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The relationship between daily physical activity levels and cardiometabolic parameters in elderly postmenopausal women

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Abstract
Work intensity indices management (vo2max%, HRR max% &HRmax%) during sub-maximal physical activities are difficult for an evaluating in the cardio-metabolic risk factors profile (CMR).The aim of this study was to investigate the relationship among step per day volume (SPD) with CMR , anthropometry variables and the effects of SPD on the dependent parameters. The study performed on the healthy post-menopausal women (n=40). SPD was measured by the pedometer during 2 weeks interval period. participants (aged 55.9 ±4.6) and BMI 30±3.8 kg/m2 were divided voluntarily as an active group in the aerobic group (AG =20) and sedentary group (SG=20). Baseline CMR was analyzed by the standards methods, also 8000-10000 SPD range was determined as an daily active conditions index. Baseline CRM levels was assessed by a standard methods. Daily step averages in the AG significantly was higher than SG . There were a significant differences in anthropometric variables among 2 groups and significant inverse correlations were found between SPD and body composition variables in PMEW The significant inverse correlations was found between SPD and HDL-C. Meanwhile, baseline plasmatic LDL-C, total cholesterol ,triacylglycerol , Insulin and FBS concentrations and HOMA (Homeostasis model assessment) with SPD were not significantly corrected. In view of regular physical activity pattern , increasing in SPD may be associated with an Increase and reduction at baseline HDL-C and anthropometric variables magnitudes respectively. It seems that at least 10000 SPD may be effective on the anthropometric and CMR properties in PMEW.

Keywords: Aging, Cardiometabolic, Menopause, Physical activity, Woman

Introduction
Cardiovascular diseases are a major causeof death in men and women across industrial European and fast growing Asian countries [1]. Over the past 20 to 30 years, metabolic diseases have been reported to be among the most common causes of disability and impairment [2]. Studies conducted by the national health organization across the country on individuals over the age of 15 show that more than 11.9% of women have high blood pressures and about 12.4% of them have high cholesterol levels; in other words, the distribution of obesity is more prevalent among Iranian women compared to men [3]. Reduced levels of physical activity and daily leisure in the modern lifestyle are associated with negative health outcomes, such as the incidence of

cardiometabolicas well as other diseases and sudden deaths [4]. Daily physical exercise is essential for the prevention of lifestyle-related metabolic risk factors such as obese physical form, abnormal blood lipid and lipoprotein levels (dyslipidemia), hypertension, type 2 diabetes and cardiovascular diseases [5].

Strategies for performing physical activities and the development of daily exercise routinesare measured by such components as frequency, duration and intensity of activity [6]. However, organized daily exercise based on exercise intensity measurements regulation Percentage of Maximal Oxygen Consumption ($vo2_{max\%}$), heart rate reserve Percentage of Maximal Heart Rate ($HRR_{max\%}$) and percentage of maximal heart rate ($HR_{max\%}$) appears rather difficult [7]. As a result, over the past two decades, the public health perspective has shifted its focus from the type of physical activity exercised to improved mechanical efficiency or the quality of lifestyle-dependent physical tasks. Common daily life physical activities such as walking, cycling to work or educational institutions and climbing the stairs instead of using the elevator in apartment buildings and localshopping centersare examples of this change in behavior [8]. Walking with light and moderate intensity is considered the simplest and cheapest form of increasing physical activity on the way to improving general health. Accordingly, the American College of Sports Medicine, the Center for Disease Control and Prevention and the American Heart Association recommend at least 30 minutes of fast-paced walking on most days of the week [9].

Classic epidemiological and clinical studies assessing physical activity often yield qualitative data. Recently, however, pedometer and accelerometer devices provide the option of recording people's daily physical activity in the form of steps taken [6 and 10]. On the other hand, scientific evidence suggests the protective effects of walking against cardiovascular conditions and the development of chronic diseases in the middle-aged and the elderly [11-14]. For example, a daily walking routine with a pedometer installed showed a reduction of weight by an average of 0.05 kg per week [15].

It appears that daily physical activity levels affect metabolic risk factors, such that, the dailyrate of walking in adult and elderly men and women measured by a pedometer or an accelerometer showed an inverse relationshipwith obesity, hypertension, basic triglyceride concentration, and fasting blood sugar level, as well as a direct relationship with their plasma High density lipoprotein cholesterol High Density Lipoprotein Cholesterol (HDL-C) levels, independent of race [7,11,13,16].

