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SEKİZ HAFTALIK İKİ FARKLI YÜRÜME PROGRAMININ ORTA YAŞLI KADINLARDA AEROBİK KAPASİTE, KAN LİPİD PROFİLİ VE HOMOSİSTEİN DÜZEYLERİ ÜZERİNE ETKİSİ

THE EFFECT OF TWO DIFFERENT EIGHT-WEEK WALKING PROGRAMS ON AEROBIC CAPACITY, BLOOD LIPID PROFILE, AND HOMOCYSTEINE LEVELS IN MIDDLE-AGED WOMEN

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ÖZET

Çalışmamızın amacı sekiz hafta süreli, iki farklı yürüyüş programının orta yaşlı kadınlardaki aerobik kapasite (VO_{2max}), kan lipid profili, homosistein, vitamin B12, ve folik asit düzeyleri üzerine etkisini incelemektir. Bu amaçla çalışmaya 30-50 yaşları arasında 30 sağlıklı bayan dahil edildi ve bunlar; hızlı tempo yürüyüş grubu (HTYG; n= 10), orta tempo yürüyüş grubu (OTYG; n=10) ve kontrol grubu (KG; n= 10) olarak 3 gruba ayrıldı. Egzersiz grupları, haftada beş gün, günde 30 dakikadan başlayarak 48 dakikaya kadar sabit bir şekilde artan sürelerde yürüdüler. HTYG kalp atım sayısı yedeğinin yaklaşık ~%71 şiddetinde ve ~6.85±0.32 km/s hızla; OTYG ise kalp atım sayısı yedeğinin ~%51şiddetinde ve ~5.20±0.14km/s hızla yürüdü. Antrenman periyodundan önce ve sonra maksimal oksijen tüketimi (VO_{2max}), kan basınçları, total kolesterol (TK), trigliserid (TG), yüksek yoğunluklu lipoprotein kolesterol (HDL-K), düşük yoğunluklu lipoprotein kolesterol (LDL-K), homosistein, Vitamin B12, folik asit düzeyleri ölçüldü.

VO_{2max} HTYG'de daha belirgin olmak üzere her iki egzersiz grubunda artarken ($p<0.01$), sistolik kan basıncı (SKB) azaldı ($p<0.05$). Egzersiz gruplarında TK değerlerinde anlamlı değişiklik olmadığı halde, HDL-K'nin arttığı ($p< 0.01$), LDL-K'nin ise azaldığı gözlendi ($p<0.05$). Her iki egzersiz grubunda homosistein düzeyleri anlamlı olarak artarken ($p<0.05$), vitamin B12 düzeylerinde HTYG'de azalma ($p<0.05$); OTYG'de ise azalma eğilimi ($p=0.059$) saptandı. HTYG'nin folik asit değerlerinde anlamlı azalma gözlendi ($p<0.05$).

Sonuç olarak; çalışmamızda hızlı tempo ile yapılan yürüyüşlerin aerobik kapasiteyi daha belirgin derecede arttırdığı, ancak kan lipid profili ve sistolik kan basıncı üzerinde her iki tip yürüyüşün benzer oranda olumlu etki yaptığı saptanmıştır. Her iki tip yürüyüşün kan homosistein seviyelerini arttırıcı etkisinin Vitamin B12 ve folik asit düzeylerindeki azalışa bağlı olabileceği düşünülmüştür.

SUMMARY

The aim of the study was to investigate the effect of two different eight-week walking programs on aerobic capacity (VO_{2max}), blood lipid profile, homocysteine (Hcy), vitamin B12, and folic acid levels in the middle-aged women. For this purpose, 30 healthy women (aged between 30-50 years) enrolled in the study and were divided into three groups as: brisk walking group (BWG; n=10), moderate tempo walking group (MTWG; n=10) and control group (CG; n=10). Exercise groups walked for eight weeks, five days per week from 30min per day steadily increasing up to 48min. BWG and MTWG walked at ~71% heart rate reserve (HRR), and at ~51%HRR; at the speed of ~6.85±0.32km/h and ~5.20±0.14km/h, respectively. Maximal oxygen consumption (VO_{2max}), blood pressures, serum total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), Hcy, vitamin B12, folic acid levels were measured before and after the study.

