

The Effects of Brisk Walking versus Brisk Walking Plus Diet on Triglycerides and Apolipoprotein B Levels in Middle-aged Overweight/obese Women with High Triglyceride Levels

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Purpose. The purpose of this study were to investigate the effects of a 12-week brisk walking program on triglycerides (TG) and apolipoprotein B (Apo B) and to compare these effects to those of a brisk walking plus diet program in middle-aged overweight/obese (BMI ≥ 23) Korean women with hypertriglyceridemia.

Method. This analysis was done with nineteen middle-aged overweight/obese Korean women who completed either the brisk walking program (9 women) or the brisk walking plus diet program (10 women) for 12 weeks. The brisk walking consisted of walking for 20 to 50 minutes/day at an intensity of 40 to 70% of heart rate reserve (HRR) for 3 to 6 days/week. The diet consisted of 60 minutes of group education and 20 to 30 minutes of individual counseling every week. TG and Apo B were assessed pre- and post-intervention.

Results. TG and Apo B decreased significantly after the brisk walking program ($Z = -2.31, p = 0.021$; $Z = -2.59, p = 0.009$). TG and Apo B lowering effects of the brisk walking program were not significantly different from those of the brisk walking plus diet program ($U = 37.0, p = 0.549$; $U = 42.0, p = 0.842$).

Conclusion. Brisk walking can be an effective intervention for overweight/obese middle-aged women with hypertriglyceridemia in reducing cardiovascular risk by lowering TG and Apo B levels. Adding diet to brisk walking may have no additional significant effects on changes in TG and Apo B.

Key Words : walking, diet, hyperlipidemia, obesity

INTRODUCTION

The prevalence of overweight (23 \leq Body Mass Index < 25) and obesity (BMI ≥ 25) continues to increase in Korea with inadequate physical activity and excess calorie consumption. About 30% of Korean adult population is obese (Ministry of Health and Welfare, 2002a), making overweight and obesity important public health

issues. Obesity is associated with increased mortality and numerous health problems such as hypertension, insulin resistance and diabetes, and dyslipidemia, the hallmarks of the metabolic syndrome and risk factors for cardiovascular disease. Overweight as well as obesity is a serious health issue, given that overweight individuals have a 72% chance of already having developed a comorbidity of obesity, such as type 2 diabetes, hypertension, dyslipidemia, or coronary artery disease (National

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Institutes of Health, Heart, Lung, and Blood Institute, 1998; National Task Force on the Prevention and Treatment of Obesity, Overweight, and Health Risk, 2000).

As such, managing a comorbidity of overweight and obesity is of considerable importance. Reducing cardiovascular risk is even more important, given that circulatory disease is the leading cause of death in Korean women (MOHW, 2005). Therefore, managing dyslipidemia has to be one of the first-line interventions, as lipid profiles are strong risk factors for cardiovascular disease.

Traditionally, low density lipoprotein cholesterol (LDL-C) has been considered as the representative lipid marker for predicting the risk of developing cardiovascular disease. However, the importance of other lipoproteins in increasing cardiovascular risk has emerged. Several large-population studies like the Stockholm Prospective Study and the Paris Prospective Study have suggested that triglycerides (TG) is the most important risk factor among lipid profiles (Oberman, 2000). Some studies have reported that the high level of high density lipoprotein cholesterol (HDL-C) could not reduce cardiovascular risk when TG was elevated (Williams & Welty, 2001). Some studies suggested that apolipoprotein B (Apo B) is a stronger predictor than HDL-C and LDL-C (Hirsch & Blumenthal, 2003). This may be because Apo B is contained in lipoproteins such as VLDL-C, IDL, and lipoprotein(a), important predictors of cardiovascular risk, as well as HDL-C and LDL-C. As such, TG and Apo B lowering interventions are critical to decrease the risk of developing cardiovascular disease in overweight and obese women.

Lipid imbalances were commonly treated with pharmacological agents. However, a need for alternative non-pharmacological interventions has become increasingly apparent, as several safety concerns regarding the long term use of pharmacological agents surfaced (Varady & Jones, 2005). Along with this respect, there have been studies pertaining to the effects of lifestyle modifications including exercise and/or diet. Some of them showed significant lipid lowering effects of exercise in overweight/obese middle-aged women (Behall et al, 2003).

