AJLS

Asean Journal of Life Sciences, Vol 3(1), 2023, pp. 1-6

Accepted date: 20 May 2023
Publish date: 30 June 2023

Correlation between Adiponectin and Body Composition of Pre-menopausal Women

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Abstract

Decreased bone mineral density, a risk factor for fracture is a rare condition in pre-menopausal women and is often related to abnormalities in hormone levels, bone metabolism, weight and diet. Even though the incidence is low, it can have detrimental effects on their daily activities, and this can easily be prevented through awareness and change in lifestyle. Adiponectin, a hormone secreted by adipose tissues is responsible in mediating inflammation, increasing insulin sensitivity of cells, regulation of bone metabolism, protective against cardiovascular diseases and muscle atrophy. This study aims to analyse the correlation between adiponectin and body composition of pre-menopausal women. 60 premenopausal women (mean age = 23 years) were grouped according to their BMI reading: underweight (n=20), normal (n=20) and overweight (n=20). Body composition (fat mass, muscle mass and bone mass) was measured by TANITA Body Composition Analyser whilst serum adiponectin was determined by enzyme-linked immunoassay. The level of adiponectin in all groups were within normal range, with the highest level found in the underweight group, followed the normal group and lowest in the overweight group. Adiponectin showed a significant negative correlation with fat mass ($r=-0.565$, $p<0.001$) and bone mass ($r=-0.370$, $p=0.04$). However, fat mass and bone mass had no significant correlation ($r=0.210$, $p=0.107$). In conclusion, this study suggest that adiponectin has significant negative correlation with both fat mass and bone mass.

Keyword: Adiponectin, BMI, Bone mass, Fat mass, Premenopausal

Introduction

Decreased bone mineral density (BMD) and bone mass associated with decline in oestrogen during menopause is well established (Beck et al., 2021). However, this condition is rare in premenopausal women due to the continuous secretion of oestrogen that balances bone formation and bone resorption. In addition to hormones, bone mass is also influenced by age,

gender, diet and physical activities. There is a generalized view of increased mechanical loading, increases bone mass (Wang, et al., 2022). Mechanical loading may arise due to increase in fat mass and/or an increased in muscle mass. However, the relationship between fat and bone mass is much more complicated. There is growing evidence showing biochemical factors influence fat mass and BMD. Adiponectin, a hormone secreted by adipocytes is responsible for increasing insulin sensitivity in cells for glucose regulation and fatty acid oxidation (Iacobellis et al., 2013). In vitro studies have shown that adiponectin have positive effects in bone through promotion of osteoblast proliferation and differentiation while inhibiting osteoclastogenesis (Naot et al., 2016). The levels of adiponectin decrease in obese individuals. High-fat mass in obesity leads to depression in osteoblasts activities and increased in osteoclasts activities. Consequently, this promotes heightened bone resorption (Zhuang et al., 2021). It was suggested that the effect of adiponectin on bone varies based on gender with indications that it acts as a risk factor for fractures especially in males (Naot et al., 2016). Many evidence have shown that adiponectin aid in the development, maintenance of muscle mass and protective against muscle wasting conditions (Krause et al., 2019). Therefore, this study aims to elucidate the correlation between adiponectin and body composition in pre-menopausal women to serve as a possible resource for clinicians in management of patients.

Methodology

This research was carried out at Universiti Selangor, Shah Alam Campus. 60 pre-menopausal women were chosen according to the inclusive criteria of healthy, aged between 21-40 years old, not pregnant, not smoking and not on any medications or supplements that may affect their bone and muscle health. Informed consent was obtained and the subjects were grouped according to their BMI reading: $<18.50 kg/m^2$ as underweight, 18.50-24.99 kg/m^2 as normal and ≥ 25.00 kg/m^2 as overweight.

The subjects' physical activities, such as walking, moderate-intensity activity and vigorous-intensity physical activity were measured using the validated international physical activity questionnaire short version (IPAQ-s) over the course of the previous seven days (Tomioka et al., 2011).

The subject's body composition (fat mass, muscle mass and bone mass) was measured by BC541 TANITA body composition analyzer. The body composition analyzer was used with all the safety measures that were advised.

Blood sample collection was handled by a certified phlebotomist. 5 mL of blood were collected in a plain tube and left at room temperature for 40 minutes before centrifuged to obtain the serum. The collected serum were stored at -20°C.

Serum adiponectin was analyzed using the sandwich method enzyme-linked immunoassay (ELISA) ADP/Acrp30 (Elabscience Biotechnology,China). Steps in analyzing the serum samples were carried out in accordance with the manufacturer's manual. The data were analyzed using the software of statistical package for social sciences (SPSS) version 18. The data obtained were normally distributed and statistical tests used were One-way analyses of variance (ANOVA) and Pearson's correlation. The results were expressed in mean ± standard deviation with statistical significance at $p<0.05$ or $p<0.001$.

Result and Discussion

The subjects consisting of 60 pre-menopausal women were recruited and grouped according to their BMI reading < 18.50 kg/m^2 underweight, 18.50-24.99 kg/m^2 normal and ≥ 25.00 kg/m^2 overweight. The IPAQ-s score showed low physical activity, common across the three groups. The mean of each variable; age, weight, height, BMI, fat mass, muscle mass, bone mass and adiponectin is presented in Table 1.

Based on the TANITA body composition analyzer's manual, the mean value of muscle mass and bone mass were still within the normal range of women. Mean fat mass for the overweight group is above normal range.

