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The Effect of Exercise, Reflexology and Chrome on Metabolic Syndrome

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ABSTRACT

Background: *Metabolic syndrome (METS) is associated with a cardiovascular risk factor characterized by waist circumference, hypertension, hypertriglyceridemia, low HDL, and high blood sugar. Exercise and physical activity might support the prevention of metabolic syndrome.* ***Study design:*** *This study comprised a 12-week randomized controlled trial.* ***Method:*** *A total of 25 university workers with METS risk factors participated in this study voluntarily. They were randomly divided into 3 groups: those undertaking a core exercise program (n=7), reflexology intervention group (n=8) and chrome intake group (n=10). The subjects took part in a core exercise program for 1 hour per day, 3 days a week and a reflexology interfered for 30 minutes per day, 1 day a week and chrome group took chromium picolinate every day in the week for 12 weeks. The components of METS were analyzed before and after the completion of all the intervention.* ***Results:*** *There were significant differences in pre-prandial blood glucose (PBG) in the core exercise group and at systolic blood pressure (SBP) in chrome group after the 12-week interventions ($p<0.005$). While high-density lipoprotein cholesterol (HDL-C) excluding the components of METS decreased after the interventions on all groups; levels of HDL-C and the other components of METS decreased in reflexology group.* ***Conclusion:*** *There was a clear response to the 12-week interventions regarding METS control. Besides, the reflexology intervention should not be applied to individuals with low HDL-C levels, and core exercise and intake chrome picolinate suggested to improve the components of METS.*

Keywords: Exercise, Reflexology, Chromium, Metabolic syndrome

INTRODUCTION

METS results from damaged glucose metabolism, central obesity, high blood pressure, and dyslipidemia [1]. The METS have estimated as a pandemic with a rapidly increasing prevalence worldwide over the past 20 years [2]. Management of METS is significant regarding public health because it causes premature mortality, disability, health and social economic costs [3].

Lifestyle therapies propose that weight loss, increasing physical activity, and an anti-atherogenic diet is required for controlling of the METS [4]. METS can be reduced by a sustainable exercise program (provided there is no medical contraindication). If there is weight loss with exercise, it can be beneficial for blood pressure (BP), cholesterol levels, and insulin sensitivity. Thus, exercise is a helpful tool in treating METS [5]. Lakka noted that exercise has a mild or moderately favorable effect on many metabolic and cardiovascular risk factors which are related to METS [6]. Exercise is very important for the prevention and hindrance of the advance of many chronic diseases, including metabolic syndrome [7].

Chromium is an essential mineral that is necessary for normal glucose and lipid metabolism [8]. Because it improves glucose tolerance and balances blood sugar levels [8]. Deficiency of chromium can lead to some disorders which decreased glucose tolerance, increased serum insulin levels, and decreased the number of insulin receptors that are symptoms of type 2 diabetes. Also, it can lead to elevated serum total cholesterol (TC) and triglycerides (TG), as well as decreased HDL-C from signs of cardiovascular disease [9]. Potenza and Mechanic reported that even though chromium supplement may improve insulin activity and have a positive effect on body composition in people with METS, its routine use is not supported by the evidence [10].

Reflexology increases blood supply to the body whereby massage specific points of the foot, is a complementary and alternative medicine [11]. It is used in trend nursing, and medical practice is gradually increasing, and many nurses have also trained reflexologists [12]. Song, mention that while a reflex zone stimulated in the foot, body cells respond by generating reflex effects on the organs, muscles, and nerves [13]. The reflex effects can reduce symptoms of stress which are slowing blood flow, increasing tension, exciting the mental state, make worse immunity, and worse the sense of well-being. Reflex effects are known to release symptoms of stress by accelerating blood flow, diminishing tension, relaxing the mental state, increasing immunity, and improving the sense of well-being.

There are no studies which investigated the effects of exercise, reflexology, and chrome on METS. Therefore our study is very important for literature. The purpose of this study was to investigate the effect of core exercise, reflexology and intake chrome picolinate on METS.