Favoring BWG, VO_{2max} increased ($p<0.01$); Systolic blood pressure (SBP) decreased ($p<0.05$) in both exercise groups. Despite no change in TC, HDL-C increased ($p<0.01$), LDL-C decreased ($p<0.05$) in exercise groups. While Hcy increased ($p<0.05$) in exercise groups, vitamin B12 levels decreased in BWG ($p<0.05$) and tended to decrease in MTWG ($p=0.059$). Folic acid levels of BWG reduced ($p<0.05$). In conclusion, we determined that walking with high tempo increased aerobic capacity more dominantly, but that both type of walking resulted in similar positive effects on blood lipid profiles and SBP. The increasing effect of both walking types on Hcy is thought to be related to the decrease in vitamin B12 and folic acid levels.

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INTRODUCTION

Coronary heart disease (CHD) is known to be one of the main causes of death in most countries. Poor blood lipid profile and inactive life-style affect CHD. Research has shown that elevated plasma levels of low-density lipoprotein cholesterol (LDL-C) are major factors for developing CHD, whereas elevated high-density lipoprotein cholesterol (HDL-C) concentrations may help protection against premature CHD (1). Homocystein (Hcy) is a sulphur-containing amino acid and intermediate in the metabolic pathway of the essential amino acid methionine. In recent years, elevated plasma Hcy levels have been identified as an independent risk factor for cardiovascular diseases (2,3). Hcy metabolism is quite complex since it takes part in various biochemical pathways (4,5). Vitamin B12 and folic acid are accepted to have an important link between Hcy metabolism and physical activity. This caused researchers to consider whether physical activity influences Hcy metabolism and if it alters Hcy plasma levels in humans. However the results are controversial since exercise intensity, gender, age, and accompanying risk factors seem to play important roles (5-9).

Plasma vitamins serve primarily as regulators of metabolic functions, many of which are critical to exercise performance (10). Folic acid and vitamin B12 are integrally involved in red blood cell (RBC) development; and research has shown that vitamin deficiency impairs physical performance (10). The relationship between Hcy concentration, vitamin B12 and folic acid levels is documented (11). In previous studies it was shown that the supplementation with vitamin B12 and folic acid reduced elevated Hcy levels (12,13).

Intervention studies have demonstrated the potential of brisk walking to improve fitness in sedentary men and women (14,15). Many studies have investigated the effect of regular walking exercises on blood lipids (16-18). The number of studies investigating how walking exercises can affect the Hcy levels of healthy people is very limited. Only Randeva et al (8) researched the effect of a 6-month of walking program on plasma total Hcy concentrations. To our knowledge, there is no published data concerning the effects of walking exercise with different intensities on the above-cited parameters. Therefore, the aim of the present study was to investigate the influence of an 8-week walking program conducted with two different intensities to determine the interrelation between exercise-induced changes in Hcy and blood concentrations of folate and vitamin B12 levels together with the other cardiac risk factors in middle-aged women.

MATERIAL AND METHODS

Subject selection: Female volunteers aged between 30-50 years were recruited for the study. After a medical screening and activity questionnaire, some of them were excluded from the study if they had high resting blood pressure (>160 mmHg systolic or >95 mmHg diastolic), a previous history of cardiovascular disease or diagnosed CHD, smoking, being under medication known to influence plasma lipid levels, musculo-skeletal problems or injury, having diabetes mellitus, reporting a ±5 kg change in body weight during the previous year. Participants were allocated to two study groups, which were initially stratified for the exercise and a control group; they were not randomized. To maintain compliance, subjects were allowed to choose which of the two groups (exercise n= 20, or control n=10) to join. Afterwards, the ones selecting exercise groups (EG) were randomly placed into the brisk walking (BWG; n=10) or moderate tempo walking (MTWG; n= 10). After informing about the study design, each subject signed a consent form. Dietary intake was measured by using two dietary questionnaires developed by Block (19). There were no significant differences in pre exercise food intake among groups and they were asked not to change their dietary habits throughout the study. The ethical council of Celal Bayar University approved the study.

Testing and measurements: Pre and post exercise resting blood pressures were measured. Body composition was measured using bioelectrical impedance analysis method (Tanita TBF 300) between 8.00-10.00a.m after a 12-hour fast. Body Mass Index (BMI) was calculated as weight/height^2 (kg/m^2). The Astrand - Ryhming test was performed on a calibrated bicycle ergometer (Monark 860, Varberg, Sweden) and maximal oxygen consumption (VO_{2max}) was predicted using Astrand-Ryhming nomogram (20). Fasting venous blood samples were collected from an antecubital vein (20 mL) in the sitting position after a 20-minute rest between 8:00 and 9:00a.m. TC, TG, HDL-C, LDL-C levels were determined in a Cobas Integra 800 autoanalizer (Roche Diagnostics GmbH, USA) by enzymatic calorimetric method. In TC, TG, and HDL-C analyses, within-run coefficients of variation were 4.8%, 3.0%, and 4.7%, respectively. The Hcy concentrations were analyzed from plasma in an Immulite 2000 (DPC Diagnostic products corporation, USA, Los Angeles) hormone autoanalyzer using a competitive immunoassay method. Folate and vitamin B12 concentrations in serum were analyzed using an E 170 analyzer (Roche Diagnostic GmbH, USA) by electrochemiluminescence immunoassay method.

