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# The effect of different intensity walking programs on resistin and visfatin levels in pre-menopausal women

## Farklı şiddetteki yürüyüş programlarının pre-menopozal kadınlarda resistin ve visfatin düzeyleri üzerine etkisi

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**Summary**

**Aim:** The aim of the study was to examine the effect of two different intensity (walking speeds) walking programs on resistin and visfatin levels in pre-menopausal women.
**Material and Methods:** Thirty-seven pre-menopausal women (30-49 years) were divided into a high-intensity walking group (HIWG; n=12), a moderate-intensity walking group (MIWG; n=14), and a control group (CG; n=11). The exercise groups walked for twelve weeks, five days per week from 30-60min/day. The HIWG and MIWG walked at 70-75% and 50-55% maximum heart rate reserve, respectively. Body weight, percent body fat, body mass index (BMI), waist circumference (WC), maximal oxygen consumption (VO2max), glucose, insulin, resistin, and visfatin were measured; the HOMA-IR (homeostasis model assessment of insulin resistance) index was calculated before and after the study.
**Results:** VO2max improved in both exercise groups (p<.01), favoring HIWG (p<.01); body weight, percent body fat, BMI and WC reducing significantly in exercise groups. Visfatin (p<.05) and resistin (p<.01) reduced only in the HIWG; with no differences between groups. The exercise groups showed significant differences from the CG in terms of percent body fat, WC, and VO2max. The reduction in WC was greater in the HIWG than in the MIWG (p<.01). There were no intra and inter group differences for insulin, glucose, and HOMA-IR index, except for a significant increase in insulin levels in MIWG (p<.05).
**Conclusion:** Walking programs with different intensity resulted in favorable changes. However, due to the significantly greater increases in VO2max, and greater reductions in percent body fat, resistin and visfatin levels, high-intensity walking is advisable to healthy pre-menopausal women to improve cardiac fitness, prevent obesity and reduce insulin-resistance.
**Key Words**: pre-menopausal women, resistin, visfatin, walking.

***Özet***

***Amaç:*** *Çalışmanın amacı on iki haftalık, iki farklı şiddette (yürüme hızında) yapılan yürüyüş programlarının resistin ve visfatin düzeyleri üzerine etkisini incelemekti.*

***Yöntem ve Gereç:*** *Otuz yedi pre-menopozal kadın (30-49 yaş) hızlı tempo yürüyüş grubu (HTYG; n= 12), orta tempo yürüyüş grubu (OTYG; n=14) ve kontrol grubu (KG; n= 11) olarak ayrıldı. Egzersiz grupları 12 hafta, haftada beş gün, günde 30-60 dakika yürüdüler. HTYG ve OTYG maksimum kalp atım sayısı yedeğinin sırasıyla %70-75 ve %50-55'inde yürüdüler. Antrenman periyodundan önce ve sonra vücut ağırlığı (VA), vücut yağ oranı (VYO), beden kitle indeksi (BKİ), bel çevresi (BÇ), maksimal oksijen tüketimi (VO2max), glikoz, insülin, resistin ve visfatin düzeyleri ölçüldü; HOMA-IR (insülin direncinin homostatik model değerlendirilmesi) hesaplandı.*

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***Bulgular:*** *VO2max her iki egzersiz grubunda (p<.01), HTYG lehine (p<.01) arttı; VA, VYO, BKİ, BÇ egzersiz gruplarında anlamlı olarak azaldı. Visfatin (p<.05) ve resistin (p<.01) sadece HTYG'de azaldı; gruplar arasında farklılık belirlenmedi. Egzersiz grupları VYO, BÇ ve VO2max bakımından KG'den farklılık gösterdi. HTYG'de BÇ'de meydana gelen azalma OTYG'dekinden daha fazlaydı (p<.01). OTYG'de insülindeki anlamlı artışın (p<.05) dışında, insülin, glikoz, ve HOMA-IR indeksinde grup içi ve gruplar arası farklılık belirlenmedi.*