Adiponectin levels for the overweight group falls under normal range whilst the underweight and normal groups were within the normal range of 3-30μg/ml (Kadowaki & Yamauchi, 2005). Additionally, there were significant variations in the mean of weight, BMI, fat mass, muscle mass and adiponectin across the 3 groups.

Table 1 Demographic data according to BMI groups

Variables	Underweight (n=20)	Normal (n=20)	Overweight (n=20)	p-value
Age	24.20 (0.40)	23.45 (0.20)	23.85 (0.30)	0.20
Weight (kg)	43.62 (0.70)	43.62 (0.50)	51.41 (0.80)	0.00*
Height (cm)	155.95 (0.30)	155.95 (0.30)	156.65 (0.30)	0.58
BMI (kg/m^2)	17.39 (2.00)	20.46(1.10)	29.79 (0.03)	0.00*
Fat (kg)	10.1 (4.00)	15.14 (3.04)	36.74 (4.00)	0.00*
Muscle (kg)	31.05 (0.80)	32.48 (0.60)	36.98 (0.42)	0.00*
Bone (kg)	1.77 (0.05)	1.93 (0.02)	1.91 (0.20)	0.16
Adiponectin (μg/mL)	3.78 (1.3)	2.76 (1.10)	1.49 (0.70)	0.00*

All results are shown in mean (s.d), value is significant at p <0.001* by using One way ANOVA statistical analysis.

Correlation analysis of adiponectin, fat mass and bone mass in Table 2 showed there is significant fair negative correlation between bone mass and adiponectin (r=0.371, p=0.04) and fat mass (r=-0.565, p<0.001). There was no significant correlation between bone mass and fat mass.

Table 1 Correlation analysis of adiponectin, bone and fat mass

Variables	r	p-value
Bone mass vs adiponectin	-0.371	0.04*
Fat mass vs adiponectin	-0.565	0.00*
Bone mass vs fat mass	0.201	0.107

*Mean value is significant at p <0.05 and p<0.001. Test used Pearson's correlation analysis

IPAQ-s questionnaire scores showed consistently low level of physical activities across all 3 groups. Thus, there no significant difference between the mean scores of the 3 groups.

This study showed there were no significant differences in mean height and age between groups. The subjects recruited were in the mean age of 23 years old and were healthy. Thus,

these variables did not influence other variables such as adiponectin and muscle mass. (Tudor-Locke & McColl, 2000) also reported similar findings in their study regarding factors associated with variation in premenopausal bone mineral status.

The BMI formula divides a person's weight by the square of their height while accounting for the fact that this weight is made up of a variety of components, including fat mass, bone mass, body fluid, and muscle mass. In this study, mean fat mass and bone mass had shown significant differences between the 3 groups. Nonetheless, it's important to note that this study did not measure body fluid. Therefore, it is reasonable to assume that the factor potentially impacting the BMI of the individuals in this study was fat mass given that there were no significant changes in mean muscle mass across the groups and that fat tissue normally retains very little fluid. A more detailed future study, taking all limitations into consideration is highly recommended.

Many findings reported that physical activity has positive effects on bone mass density via mechanical loading mechanisms (Tobeiha et al., 2020). The mean physical activity difference between groups, as determined by the IPAQ-s scores from this study, was not significant and classified as low physical activity, which is also referred to as low levels of participation in physical activity since every subject in every group failed to achieve a score of at least 600 MET/min/week. Thus, physical activity was excluded as one of the contributing factors that could affect the correlations between adiponectin, fat mass and bone mass.

Adiponectin has significant negative correlation with both fat and bone mass. This is seen in similar researches by (Landrier et al., 2017) and (Cnop et al., 2003) respectively. Adiponectin is a product of adipogenesis together with other adipocytokines such as leptin. Development of excessive fat will cause increase in production of other adipocytokines and adiponectin inhibitor. The adiponectin inhibitor will bind to the adiponectin receptor and disrupts adiponectin action. Thus, in underweight individuals it is expected that their adiponectin level is within normal range as seen in the results of this study. In overweight individuals, low adiponectin level may put them at risk of developing diabetes (Juonala et al., 2011). Similarly, the overweight group in this study has shown low levels of adiponectin. The inverse relationship between adiponectin and bone mass may give an insight to the results of this study in which the group with the lowest BMI had the highest level of adiponectin. High adiponectin level decreases bone mass seen commonly in underweight individuals on low calcium diet. In order to the maintain plasma calcium homeostasis, adiponectin decreases osteoblast proliferation and trigger their apoptosis to decrease bone formation. Thus, there will be less calcium deposited into bone and more calcium available in the plasma (Fazeli & Klibanski, 2014)

Additionally, in this study bone and fat mass were not significantly correlated. This is in line with a cross sectional study carried out between 2011 until 2018 in the United States which showed moderate negative association between fat mass and bone mineral density in adults below 60 years old (Jain & Vokes, 2022). Bone mass does not depend solely on fat mass. There are other factors that can influence bone mass such as age, gender, family history, hormonal status, nutrition and physical activity (Zhu & Zheng, 2020).

Conclusion

Adiponectin level is significantly negative correlated with both fat mass and bone mass. However, there are many limitations to this study that may influence the results such as body

fluid, blood glucose level, bone density measurements and dietary records that were not taken into consideration. Thus, a more detailed study taking into account all the limitations, adding consideration of other factors such as various age groups and menopause status is highly recommended.

Acknowledgement

This research has been ethically approved by the Research Ethics Committee of the Faculty of Health Sciences, Universiti Selangor (J150012E).

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