

CROSS SECTIONAL STUDY

IJPHY

CORRELATION OF PHYSICAL ACTIVITY LEVEL WITH BONE MINERAL DENSITY, CARDIO-RESPIRATORY FITNESS AND BODY COMPOSITION IN POST-MENOPAUSAL WOMEN

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ABSTRACT

Background: Due to the hormonal changes in postmenopausal women they are prone for many complications like increased CVD risk factors, osteoporosis, obesity, mood swings and urinary incontinence. Physical inactivity in postmenopausal women leads to higher risk of developing CVD and osteoporosis. The objective was to find out the correlation of physical activity level with BMD, cardio-respiratory fitness and body composition in post-menopausal women

Methods: 42 postmenopausal women were included. A detailed clinical evaluation with physical activity level (IPAQ-METS-mins/week), BMD (T-Scores), body composition (BMI, waist circumference, BIA & Skin fold calliper for fat %), cardio-respiratory fitness was measured by Balke protocol and VO₂peak (ml/kg/min) is estimated. Correlation of physical activity level with BMD, cardio-respiratory fitness and body composition were analysed using "Pearson's product moment correlation co-efficient and Spearman's rho."

Results: Spearman's rank correlation rho for IPAQ with VO₂ peak was 0.420, BMI was -0.388 and visceral fat was -0.384 indicating moderate positive correlation between IPAQ and cardio-respiratory fitness and weak negative correlation between IPAQ and BMI and visceral fat. Pearson's product moment correlation coefficient of IPAQ with BMD was 0.147, body fat was -0.234 and waist circumference was -0.256 indicating no correlation. P value was significant for correlation of IPAQ with CRF (0.006), BMI (0.011) and Visceral fat (0.012).

Conclusion: There is moderate positive correlation between IPAQ and cardio-respiratory fitness, weak negative correlation between IPAQ and BMI and visceral fat and no correlation between IPAQ and BMD, body fat and waist circumference.

Keywords: physical activity, postmenopausal women, CVD risk, BMD, body composition, visceral fat, body fat %.

Received 16th November 2016, revised 05th January 2017, accepted 05th February 2017



www.ijphy.org

10.15621/ijphy/2017/v4i1/136154

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INTRODUCTION

Menopause is defined “as the permanent cessation of menstruation resulting from loss of ovarian follicular activity”. Menopause is confirmed after 12 consecutive months of a menorrhoea (<http://www.who.int/whr/1996/en/->). In the Western world, women reach menopause between the age of 40 and 61yrs[1] and the average age for last menstrual cycle is 51 years [2]. In Indian women menopause occurs at the age of 44yrs much before other women [3].

Most significant changes associated with menopause are the changes that occur in the endocrine system, drastic reduction in secretion of Estradiol, rise in the levels of Follicle stimulating hormone and luteinizing hormone [4]. Due to these hormonal variations postmenopausal women are prone for many complications like increased Coronary heart disease risk factors, osteoporosis obesity, mood swings and urinary incontinence [5,6,7]. Prevalence of these complications is high, the risk factors for CVD (cardio-vascular disease) in postmenopausal women was found to be 56% were hypertensive, 21% were diabetic, 68% had truncal obesity, 60% had abdominal obesity, dyslipidaemia present in 39%[8]. 12.6% of Indian postmenopausal women are obese [9]. 42.5% of postmenopausal women were osteoporotic and 44.9% were osteopenic (<http://www.sciencedaily.com/releases/2010/02/100223132015.htm>).

Menopause may not directly cause cardiovascular diseases but the risk factors certainly increase at the time and post menopause. Late menarche was found to be associated with decreased CVD risk [6]. The cause for this increased CVD risk is said to be the decline in the apparent cardio-protective effects of estrogen in postmenopausal women [10]. Other than estrogen other factors which could cause this increase are increased BP, LDL (bad cholesterol) and triglycerides and decline in levels of HDL (good cholesterol). Weight gain could also play a role to increase the CVD risk factors. Post menopause the gender differences in CVD are reduced [11,12].