***Sonuç:*** *Farklı şiddette yapılan yürüme programları olumlu değişikliklere neden oldu, ancak, VO2max'daki daha fazla artışlar ve VYO, resistin ve visfatin düzeylerindeki daha fazla azalmalara bağlı olarak, kardiak fitnesi arttırmak, obesiteyi önlemek ve insülin direncini azaltmak için pre-menopozal sağlıklı kadınlara hızlı tempo yürüyüş önerilebilir.*

***Anahtar Kelimeler:*** *pre-menopozal kadın, resistin, visfatin, yürüme.*

## Introduction

Obesity is characterized by an excess of body fat (1), and in recent years it has been defined as a risk factor for the development of insulin resistance, type 2 diabetes, dyslipoproteinemia, hypertension, and cardiovascular disease (2). Obesity is accepted as a major health problem because of the threat of morbidity/mortality from vascular diseases.

Resistin is a recently discovered protein that is expressed and secreted from adipocytes and is present in the circulation. Resistin has been proposed to be a potential link between obesity, a prominent cause of cardiovascular diseases (CVD), and insulin resistance (3). Recent studies have revealed that resistin promotes endothelial cell activation, including the promotion of endothelin-1 release and the up-regulation of adhesion molecules and cytokines (4,5). In humans, resistin is expressed in adipocytes, and to an even greater extent in macrophages (6). Resistin appeared to add to the risk of heart failure associated with obesity, insulin resistance, and inflammation. The data suggest that resistin may promote heart failure via mechanisms independent of insulin resistance and inflammation (7). A significant association between plasma resistin levels and cardiovascular heart disease (CHD) was found in women (8).

Visfatin is a newly identified adipocytokine in visceral adipose tissue and has insulin-like metabolic effects that may improve insulin sensitivity (9). Adipocyte visfatin expression and plasma concentrations increase with obesity in animals (4) and humans (10). Visfatin is thought to facilitate glucose control and to promote the development of obesity (11). The metabolic effects of visfatin are apparently mediated by the binding to and activation of the insulin receptor (9). Some studies suggest that visfatin is related to the development of the metabolic syndrome (9) while others reported that visfatin gene expression was not associated with the metabolic syndrome in diseased rats when compared to lean controls (12). It has been reported that plasma visfatin levels are reduced in human obesity (13).

Research has shown that modest weight loss through dietary changes and exercise is an effective way for preventing and developing obesity-associated disorders (14,15). Regular physical activity confers many physiological and psychological benefits including an improved lipid profile, enhanced insulin sensitivity, lowered blood pressure and an increased energy expenditure which has the potential to lower body fat and body weight (16,17). There are controversial data related to the role of exercise on resistin levels. While a six-month lifestyle modification through combined diet and exercise (18) and a 14-week diet alone, exercise alone, diet + exercise program (19) did not reveal any significant changes in resistin levels of participants, a 16-week aerobic exercise reduced resistin levels of previously sedentary patients with Type 2 diabetes (20). Plasma visfatin concentrations are elevated in patients with diabetes mellitus (21-23) and can be lowered in obese subjects by weight loss (24) and in patients with type 1 and type 2 diabetes mellitus by aerobic exercise programs (22,25). Visfatin and insulin-resistance were also found to be reduced in an older, obese population following an exercise program (26). The exercise program also had lowering effects on visfatin levels in non-diabetic women (27). There are limited data on the role of physical exercise on resistin and visfatin; and to our knowledge, there are no studies examining the effects of two different intensity walking exercises on these parameters in healthy pre-menopausal women. Therefore, we aimed to illuminate the changes in resistin and visfatin levels following a 12-week walking program of two different intensities (walking speeds) in healthy pre-menopausal women.