Recently, a mean threshold of 10000 steps per day is recommended by scientific reports as a means of improving and enhancing adults' physiological health [17,18,19]. Broad-ranging cross-sectional studies have also suggested that middle aged and young people should take a minimum of 10000 steps per day to maintain their cardiovascular health; however, achieving this number seems out of reach givenpresent day normal activities. As a result, individuals require further complementary steps taken in other forms of physical activity during their leisure [6,20]. Epidemiological studies suggest that walking and aerobics, even below the maximum intensity and for a minimum of 3 hours per week, reduce certain metabolic risk factors in sedentary women by 30% [21]. Meanwhile, long-term walking protects against atherosclerosis while short-term walking improves bad blood lipid profile and regulates glucose metabolism [22].

Given the fewstudies conducted on the role of the number of steps taken per dayon the elderly's cardiovascular health, the present study aims to determine the relationshipbetween the daily walking pattern of elderly women in Shahrekourd and reduced cardiometabolic and anthropometric risk factors in them, and also the variance of cardiometabolic parameter responses in elderly women with active lifestyles of 8000 to 10000 steps taken per day and the ones with sedentary lifestyles of less than 5000 steps.

Method

The present study is conducted using the correlation analysis and through comparing the anthropometric and cardiometabolic parameters in active and sedentary groups of women.The statistical population consists of 96 eligible postmenopausal women from Shahrekourd city at an age range of 48 to 68 and witha BMI (Body mass index) of 30±3.81 kg/m2 and a waist to hip ratio WHR (Waist–hip ratio) of 0.99±0.06, who were placed in two distinct groups of active (20) and sedentary (20) women through the simple random sampling method. Members of the first group were selected from a pull of women attending 4 different gyms for aerobics with at least a 2-year history of regular physical activity supervised by sports coaches, and members of the second group were selected from 2 localnursinghomes for the elderly without a history of previous regular exercise during leisure, on a volunteer basis and through the convenience sampling method (Z=1.96 and CI=19.4). Participants were first clarified on the process of the research project and then proceeded to submitting their written consents along with their filled-out medical questionnaires, Physical Activity Readiness Questionnaire (PAR-Q) and Baeke's daily physical activity questionnaire. Participants had no history of cardiovascular, metabolic and orthopedic diseases and had not takenmedications affecting dependent variables or used tobacco products over the 18 months preceding the study.

Measuring physical activity levels:

In order to measure the subjects' number of steps per day, 12 pedometers, OMRON Hj-152 model made in China, were used. Before the pedometers were installed, their reliability and accuracy were tested using two different methods, including of filming the number of steps in walking a distance of 400 meters at any desired speed upon a treadmill apparatus using a SONY-CAM made in Japan and recording it in a pedometer portable (P=0.000, r2=0.99, SEE=4.03 step/day) [22,23].

Participants were familiarized with pedometers and their method of functioning, and it was requested of them to horizontally attach the device on their bodies to the right of their waist during routine activities from the morning to the end of the day except when sleeping or at home, so thattheir number of steps taken per day would be recorded. All participants had to attach the device for two consecutive weeks and each week for a minimum of 5 working days or holidays. By the end of each week, data stored in the pedometer's memory would be delivered tothe researcher, and then, at the end of the two weeks, the mean number of steps recorded would be considered as the daily rate of physical activity of the two groups for the purpose of statistical analysis of the data.

Measuring body composition parameters

The subjects' height was measured using a wall-mounted stadiometer, SOEHNLE model made in Germany, with no shoes on and with an accuracy of 0.1 cm. The subjects' weightas well as their body composition including their BMI, waist to hip ratio and subcutaneous fat to waist ratio were measured using In Body 220 Body Composition Analysis made in Korea. Blood pressure, as well, was measured using ALPK2 sphygmomanometer, made in Japan, at 8am and after 10 minutes of rest and in a seatedposition, by the help of an experienced nurse who held their arm at heart level.

Measuring biochemical parameters

After measuring the physical activity levels at the end of the two weeks, blood samples were taken from the elderly subjects at medical diagnosticreference laboratories following 12 to 14 hours of fasting. 7 ml of blood were taken from the left brachial vein at 8-9am. Blood samples were then kept in a sigma centrifuge 330 made in Germanywith a 2500 RPM and at -70°C for conducting further biochemical analysis. The subjects' HDL-C, Low Density Lipoprotein Cholesterol (LDL-C), TG and fasting blood glucose (FBG) were each measured through the enzymatic and colorimetricphotometric methods using their own specific kits. Fasting insulin was also measured using the ELISA method with a DRG Insulin ELISA kit. The homeostatic model assessmentconsisting of insulin resistance index and beta-cell function was carried out through the equation proposed by Matthews et al [24].

