you to complete the study. Depending on your answers to the questionnaire you may be required to obtain your physician’s approval before participation.
2. Having your blood pressure and heart rate measured. This is also to ensure your safety.
3. Having your height and weight measured.
4. Having the strength of your legs tested using a piece of equipment known as an isokinetic dynamometer. This equipment provides accommodating resistance to match the effort you give at a preselected speed. If you reduce your effort the machine will reduce the resistance and if you stop, the machine will stop. This is a safe method of determining peak strength of a muscle throughout the range of motion. Your muscle strength will be tested at two speeds- slow and fast- and you will be tested in a seated position. You will be given a light warm-up and several practice trials before testing to ensure you are comfortable with the equipment.
5. Completing a standardized questionnaire to assess your menopause-related symptoms. You will complete this questionnaire at three time points: before, mid-way and at the end of the 10 week activity program.
6. Having a resting blood sample drawn by a fully trained individual. Approximately 7 ml of blood will be drawn each time for a total of 14 ml of blood over the 10 weeks.
7. In addition if you are selected to participate in the yoga class, one additional session will be required at the completion of the 10 week program. During this session a blood sample and a saliva sample will be collected immediately before and immediately after a 75 minute yoga class. Approximately 7ml of blood from a vein in your arm will be taken by a fully trained individual at each time, so a total of 14 ml of blood will be drawn during this session. 2 ml of saliva will be collected by passive drooling into a small plastic tube.

There is a very small risk of physical discomfort and/or muscle strain from the strength testing but every effort will be made to minimize these risks. Upon completion of the study, you will be

given a report outlining your results. The results obtained will inform you of any strength imbalances or weaknesses.

Saliva sampling should cause no discomfort, is rapid and non-invasive, and requires only overcoming some degree of social conditioning. Blood sampling may cause some minor discomfort. The samples will be taken under sterile conditions by a trained individual and no complications resulting from blood sampling have ever occurred in this laboratory.

The results of the study may be used for a research publication, but will be presented as group data only, and your individual identity will remain anonymous. You will be given an ID code to help protect your privacy and only the researchers will have access to your personal information. The results will be securely stored by the principal researcher at the University of Lethbridge.

Your participation in this research is completely voluntary. Please note you are free to withdraw from this study at any time with no penalty. The decision to withdraw will not result in any negative consequences and all your information will be destroyed at your request.

If you have questions about this research please contact the Principal Investigators:

Sophia Verzosa, B.Sc.
Dept. of Kinesiology
University of Lethbridge
(403) 317-5073 (p)
sophie.verzosa@uleth.ca

Jennifer Copeland, Ph.D.
Dept. of Kinesiology
University of Lethbridge
(403) 317-2804 (p)
jennifer.copeland@uleth.ca

Questions regarding your rights as a participant in this research may be addressed to the Office of Research Services, University of Lethbridge (Phone: 403-329-2747).

Consent

My signature on this sheet indicates that I _____ agree to participate in the study of the effects of yoga on women's health. It indicates that I understand and agree to the following the following:

1. I received information regarding the nature of the study, its purpose, and procedures.
2. Participation is voluntary, I can withdraw from the study at any time without any fear of penalty.
4. All individual data that is provided will remain confidential from sources outside of the study.
5. I understand that due to the study procedure, complete anonymity will not be possible. (We will assign you an ID code so that we can match your test data from each of the pre and post testing sessions.)
6. I will receive a summary of my results following completion of the project.
7. I have read and understood the information provided in the cover letter, and have received a copy of that letter and the consent form for my records.

I have read the above statements regarding the study and understand the conditions of my participation in this study.

Signature of participant _____ Date _____

Signature of researcher _____ Date _____

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
<input type="checkbox"/>	<input type="checkbox"/>	1. Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?
<input type="checkbox"/>	<input type="checkbox"/>	2. Do you feel pain in your chest when you do physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	3. In the past month, have you had chest pain when you were not doing physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
<input type="checkbox"/>	<input type="checkbox"/>	5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
<input type="checkbox"/>	<input type="checkbox"/>	7. Do you know of <u>any other reason</u> why you should not do physical activity?

**If
you
answered**

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- if you are or may be pregnant — talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____

DATE _____

SIGNATURE OF PARENT _____
or GUARDIAN (for participants under the age of majority)

WITNESS _____

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.



© Canadian Society for Exercise Physiology

Supported by:



Health
Canada

Santé
Canada

continued on other side...