Though a few studies reported there were significant TG or Apo B lowering effects of exercise in middle-aged women (Grandjean & Crouse, 2004; Yoo, 2004), the effects of exercise training on lipid profiles of overweight/obese women with hypertriglyceridemia has

been scarcely investigated. As mentioned earlier, the importance of reducing cardiovascular risk is even greater when women have high TG levels. Since most Korean women consume a lot of carbohydrates as their staple food is steamed rice, high TG levels in Korean overweight/obese women should receive greater emphasis.

Brisk walking requires no special skills or facilities, has little injury risk, and is effective. As such, it is an feasible, safe, and effective exercise modality for overweight and obese women. However, limited number of studies have investigated the effects of brisk walking in this population (Hinkleman & Nieman, 1993; Kim, 2002, 2004; Lee, Park, & Yoon, 2000; Melanson et al, 2003; Park, 2001; Santiago, Leon & Serfass, 1995; Stensel et al., 1993; Tully, Cupples, Chan, McGlade, & Young, 2005; Yoo, 2004). Moreover, studies investigating the effects of brisk walking on TG and Apo B levels in women with dyslipidemia are even more scarce. To our knowledge, this is the first study to investigate TG and Apo B lowering effects of brisk walking in Korean women with hypertriglyceridemia.

By conducting this kind of researches, we can obtain information on individual differences in responses to exercise training. Information on individual differences in response to exercise training is required in the field of exercise science (Grandjean & Crouse, 2004; Thompson et al, 2003). This information can lead us to know whether a client with a specific characteristic is a good responder or not and the minimal amount of exercise required to obtain specific health benefits, making it possible to prescribe an individualized tailored exercise program.

To determine more effective interventions to reduce cardiovascular risk, studies comparing the effects of different lifestyle modifications are required. A combination of exercise and diet therapy can be considered to be particularly advantageous because diet and exercise elicit complementary effects on lipid profiles (Varady & Jones, 2005). Though a few studies showed beneficial effects of multidisciplinary interventions consisting of exercise and diet on dyslipidemia (Varady & Jones, 2005), effects of brisk walking plus diet intervention on TG and Apo B was not compared with those of brisk walking only intervention. To our knowledge, there have been no study investigating the relative efficacy of brisk walking on these parameters when combined with diet in women with hypertriglyceridemia.

In summary, the epidemic of overweight and obesity

has become an important public health issue because this population is increasing dramatically in Korea. Reducing cardiovascular risk in this population is critical and TG and apo B has emerged as one of the strongest risk factors for cardiovascular disease. Though brisk walking has been suggested to be an effective intervention in improving lipid profiles in overweight and obese subjects, the effects of brisk walking on TG and apo B in overweight/obese middle-aged women with hypertriglyceridemia has been scarcely studied. Moreover, there has been no trial to compare the effects of brisk walking plus diet intervention on TG and Apo B to those of brisk walking only intervention to find a more efficient intervention.

Purpose of the study

As such, the purpose of the present study was to investigate the effects of a brisk walking program on TG and Apo B in middle-aged Korean overweight/obese women with hypertriglyceridemia and to compare these effects to those of a brisk walking plus diet program.

METHODS

Subjects

The subjects of this study were 19 (9 for the brisk walking group and 10 for the brisk walking plus diet group) middle-aged overweight/obese (BMI ≥ 23) women with hypertriglyceridemia (TG ≥ 150 mg/dl). They were selected among middle-aged women (35 women between the ages of 35 and 50 y) who were assigned to a 12-week program involving brisk walking or brisk walking plus diet which was provided at one public health center located in Kyonggi Province from August to November, 2004. As such, this study was not a randomized trial.

All subjects had no diagnosed diseases. All of them were sedentary and had no evidence of participation in a structured exercise or diet intervention within the last 6 months. Before the program, an informed consent was explained and agreed by the subjects. For all subjects, a graded exercise testing was underwent prior to starting brisk walking to see their responses to exercise and to determine the appropriate level of exercise intensity. A modified Bruce protocol was used (American College of Sports Medicine, 2000). All subjects completed the programs. Participants attended at least 95% of the sessions. Demographics of the subjects are presented in

Table 1.