Participants' dietary data were recorded on a special diet form using the 24-hour diet recallquestionnaire over a three-day period (the first two days and the very last day of the week). Participants were asked to record their main daily food and drinkplan from the 24 hours preceding their completion of the questionnaire. Amounts of food taken were converted into grams and calculated in calories using the Food Analyzer software made by SelakTeb Comp.

Statistics

After confirmation of the equality of variances (using Levene's test) and the normal distribution of the data (Kolmogorov-Smirnovtest of normality), the parametric independent t test was used for comparing the mean values of the two groups under study at a significance level of P<0.05 and assuming that type I errors can be controlled. In addition, the multivariate linear regression model was used to assess any potential relationships between cardiometabolic parameters and the elderly's number of steps taken per day. Calculations were made using SPSS16 software.

Results

The study subjects' mean age of 55.4±4,6 years, anthropometric measurements of BMI=30±3.9 kg/m2 and WHR=1.05±0.6, systolic blood pressure of 123.5±10.3 mmHg, andenergy expenditure of 2337+206 Kcal per day for the active groupdoing aerobics and 2541+234 Kcal per day for the sedentary group were compared against each other in proportion to their daily physical activity levels and based on their anthropometric and cardiometabolic parameters and yielded the following results.According to the intergroup assessment, the mean steps taken per day in the first group (8022±2659) was significantly larger than in the second group

Table 1 *Comparison on anthropometry & cardiometabolic variables in the active & inactive females*

Physical & biochemical variables	Active Subjects Mean±SD	Sedentary Subjects Mean±SD	F_{Ratio}	P_{Value}
Age(yr)	5.06±55.5	4.2 ± 56.35	0.295	0.59
High (cm)	6.43 ± 155	5.68 ± 152	2.367	0.132
Wight (Kg)	8.9 ± 68.1	11.8 ± 73.81	2.94	0.095
(kg/m^2) BMI	3.33 ± 28.2	4.62 ± 31.8	7.593	*0.009
(%) Body Fat	4.62 ± 39.8	7.7± 47.16	13.105	*0.001
WHR	0.04 ±.0.97	0.09 ± 1.04	9.511	*0.004
BP_s (mmHg)	8.9 ± 122	11.4 ± 124.5	0.592	0.447
BP_d (mmHg)	6.38 ± 87.5	7.88±89	0.437	0.512
(mg/dl)TG	56.6 ± 132.9	74.28±141.15	0.156	0.659
(mg/dl)TC	15.25± 203.05	30.35 ± 205.25	0.084	0.774
(mg/dl) HDL-C	9.7 ± 59.5	15.19 ± 53.05	2.601	0.115
(mg/dl) LDL-C	17.95± 118.7	21.27± 121.55	0.21	0.65
(mg/dl) FBS	8.7 ± 84.65	88.58 ±83.4	0.096	0.759
(µIU/ml) Fasting Insulin	3.03 ± 9.2	4.76 ± 11.52	3.353	0.075
HOMA-IR	0.74 ±1.93	1.36±2.4	1.82	0.185
Daily Steps	2659 ± 8022.	913 ± 3450	52.857	*0.000

(3450±913), (P<0.001), which probably indicates a more dynamic lifestyle in the active group doing aerobicscompared to the sedentary group. According to table 1, significant differenceswere only observed between the two groups in terms of their anthropometric measurements, i.e. theirbody mass index (BMI), body fat percentage and waist to hip ratio (WHR) (P<0.05).

No significant differences were observed in terms of cardiometabolic parameters including the Fasting Blood Sugar (FBS), HDL-C, LDL-C, TG, TC, Homeostasis Model Assessment (HOMA-IR) and fasting insulin levels (P≥0.05). Nevertheless, the body composition profile of the groups under studystill signified the over-weight and obese range.