Osteoporosis is “a disease characterized by reduction in the bone mass and disruption of bone architecture leading to impaired skeletal strength and an increased susceptibility of fractures”[13]. In the present study we have calculated BMD by T-scores “(normal: -1, Osteopenia: > -1 to -2.4 & Osteoporosis: < -2.5)” A study done on south Indian women suggested that there was higher rate of osteoporosis and vitamin D deficiency in these women post menopause[14]. There are also variations among different ethnic groups, a study found that by the age of 80 one – fifth women in each ethnic group had T-Scores more than -2.5 and African origin women had the highest BMD (bone mineral density) while the Asian women had the lowest BMD [15].

A woman reaches her maximum body weight at the onset of menopause, with rise in body fat % and abdominal fat % associated with subsequent increase in body weight linearly with age [5]. Some studies suggest that there is menopause related increase in body weight, total body fat, central and intra-abdominal fat accumulation [5,16,17]. There is shift

to android or male pattern adiposity due to redistribution of body fat in anterior abdominal wall.

“Physical activity is defined as any bodily movement produced by skeletal muscles that require energy expenditure”. Physical inactivity is the major cause of diseases across the world. “Elimination of physical inactivity would remove between 6% and 10% of the major NCD (non-communicable diseases) of Coronary heart disease, type 2 diabetes, and breast and colon cancers, and increase life expectancy”. Physical inactivity causes an increase in the risk of CVD, type 2 diabetes and obesity [18].

A study done among south Indian women suggested that they performed lesser physical activity than European women and they do not perform 150 minutes of moderate physical activity which is recommended [19]. Physical inactivity in postmenopausal women leads to higher risk of developing CVD and osteoporosis. Thus the complications associated with menopause may be mediated by physical inactivity and loss of the protective effects of estrogen.

Zhong W et al in 2012 in a cross sectional study concluded that greater total PA and moderate-intensity PA (physical activity), and moderate vigorous-intensity PA might improve bone mass in postmenopausal women [20]. Colpani V et al in 2013 in a cross sectional study found that regular physical activity, i.e. walking 6,000 or more steps daily, was related to diminished risk of cardiovascular disease and diabetes in middle-aged women [21]. Pitanga CP et al in 2012 in a study found that “mild to moderate physical activity, with a caloric expenditure between 1,601 and 2,283 kcal /week,” protects against accumulation of adipose tissue causing central adiposity in postmenopausal women [22].

The literature suggests that low level of physical activity is associated with osteoporosis, high CVD risk and obesity in post-menopausal women. Even though the relationship between physical inactivity and risk for complications in chronic conditions has been established; there is a dearth of literature in postmenopausal women especially in Indian population. Therefore, the present study.

The objective of this study was to find out the correlation of physical activity level with bone mineral density, cardio-respiratory fitness and body composition in postmenopausal women.

METHODS

Ethical approval from Institutional ethical committee and study approval from Institution research committee was taken. Volunteers were assessed for eligibility on basis of inclusion & exclusion criteria. Informed consent was taken from the eligible subjects. Assessment of variables i.e. BMD, BMI, waist circumference, Body fat %, PA and VO2 peak was done.

Study design- Cross-sectional study

Study setting- a. Department of physiotherapy, SOAHS, Manipal, India b. Kasturba Hospital, Manipal, India

Period of study- February 2014-April 2015

Study subjects-The study subjects are the post-menopausal women. The inclusion criteria were 1 year post menopause and age between 40 to 65 yrs. The exclusion criteria were history of systemic infection or any cardio-respiratory, neurological, musculo-skeletal, metabolic conditions contraindicating exercise testing. 42 postmenopausal women consented to participate in the study. Participants were recruited from the BMD clinic in the department of orthopaedics, KH, Manipal. (2nd Saturday of every month).

Assessment of variables

Participants underwent BMD assessment with quantitative ultrasound (site- radial shaft) in the department of orthopaedic, Kasturba hospital, Manipal for which scores are reported as “T-Scores”.