...continued from other side

PAR-Q & YOU

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

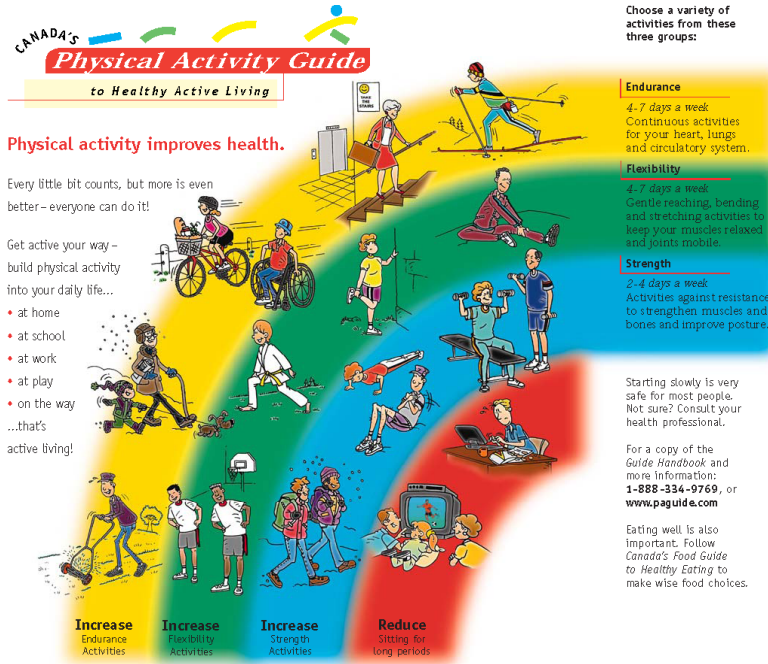


Physical activity improves health.

Every little bit counts, but more is even better – everyone can do it!

Get active your way – build physical activity into your daily life...

- at home
 - at school
 - at work
 - at play
- ...that's active living!



Choose a variety of activities from these three groups:

Endurance
4-7 days a week
Continuous activities for your heart, lungs and circulatory system.

Flexibility
4-7 days a week
Gentle reaching, bending and stretching activities to keep your muscles relaxed and joints mobile.

Strength
2-4 days a week
Activities against resistance to strengthen muscles and bones and improve posture.

Starting slowly is very safe for most people. Not sure? Consult your health professional.

For a copy of the *Guide Handbook* and more information: 1-888-334-9769, or www.paguide.com

Eating well is also important. Follow *Canada's Food Guide to Healthy Eating* to make wise food choices.

Get Active Your Way, Every Day – For Life!

Scientists say accumulate 60 minutes of physical activity every day to stay healthy or improve your health. As you progress to moderate activities you can cut down to 30 minutes, 4 days a week. Add-up your activities in periods of at least 10 minutes each. Start slowly... and build up.

Time needed depends on effort			
Very Light Effort	Light Effort	Moderate Effort	Vigorous Effort
60 minutes	30-60 minutes	20-30 minutes	Maximum Effort
• Strolling • Dusting	• Light walking • Volleyball • Keep gardening • Stretching	• Brisk walking • Biking • Raking leaves • Swimming • Dancing • Water aerobics	• Aerobics • Jogging • Hockey • Basketball • Fast swimming • Fast climbing
Range needed to stay healthy			

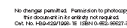
You Can Do It – Getting started is easier than you think

Physical activity doesn't have to be very hard. Build physical activities into your daily routine.

- Walk whenever you can – get off the bus early, use the stairs instead of the elevator.
- Reduce inactivity for long periods, like watching TV.
- Get up from the couch and stretch and bend for a few minutes every hour.
- Play actively with your kids.
- Choose to walk, wheel or cycle for short trips.
- Start with a 10 minute walk – gradually increase the time.
- Find out about walking and cycling paths nearby and use them.
- Observe a physical activity class to see if you want to try it.
- Try one class to start – you don't have to make a long-term commitment.
- Do the activities you are doing now, more often.

Benefits of regular activity: Health risks of inactivity:

<ul style="list-style-type: none"> • better health • improved fitness • better posture and balance • better self-esteem • weight control • stronger muscles and bones • feeling more energetic • relaxation and reduced stress • continued independent living in later life 	<ul style="list-style-type: none"> • premature death • heart disease • obesity • high blood pressure • adult-onset diabetes • osteoporosis • stroke • depression • colon cancer
--	--



Source: *Canada's Physical Activity Guide to Healthy Active Living*, Health Canada, 1998 <http://www.hc-sc.gc.ca/hppb/paguide/pdf/guideEng.pdf>

© Reproduced with permission from the Minister of Public Works and Government Services Canada, 2002.

FITNESS AND HEALTH PROFESSIONALS MAY BE INTERESTED IN THE INFORMATION BELOW:

The following companion forms are available for doctors' use by contacting the Canadian Society for Exercise Physiology (address below):

The **Physical Activity Readiness Medical Examination (PARmed-X)** – to be used by doctors with people who answer YES to one or more questions on the PAR-Q.

The **Physical Activity Readiness Medical Examination for Pregnancy (PARmed-X for Pregnancy)** – to be used by doctors with pregnant patients who wish to become more active.