Table 2 indicates a significant relationship between BMI and physical activity levels in the elderly (P=0.02 and r=0.35).The correlation pattern between the number of steps taken per day and body fat percentage also reached the significance level (P=0.005 and r=0.43). However, given the low value of the coefficient of determination (r2=0.188), this correlation is just as unreliable as BMI. Figure 1 also shows a significant relationship between WHR and the number of steps taken per day; in other words, with

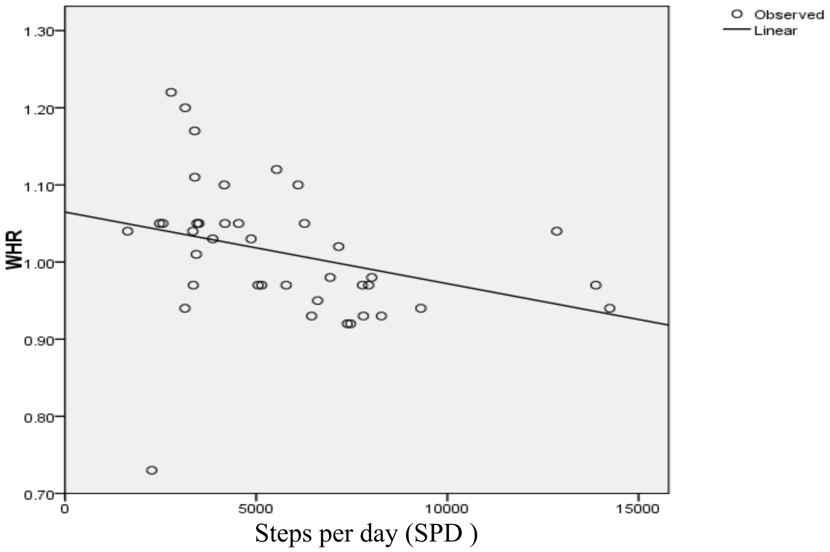

Figure 1 *Correlation among WHR & daily steps in orderly females*

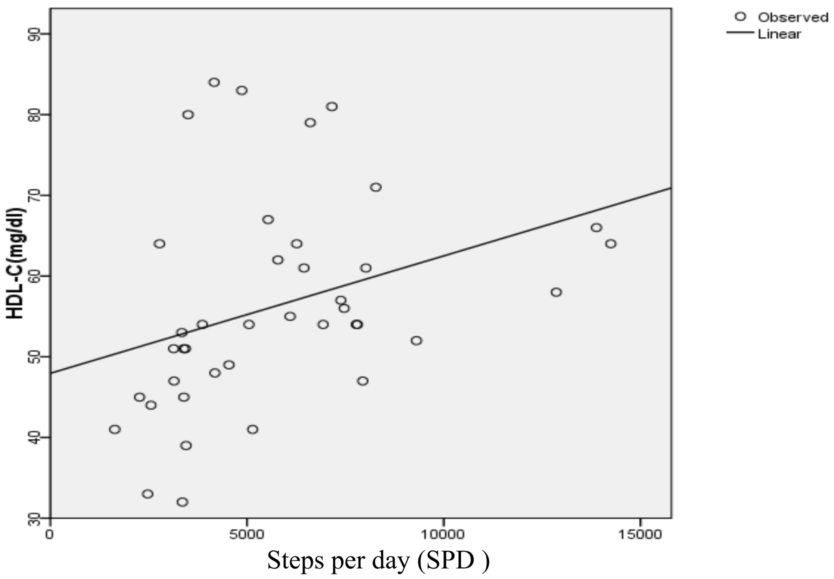

Figure 2 *Regression line for basal HDL-C levels & orderly females*

an increase in the number of steps taken per day, the waist circumference to hip ratio risk factor tends to decrease as well (P=0.045 and r=0.319); however, given the low value of the coefficient of determination (r2=0.102), this correlation does not seem significant. Of the lipoproteins and the blood lipid profile, the only significant relationshipfound was between baseline HDL-C levels and the number of steps taken per day (P=0.032 and r=0.34); its linear relationshipto the number of steps per day is shown in Figure 2.

Meanwhile, according to table 2, the relationship between the elderly women's number of steps per day and their insulin resistance index (HOMA-IR) also proved to be insignificant (P=0.14). Nevertheless, a similar pattern was also observed in the relationshipbetween fasting glucose and insulin levels and the number of steps per day. Although there was a significant difference between the two groups in terms of their BMI, WHR and BF% (Measuring Percent Body Fat), the difference in their mean baseline levels of HOMA-IR, TG, TC, Low density lipoprotein cholesterol (LDL-C) and fasting glucose and insulin was insignificant (P>0.05).