Participants filled an IPAQ-SF questionnaire (interview) Physical activity through IPAQ-SF which consists of 7 questions regarding the minutes spent in the last week in moderate activity, vigorous activity, walking and sitting. These scores is substituted in the following formulae to calculate the scores for total physical activity METs minutes/week. “Total physical activity MET-minutes/week = sum of Walking + Moderate + Vigorous METs minutes/week scores.”

Measurements for body composition were done in the Fitness lab of department of physiotherapy, SOAHS Manipal as per American college of Sports Medicine guidelines. “Height was measured with the participant standing erect against the wall with, heels, gluteal region, back of shoulders and head touching a vertical ruler at right angle brought into contact with the highest point on the head (23)Weight and Visceral fat was measured with the participant standing erect on a BIA. BMI Calculated by the formula- BMI= Wt (kg) / Ht² (mts) [23]. Waist circumference was measured at the end of exhalation with the subject in standing with feet apart, inch tape placed at the superior border of the iliac crest (highest level) [23]”.

“Skin fold Measurement was measured on the right side of the body with the participant standing erect. Grasping a fold of skin and fat away from muscle. Using a calliper to measure skin fold thickness to the nearest 0.5 mm. Placing calliper 1 cm from thumb and finger perpendicular to skin fold 1/2 way between crest and base of fold. Maintaining the “pinch” while reading (1-2 sec). Sites were Supra-iliac slightly oblique fold superior to the iliac crest thigh vertical fold on the anterior midline of the thigh, midway between the inguinal crease and proximal border of the patella. Body weight is shifted to left foot and triceps vertical fold on the back of the upper arm measured half way between the olecranon (elbow) and acromion (a bony prominence at the top of the shoulder blade) processes [23]”. The values obtained is substituted in the following formula- “Body density = 1.0994921 – (0.0009929 * sum of three skin folds) + (0.000023 * [sum of three skin folds]²)-(0.0001392 * age). Body density then is substituted in the following formula to calculate Body fat % = 495/ Body Density – 450 “

Participants underwent sub maximal symptom limited

treadmill testing (BALKE protocol) in the fitness lab of department of physiotherapy, SOAHS Manipal. The participant were informed to walk at the set speed of 5.4 km/hr (3.3 mph) at 0% gradient and then gradually gradient was increased by 1% every 1 min. If the subjects felt any discomfort (breathlessness, chest pain, etc) the test was terminated immediately. HR max, time and HR post recovery after 1min was taken. Time is used in the following formula - for active and sedentary women- Estimated VO2 peak (mL.kg-1.min-1) = 1.38* Time +5.22.

2.6. Data Analysis

Analysis of data was done using SPSS version 15. Descriptive statistics for the age, last menstrual period, IPAQ, BMD, VO2 peak, BMI, body fat%, waist circumference & visceral fat was calculated. Test for normality Shapiro Wilk test was done for IPAQ, BMD, VO2 peak, BMI, body fat%, waist circumference & visceral fat. “Pearson’s Correlation coefficient of BMD, body fat% and waist circumference with IPAQ was calculated. Spearman’s Correlation coefficient of VO2 peak, BMI and visceral fat with IPAQ was calculated.

RESULTS

112 participants were screened out of which 45 were included according to the inclusion and exclusion criteria, 3 refused to consent for the study hence were excluded and 42 consented to participate in the study and data was analysed.

The mean age of the participants was 55.40±5.68 years and the mean duration of menopause was 7.5±5.99 years. Among the participants 35.7% were hypertensive and 50% were diabetic. 73.8% were home makers and 26.2% were office goers (Table 1).

Table 1: Demography and Clinical profile of the participants

	Mean ± SD
Age	55.40 ± 5.68
Duration of menopause	7.5 ± 5.99
Co-morbidities %	35.7 % hypertensive 50 % diabetic
Occupation	73.8% home makers 26.2% office goers

The mean and the standard deviations of the outcome measures were IPAQ- 607.35±225.7 MET-mins/week, BMD -2.13±0.91, VO2 peak 14.77±3.02 ml/kg/min, BMI 26.49±4.56kg/m², body fat 38.21±4.12%, Visceral fat 10.43±5.61% & Waist circumference 92.45±8.96 cms (Table 2).