PATIENTS AND METHODS

Subjects and Settings

The information was provided for a total of 654 university employees in the study through e-mails. Of these, 194 employees agreed to participate in the study and they were screened for METS. Around 67 employees were found to have METS and from these 22 were randomly assigned to the reflexology group, 22 to the exercise group and 23 to chromium group. Total 14 participants left from the sample for failing to practice reflexology, 15 for failing to do exercise and 13 for failing to use chromium, so the study was completed with 25 participants: 8 from the reflexology group, 7 from the exercise group and 10 from the chromium group (Figure 1). It was carried out between 13 February 2013 and 13 February 2015 at Nevşehir Hacıbektaş Veli University in Nevşehir province.

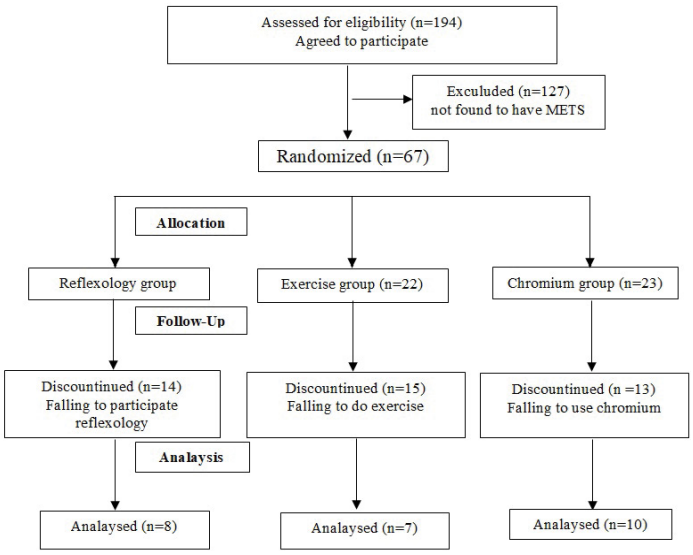

Figure 1 Study enrollment diagram

Height, weight, body fat index and body mass index (BMI) measurements: Weights, body fat indexes and BMI were of participants by Tanita-brand body composition analyzer. Their heights were measured using a non-stretching tape without shoes, their heels touching the wall, backs in a straight position and heads in their normal anatomic position.

Waist circumference (WC) measurements: WCs measured with a non-stretching tape placed on a horizontal line passing just above the top of the iliac bone when the person is standing with arms hanging down freely following a normal expiration.

BP measurements: SBP and diastolic blood pressure (DPB) measured by the same nurse using the same calibrated sphygmomanometer and stethoscope after a 5-minute hearing from the left arm in a sitting position.

Biochemical Measurements

Blood samples (10 ml) were taken from all study participants at 09:00 hours after a 12 hour overnight fast and immediately centrifugation for 10 min at 3000 g at 4°C. The resulting serum was stored at 80°C until analyzed.

Hexokinase phosphorylation measured plasma glucose concentration (% CV 2.15% to 1.51%) by enzymatic kits (Abbott Diagnostics Co). Serum TC (% CV 1.5% to 1.6%), serum low-density lipoprotein cholesterol (LDL-C) (% CV 3.4% to 4.6%), serum HDL-C (% CV 5.5% to 1.4%), and serum TG (% CV 1.7% to 2.0%) concentrations were determined by enzymatic kits (Abbott Diagnostics Co). A spectrophotometer (Abbott C16000, USA) was used for the analysis at the Faculty of Medicine, Selcuk University, Konya.

Plasma chromium concentrations were measured with an inductively coupled plasma-mass spectroscopy (ICP-MS ELAN DRC-e) (Perkin Elmer, Massachusetts, USA).

HbA1c (% CV 0.5% to 0.4%) was analyzed in the whole blood sample in primary tubes, which contain EDTA. Used to Tosoh mark kits (K7-105Y, K7-203Y, K7-301Y) by G7 HPLC Analyzer-Tosoh Bioscience, Inc (Tokyo, Japan). The hba1c level was by the National Glycohemoglobin Standardization Program (NGSP) guidelines (%) as recommended by the Japanese Diabetes Society [14,15]. In addition to the International Federation of Clinical Chemistry (IFCC) (mmol/mol) calculated by the following equation:

HbA1C-IFCC=10.93 × HbA1C-NGSP−23.52.

