



# Exercise and Women's Health

*New Research*

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# **EXERCISE AND WOMEN'S HEALTH: NEW RESEARCH**

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AND  
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# **EXERCISE AND WOMEN'S HEALTH: NEW RESEARCH**

## PREFACE

In the last 50 years significant numbers of men and women take little exercise in the course of their occupation. The computer keyboard, the rise of private transport, the world by television, household "labor saving" devices mean that with the minimal of physical effort people work and play. The benefits of doing regular exercise include a reduced risk of: heart disease, stroke, colon cancer, breast cancer, osteoporosis, and obesity. In addition, many people feel better about themselves during and after exercise. Regular exercise is also thought to help ease stress, anxiety, and mild depression. This book presents the latest research in this field.

Short Communication A - The benefits of exercise are well known. However, certain body systems can be sent into a cycle of inflammation when stimulated by exercise. For example, exercise and the need for increased oxygen can trigger an inflammatory reaction within asthmatic individuals termed exercise-induced bronchoconstriction (EIB). Additionally, several studies have investigated the inflammatory response of muscles after eccentric exercise. In addition, other researchers have tried to elucidate the role of inflammation in delayed onset muscle soreness (DOMS). Physicians try to balance the inflammation that can be caused by unaccustomed exercise on a healing body with its benefits. In female athletes, these relationships become even more challenging to investigate. There is a general agreement among immunologists that estrogen, and perhaps progesterone, play a role in inflammation. In most cases, the inflammatory response is considered more vigorous in females than in males. This has been shown numerous times in animal studies but has yet to be entirely accepted in humans. This chapter will review current research concerning the relationship between exercise, inflammation, and female sex hormones, particularly estrogen and progesterone.

Short Communication B - The intention of this study was to examine adaptations of ground reaction forces (GRFs) of the stance limb and stance time during unilateral obstacle walking, and investigate if there is an association between these gait parameters and lower extremity strength in early postmenopausal women. Sixteen postmenopausal women with no resistance-training background, and no hormone replacement therapy participated in the study. Knee extension and flexion and ankle plantar and dorsi flexion were measured unilaterally at 2-speeds ( $60^{\circ}\cdot s^{-1}$  and  $180^{\circ}\cdot s^{-1}$ ) using BIODEX. The gait sessions consisted of walking unobstructed (0 cm) and with obstacles (width: 20 cm; depth: 5 cm) of two different heights (5 cm and 30 cm) placed in the travel path. GRFs were measured from two force plates positioned immediately before and to the left of the obstacle. Significant increases in

stance time as well as the magnitude of braking forces in the anterior/posterior (A/P) and vertical (V) directions were observed when stepping over the 30 cm obstacle. However, there were no significant associations between any of the strength measures and A/P and V forces and impulses. There was a trend toward increases in medial/lateral (M/L) braking forces when stepping over the 30 cm obstacle. Importantly, ankle strength was significantly associated with M/L braking forces and impulses when stepping over the 30 cm obstacle accounting for 32% and 55% of the variance respectively. The results of the present study indicate that postmenopausal women adapt to a high obstacle in their travel path by increasing braking forces with changes in the M/L direction associated with ankle strength.