Exercise program: After completion of baseline testing, EG subjects walked on an outdoor track (400 m) for 8 weeks, 5 days per week. The exercise intensity was prescribed based on target heart rates (THRs): [Heart Rate Reserve (HRR) * (0.50-0.55)] + resting Heart Rate (resting HR), for MTWG, and [HRR * (0.70-0.75)] + resting HR, for BWG (17). On the first four weeks, BWG aimed to walk for 30, 33, 36, and 39 minutes at 70% HRR. On the second four weeks, they aimed to walk for 39, 42, 45, and 48 minutes at 75% HRR. MTWG aimed to walk in the same duration as the BWG, but their walking speed was targeted to be at 50% HRR for the first four weeks and 55% HRR for the second four weeks. To ensure compliance with the training intensity (walking speed), at least three heart rate readings were taken through use of Polar Pacer heart rate monitors (Polar Electro oy Finland) and Rates of Perceived Exertion (RPE) were also taken using a 15-point RPE scale (21) and noted on training logs.

Statistical analysis: The Kruskall-Wallis test was used to compare changes among the study groups; Mann-Whitney U test was used to determine the difference between the two groups. The differences between pre and post data of the intervention period were determined by using the Wilcoxon test. All comparisons were considered statistically significant at $p < 0.05$.

RESULTS

BWG members who aimed to walk at 70-75% of HRR had an average heart rate of ~149.5±3.9 beat.min^{-1} (corresponding to ~71% of HRR) during the training. MTWG members aiming to walk at 50-55% of HRR had an average heart rate of ~130.8±4.5 beat.min^{-1}, (corresponding to ~51% of HRR), during the training period. Mean walking speed for the whole program for BWG was ~6.85±0.32 km/h; and it was ~5.20±0.14km/h for MTGW. The RPE reported by BWG was 15.1±0.9 and it was 13.0±0.4 for MTWG. Total distance walked for BWG was ~183666±9246 m and it was ~157060±3659 m for MTWG. Pre-study characteristics of the subjects were not significantly different (Table I).

Table I. Characteristics of subjects before the 8-week intervention period (mean±SD)

Group	n	Age (yr)	Height (cm)	Body mass (kg)	BMI (kg/m^2)	Percent body fat (%)	VO_{2max} (mL.kg^{-1}.min^{-1})
BWG	10	38.8±3.5	159.0±7.1	73.5±11.0	29.0±3.5	34.9±4.4	24.0±4.5
MTWG	10	40.5±5.8	155.9±6.2	72.1±11.3	29.8±5.8	32.8±6.1	23.6±5.0
CG	10	38.8±5.6	162.1±5.6	68.8±9.7	26.2±3.4	34.1±4.8	22.8±3.1

BWG= Brisk walking group; MTWG: Moderate tempo walking group; CG= Control group

There was no significant change in pre- and post study body weight or percentage of body fat in the exercise groups. We observed significant improvement in VO_{2max} at both type of walking exercise ($p < 0.01$), while this improvement was more prominent in BWG ($p < 0.01$; Table II).

Table II. Changes in physical and physiological parameters for the BWG, MTWG and CG following 8 weeks of two different walking programs

Variable	n	Pre-intervention	Post-intervention	Mean differences
Body weight (kg)				
BWG	10	73.5±11.0	72.7±11.5	-0.72±1.19^c
MTWG	10	72.1±11.3	71.2±10.4	-0.84±1.82^c
CG	10	68.8±9.7	69.2±9.5	0.45±0.79
Percent body fat (%)				
BWG	10	34.9±4.4	34.8±4.0	-0.11±0.94
MTWG	10	32.8±6.1	32.8±5.9	-0.01±1.04
CG	10	34.1±4.8	34.3±5.5	0.03±0.64
BMI (kg/m^2)				
BWG	10	29.0±3.5	28.7±3.7^a	-0.33±0.41^c
MTWG	10	29.8±5.8	29.3±5.3^a	-0.57±0.82^c
CG	10	26.2±3.4	26.3±3.3	0.14±0.30
VO_{2max} (mL.kg^{-1}.min^{-1})				
BWG	10	24.0±4.5	35.0±3.8^b	10.98±3.11^e
MTWG	10	23.6±5.0	28.2±4.3^b	4.57±2.61^d
CG	10	22.8±3.1	23.4±3.6	0.57±3.28