Definition of the METS

The Adult Treatment Panel III (ATP III) criteria set out by the National Cholesterol Education Program of the American Heart Association (AHA) were used for the diagnosis of METS. AHA considers the presence of 3 or more of the 5 components below sufficient for the diagnosis of METS [16].

- High waist circumference, ≥ 102 cm in men and ≥ 88 cm in women
- TG ≥ 150 mg/dL
- HDL-C, ≤ 40 mg/dL in men and ≤ 50 mg/dL in women
- BP ≥ 130/85 mm Hg
- PBG ≥ 100 mg/dL

Exercise Intervention Program

Core stability exercises were carried out at home. The participants performed core stability exercises that including crunches, oblique crunches, plank, side plank, oblique plank, bridge, static leg and back, dynamic leg and back, hamstring raises, superman, controlled lowering, raising of legs and hundreds. They performed each movement 8 times and 3 set for 1 arm/leg, 4 days per week for 12 weeks. Before the beginning of the core exercise program, the participants in the experimental group were given an individual specific core stability exercises instruction by the researchers, and at the time point, the participants in the experimental group were asked to demonstrate the exercises to ensure that they had mastered the train. The subjects in the experimental group did in four 40 minute sessions per week for 6 weeks initially, followed by four 50-minute sessions per week for another 6 weeks. For the first 6 weeks, each session consisted of 10 minutes of warming up, 20 minutes of core stability exercises, followed by 10 minutes to cool down. For the following 6 weeks, the number of repetitions and sets gradually increased, while the warming up and cooling down times remained the same for the 12 weeks.

Reflexology Practice

Reflexology was applied to the participants once a week for 30 minutes for 12 weeks by the certified investigator who attended a reflexology course. The experts made reflexology that the areas designed for METS were the lungs, thyroid, liver, gallbladder, stomach from the right foot and small and large intestines from the left foot; spinal cord and solar plexus from both foot and hypothalamus and hypophysis in the brain from both foot but mostly on the right foot.

Intake of Chromium

The participants took oral chromium picolinate 200 mcg daily for 12 weeks.

Baseline and After the 12-Week Measurements

The height, WC, BP, weight, BMI, body fat index, fasting blood sugar, HbA1c, TG, HDL-C and chromium measurements of the participants in each group were carried out before the interventions and at the end of the 12-weeks interventions. All the measurements were performed in the morning on an empty stomach.

Ethical Considerations

The Ethics Committee of Aksaray University certified an ethics committee approval from before starting the study (Number 6). The participants provided both verbal and written consents before starting work.

Statistical Analysis

The study data was transferred to the electronic environment and the differences between the baseline (initial). Completion (final) measurements of the groups were assessed using the t-test, a parametric test, in those that showed a normal distribution and using the Wilcoxon signed ranks test, a non-parametric test, in those that did not show a normal distribution.

RESULTS

Data were expressed as mean ± SD. Reflexology group's mean age is 42.00 ± 9.12 years, core exercise groups mean age is 38.00 ± 6.82 years, and chrome groups mean age is 42.5 ± 7.22 years; weight is respectively 85.48 ± 15.97 kg in reflexology groups, 88.38 ± 17.07 kg in core exercise groups and 85.10 ± 13.68 kg in chrome groups. Length is respectively 1.74 ± 0.76 m in reflexology groups, 1.75 ± 0.97 m in core exercise groups and 1.70 ± 0.88 m in chrome groups (Table 1).