Chapter 1 - Cardiovascular disease affects over 200 million people worldwide and accounts for nearly 30% of global mortality. Approximately 80% of these cardiovascular deaths occur in low and middle-income countries. By the year 2020, ischemic heart disease mortality in developing countries is predicted to increase by 120% for women and 137% for men. In the United States alone, cardiovascular disease (CVD) affects over 37 million American women, representing over one third of the American female population, with coronary heart disease (CHD) affecting 5.9 million women. By age 55, the prevalence of cardiovascular disease in women exceeds that in men. Cardiovascular disease accounts for 1 in 2.5 female deaths compared to 1 in 30 deaths attributable to breast cancer. Despite the high prevalence and mortality rate of cardiovascular disease, only 13% of women consider it to be their greatest health risk. While a recent survey of 1008 women found that the level of awareness regarding CVD mortality in women has nearly doubled since 1997, still only 55% of women recognize CVD as the leading cause of mortality in women. In addition, the survey found that the level of awareness in minorities continues to significantly lag behind the white population with only 38% of blacks and 34% of Hispanics recognizing the magnitude of the problem. Although the past two to three decades has seen a decline in the overall mortality rate from CHD in men, the mortality rates for women have remained stable. The overall incidence of CHD in women has actually increased, as evidenced by a 47% increase in hospital discharges related to CHD. A prospective registry study of men and women who presented with an acute myocardial infarction found that women were at increased risk for 28-day case fatality (18.5% vs. 8.3%), 6-month mortality (28.5% vs. 10.8%) and readmission rates (23.3% vs. 12.2%) after a first myocardial infarction compared with men, independent of co-morbidities, coronary risk factors and the use of thrombolytics. Not only did women in this study have a higher mortality from their first MI compared to men, it was also found that the median time between symptom onset and initial presentation to the hospital was on average one hour longer in women compared to men. Furthermore, the delay between the emergency room and admission to the coronary care unit was also on average over two hours longer in women than in men. The results from this registry were recently mirrored in the Euro Heart Survey of Stable Angina. This prospective observational trial found that women who presented with a new diagnosis of stable angina were less often referred for noninvasive or invasive studies and were less likely to undergo revascularization or given optimal secondary prevention medication even in the presence of confirmed obstructive coronary artery disease compared to men. These studies highlight the discrepancies in the recognition and appropriate treatment of CHD in women as compared to men and underscore the importance of appropriately identifying women who are at risk for CHD. The aim of this report is to review the primary and secondary prevention measures that are unique to women

and to examine the sensitivity and specificity of the current diagnostic modalities in detecting CHD in women.

Chapter 2 - Consensus exists that exercise can and does pose the potential of becoming an all-consuming and damaging obsession, a phenomenon now widely known as exercise dependence. In the study reported in this chapter, two males shared their experiences with exercise dependence. These males provided their stories in multiple one-on-one semi-structured interviews. Grounded theory and a social constructivist approach were used to collect and analyze the data. The two university-aged male participants who reported excessive exercise patterns typical of exercise dependence revealed that at the core of their unrealistic beliefs toward exercise, diet, and their bodies lay a polarized mindset that perceived the world in terms of black-and-white. This limited perception, in turn, translated into extreme and inflexible exercise and dieting behaviors, and an associated expectation of absolute adherence that, when interrupted, resulted in significant psychological ramifications. Moreover, these participants' experiences were expressed in remarkably different terms, supporting the concept of exercise dependence as a multi-faceted phenomenon uniquely encountered by each individual.

Chapter 3 - Recently, Burke, Carron, and Eys (2006, 2007) asked university- and middle-aged women to rate their *most* and *least* preferred contexts for strength training from a list of four possible response options: exercising in a structured class, exercising with others outside of a structured class, exercising on one's own in an exercise setting, and exercising completely alone. With regard to the *most* preferred context, female university students identified exercising with others outside of a structured class, while female adults selected exercising in a structured strength training class. Insofar as the *least* preferred context for strength training is concerned, both female students and adults identified exercising completely alone. Although these studies yielded interesting and potentially useful results, it has been repeatedly emphasized) that scientists should go beyond description and concern themselves with *why*. Thus, the purpose of the present study was to investigate the underlying reasons for university- and middle-aged females' most and least preferred contexts for strength training. A total of 382 female university students (between the ages of 19 and 25) and 173 female adults (between the ages of 30 and 60) completed a questionnaire in which they were asked to indicate in one or two sentences *why* the abovementioned contexts were selected as most and/or least preferred. Insofar as why strength training with others outside of a structured class setting was most preferred by university students, frequently cited reasons revolved around factors associated with *instruction*, *exercise dedication*, *control*, and *social opportunities*. The most frequently cited reasons by middle-aged women for why strength training in a structured class was most preferred involved factors associated with *instruction* and *exercise dedication*. Both age groups indicated that strength training completely alone was least preferred because of factors associated with *exercise dedication* and *instruction*. The results are discussed in terms of their relation to group dynamics theory, as well as their potential application to strength training intervention programs for women.