## Material and Methods

**Subject selection:** We recruited pre-menopausal (30-49 years old), non-smoking, sedentary (<15min exercise twice a week) women living in Manisa for at least 10 years to participate in this study. Exclusion criteria included acute or chronic diseases (cardiovascular, cerebro-vascular, renal, hematological, thyroid, or

cancer), medication affecting metabolism, high resting blood pressure (>160 mmHg systolic or >95 mmHg diastolic), musculo-skeletal problems, diabetes mellitus, irregular menses, and a ±2 kg change in body weight during the previous six months. We gathered all information about the subjects via questionnaires and the subjects were examined carefully before participation. Tests included medical history, physical examination, resting ECG, and blood pressure measurements. We measured their dietary intake using two dietary questionnaires related to fat consumption and fruit, vegetable and fiber consumption developed by Berkeley Nutrition Services (28). Questionnaires revealed that the groups had balanced and sufficient dietary intake and they were warned not to change their dietary habits throughout the study period.

A total of 60 people were recruited for the study, but 18 of them did not meet the initial screening criteria. Therefore, a total of 42 subjects who underwent laboratory screening were assigned to walking groups and a control group. To maintain compliance, subjects were allowed to choose which of the two groups (exercise n=30, or control n=12) to join without randomization. After that, the ones who wanted to take part in the exercise groups were randomly categorized as either the high-intensity walking group (HIWG; n=14) or the moderate-intensity walking group (MIWG; n=16). Five subjects dropped out of the study. Therefore, in total, 37 participants – 12 belonging to HIWG, 14 belonging to MIWG and 11 belonging to CG – were subjected to final evaluation (Table-1). Exercise group members were warned not to participate in any other form of physical exercise; CG members were also warned not to take part in any physical activity that would make them tired. The protocol was approved by the ethical council of Celal Bayar University, Faculty of Medicine and was in accordance with the Declaration of Helsinki (1989) of the World Medical Association and all participants gave their informed written consent in order to participate in the study.

**Study Design:** Height, body weight, body fat, blood pressure, waist circumference (WC), and estimated maximal aerobic capacity (estimated $VO_{2max}$) of the participants were measured during their first visit to the human performance laboratory and the 400m-outdoor track. Blood samples were collected on their second visit. Body composition was measured using bioelectrical impedance analyzer (Model TBF-300, Tanita Corp., Tokyo, Japan). $VO_{2max}$ was estimated via a 2-km walking test (29,30). The participants walked the 2-km distance in groups of two as fast as possible and the following predictive equation developed for women was used to estimate $VO_{2max}$ from the heart rate (HR), age, BMI and the duration.

116.2 – 2.98 x duration (min) – 0.11 x HR – 0.14 x age – 0.39 x BMI

All testing and measurements were repeated at the end of the 12-week training period. Subjects were warned not to do any physical activity within 48 hours preceding the assessment days.

**Table- 1.** Baseline physical and physiological characteristics of subjects (mean±SD).

| Variable | HIWG (n= 12) | MIWG (n= 14) | CG (n=11) | P |
|---|---|---|---|---|
| Age (year) | 41.5±4.6 | 41.3±5.1 | 38.4±6.0 | NS |
| Height (cm) | 162.5±4.2 | 162.2±6.3 | 162.3±5.3 | NS |
| Body weight (kg) | 74.5±12.8 | 77.1±7.5 | 71.8±12.4 | NS |
| BMI (kg/ $m^2$) | 28.2±4.4 | 29.3±2.5 | 27.3±4.9 | NS |
| Percent body fat (%) | 36.0±6.3 | 37.7±3.8 | 34.2±7.5 | NS |
| WC (cm) | 87.1±8.4 | 90.0±7.4 | 86.6±15.7 | NS |
| Waist/hip | 0.80±0.73 | 0.80±0.06 | 0.77±0.07 | NS |
| $VO_{2max}$ ($mlkg^{-1}min^{-1}$) | 25.7±3.3 | 26.2±2.4 | 26.2±4.0 | NS |
| Visfatin (pg/ml) | 793±545 | 790±692 | 614±718 | NS |
| Resistin (ng/ml) | 5.16±1.52 | 5.04±2.25 | 3.95±1.50 | NS |
| Insulin (µU/ml) | 7.94±6.42 | 5.22±3.32 | 5.91±4.16 | NS |
| Glucose (mg/dl) | 93.6±11.5 | 91.1±6.5 | 93.1±9.7 | NS |
| HOMA-IR | 1.88±1.50 | 1.16±0.73 | 1.36±0.96 | NS |

HIWG= High-intensity walking group; MIWG= Moderate-intensity walking group;
CG= Control group; Group comparisons were made using Kruskall-Wallis test;
NS= No significant.