Table 1 Descriptive characteristic of groups

Variables	Reflexology	Core exercise	Chrome
Age (years)	42.00 ± 9.12	38.00 ± 6.82	42.5 ± 7.22
Weight (kg)	85.48 ± 15.97	88.38 ± 17.07	85.10 ± 13.68
Length (m)	1.74 ± 0.76	1.75 ± 0.97	1.70 ± 0.88

Changes occurred in the anthropometric and laboratory parameters of the 3 groups of participants after completion of the study as shown in Table 2. While HDL-C excluding the components of METS decreased after the interventions on all groups; levels of HDL-C and the other components of METS decreased in reflexology group. There were significant differences at SBP in the chrome group after the 12-week interventions ($p<0.005$). Besides, it was detected in this study that was an important difference at PBG in the core exercise group after the 12-week interventions ($p<0.005$).

Table 2 The mean dispersion METS components of the individuals in reflexology, core exercise, and chrome group during pre and post-practice

Variables	Groups	N	Pre-test	Post-test	t	p-value
			Mean ± SD	Mean ± SD		
Waist circumference	**Reflexology**	**8**	99.62 ± 11.36	95.75 ± 13.57	1.404	0.203
	Core Exercise	**7**	99.14 ± 7.55	97.71 ± 8.88	1.198	0.276
	Chrome	**10**	102.20 ± 8.05	98.40 ± 14.07	1.348	0.211

Triglyceride	**Reflexology**	**8**	172.37 ± 79.26	108.50 ± 44.22	1.889	0.101
	Core Exercise	**7**	167.85 ± 59.62	152.71 ± 54.61	0.941	0.384
	Chrome	**10**	204.70 ± 76.39	170.70 ± 69.57	-1	0.464
HDL	**Reflexology**	**8**	38.62 ± 3.92	35.12 ± 8.30	1.564	0.155
	Core Exercise	**7**	33.00 ± 6.16	33.42 ± 6.37	1	0.356
	Chrome	**10**	36.40 ± 7.63	37.30 ± 10.71	-0.764	0.464
SBP	**Reflexology**	**8**	128.75 ± 10.03	118.75 ± 15.52	1.589	0.156
	Core Exercise	**7**	144.28 ± 40.68	115.71 ± 13.97	1.704	0.139
	Chrome	**10**	135.70 ± 11.31	125.00 ± 11.78	2.646	0.027
DBP	**Reflexology**	**8**	82.25 ± 7.02	76.25 ± 13.02	1.631	0.147
	Core Exercise	**7**	80.42 ± 12.39	77.14 ± 11.12	0.521	0.621
	Chrome	**10**	86.80 ± 8.16	83.00 ± 8.23	1.406	0.193
PBG	**Reflexology**	**8**	97.87 ± 14.09	88.12 ± 7.12	2.064	0.078
	Core Exercise	**7**	95.00 ± 8.90	78.00 ± 9.71	4.831	0.003
	Chrome	**10**	120.30 ± 64.67	121.60 ± 65.69	-0.199	0.846

During study time, weight loss was achieved by reflexology group (baseline: 85.48 ± 15.97; 83.28 ± 15.60; $p>0.005$), in the core exercise group (baseline: 88.38 ± 17.07; $p<0.005$), and in the chrome group (baseline: 85.10 ± 13.68; 84.31 ± 13.64; $p>0.005$) (Table 3). BMI decreased in all 3 groups but only the core exercise group was statistically significant, only significant differences had increased compared to pre-treatment levels of chromium in the chrome intake and this increase was statistically significant ($p<0.005$). Fat percent loss was achieved in the core exercise group after the 12-week interventions and was statistically significant ($p<0.005$). Besides, waist-to-height ratio (WHtR) was shown to decrease in all 3 groups but this decrease was not statistically significant ($p>0.005$).

Table 3 The dispersion of BMI, HbA1c, chrome, FAT% and weight average of the individuals in reflexology, core exercise, and chrome group during pre and post implementation