Chapter 4 - The presence of dependent children in the family home is a consistent correlate of physical inactivity among women. It is presumed that the demands and responsibilities of early motherhood may trigger obesogenic lifestyle changes such as reduced leisure-time physical activity. Limited research, however, has focused on the transition to motherhood and its effect on physical activity. In this chapter, the authors review the existing literature on postpartum physical activity and provide direction for future research and



interventions focused on intrapersonal, interpersonal, and policy-level physical activity campaigns aimed at increasing physical activity during early family development. Overall, 34 studies with 31 independent samples met the authors' review criteria using systematic review procedures. Review and discussion topics include mothers compared to non mothers, the effect of motherhood on leisure-time exercise compared to lifestyle activity, number of children in the family home, age of children in the family home, maternal age, marital status, work status, personal, social, environmental, and policy-level barriers and facilitators to physical activity.

Chapter 5 - Physical exercise plays a growing role in prevention, diagnosis and rehabilitation programs of cardiovascular diseases (CVD). CVD is no longer considered a chronic disease unique to men.

Some studies have recently explored possible gender differences in cardiovascular responses to acute and chronic exercise. A growing literature suggests that women and men may have similar physiological responses to training but differ significantly in psychosocial needs during the rehabilitation process.

Prevention of CVD: the American Health Association has recognized physical inactivity has a primary risk factor for CAD. However the inverse relationship that has been demonstrated between CAD incidence and habitual physical activity is based primarily on male-dominated cohorts. Only recently new studies have demonstrated an inverse association between physical activity and all cause mortality also in women. So women who report increased levels of physical activity and fitness have an improvement in health status and a reduction in relative risk of death by about 20%–35%. Physical activity, in fact, has multiple healthy effects on health, including the ability to reduce blood pressure, improve blood coronary flow, enhance autonomic tone, improve cardiac and endothelial functions, glucose homeostasis and insulin sensitivity and modify lipid profile, reducing triglyceride and LDL-cholesterol and increasing HDL level.

Diagnosis of CVD: as regards the role of exercise in CVD diagnosis, exercise stress testing with treadmill or bicycle ergometer remains a mainstay in the non-invasive evaluation of patients with suspected cardiovascular disease. Stress testing has long been reported as having a low sensibility in the diagnosis of CVD in women, this may be related to hormonal influences, selection bias and exercise performance. Otherwise recent studies have shown that the Duke Treadmill Score (DTS), calculated using exercise duration, exercise-induced angina and ST-segment depression, can effectively stratify asymptomatic women into diagnostic and prognostic risk categories.

The predictive value of DTS is entirely due to the exercise capacity, and in particular exercise duration constitutes not only an important factor of exercise capacity but also it may be considered an important predictor of cardiac mortality in woman.

Chapter 6 - Epidemiological evidence for the association between physical activity and cardiovascular risk has been mainly drawn from male cohorts, with the assumption that the effects are transferable to women. However, given that there is distinct biological variation between men and women, several gender differences may exist that relate to specific mechanisms, changes across the life span, and dose-response issues. The beneficial effects of physical activity may operate through different pathways specific to gender, for example, adiposity may play a more important mediating role among women. The relative importance of physical activity in women during pre- and post-menopause is also unclear. In addition, the type and amount (intensity/duration/frequency) of exercise to achieve optimal cardiovascular



benefits in women has not been well established. This chapter reviews the major epidemiological evidence for physical activity and cardiovascular risk among women and also examines the effects of exercise on important risk factors including inflammatory markers, blood pressure, glucose homeostasis, lipids, and cardiorespiratory fitness.

Chapter 7 - Self-efficacy expectations represent a domain-specific type of control and have been demonstrated to be important social cognitive influences on physical and psychological function. The aging process is often accompanied by declines in physical health and physical function. Confidence in abilities to ambulate and preserve balance during later life has been inversely associated with falls and risk for institutionalization. Few studies, however, have examined the trajectories of change in these aspects of self-efficacy or how demographic factors and health conditions predict such changes. Such trajectories of change have implications for public health prevention initiatives and health practices. The purpose of this study was to assess patterns of change in efficacy cognitions relative to gait and balance over a 24-month period in a sample of older ( $M$  age = 68 yrs) White ( $n = 168$ ) and Black ( $n = 81$ ) women. Individuals' confidence in their ability to negotiate stairs and objects in their path (i.e. gait efficacy) and confidence in their ability to complete activities of daily living (ADLs) while maintaining balance (i.e. balance efficacy) were assessed through self-report measures at baseline, 12, and 24 months. Latent growth curve analyses within a covariance modeling framework examined the trajectories of change in gait efficacy and balance efficacy. To assess the effects of demographic factors and health conditions on both initial status and change in efficacy over time, a second series of growth curve models for gait efficacy and balance efficacy were run using age, race, education, income, and chronic health conditions as predictors. There were modest but significant declines in gait efficacy and balance efficacy over the 24-month period. Only chronic health conditions demonstrated a significant effect on efficacy levels at baseline, with women reporting more chronic health conditions being less efficacious with respect to gait and balance capabilities. In subsequent analyses none of the demographic or health conditions variables were independently associated with declines in balance efficacy. However, education and income were associated with declines in gait efficacy; higher education and income were associated with significantly less declines in gait self-efficacy. These findings suggest that interventions to bolster feelings of efficacy are particularly important for older adults of lower socioeconomic status and with less education. Public health initiatives may need to target personal risk factors, such as self-efficacy, in addition to performance-based indicators of functional health in an effort to attenuate age-related functional decline and disability.