^{a}p<0.05 change from baseline; ^{b}p<0.01 change from baseline; ^{c}p<0.05 vs. CG
^{d}p<0.01 vs CG; ^{e}p<0.01 vs. MTWG and CG

There were significant decreases in SBP of the exercise groups ($p < 0.05$). HDL-C increased in BWG and MTWG significantly ($p<0.01$). LDL-C decreased significantly in BWG and MTWG ($p<0.05$). Hcy concentrations increased in both BWG and MTWG ($p < 0.05$), although no significant change was observed in the CG. While vitamin B12 reduced in BWG ($p < 0.05$), it tended to decrease in MTWG ($p=0.059$). Folic acid values decreased significantly in BWG ($p<0.05$), but revealed no significant changes in MTWG and CG (Table III).

Table III. Changes in the blood pressures, blood lipids, Hcy, vitamin B12 and Folic acid for BWG, MTWG and CG following 8 weeks of two different walking programs

Variable	n	Pre-intervention	Post-intervention	Mean differences
SBP (mmHg)				
BWG	10	120.5±13.4	110.5±13.8 [a]	-10.0±13.5
MTWG	10	116.0±20.7	111.0±13.7 [a]	-5.00±14.3
CG	10	114.0±12.6	110.5±10.1	-3.50±10.6
DBP (mmHg)				
BWG	10	77.0±10.3	73.0±4.8	-4.00±8.8
MTWG	10	70.0±12.2	68.5±3.4	-1.50±12.3
CG	10	67.0±8.2	68.5±6.7	1.50±10.0
TG (mg/dL)				
BWG	10	83.4±34.4	94.9±53.7	11.5±35.9
MTWG	10	66.9±27.5	79.0±33.6	12.1±36.3
CG	10	85.9±31.8	92.2±39.6	6.3±40.9
TC (mg/dL)				
BWG	10	221.1±41.8	214.0±43.7	-7.10±26.5
MTWG	10	188.4±36.8	181.4±32.8	-7.00±27.7
CG	10	192.7±40.5	176.6±47.3	-16.1±25.2
HDL – C (mg/dL)				
BWG	10	46.8±8.0	55.7±10.3 [b]	8.9±7.8
MTWG	10	48.8±10.3	57.1±12.0 [b]	8.3±8.5
CG	10	51.7±13.5	56.1±13.6	4.4±7.9
LDL – C (mg/dL)				
BWG	10	157.4±40.4	139.0±42.0 [a]	-18.4±23.1
MTWG	10	126.1±30.4	108.3±26.1 [a]	-17.8±17.9
CG	10	123.8±35.3	111.9±44.4	-11.9±41.0
Hcy (µmol/L)				
BWG	10	8.13±1.57	9.86±1.62 [a]	1.72±1.84
MTWG	10	7.61±1.53	9.66±1.84 [a]	2.04±2.16
CG	10	7.04±2.10	7.42±1.13	0.38±1.98
Vitamin B12 (ng/L)				
BWG	10	322.6±72.1	282.2±83.6 [a]	-38.4±34.0
MTWG	10	295.6±89.1	259.6±116.6	-36.1±40.6
CG	10	389.2±97.5	358.0±96.6	-31.2±46.6
Folic Acid (µg/L)				
BWG	10	12.0±1.6	10.2±2.32 [a]	-1.76±1.79
MTWG	10	10.4±3.2	9.04±2.36	-1.33±2.05
CG	10	10.3±2.6	11.2±3.5	0.90±3.32

[a] $p<0.05$ change from baseline; [b] $p<0.01$ change from baseline

DISCUSSION

The results of the present study revealed that brisk walking resulted in a greater increase in VO_{2max} when compared to moderate tempo walking. The type of walking did not affect the other parameters differently. While both type of walking caused similar positive changes in SBP, HDL-C, and LDL-C, they led to increase Hcy and decrease vitamin B12 and folic acid levels.