Variables	**Groups**	**N**	**Pre-test**	**Post-test**	**t**	**p-value**
			Mean ± SD	**Mean ± SD**		
Weight	**Reflexology**	**8**	85.48 ± 15.97	83.28 ± 15.60	1.298	0.235
	Core Exercise	**7**	88.38 ± 17.07	86.12 ± 16.26	3.435	0.014
	Chrome	**10**	85.10 ± 13.68	84.31 ± 13.64	1.481	0.173
BMI	**Reflexology**	**8**	28.21 ± 5.43	27.56 ± 4.61	1.029	0.34
	Core Exercise	**7**	28.45 ± 4.31	27.78 ± 4.13	2.576	0.042
	Chrome	**10**	28.55 ± 3.10	28.40 ± 3.28	0.78	0.45
Hba1c	**Reflexology**	**8**	5.73 ± 0.60	5.68 ± 0.67	0.338	0.43
	Core Exercise	**7**	5.34 ± 0.31	5.11 ± 1.03	0.756	0.478
	Chrome	**10**	5.74 ± 0.56	6.04 ± 1.41	-0.966	0.359
Intake of Chromium	**Reflexology**	**8**	83658.86 ± 1.54	198527.85 ± 1.66	1.281	0.241
	Core Exercise	**7**	93397.60 ± 2.46	379525.42 ± 2.75	-2.013	0.091
	Chrome	**10**	88704 ± 1.95	332114 ± 1.68	-2.911	0.017
Fat%	**Reflexology**	**8**	25.57 ± 10.45	23.30 ± 7.08	1.207	0.267
	Core Exercise	**7**	26.12 ± 7.37	23.22 ± 9.50	4.407	0.018
	Chrome	**10**	25.32 ± 8.27	26.27 ± 7.98	-0.831	0.427
WHtR	**Reflexology**	**8**	0.57 ± 0.74	0.55 ± 0.78	1.434	0.195
	Core Exercise	**7**	0.57 ± 0.44	0.56 ± 0.59	1.112	0.309
	Chrome	**10**	0.59 ± 0.05	0.57 ± 0.08	1.336	0.214

DISCUSSION

To our knowledge, the present study was the first study in conjunction with the reflexology, core exercise program and intake of chromium because we examined the effect of reflexology, core exercise program and intake of chromium on components of metabolic syndrome. In the study, the participants who were chosen to join the research from the ones who have METS diagnosis.

Changes occurred in the anthropometric and laboratory parameters of the 3 groups of participants after completion of the study were shown in Tables 2 and 3. All of the groups, there was a significant decrease in the means of body

weight, BMI, WC, SBP, DBP, PBG, TG, fat percent and WHtR after the 12-week interventions. But body weight, BMI, and fat percent were statistically significant in core exercise group than reflexology and intake of chromium group ($p<0.05$). Mc Cord, et al., and Carroll, et al., reported that they found a decrease in body weight and fat composition after the 8 to 12-week aerobic, endurance exercise program [17,18]. In the other study was reported that 7 trials were included, involving 9 study groups and 206 participants (128 in the exercise group and 78 in the control group). Decreases in the mean of WC and BP were significant and a significant increase in the mean of HDL-C was observed after dynamic endurance training. Mean plasma glucose levels and TG remained statistically unaltered [19]. Besides Eric, et al., noted that exercise was effective at lowering mean arterial BP and reducing body weight and fat. Exercise intensity was an important factor for reversing the risk factors of the METS. In the other studies were noted that high levels of cardiorespiratory fitness are associated with low prevalence of METS [20-22], and aerobic exercise training reduced METS prevalence [23]. Besides Reiner, et al., reported that physical activity seems to be a relevant factor for preventing age-related diseases [24]. As understood from this study, the intensity and duration of the exercise were significant.