Interventions

Interventions were done at one public health center located in Kyon-gi province from August to November, 2004. The brisk walking intervention was a 12-week treadmill walking program. This program was done under the supervision of a research assistant whose major was exercise prescription. Initially, it consisted of walking for 20 minutes/day at an intensity of 40 - 50% of the subjects' individually determined heart rate reserve (HRR) for 3 days/week. As the subjects' tolerance for exercise improved, they were asked to increase the duration of exercise to 50 minutes/day, the intensity of exercise to 60-70% of their HRR, and the frequency of exercise to 6 days/week. The initial exercise suggestions were made based on the current minimum exercise recommendation from the American College of Sports Medicine, the Centers for Disease Control and Prevention, and the Surgeon General which suggests at least 30 minutes of moderate (40 - 60% HRR) physical activity on most days of the week (ACSM, 2000) and were progressed to the intensity of 60 - 70% HRR based on the recommendation for dyslipidemia (60 - 85% HRR)(Ehrman, Gorden, Visich, & Keteuyian, 2003).

The diet intervention was based on the recommendations of MOHW(2002b) and Lee (2003), consisting of a balanced, weight and cardiovascular risk-reducing diet. Participants were directed to have an energy intake of 1200 - 1500 kcal a day. The diet contained 60 - 65% of carbohydrates, 15 - 20% of proteins, and less than 20% of fat. Daily cholesterol consumption was restricted to less than 300 mg/dl. Participants were required to attend 60 minutes of group education and 20 - 30 minutes of individual counseling with a nutritionist every week.

Blood analysis

A 10-ml blood sample was taken by venipuncture after a 12-hour fast. Fasting TG and Apo B levels were measured with standard techniques. Enzymatic glycerol method(Hitachi 747, Japan) was used for TG and immuno-tubidimetric method(Cobas Integra, Switzerland) was used for Apo B. Subjects were instructed to avoid strenuous physical activity and unusual changes in diet on the previous day.

Statistical analysis

All analyses were performed with the SPSS PC pro-

gram. Mann-Whitney U test and Wilcoxon signed rank test were used. Pre- and post-intervention values were compared using Wilcoxon signed rank test. General characteristics and the changes in TG and Apo B levels of 2 groups were compared using Mann-Whitney U test. A value of $p < 0.05$ was considered significant.

RESULTS

General characteristics of the subjects

Demographic information of subjects are presented in Table 1. Baseline TG level was 220.44 ± 54.88 mg/dl for the brisk walking group and 188.70 ± 25.39 mg/dl for the brisk walking plus diet group. Baseline Apo B level was 93.00 ± 9.94 mg/dl and 91.70 ± 18.06 mg/dl for each group. Baseline BMI was 26.25 ± 1.83 and 26.53 ± 1.38 for each group. There were no significant differences in age, height, body weight, body fat, BMI, TG, and Apo B between the two groups.

TG and Aop B reductions

The magnitude of the TG reduction was 95.44 ± 85.97 mg/dl for the brisk walking group and 77.30 ± 53.14 mg/dl for the brisk walking plus diet group. The magnitude of these reductions were significant in both groups ($Z = -2.31$, $p = 0.021$; $Z = -2.59$, $p = 0.009$).

The magnitude of the Apo B reduction was 11.66 ± 12.30 mg/dl for the brisk walking group and 13.60 ± 13.04 mg/dl for the brisk walking and diet group. The magnitude of these reductions were significant in both groups ($Z = -2.10$, $p = 0.036$; $Z = -2.39$, $p = 0.017$). There were no significant differences between groups for changes in TG ($U = 37.0$, $p = 0.549$) or Apo B ($U = 42.0$, $p = 0.842$) from pre- to post-intervention <Table 2> <Table 3>.