Table 2: Characteristics of the various outcome measures

Outcome measures	Mean ± SD
IPAQ	607.35 ± 225.7
BMD*	-2.13 ± 0.91
Cardio-respiratory fitness	14.77 ± 3.02
Body fat %	38.21 ± 4.12
BMI	26.49 ± 4.56
Waist circumference	92.95 ± 8.96
Visceral fat	10.53 ± 5.61

BMD- Bone mineral density BMI-Body mass index IPAQ- International physical activity questionnaire

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IPAQ scores, BMD, body fat % and waist circumference followed normal distribution. Pearson’s product moment correlation coefficient (Table 3) of IPAQ with BMD was 0.147, with body fat was -0.234 and with waist circumference was -0.256 indicating no correlation between BMD, body fat and waist circumference

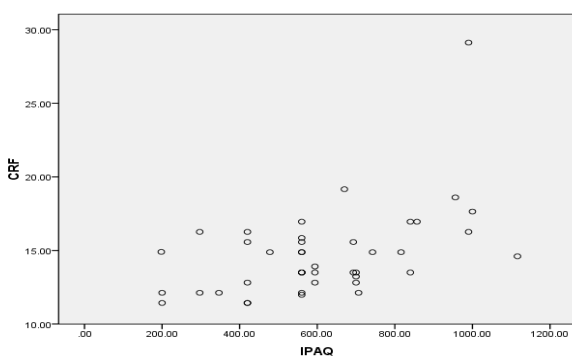
Cardio-respiratory fitness, BMI and visceral fat did not follow normal distribution. Spearman’s rank correlation rho (Table 3) for IPAQ with VO₂ peak was 0.420 (Figure 1), with BMI was -0.388 and with visceral fat was -0.384 indicating moderate positive correlation between IPAQ and cardio-respiratory fitness and weak negative correlation between IPAQ and BMI and visceral fat.

Table 3: Correlation of physical activity level with other measures

Measures	r value	Rho value	p-value
Bone mineral density	0.147		0.354
Cardio-respiratory fitness		0.420	0.006**
Body fat %	-0.234		0.135
BMI		-0.388	0.011**
Waist circumference	-0.256		0.101
Visceral fat		-0.384	0.012**

a- Cardio-respiratory fitness, bone mineral density and body composition *p value significant Table- 3: Demonstrates that physical activity levels correlation with cardio- respiratory fitness is moderately positive, with BMD is nil and with body composition is weakly negative in post-menopausal women.

Figure1: Correlation of IPAQ with CRF



CRF- Cardio-respiratory fitness Figure-1: Scatter plot for correlation between physical activity level and cardio- respiratory fitness in post-menopausal women (moderate positive correlation)

Among the participants 59.5 % of women were sedentary (IPAQ<600MET- min/week) & 40.5% were active (Table 4) and participants were confirmed osteoporotic.

Table4: Physical activity levels and BMI

IPAQ values	Number of participants	With BMI (kg/mts ²) (Number)		
		> 23	>27	>30
< 600 MET- min/week	25 (40.5%)	12	7	5
>600 MET- min/week	17 (59.5%)	6	3	1

Table4: Demonstrates that obesity was more prevalent in sedentary participants

DISCUSSION

The present study focused on measuring the physical activity levels of post- menopausal women and its correlation with various other physiological and clinical parameters.

Even though earlier studies had focused on each parameter separately, our study was focussed on identifying physical activity level and correlation with many clinical measures in postmenopausal women in a single research study.

Earlier studies have reported that physical inactivity was associated with reduced CVD risk, improved Body composition but not much association with BMD which similar to what this study concludes. Certain studies also reported that moderate physical activity was associated with better BMD contrary to what this study reports. Not much studies have been done to find the correlation levels between physical activity levels and CRF, BMD and Body composition.

In the present study we found there is positive moderate correlation between physical activity levels and cardio- respiratory fitness (Table 3). Thus lower the physical activity, lower the Cardio-respiratory fitness. The results of this study were similar to what was observed in an observational study done in 2013 by Colpani et al concluded that sitting for longer time was associated with increased CVD risk, which was not dependent on leisure-time physical activity, in postmenopausal women without a history of CVD [21].