**Exercise Program:** All exercise training sessions were supervised by exercise specialists and they were conducted at two different intensities (walking speeds), five days per week for 12 weeks with a 10-min warm-up and cool-down. The exercise program was planned according to the principles of the ACSM recommendation (31). We chose walking as the mode of aerobic exercise because it appears to be the most common, most feasible, and safest form for our subjects. The exercise intensity was prescribed based on target

heart rates (THRs) calculated from the Karvonen equation:

$[(HR_{maximal} - HR_{rest}) \times (0.50\text{-}0.55) + HR_{rest}]$ for MIWG and

$[(HR_{maximal} - HR_{rest}) \times (0.70\text{-}0.75) + HR_{rest}]$ for HIWG

$HR_{maximal}$ was predicted via the 220 – age formula.

Exercise groups started to walk for 30 minutes and added three minute increments per week reaching 60 minutes at the end of the study. HIWG walked at 70% maximum heart rate reserve ($HRR_{max}$: the difference between the resting heart rate and the maximal heart rate: $HR_{maximal} - HR_{rest}$) on the first six weeks and at 75% $HRR_{max}$ on the second six weeks. MIWG walked at 50% and 55% $HRR_{max}$.

In order to adjust the training intensity (walking speed), at least three heart rate readings were taken through use of Polar Pacer heart rate monitors (Polar Vantage, Kempele, Finland). The rate of Perceived Exertion (RPE) was also taken using a 15-point RPE scale and noted on training logs.

**Blood Analysis:** Following a 12 h overnight fast, venous blood samples were collected from an antecubital vein (20 ml) in the sitting position after a 20-minute rest between 8:00 and 9:00 a.m. Serum was separated by centrifugation, and samples were stored at –80C° until a batch assessment within one month in all samples.

Plasma human resistin was assessed using ELISA method (Bio Vendor, Heidelberg, Germany). The lowest detection limit is 0.033ng/ml. Intra-assay CV for 7.53ng/ml is 2.8%; inter-assay CV for 6.46ng/ml is 5.1%. Serum visfatin was assessed using ELISA method (Alpco Diagnostics, 26-G Keewaydin Drive Salem, NH 03079). The lowest detection limit was 30pg/ml; intra-assay CV for 1510pg/ml is 5.33%; inter-assay for 720pg/ml is 4.66%. Glucose was analyzed using a commercial kit (Beckman Coulter Ireland Inc., Mervue Business Park, Mervue, Galway, Ireland) in the analyzer (UniCel DxC 800 Synchron Clinical System, Fullerton, CA, USA) using the spectrophometric method. Insulin was analyzed using a commercial kit (Immulite 2000, DPC, Los Angeles, USA) in the analyzer (Immulite 2000 Quantitative Immunassay Analyzer, DPC, Los Angeles, USA) using the immunoassay method. HOMA-IR (homeostasis model assessment of insulin resistance) index was calculated using the following formula:

HOMA-IR = Glucose (mmol/lt) x 0.0555 x Insulin (µU/ml) / 22.5

**Statistical Analysis:** Data were analyzed using SPSS package program (version 15.0) with non-parametric tests due to the low number of subjects in different groups and lack of homogeneity of variance. Results were presented as mean ± standard deviation (SD). Kruskall-Wallis test was used to compare both the baseline physical–physiological characteristics of the subjects and the changes obtained in groups. If a significant difference was obtained from this statistical operation among the three groups, the Mann Whitney U test was used to determine the difference between the two groups. The differences between pre- and post-values of the intervention period were determined by using the Wilcoxon Signed Ranks test. Statistical significance was defined at $p \leq 0.05$ level.