Chapter 8 - *Background*: Being physically active has been demonstrated to be associated with health benefits, including prevention of diabetes, higher blood pressure levels, and reduction in cardiovascular mortality. The authors overarching aim was to examine the benefits associated with exercise and physical activity during pregnancy, with a focus on the health of the expectant mother. Of note, medical complications of pregnancy, particularly gestational diabetes and preeclampsia, are known to be associated with subsequent development of chronic illnesses, such as diabetes and hypertension in the mother.

*Objectives*: To assess (1) the benefits of physical activity during pregnancy, with particular attention to impact on rates of gestational diabetes, preeclampsia and mood disorders (2) the risks of physical activity during pregnancy (3) current patterns of physical activity during pregnancy, and (4) beliefs and barriers related to physical activity during pregnancy.

*Design:* Narrative review.

*Method:* A literature search was conducted through Medline and Pub Med using the following key words: pregnancy, pregnant woman, exercise, exercisers, physical activity, gestational diabetes, preeclampsia, mood, depression, anxiety, child-bearing, gestation, activity, patterns, exercise beliefs, barriers, risks, benefits.

*Results:* Observational studies suggest that some involvement in recreational physical activity during the first 20 weeks of pregnancy lowers the risk of preeclampsia by approximately one third and almost halves the risk of GDM. More vigorous activities appear to be more protective. Less than two thirds of women report regular physical activity during pregnancy. Physical limitations such as nausea and vomiting are considered to be a major exercise barrier by three-fifths of pregnant women. Between one-third and one-half women report the primary influence on their prenatal exercise behavior to be from their husbands or partners.

*Interpretation:* Interventions with the potential to increase activity levels among women of child bearing age need to be developed and tested through randomized controlled trials.

Chapter 9 - Regular physical activity is associated with both the prevention and treatment of cardiovascular risk factors and plays a vital role in the prevention of many chronic diseases including cardiovascular disease. Physical activity can decrease the risk of the metabolic syndrome and can decrease the risk of diabetes in those with impaired glucose tolerance. Other cardiovascular risk factors, such as hypertension and hypercholesterolemia, are improved with regular physical activity. There is considerable evidence supporting the risks of inactivity on all-cause and cardiovascular mortality in adults as seen from the studies above. In children, there is less evidence, probably due to a lack of completed longitudinal studies. Currently there are a number of population studies investigating the prevalence of cardiovascular risk factors in children and adolescents including The Bogalusa Heart study, The Amsterdam Growth and Longitudinal Study, The Northern Ireland Young Hearts Project, The Cardiovascular Risk in Young Finns Study and The European Youth Heart Study (EYHS). The long-term findings of these studies in terms of mortality/morbidity end-points will take many years, but there is evidence supporting the benefits of physical activity on cardiovascular parameters and in particular body composition in children. In a number of studies the effect of activity on cardiovascular risk appears to differ in boys and girls. This review will identify studies where the response to exercise and activity may differ between the genders and will make suggestions that the guidelines for activity need to be gender specific in children. It will also suggest that current physical activity guidelines may need to be higher for both genders based on the evidence to date.