Several biological mechanisms are responsible for the association of risk for CVD and physical activity level-by improving the glucose control and insulin sensitivity, decreasing blood pressure, improve autonomic tone, decreasing systemic inflammation; reducing blood coagulation, increasing coronary blood flow [24, 25].”

Routine physical activity correlated with psychological well- being by reducing stress, anxiety and depression which helps in prevention and management of cardiovascular disease [26, 27, 28].

It was observed that office goers had better levels of physical activity than the home makers thus showing the effect of occupation on increasing the levels of physical activity.

However, we did not find any correlation of physical activity levels with bone mineral density. This result is similar to that of a study done in 2013 by Qiu C et al, which concluded that moderate physical activity had little impact on bone mass in healthy postmenopausal women [6]. Another study by Kemmler et al, in 2004 also concluded that “the isolated effect of habitual physical activity, non-athletic low impact exercise, and muscle strength on bone parameters is rather low in (early) postmenopausal women [29].” The lack of correlation may also be due to the participants in the current study participated only in low intensity activities such as household work and none of the participants engaged in the vigorous activities.

Also, there was weak negative correlation of physical activity level with body and visceral fat % and waist circumference. In an earlier study by Sims ST et al in 2013 moderate intensity of aerobic exercise was not found to be effective in decreasing body fat and resistance exercise was found to be beneficial [30] however there is dearth of studies on moderate to vigorous physical activity and its effect on body fat.

Routine physical activity has been shown to improve body fat distribution “by reducing abdominal adiposity and improving weight and improving lipid lipoprotein profiles by reducing triglyceride levels, improving high density lipoprotein [HDL] cholesterol levels and decreasing low-density lipoprotein [LDL]-to-HDL ratios.” Thus, lesser the physical activity higher is the BMI, body fat %, waist circumference and visceral fat % [31, 32].

In addition, we also found that the participants who were sedentary had higher BMI, more participants were overweight and obese in the sedentary group (Table-4). In this study we assessed both subcutaneous and visceral fat and found there is a mean increase in both in 50% of the participants. Increase in fat is risk for CVD therefore we also recommend prescribing a moderate-vigorous physical activity to reduce both subcutaneous and visceral fat thereby preventing CVD.

The limitations of the present study was that IPAQ records only activities done beyond 10 mins thus activities done less than that duration is not recorded thus it tends to underestimate the physical activity levels. The BMD was measured by ultrasound which is not the gold standard for analyzing the BMD but due to unavailability of DEXA and radiation effects of CT scan ultrasound was used.

Future research could be done for studying the effects of increasing habitual physical activity on Bone mineral density, cardio-respiratory fitness and body composition and effect of body fat on BMD can also be studied which could further explain the association with physical activity of these measures.

CONCLUSION

In the present study we concluded that there is no correlation between bone mineral density and physical activity

level, moderate positive correlation between cardio-respiratory fitness and physical activity level in post-menopausal women and weak negative correlation between body composition and physical activity level in post-menopausal women. With this study we recommend early screening of physical activity level, comprehensive evaluation of the physical activity for postmenopausal women will help to prevent loss of BMD, reduce CVD risk and make the women more physically active and healthy.

LIST OF ABBREVIATIONS

BMD- Bone Mineral Density
QUS- Quantitative Ultrasound
IPAQ- SF- International Physical Activity Questionnaire-short form
CVD- Cardiovascular Disease
METS- Metabolic Equivalent
PA- Physical Activity
CRF-Cardio-Respiratory Fitness
BF-Body Fat %
BMI- Body Mass Index
WC-Waist Circumference
VF-Visceral Fat

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Citation

Khona, N. N., Maiya, A. G., Acharya, K., & Samuel, S. R. (2017). CORRELATION OF PHYSICAL ACTIVITY LEVEL WITH BONE MINERAL DENSITY, CARDIO-RESPIRATORY FITNESS AND BODY COMPOSITION IN POST-MENOPAUSAL WOMEN. *International Journal of Physiotherapy*, 4(1), 6-11.