While the levels of HDL-C were increasing at core exercise and chrome groups after the interventions; it is decreased in the reflexology group. In the reflexology group, TG, HDL-C, SBP, and DBP are lower during the post-practice than pre-practice, but this reduction was not meaningful statistically ($p>0.005$). However, according to the results of the research was not desired the reduction HDL-C wherein, because of this, we can say that the participants should not be given reflexology treatments under the normal HDL-C value. The reflexology foot massage is notified to be an effective attempt at BP reduction. In the study of Han and Lee, they said that the reduction in SBP and DBP of the persons in the reflexology group was meaningful statistically [25]. Park applied foot reflexology massage at 5 times a week, for a total of 2 weeks and found that foot reflexology massage is a useful nursing intervention that decreases serum lipids level in postpartum women [26]. In Güven and Karatas's study, after the 6 weeks of reflexology practice, LDL-C, TC, TG, the median had been observed to go down, but HDL-C value median had been observed to rise [27]. These results were different too with the results of our study. In this study, it was considered that differences result from 12 weeks of reflexology practice. Besides, there were significant differences in SBP in chrome group after the 12-week interventions ($p<0.005$). Besides, Cho and Park said that after the reflexology practice decreased TC, LDL, TG values increased HDL-C [28]. Besides, chromium is not synthesized in our body, so it is an element to take from the outside. It regulates the breakdown and use of simple sugars in the body and its effects on carbohydrate, protein and lipid metabolism. Individuals obtain chromium with diet, and it has recovery effect of the level of blood glucose high or low. Abraham, et al., showed that 2 months of chromium supplementation resulted in a modest increase in HDL-C and chromium levels [29]. In this study, a modest increase in HDL-C and chromium levels were found. These results are similar to the results of this present study.

As seen in Table 2, while there was a significant decrease at SBP in the intake of chromium group, core exercise group had more significant reductions in PBG after the interventions and it was statistically significant ($p<0.05$). Sharma, et al., found that beneficial effect of chromium supplementation had regarding SBP after 3 months of chromium intake (totally 9 capsules and 9 g) 3 times a day and it was statistically significant [30]. Diaz, et al., did an investigation on overweight women [31]. They found that SBP and DBPs were not changed over time or influenced by CP-CLA after 12 weeks once daily in the morning (133 mcg), 3 soft-gel capsules. Daily chromium picolinate consumption can be effective in their research that they found no change. While in this work done results were similar with the results of Sharma, et al., whereas, it was not similar to the results of Diaz, et al., because the amount of chromium consumption is important.

Besides, this study was shown that all of the participation generally had abdominal obesity and their values were critical. But, there was a decrease in the means of WHtR. Browning, et al., represented that for people under 40 years of age, a WHtR of under 0.5 was critical for people in the age group between 40-50 years the critical value was between 0.5 and 0.6, and for people over 50 years of age the critical values start at 0.6 [32]. Higher values of WHtR indicate a higher risk of obesity-related cardiovascular diseases; it is correlated with abdominal obesity. Abdominal obesity defined by WC or WHtR more effectively reflects the visceral fat [33,34]. Niclas, et al., reported that lifestyle intervention with exercise was reported to reduce abdominal obesity and improve coronary heart disease risk factors [35]. Ross, et al., noted that fixed amounts of exercise resulted in reductions in abdominal obesity [36]. In some researches have been mentioned that in adults, both, endurance and resistance exercise paired with energy restriction

may effectively reduce visceral fat mass and risk markers for the metabolic syndrome [37,38]. As known, regular physical activity leads to significant changes regarding increased health-related fitness and can reduce risk factors for developing a range of disabling medical conditions which occur in inactive people. Another study mentioned that physical activity and exercise make a significant contribution to health and that the characteristics and mode of physical activity and exercise can be highly influential in defining the type and extent of impact in a range of cardiovascular disease risk factors [39].

As shown in Table 3, while the HbA1c has a significant decrease in the reflexology and core exercise groups, it increases in chrome group after the 12-week interventions ($p>0.05$). Umpire, et al., have found that structured exercise training that consists of aerobic exercise, resistance training, or both combined is associated with a HbA1c reduction in patients with type 2 diabetes. Structured exercise training of more than 150 minutes per week is associated with greater HbA1c declines than that of 150 minutes or less per week. Besides, Umpire, et al., reported that physical activity was associated with lower HbA1c, but only when combined with dietary [40].

CONCLUSION

Thus, it can be stated that a core exercise program and reflexology is an effective method of reducing body weight, BMI, WC, WHtR, TG, SBP and DBP, PBG and Hba1c. Besides, a decrease in HDL-C is undesirable. HDL-C levels according to the results of our research, we can say that participants must not be below the normal value of taking reflexology therapy. Core exercise program and intake of chromium can be applied to the improvement of all METS components.

DECLARATIONS

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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