Chapter 10 - Sedentary lifestyle is one of major public health and clinical problems. There is good evidence that regular physical activity has a protective effect against several chronic diseases, including coronary heart disease, stroke, hypertension, obesity, type 2 diabetes, osteoporosis, cancers of the breast and colon, depression and premature mortality. In recent years, the author assessed whether occupational, commuting, or leisure-time physical activity is independently associated with a reduced risk of incident hypertension, type 2 diabetes, coronary heart disease, stroke, and total and cardiovascular mortality among Finnish women. Moderate or high occupational physical activity is associated with a reduced risk of incident type 2 diabetes, coronary heart disease, stroke, and total and cardiovascular mortality among Finnish women. Moderate or high leisure-time physical activity is associated with a reduced risk of incident hypertension, type 2 diabetes, coronary heart disease, stroke, and

total and cardiovascular mortality among Finnish women. Daily commuting physical activity on foot or by bicycle is associated with a reduced risk of incident type 2 diabetes, coronary heart disease, stroke, and total and cardiovascular mortality among Finnish women. The protective benefit of physical activity is consistent regardless of body mass index.

Chapter 11 - Aorta and large arteries buffer the pulsation of blood pressure and flow through arterial wall extension. Increased arterial stiffness decreases this buffering function, and it is an independent risk factor for the development of cardiovascular disease. It is generally accepted that arterial stiffness increases with advancing age. In particular, women are likely to experience proportionally greater arterial stiffening in the post menopausal years. However, life style modifications, *e.g.* sodium restriction, improve arterial stiffness and may reduce the risk of developing adverse complications. Furthermore, the authors and others have demonstrated that endurance exercise training, *e.g.* walking and cycling, decreases arterial stiffness in both young and older men and women. Endurance exercise intervention can improve arterial stiffness even in postmenopausal women. On the other hand, although strength training, *e.g.* weight training, is beneficial to the attenuation of osteoporosis and sarcopenia, it increases arterial stiffness. The mechanisms underlying the exercise training effects on arterial stiffness have also been reported. It may be associated with vascular endothelial cells, which produce vasoactive substances such as nitric oxide and endothelin-1. Based on these documented evidence, the authors would like to recommend exercise training as one of life style modifications to prevent age-associated arterial stiffening.

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*Expert Commentary*

## **ROLE OF REGULAR EXERCISE ON VASCULAR HEALTH IN AGING WOMEN**

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For a number of years, women's health was dealt with a bikini approach, focusing mainly on the breast and the reproductive system [1]. The rest of the women's body, including the heart and the vasculature, was underemphasized and often ignored as cardiovascular disease was considered to be the men's disease. In contrast to this old notion, 1 in 2.4 deaths in women is claimed by cardiovascular disease whereas breast cancer accounts for only 1 of 29 deaths. It is now well-established and reasonably well-disseminated that cardiovascular disease is the leading cause of death for women both in the United States and in most of the industrialized world [2]. As with most chronic degenerative diseases, the prevalence of cardiovascular diseases increases markedly with advancing age in both sexes [2]. Thus, cardiovascular diseases exert their greatest impact on middle-aged and older adults both in terms of human suffering and health care costs. The incidence of coronary heart disease in women lags behind men by 10 years for total coronary heart disease and by 20 years for more serious clinical events such as myocardial infarction [2]. This statistics, however, is misleading as it undervalues the clinical importance of cardiovascular disease in women. Although cardiovascular mortality in US men has declined, the number of cardiovascular death in women remains unchanged [2]. Approximately two thirds of women who died suddenly of coronary heart disease had no previous symptoms compared with only 50% in men [2]. Moreover, in the US patient population who was diagnosed with acute myocardial infarction, more women died within a year than men and experienced another myocardial infarction and stroke more frequently than men [3]. Accordingly, a more comprehensive approach for primary and secondary prevention of cardiovascular disease specifically targeted for women, in particular postmenopausal women, is critically needed.