**Results**

HIWG members aimed to walk at 70-75% of $HRR_{max}$. The average heart rate per week during the training for HIWG was ~147.8±2.8 $beat.min^{-1}$. MIWG members aimed to walk at 50-55% of $HRR_{max}$ and their average heart rate per week during the training period was ~131.6±3.7 $beat.min^{-1}$. The mean walking speed per week for the whole program for HIWG was ~6.40±0.33 km/h; and ~5.07±0.21km/h for MIWG. The RPE reported by HIWG was 14.3±0.3 and 12.0±0.3 for MIWG. The total distance walked for the whole program for HIWG was 301640±5947m and 225912±5165m for MIWG.

At the pre study evaluation, the three groups did not differ significantly in any of the physical and physiological parameters (Table 1). After 12 weeks, estimated $VO_{2max}$ improvement was seen in both exercise groups (p=0.002 for HTYG; p=0.001 for MIWG). Their body weights (p=0.007 for HTYG; p=0.001 for MIWG); percent body fat (p=0.002 for HTYG; p=0.001 for MIWG); WC (p=0.006 for HTYG; p=0.006 for MIWG); and BMI (p=0.022 for HTYG; p=0.002 for MIWG) decreased (Table 2). Visfatin (p=0.05) and resistin (p=0.004) were found to be reduced only in HIWG while insulin increased in MIWG (p=0.023; Table 2). Pre- and post-intervention differences in CG were not significant in any of the measured parameters (Table 2).

We found no significant changes in the measured parameters among the three groups except for percent body fat, WC, and $VO_{2max}$ (Table 2). The change observed in both exercise groups in their percent body fat was significantly different from the change that occurred in CG (p=0.007 HIWG vs. CG; p=0.045 MIWG vs. CG; Table 2). The reduction in WC was higher in HIWG than in MIWG (p=0.006) and CG (p=0.001), and was higher in MIWG than in CG (p=0.013; Table 2). The increase in HIWG in $VO_{2max}$ was significantly higher than that of MIWG (p=0.0001) and CG (p=0.0001) and it was higher in MIWG than in CG (p=0.005; Table 2).

**Table-2.** Changes in the physical and physiological parameters following 10-week walking programs (mean±SD)

| Test/unit | HIWG (n= 12) | | | MIWG (n= 14) | | | CG (n=11) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pre | Post | Change | Pre | Post | Change | Pre | Post | Change |
| Body weight (kg) | 74.5±12.8 | 72.4±11.6** | -2.1±2.0 | 77.1±7.5 | 74.7±8.2** | -2.4±1.9 | 71.8±12.4 | 71.1± 12.6 | - 0.7±2.1 |
| BMI ($kg/m^2$) | 28.2±4.4 | 27.3±3.8* | -0.9±1.0 | 29.3±2.5 | 28.3±2.4** | -1. 1±0.9 | 27.3±4.9 | 27.0± 4.7 | - 0.4±0.7 |
| Percent body fat (%) | 36.0±6.3 | 33.8±5.7** | -2.2±1.4[b] | 37.7±3.8 | 36.3±3.6** | -1.4±1.0[a] | 34.2±7.5 | 33.7± 7.7 | - 0.5±0.9 |
| WC (cm) | 87.1±8.4 | 81.3±6.9** | -5.8±4.6[b,c] | 90.0±7.4 | 86.5±7.7** | -2.7±2.0[a] | 86.6±15.7 | 85.9± 15.0 | - 0.5±1.5 |
| Waist/hip | 0.80±0.73 | 0.77±0.02 | -0.02±0.96 | 0.80±0.06 | 0.77±0.06 | -0.02±0.06 | 0.77±0.07 | 0.75±0.05 | -0.02±0.02 |
| $VO_{2max}$ ($ml \cdot kg^{-1} \cdot min^{-1}$) | 25.7±3.3 | 34.4±3.4** | 8.7±1.6[b, c] | 26.2±2.4 | 29.5±2.9** | 3.2±1.3[b] | 26.2±4.0 | 26.6±5.4 | 0.4±3.2 |
| Visfatin (pg/ml) | 793±545 | 475±346* | -318±446 | 790±692 | 592±561 | -198±877 | 614±718 | 665±136 | 51±104 |
| Resistin (ng/ml) | 5.16±1.52 | 4.11±0.72** | -1.05±1.04 | 5.04±2.25 | 4.81± 3. 05 | -0.22±2.77 | 3.95±1.50 | 3.40±0.90 | -0.51±1.72 |
| Insulin (µU/ml) | 7.94±6.42 | 6.65±3.93 | -1.28±4.88 | 5.22±3.32 | 6.54±4.23* | 1.31±2.13 | 5.91±4.16 | 6.58±4.67 | 0.67±2.66 |
| Glucose (mg/dl) | 93.6±11.5 | 90.2±5.7 | -3.4±8.1 | 91.1±6.5 | 88.1±8.5 | -2.9± 8.1 | 93.1±9.7 | 91.2±11.7 | -1.9±4.4 |
| HOMA-IR | 1.88±1.50 | 1.49±0.92 | -0.38±1.24 | 1.16±0.73 | 1.41±0.91 | 0.24±0.56 | 1.36±0.96 | 1.52±1.1 | 0.16±0.68 |

