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Influence of cardiorespiratory fitness and physical activity levels on cardiometabolic risk factors during menopause transition: A MONET study

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ABSTRACT

To determine the influence of cardiorespiratory fitness (hereafter "fitness") and physical activity levels on cardiometabolic risk factors in premenopausal women going through the menopause transition. An ancillary study including 66 premenopausal women who participated to a 5-year observational, longitudinal study (2004 to 2009 in Ottawa) on the effects of menopause transition on body composition and cardiometabolic risk factors. Women underwent a graded exercise test on treadmill to measure peak oxygen uptake (VO_2 peak) at year 1 and 5 and physical activity levels were measured using accelerometers. Cardiometabolic risk factors included: waist circumference, fasting plasma lipids, glucose and insulin levels, HOMA-IR score, c-reactive protein, apolipoprotein B (apoB) and resting systolic and diastolic blood pressure. Change in fitness was not associated with changes in cardiometabolic risk factors. The changes in total physical activity levels on the other hand showed a significant negative association with apoB levels. Three-way linear mixed model repeated measures, showed lower values of waist circumference, fasting triglycerides, insulin levels, HOMA-IR score, apoB and diastolic blood pressure in women with a fitness ≥30.0 $mlO_2\ kg^{-1}\ min^{-1}$ compared to women with a fitness <30.0 $mlO_2\ kg^{-1}\ min^{-1}$ ($P < 0.05$). However, only fasting triglycerides was lower in women with physical activity levels ≥770.0 Kcal/day ($P < 0.05$). Between fitness and physical activity levels, fitness was associated with more favorable values of cardiometabolic risk factors in women followed for 5 years during the menopause transition.

1. Introduction

Cardiovascular disease (CVD) is the leading cause of mortality among women in developed countries (Bittner, 2002). Many CVD risk factors have been identified such as abdominal obesity, physical inactivity, diabetes, hypertension and dyslipidemia (Bittner, 2002; Pearson, 1999). Cardiorespiratory fitness (hereafter "fitness") as well as physical activity levels are important and independent predictors of CVD, cardiac events and death among symptomatic and asymptomatic women (Blair & Jackson, 2001; Gulati et al., 2005; Berlin & Colditz, 1990; Hu et al., 2005).

Fitness is a physiological attribute, defined by maximal oxygen uptake (VO_2 max) measured using a maximal exercise test (Lee et al., 2011). A high fitness level estimated in metabolic equivalents (METs) has been defined as the 2 highest quintiles, which represents ≥8.5 METs for women between the ages of 50–59 years according to the Aerobics Center Longitudinal study (Sui et al., 2007). Furthermore, a low fitness value (<8.5 METs) was shown to be associated with a higher incidence of CVD events in men and women (Sui et al., 2007). Conversely, high fitness has been found to be inversely associated with the levels of visceral fat, insulin resistance, blood lipids and blood pressure as well as with the prevalence of the metabolic syndrome (Abdulnour et al., 2010; Arsenault et al., 2007; LaMonte et al., 2005; LaMonte & Blair, 2006) collectively reducing the risk of CVD.

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Physical activity is defined as any body movement that increases energy expenditure, including both leisure time and non-leisure time activities (American College of Sports Medicine et al., 2006). The 2011 Canadian Physical Activity Guidelines for adults recommends at least 150 min of moderate-to-vigorous intensity of aerobic physical activity per week (Tremblay et al., 2011 Feb). It has also been recommended to expend a minimum of 150 kcal/day or 1000 kcal/week of moderate-to-vigorous physical activity energy expenditure (Anon., 1996). Such physical activity levels recommendations have been demonstrated to be associated with increased health benefits, by reducing the risk of cardiometabolic risk factors and CVD in men and women (Hu et al., 2005; Tremblay et al., 2011; Warburton et al., 2010; Dvorak et al., 2000; Owens et al., 1990).

Despite the fact that several studies having simultaneously investigated the association between fitness and physical activity levels and body composition, body fat distribution and cardiometabolic risk factors (Lee et al., 2011; Dvorak et al., 2000; Eriksen et al., 2013; Minder et al., 2014; Yu et al., 2013), controversy remains. While the majority reported that fitness is more strongly associated than physical activity levels with CVD and cardiometabolic risk factors (Lee et al., 2011; Dvorak et al., 2000; Minder et al., 2014; Yu et al., 2013), one study suggested that physical activity level is as good as fitness to predict individual health (Eriksen et al., 2013). However, the majority of the studies used self-reported questionnaire for the assessment of physical activity levels (Lee et al., 2011; Eriksen et al., 2013; Minder et al., 2014; Yu et al., 2013). Although, self-reported physical activity may be useful for ranking physical activity levels in large epidemiological studies, it lacks precision and validity (Dvorak et al., 2000) for longitudinal and prospective studies compared to the measurement of total volume of physical activity by accelerometry (Bassett et al., 2015). Furthermore, accelerometer-derived physical activity measurements are more closely associated to cardiometabolic risk factors than that obtained from self-reported questionnaire (Bassett et al., 2015).