Because cardiovascular disease is progressively and subclinically advanced till the first symptoms appear, prevention is the ideal strategy to combat cardiovascular disease. The epidemic proportions of cardiovascular disease in women further highlight the need and



importance for both primary and secondary prevention of cardiovascular disease. Guidelines for prevention of cardiovascular disease typically include various lifestyle modifications such as smoking cessation, healthy eating, weight loss, and physically active lifestyle [4]. However, previous clinical trials have documented that preventive strategies found to be successful in men cannot be systematically extrapolated to women. For example, a significant benefit of aspirin in preventing acute myocardial infarction is found in men, but not in women [5]. Findings from the Women's Health Initiative trial indicated that diet low in fat and high in vegetables, fruits, and grains was ineffective in reducing fatal and nonfatal coronary heart disease, stroke, and overall cardiovascular disease during the 8-year follow-up period in women [6]. Although evidence is lacking in many areas because of the under-representation of women in clinical research [7], the accumulating evidence indicates that regular physical activity is an effective strategy for preventing cardiovascular disease in aging women [8-12]. Considering the fact that over 40% of US women remain sedentary and that activity levels of the majority of exercising women are insufficient to gain health benefits, the potential role of proper exercise routine for prevention and treatment of cardiovascular disease is substantial.

It is now well established that a physically active lifestyle is in general associated with a more favorable risk factors and reduced incidence of cardiovascular disease. Evidence is also accumulating that habitual moderate-intensity aerobic exercise and/or vigorous endurance exercise training either prevent or attenuate age-related increases in cardiovascular risks in women. For example, progressive increases in arterial stiffness with age observed in sedentary women are markedly attenuated in endurance-trained women [9, 11]. Furthermore, the elevations in systolic blood pressure and pulse pressure seen with age in sedentary women are absent in women who perform endurance exercise [10]. This is important considering that in middle-aged and older women, the relative risk of developing coronary heart disease associated with elevated systolic blood pressure is greater than that associated with any other risk factors, including plasma LDL-cholesterol concentrations and smoking [13]. Collectively, these results suggest that habitual exercise is beneficial for the "primary" prevention of cardiovascular disease in women.

There are also accumulating evidence indicating that regular exercise is an effective intervention for the "secondary" prevention of age-related cardiovascular disease as postmenopausal women can reverse some or all of the age-related changes in cardiovascular function and disease risks. In fact, aging women appear to gain similar or even greater cardiovascular benefits from regular exercise compared with men. In the INTERHEART study, a large international case control study designed to assess the importance of risk factors for coronary heart disease worldwide, the protective effects of exercise in relation to acute myocardial infarction was substantially greater in women than in men as evidenced by the adjusted odds ratios of 0.48 for women and 0.77 for men [14]. We have also demonstrated that when identical moderate-intensity aerobic exercise was prescribed to middle-aged and older men and women, postmenopausal women achieved a greater improvement in the elastic property of arteries than men (50% vs. 25%) [9, 12]. In fact, the magnitude of increases was so great that post-exercise value of postmenopausal women was no longer different from premenopausal women, suggesting that short-term regular exercise may be able to reverse age-related arterial stiffening [9]. Thus, habitual exercise has consistently been shown to be a highly effective strategy to prevent and treat cardiovascular disease whereas other preventive interventions, including aspirin and dietary modification, may not be always beneficial for women [5, 6].

When prescribing physical activity, it is important to note that improvements in the cardiovascular risk factors do not depend on an increase in cardiovascular fitness [8, 12, 15, 16]. That is, physical activity does not have to be vigorous to gain health benefits. The current guidelines set a goal of 30 min/day of moderate physical activity, which can be accumulated in bouts of at least 10 minutes, most days of the week [17]. Research addressing the impact of various exercise programs on cardiovascular disease in women is rapidly accumulating. However, there are many unanswered questions remaining. Considering the impact of sarcopenia and osteoporosis in aging women, what is the effect of regular resistance exercise on cardiovascular disease risks in aging women? What is the impact of aerobic exercise when it is combined with other therapeutic (pharmacological or non-pharmacological) interventions or other exercise modes (e.g., resistance exercise training)? Given the high prevalence of sedentary lifestyle in women, how much or how little physical activity is required to gain health benefits in women? What is the effective exercise to implement particularly in minority women? What is the most effective way to retain dropout-prone women in the exercise program? We also require information regarding the physiological mechanisms underlying beneficial effects of regular exercise on cardiovascular function and disease risks in women. Once exercise intervention studies define effectiveness of regular exercise in women as well as differences in the way in which men and women respond to exercise training stimuli, these data must be incorporated in their preventive and therapeutic practices. In this context, it is critical that sufficient number of women is included in the future clinical trials and exercise intervention studies to allow sub-group analyses or to assess sex differences.

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