HIWG= High-intensity walking group; MIWG= Moderate- intensity walking group; CG= Control group; WC= waist circumference
Within group comparisons were made using Wilcoxon Signed Ranks test; Group comparisons were made using Kruskall-Wallis and Mann-Whitney U tests; *Significant change from pre to post ($p \leq 0.05$); ** Significant change from pre to post ($p<0.01$); [a]$p \leq 0.05$ different from CG; [b]$p< 0.01$ different from CG; [c]$p< 0.01$ different from MIWG.

## Discussion

The most outstanding finding of this study, which aimed to examine the effect of two different intensity walking programs on resistin and visfatin levels in pre-menopausal women, is the significant reduction in resistin and visfatin by means of high intensity walking.

**Body composition and $VO_{2max}$:** BMI and WC are frequently used to define obesity. Especially central obesity is confirmed to be strongly associated with CVD risk (32,33). Recent findings indicate that WC is a stronger marker of health risk than is BMI (34). A WC of 80 cm for women is considered the cutoff for limiting weight gain, whereas a WC of 88 cm for women should be the cutoff for reducing weight (35). The positive influence of exercise on waist reduction (36-39) and BMI (40) has been reported in literature, which has also been confirmed in our present study. The reductions we obtained in WC values in our exercising groups indicate the positive effects of exercise, especially walking with high-intensity. Considering the 1.6cm of WC reduction determined by Bergström et al. (38), the approximately 6-cm reduction determined as a result of high-intensity walking in our study is considerable. This discrepancy might have resulted from the higher baseline WC values of the participants in our HIWG members (81.8cm vs. 87.1cm).

Favorable effects of physical activity on lowering percentage body fat and body weight have been demonstrated (41,42). Our study is in agreement with the previous findings since we determined significant reductions in body weight and percent body fat of the experimental group subjects. $VO_{2max}$, an index of cardiorespiratory function, has been found negatively associated with cardiovascular risk factors (43). The $VO_{2max}$ values we obtained from HIWG in this study are better than the $VO_{2max}$ recommended by Blair et al. (43). In addition, the difference between the two exercise groups in $VO_{2max}$ at the end of the 12-week period

proved that walking at 70-75% $HRR_{max}$ is necessitated to reach "good enough" levels in $VO_{2max}$.