References:

- Arraix, G.A., Wigle, D.T., Mao, Y. (1992). Risk Assessment of Physical Activity and Physical Fitness in the Canada Health Survey Follow-Up Study. *J. Clin. Epidemiol.* 45:4 419-428.
- Mottola, M., Wolfe, L.A. (1994). Active Living and Pregnancy, In: A. Quinney, L. Gauvin, T. Wall (eds.), **Toward Active Living: Proceedings of the International Conference on Physical Activity, Fitness and Health**. Champaign, IL: Human Kinetics.
- PAR-Q Validation Report, British Columbia Ministry of Health, 1978.
- Thomas, S., Reading, J., Shephard, R.J. (1992). Revision of the Physical Activity Readiness Questionnaire (PAR-Q). *Can. J. Sport Sci.* 17:4 338-345.

To order multiple printed copies of the PAR-Q, please contact the:

Canadian Society for Exercise Physiology
202-185 Somerset Street West
Ottawa, ON K2P 0J2
Tel. 1-877-651-3755 • FAX (613) 234-3565
Online: www.csep.ca

The original PAR-Q was developed by the British Columbia Ministry of Health. It has been revised by an Expert Advisory Committee of the Canadian Society for Exercise Physiology chaired by Dr. N. Gledhill (2002).

Disponible en français sous le titre «Questionnaire sur l'aptitude à l'activité physique - Q-AAP (révisé 2002)».



© Canadian Society for Exercise Physiology

Supported by:



Health Canada / Santé Canada

The Menopause-Specific Quality of Life Questionnaire

Name..... Today's date.....

For each of the following items, indicate whether you have experienced the problems in the PAST MONTH. If you have, rate how much you have been bothered by the problem.

Not at all _____ Extremely
bothered 0 1 2 3 4 5 6 bothered

1. Hot flushes	No	Yes	->	0	1	2	3	4	5	6
<hr/>										
2. Night sweats	No	Yes	->	0	1	2	3	4	5	6
<hr/>										
3. Sweating	No	Yes	->	0	1	2	3	4	5	6
<hr/>										
4. Being dissatisfied with my personal life	No	Yes	->	0	1	2	3	4	5	6
<hr/>										
5. Feeling anxious or nervous	No	Yes	->	0	1	2	3	4	5	6
<hr/>										
6. Experiencing poor memory	No	Yes	->	0	1	2	3	4	5	6
<hr/>										
7. Accomplishing less than I used to	No	Yes	->	0	1	2	3	4	5	6
<hr/>										
8. Feeling depressed, down or blue	No	Yes	->	0	1	2	3	4	5	6
<hr/>										
9. Being impatient with other people	No	Yes	->	0	1	2	3	4	5	6
<hr/>										

10. Feelings of wanting to be alone	No	Yes	->	0	1	2	3	4	5	6
11. Flatulence (wind) or gas pains	No	Yes	->	0	1	2	3	4	5	6
12. Aching in muscle & joints	No	Yes	->	0	1	2	3	4	5	6
13. Feeling tired or worn out	No	Yes	->	0	1	2	3	4	5	6
14. Difficulty sleeping	No	Yes	->	0	1	2	3	4	5	6
15. Aches in back of neck or head	No	Yes	->	0	1	2	3	4	5	6
16. Decrease in physical strength	No	Yes	->	0	1	2	3	4	5	6
17. Decrease in stamina	No	Yes	->	0	1	2	3	4	5	6
18. Feeling a lack of energy	No	Yes	->	0	1	2	3	4	5	6
19. Drying skin	No	Yes	->	0	1	2	3	4	5	6
20. Weight gain	No	Yes	->	0	1	2	3	4	5	6
21. Increased facial hair	No	Yes	->	0	1	2	3	4	5	6
22. Changes in appearance, texture or tone of your skin	No	Yes	->	0	1	2	3	4	5	6
23. Feeling bloated	No	Yes	->	0	1	2	3	4	5	6

24. Low backache	No	Yes	->	0	1	2	3	4	5	6
25. Frequent urination	No	Yes	->	0	1	2	3	4	5	6
26. Involuntary urination when laughing or coughing	No	Yes	->	0	1	2	3	4	5	6
27. Change in your sexual desire	No	Yes	->	0	1	2	3	4	5	6
28. Vaginal dryness during intercourse	No	Yes	->	0	1	2	3	4	5	6
29. Avoiding intimacy	No	Yes	->	0	1	2	3	4	5	6

Thank you for completing this questionnaire.

Please return to:

Sophia Verzosa
Department of Kinesiology
University of Lethbridge

Email: Sophia.Verzosa@uleth.ca

Tel: (403)317-5073

Copyright:

John R Hilditch, Jacqueline Lewis 1992.
Primary Care Research Unit,
Department of Family & Community Medicine,
Sunnybrook Health Science Centre,
University of Toronto, Toronto.