In contrast to previous studies indicating weight loss and reductions in body fat as a result of regular physical activity (17,22), we did not observe significant changes in these parameters. Since there was a significant increase in HDL-C combined with a significant reduction in LDL-C in both exercise groups, our findings confirm the results of Tran and Weltman (23), who suggested that weight loss is not a necessary consequence of regular aerobic exercise and not needed to achieve favorable alterations in plasma lipid levels. The significant reduction observed in the BMI of the exercise groups can be considered as the positive effect of exercise on CHD risk factors as indicated in the literature (24). Many studies have stated the negative relationship between VO_{2max} and cardiovascular risk factors (25,26). The VO_{2max} values we obtained from BWG (35.0±3.8 $mL.kg^{-1}.min^{-1}$) in this study are better than the ones recommended by Blair et al. (32.5 $mL.kg^{-1}.min^{-1}$) (25). In addition, the difference between the two exercise groups in VO_{2max} at the end of the 8-week period proved that walking exercises with the intensity of 71% of HRRmax were more favorable than walking exercises performed at 51% of HRRmax to increase aerobic capacity.

Exercise is effective in both prevention and treatment of hypertension (27). However, there is no consensus on whether vigorous or moderate exercise intensity will be required to reduce blood pressures (28). In our study, both exercise groups yielded similar reductions in their SBP ($p< 0.05$), confirming the literature. Roman et al. (29) observed that women training at an estimated 70% of VO_{2max} reduced their BP to the same extent as when they trained at 50% of VO_{2max}. Similarly, in our study, the women training both at 50-55% of HRR and 70-75% of HRR displayed similar reductions in their SBP.

Research indicates that moderate aerobic exercise increases serum HDL-C (17,30,31) and reduces TC, LDL-C and TG levels (17,30). However, positive changes in HDL-C are not always accompanied by positive changes in other blood lipids (31,32). The lack of significant decrease in TC in our exercise groups confirms previous research indicating that exercise alone cannot cause a reduction in TC (33). Reduction can be achieved together with reductions in body weight (34). Stein et al (35) suggested that a minimum training intensity equal to 75%HRR is required to increase HDL-C. We obtained significant increases for HDL-C in both exercise groups ($p< 0.01$). According to Hardman (36), although fast walking at 8km/h produces greater improvements in fitness than walking the same distance at 4.8 or 6.4 km/h, it did not increase HDL-C more than walking the same distance at lower speeds. Our finding is in parallel with this suggestion, since in our study VO_{2max} increased in BWG more than it did in MTWG, but HDL-C increased in the same level in both groups ($p< 0.01$).

Some studies suggested that the fall in Hcy levels with exercise is of vital importance (37-40) since elevated plasma Hcy levels have been identified as an independent risk factor for cardiovascular diseases (2,3). However, our study has demonstrated that 8-week walking exercises with different speed (6.85 km/h vs. 5.20 km/h) may induce a relevant Hcy increase in exercise groups ($p< 0.05$). Our finding is in accordance with the results of Bailey et al., who reported a 10% increase in resting Hcy after 4 weeks of cycle-ergometer training in healthy men (7). Similarly, Herrmann et al. also found an increase in Hcy in young healthy swimmers after a 3-week volume-oriented training and high-intensity interval training. In contrast, König et al. (9) did not find any effect after 4 weeks of non-standardized triathlon training. Randeva et al. (8) reported an Hcy-lowering effect in obese women with polycystic ovary syndrome after 6 months of moderate walking training. Wright et al. (5) confirmed that exercise at moderate or intermediate intensity is probably not sufficient to induce an Hcy increase, which is contradictory to our findings. Actually, there is no proven explanation for exercise-induced increase in serum Hcy because there is very little data on exercise and Hcy (5-8) and the results of the existing studies are controversial, which is most probably due to differences in exercise intensity, training frequency and duration of the training program (7,8).

The relationship between Hcy concentration, vitamin B12 and folic acid levels has been documented (12). It was demonstrated that the supplementation with vitamin B12 and folic acid reduces elevated Hcy levels (12,13). However, Hermann et al (41) suggested that there was high prevalence of folate- and vitamin B12 deficiencies among endurance athletes, which probably caused an adverse effect on resting Hcy. They stated that regular endurance training was likely associated with a noticeable increase in vitamin B12 and folate consumption. Therefore, they indicated that the recommended daily intake might be insufficient for exercising people. The results of the present study are in accordance with their hypothesis that vitamin B12 and folic acid deficiencies may result in exercise-induced Hcy increase. Since our subjects maintained their normal diet, their vitamin B12 and folic acid intake via their daily food intake might not have been sufficient and this deficiency might have influenced their Hcy levels.

In conclusion, brisk walking to increase VO_{2max}, and either brisk or moderate tempo walking to cause favorable alterations in blood lipids and systolic blood pressure may be advisable. Moreover, to reduce Hcy levels, vitamin B12 and folic acid supplementation, accompanied with the walking exercises, is thought to be required, although this relationship needs to be confirmed with studies including larger number of subjects.

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