The evidence supporting a relationship between fitness and/or physical activity levels and CVD risk factors has been well documented in the general population. Still, it is questionable if these relationships are the same in women going through the menopause transition. First, this is a period in a woman's life that results in a progressive decrease in estrogen (Lovejoy et al., 2008 Jun), which is associated with an increase incidence and prevalence of cardiometabolic risk factors (Lovejoy et al., 2008) and CVD (Rosano et al., 2007). Second, we have previously reported, in the same cohort, that the time spent performing light physical activity have a greater effect on adiposity during menopause transition than moderate and/or vigorous physical activity (Riou et al., 2014). Third, the intensity of non-leisure time activities is lower than the relative intensity necessary to improve fitness (American College of Sports Medicine et al., 2006).

Thus, the aim of the present study was to determine the influence of fitness and physical activity levels on cardiometabolic risk factors in non-obese women going through the menopause transition. We tested the following hypothesis: fitness and physical activity levels would be related with a favorable cardiometabolic risk factors in women followed through the menopause transition.

2. Methods

2.1. Subjects

The study includes data from healthy premenopausal women aged between 47 and 55 years who participated in a 5-year longitudinal study from 2004 to 2009 (MONET Study: Montreal Ottawa New Emerging Team) (Abdulnour et al., 2012). For the purpose of this secondary analysis, 66 out of the 91 participants who completed the original study were included, based on peak oxygen uptake (VO_2 peak) and physical activity levels value availability at years 1 and 5. However, no differences were observed for baseline characteristics (data not shown) between those who completed the study and the sub-sample of participant used in the present analysis. Premenopausal women were included if they met the following criteria: (1) premenopausal status (two menstruations in the last three months, no increase in cycle irregularity in the 12 months preceding testing, and a plasma follicular-stimulating hormone level < 30 IU/l as a mean of verification); (2) aged between 47 and 55 years; (3) no surgically-induced menopause; (4) non-smoker; (5) BMI between 20 and 29 kg/m^2; and (6) reported weight stability (±2 kg) for ≥6 months before enrolment in the study. Exclusion criteria were: (1) pregnant women or planned to become pregnant; (2) had medical problems that could have interfered with outcome variables including cardiovascular and/or metabolic diseases; (3) were taking oral contraceptives or hormone replacement therapy; (4) had high risk for hysterectomy; and (5) had a history of drug and/or alcohol abuse. Prior to inclusion in the study, written informed consent was obtained from each participant. This study was conducted according to the guidelines of the Declaration of Helsinki, and received the approval from the University of Ottawa and the Montfort Hospital Ethics committees.

2.2. Menopausal status

Menopausal status was determined yearly by self-reported questionnaire about menstrual bleeding and its regularity and follicle-stimulating hormone (FSH) levels were measured annually during the early follicular phase to verify the menopausal status. Women were classified as premenopausal if they reported no change in menstrual cycle frequency and perimenopausal if they reported changes in menstrual frequency and/or amenorrhea for 3–11 months. Finally women were classified as postmenopausal based on their final menstrual period (FMP) and confirmed by 12 month of amenorrhea (Soules et al., 2001).

2.3. Anthropometric assessment

Body weight and height were measured with a BWB-800AS digital scale and a Tanita HR-100 height rod, respectively (Tanita Corporation of America, Inc. Arlington Heights, IL). Body mass index (BMI) was then calculated [body weight kg/height (m^2)]. Waist circumference (mean of two measures) was determined using a Gulick tape at the mid-distance between the lowest rib and the iliac crest (Canadian Society for Exercise Physiology, 2003). Body composition (fat mass and lean body mass) and % body fat were measured using dual-energy X-ray absorptiometry (DEXA) (GE-LUNAR Prodigy module, GE Medical Systems, Madison, Wi, USA) as previously described (Abdulnour et al., 2012).

2.4. Cardiorespiratory fitness

A graded progressive exercise test on the treadmill was performed to measure VO_2 peak by indirect calorimetry. The progressive test consisted of 3-minute stages starting with a speed of 3.4 mph and a slope of 0% with an increasing workload to the point of participant exhaustion (speed increased to 4.0 mph by stage 6, 5.2 mph by stage 8 and 6.0 mph by stage 10; slope increased by 4% at every stage). Heart rate, blood pressure and the rate of perceived exertion (Borg scale) (Borg, 1982) were taken at rest and at the end of each stage during the test. Breath-by-breath samples of expired air were collected through a mouthpiece during the test, and measurements of VO_2 and VCO_2 were obtained using a Vmax 229 series metabolic cart (SensorMedics Corporation, Yorba Linda, CA). The indirect calorimetry unit was calibrated before each test according to the manufacturer's specifications.

After a brief warm up on the treadmill, women performed the exercise test. The test was terminated when at least 2 of the following criteria were achieved (Gulati et al., 2005): 1) predicted maximal