**Resistin:** Recent research has usually focused on changes in adipocytokine concentrations with diet and/or exercise interventions in obese individuals (18,44) and in individuals with type 2 diabetes (8,18-20), revealing conflicting results. Monzillo et al. (18) and Giannopolou et al. (19) found no changes in resistin levels in obese and individuals with type 2 diabetes in response to the lifestyle intervention after a weight loss program. Lack of significant change in resistin levels in these two studies (18,19) might have resulted from the moderate exercise intensity. Likewise, in our study, we determined no reductions in the resistin levels in the MIWG, who followed a walking program of moderate intensity. Similarly, Kelly et al. (45) found no changes in resistin levels of overweight children who conducted an exercise program of 50-80% of $VO_{2max}$ four days per week for eight weeks. However, despite the similar exercise intensity, Kadoglou et al. (20) determined significant reductions in serum resistin levels due to 16-week aerobic exercise training consisting of 45– 60 min sessions per week (50–85% $VO_{2max}$), four days per week in an elderly diabetic population. This may be related to the duration of the exercise period (eight vs. 16 weeks). These enable us to speculate that the intensity of the physical activity, as well as exercise duration and frequency may be important for inducing positive adaptations in this cytokine since we determined significant reductions in the resistin levels as a result of high intensity walking exercises. Therefore, considering these results, we may express that walking with high-intensity rather than moderate-intensity for 12 weeks, five days per week appears to be more effective in causing reductions in resistin levels in the healthy pre-menopausal women.

***Visfatin:*** Due to the role of physical activity on body composition and its protective role against obesity, the association between visfatin levels and physical activity has been investigated in some trials. It was found in a recent study that visfatin is threefold upregulated at the mRNA in abdominal subcutaneous adipose tissue by acute exercise. However, visfatin in skeletal muscle was not regulated by exercise (46). Studies examining the role of physical exercise on visfatin levels of patients with type 1 and type 2 diabetes, obese individuals and healthy people revealed that physical exercise has lowering effects. Haider et al. (22) determined that circulating visfatin concentrations are reduced by chronic exercise. They also noted that this effect is maintained after training cessation. Brema et al (47) determined that plasma visfatin concentration was significantly reduced by approximately 80 and 50% after 12 weeks of aerobic exercise training in severely obese young subjects with type 2 diabetes or normal glucose tolerance, respectively. In another study, the effect of exercise training on plasma visfatin and eotaxin levels in non-diabetic Korean women was investigated. The researchers found that plasma visfatin and eotaxin levels were reduced after exercise training with weight loss. They suggested that changes in visfatin and eotaxin levels may be associated with the beneficial effect of exercise (27). The study, in which the effects of a prolonged low-intensity single scull rowing exercise session on plasma visfatin and ghrelin concentrations in trained male rowers were evaluated, revealed that plasma visfatin concentration was significantly decreased after the 30-min post-exercise of the exercise trial (48). A significant ($p=0.05$) reduction observed in our HIWG is consistent with the results of the studies determined reductions in visfatin levels of the participants due to physical training (22,27,47,48).

The lack of significant reduction in our participants walking at moderate-intensity may indicate that moderate intensity exercise is not enough to cause reductions in visfatin levels. Although chronic exercise has profound effects in improving glucose tolerance and insulin sensitivity, in our study no changes were observed in these parameters as a result of moderate and high intensity walking (except for an increase in insulin levels of MIWG). Thus, the finding that effects of training on visfatin were seen in the absence of changes in glucose metabolism suggests a different regulation of visfatin metabolism by chronic exercise. However, the mechanism of this reduction due to physical exercise requires further investigation since glucose and HOMA-IR were unchanged post-exercise in both the exercise and control groups, but insulin increased significantly only as a result of moderate-intensity walking.

A strength of the present study lies in its supervised and controlled nature. For 12 weeks all exercise sessions were supervised and monitored carefully by exercise specialists; walking intensities specific to the participants were adjusted. Despite the small sample size, walking exercises with different intensity revealed some favorable alterations in body weight, percent body fat, WC, and BMI values of healthy pre-menopausal women. In addition, we determined some significant reductions in resistin and visfatin levels as a result of high-intensity walking. However, our data are limited to pre-menopausal women. Therefore, future studies are

necessitated for more precise results with especially obese people from different ages, and following a calorie-reduction diet.

## Conclusion

An easily incorporated walking program of either high or moderate intensity into a daily routine is beneficial in increasing cardiac fitness and preventing obesity. However, due to the significant higher increases in $VO_{2max}$, and higher reductions in percent body fat, waist circumference, resistin and visfatin levels, high-intensity walking is advisable to improve cardiac fitness, prevent obesity and reduce insulin-resistance.

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