DISCUSSION

Some empirical studies (Behall et al, 2003; Hinkleman & Nieman, 1993; Mohanka et al, 2006; Santiago et al.,

Table 1. Demographic Information and Homogeneity Test of Subjects

Characteristics	BW group (n=9) (M \pm SD)	BW +D group (n=10) (M \pm SD)	U	p
Age	38.78 (3.45)	42.25 (4.40)	20.5	0.139
Height	156.66 (6.18)	158.10 (5.48)	36.5	0.497
Weight	64.66 (8.16)	66.38 (5.22)	33.0	0.356
Body Fat	22.54 (4.03)	21.76 (2.46)	37.0	0.549
BMI	26.25 (1.83)	26.53 (1.38)	39.0	0.661
Triglycerides (mg/dl)	220.44 (54.88)	188.70 (25.39)	31.0	0.278
Apolipoprotein B (mg/dl)	93.00 (9.94)	91.70 (18.06)	39.5	0.661

BW : brisk walking, D : diet, M : mean, SD : standard deviation

Table 2. Changes in TG Following the Interventions

	Pre-intervention (M \pm SD)	Post-intervention (M \pm SD)	z (p) +	Difference (M \pm SD)	U (p) ++
BW group (n=9)	220.44 (54.88)	125.00 (41.75)	- 2.31 (p=0.021)*	95.44 (85.97)	37.0 (p=0.549)
BW +D group (n=10)	188.70 (25.39)	111.40 (47.53)	- 2.59 (p=0.009)**	77.30 (53.14)	

BW : brisk walking, D : diet, M : mean, SD : standard deviation

+ : compare within group, ++ : compare with the difference between two groups

*p < 0.05, **p < 0.01

Table 3. Changes in Apo B Following the Interventions

	pre-intervention (M \pm SD)	post-intervention (M \pm SD)	z (p) +	Difference (M \pm SD)	U(p) ++
BW group (n=9)	93.00 (9.94)	81.33 (14.80)	- 2.10 (p=0.036)*	11.66 (12.30)	42.0 (p=0.842)
BW +D group (n=10)	91.70 (18.06)	78.10 (11.02)	- 2.39 (p=0.017)*	13.60 (13.04)	

BW : brisk walking, D : diet, M : mean, SD : standard deviation

+ : compare within group, ++ : compare with the difference between two groups

*p < 0.05

1995; Stensel et al., 1993; Tully et al., 2005; Yoo, 2004) and a meta-analysis (Kelly, Kelly, & Tran, 2004) showed that walking did not significantly improve lipid profiles including TG or Apo B. In the present study, however, brisk walking decreased Apo B and TG levels significantly ($Z = -2.10$, $p = 0.036$; $Z = -2.31$, $p = 0.021$). These results are consistent with other studies (Behall et al., 2003; Lee et al., 2000; Park, 2001; You, 2004), suggesting that brisk walking can be an effective intervention for overweight/obese middle-aged women in reducing cardiovascular risk by decreasing TG and Apo B levels.

The subjects in our study were hypertriglyceridemic (TG 150 mg/dl) and have higher TG levels than subjects in other studies mentioned earlier. Therefore, it is possible that substantial reductions in TG and Apo B levels in our study derived from the high baseline TG concentrations (Grandjean & Crouse, 2004). In individuals with low TG levels (less than 100 mg/dl), walking did not decrease TG levels (Kim, 2004; Yoo, 2004). The reductions in TG levels in our trial was substantial (baseline 220.44 mg/dl, after exercise training 125.00 mg/dl). As such, the result of our study confirms a notion that the effect of exercise on serum TG levels may be dependent on baseline TG concentrations and this effect is augmented when subjects' initial TG levels are high (Grandjean & Crouse, 2004). However, there is not currently enough evidence to suggest that baseline TG concentrations influence lipid response to exercise training (Grandjean & Crouse, 2004). Therefore, studies with the aim of investigating whether effects of brisk walking depend on the baseline blood lipid levels need to be done.

To our knowledge, this is the first study to compare the effects of exercise on the reduction of TG and Apo B with those of exercise plus diet in overweight/obese women with hypertriglyceridemia. In the present study, there were no significant differences between the brisk walking and brisk walking plus diet interventions for changes in TG or Apo B from pre- to post-intervention. In a study performed to investigate the effects of diet and exercise in men and postmenopausal women with dyslipidemia, changes in blood lipids were not different between the exercise plus diet and exercise only groups (Stefanick et al., 1998). Only in men, the reduction in LDL-C of the exercise plus diet group was significant as compared with that of the exercise only group (Stefanick et al., 1998).

Therefore, along with limited number of studies (Kim, 2002; Stefanick et al., 1998), it is likely that adding oth-

er lifestyle adjustment strategies to brisk walking produces no significant additional effects in the reduction of TG and Apo B levels in overweight/obese middle-aged women. With few similar studies and some limitations of our study, our findings can not be generalized. However, it is important to note this result. To reduce the risk of developing cardiovascular disease, various lifestyle modifications as well as exercise are desirable. However, making and maintaining two or more lifestyle modifications simultaneously is quite a burden to most people. Almost 50% of the people who begin an exercise program drop out within 6 months and fewer than 20% continue exercising after 24 months (Dishman, 1994). With this high dropout rate, one major concern should be the maintenance of those lifestyle modifications beyond their initiation. In this context, an intervention that delivers cardiovascular risk-reducing benefits with the minimum lifestyle modification may be quite attractive. It is because minimum lifestyle modification is easier to add to an individual's daily life than various lifestyle modifications though the latter may bring about maximal health benefits. Moreover, after adopting the minimum lifestyle modification successfully, people can adopt other lifestyle modifications more easily.

With respect to the minimum lifestyle modification, exercise should be the central part. Endurance exercise leads to a reduction in coronary artery disease risk factors by beneficially modulating blood lipid profiles, reducing systolic/diastolic blood pressure, decreasing body fat, and improving glucose tolerance (ACSM, 2000). Although weight loss due to exercise without caloric restriction is small, exercise-induced aerobic fitness itself, independent of weight loss, is associated with a reduced incidence of diabetes and cardiovascular disease (Horowitz, 2001). Diet, frequently chosen by obese people to lose weight, can cause decreased muscle mass as well as decreased resting metabolic rate and fat oxidation (Horowitz, 2001). Moreover, given the loss of muscle mass, individuals who regain their initial weight exhibit a higher percentage of body fat than their pre-diet status, increasing risk for a number of diseases (Horowitz, 2001). As such, among lifestyle modifications intended to decrease cardiovascular risk, there seems to be no strategies which surpass the effects of exercise. Therefore, the minimum exercise recommendation for obesity should be the minimum lifestyle modification for this population.

By emphasizing exercise as the minimum lifestyle

modification to decrease the risk of cardiovascular disease in terms of TG and Apo B in this paper, we are not suggesting that diet intervention be abandoned. The importance of diet cannot be underestimated. Although the effects of exercise plus diet intervention on TG and Apo B levels were not significantly different from those of exercise alone intervention in this study, meta-analyses suggest that, when combined, diet and exercise have complementary effects on lipid profiles (Varady & Jones, 2005). Moreover, diet intervention trials for secondary prevention of coronary heart disease show striking reductions in the recurrence rate of coronary events independent of changes in major risk factors including cholesterol (Kreisberg & Oberman, 2002). In this study, it is hard to say that all of subjects followed our diet recommendation strictly. Therefore, it is required to investigate the additional effects of diet intervention in which not only education and counseling but also strict changes in a diet are emphasized.

In addition, we are not attempting to marginalize the importance of multidisciplinary interventions consisting of various lifestyle modifications. Multidisciplinary interventions consisting of two or more effective lifestyle modifications are valuable if they maximize cardiovascular risk-reducing effects. If they produce significant additional effects, then they are of crucial value, though they are even more difficult to adapt to an individual's habitual lifestyle. In this context, studies which aim to compare the cardiovascular risk-reducing effects of such multidisciplinary interventions are required. There are still many questions unanswered regarding the additive effects of various lifestyle modifications including diet on lipid profiles such as TG or Apo B when added to exercise intervention. Given limited information, we still do not know whether significant additional effects will occur when diet is added to exercise.

In conclusion, the results of this study suggest that brisk walking is an effective intervention for overweight/obese middle-aged women with hypertriglyceridemia in reducing cardiovascular risk by decreasing TG and Apo B levels which have been demonstrated as strong predictors of cardiovascular disease. Adding diet intervention may have no additional significant effects on levels of TG and Apo B in a certain population.

Suggestions for future research

Studies comparing the cardiovascular risk-reducing effects of multidisciplinary interventions are required to

investigate the additive effects of various lifestyle modifications on lipid profiles when added to exercise intervention. Repeated researches with a randomized controlled design are required for the generalization of the results of this study.

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