Table 2 *Correlation between cardimetabolic & anthropometric with daily steps in menopausal women (n=40)*

Variables	R	P value
Wight (Kg)	0.245-	0.128
(kg/m2) BMI	0.350-	0.02
Body Fat (%)	0.434-	0.005
WHR	0.319-	0.045
BPS (mmHg)	0.106-	0.515
BPd (mmHg)	0.037-	0.821
TG (mg/dl)	0.003-	0.354
Col (mg/dl)	0.09	0.579
HDL-C (mg/dl)	0.34	0.032
LDL-C (mg/dl)	0.074	0.65
FBS (mg/dl)	0.006	0.97
Fasting Insulin (µIU/ml)	0.296-	0.046
HOMA-IR	0.238-	0.14

Discussion

According to the present study, assessing the relationship between cardiometabolic parameters and physical activity levels in postmenopausal women revealed a significant relationship to exist between BMI, WHR and BF% and the number of steps taken per day (P<0.05), which is in line with findings of the studies conducted by Kobayashi [5], Wolf [11], Ashton [25] and Earlene Masi [26]. Nevertheless, certain other studies failed to demonstrate this pattern [7, 27 and 28]. Although a significant difference existed between the two groups in terms of their BF%, BMI and WHR, the difference in their mean baseline levels of HOMA-IR, TG, TC, LDL-C and fasting glucose and insulin was insignificant (P>0.05).

Previous scientific evidence emphasizes the importance of understanding the roots of the incidence of metabolic diseases and developing suitable physical activity strategies in order to reduce medical costs and improve community health status. Research evidence has also uncovered thebenefits of sub maximal and maximal aerobic exercises on cardiometabolic risk factors [4, 11, 13 -15].

Most studies conducted on the effects of aerobic exercise on lipoprotein changes mainly indicate the sensitivity of the HDL-C and TG changes profile to these exercises [5]. On the other hand, a reduction in TC and LDL-C levels following aerobic exercises has rarely been reported while the reduction in LDL-C levels is often reported after substantial weight loss [11 - 29]. In the present study, though the two groups were not significantly different in terms oftheir blood lipid variables, the baseline plasma levels of TC, LDL-C and TG in the active elderly with a mean number of 8000 steps per day were, in respective order, 2.2, 2.85 and 8.25 mg/dl lower than in the sedentary group with a mean number of 5000 steps per day. These results are in line with results of the studies conducted by Wolf [11], Dancy [30], Furukawa [22] and Kobayashi [5]; although, in their studies, daily physical activity levels were often reported to be far beyond 10000 steps per day and sometimes their study subjects lived on special diets.

In the present study, no significant differences wereobserved between the two groups of elderly women in terms of their baseline levels of HDL-C (P=0.115); however, this lipoprotein was higher in the active postmenopausal women compared to their sedentary counterparts by 12.15% (equivalent to 6.5 mg/dl), which was almost in line with the range of changes in the study conducted by Dancy [30]. In assessing the relationshipbetween the profile of lipid changes and daily physical activity levels, findings of the studies conducted by Kamehi [27], Dancy [30] and Ashton [25] proved to be similar to the present study's in that a significant relationship was found between HDL-C and the number of steps per day (P=0.032).

In recent years, a physical activity threshold of 10000 steps per day is recommended and implemented as a tool for enhancing and improving adults' health [22]; the elderly taking 4000-6000 steps more than their normal lifestyle dictates to them (the threshold of 10000 steps per day) report a significantly lower systolic blood pressure and fasting blood sugar levels [7]. A study conducted by Wolf [11] on non-athlete women revealed a significantly lower fasting insulin level in active individuals compared to the sedentary ones by 3μIU/ml. In the present study, fasting insulin levels in active individuals were lower by 2.32 μIU/ml compared to the sedentary individuals; however, the difference between the two groups was not significant (P=0.075) and the relationship between fasting insulin levelsand the number of steps taken per day was not significant either (P=0.06). As for glucose levels and the insulin resistance index (HOMA-IR), the differences between the two groups were not significant and the variables did not have a significant relationship with physical activity levels. These findings were in line with results obtained by Wolf, Kamehi and Locus [1]. Meanwhile, in the study conducted by Ashton [25], therelationshipbetween changes in fasting blood sugar and physical activity levels became significant. A factor influencing this disparity could be the individuals'different diets; various studies show that changes in insulin resistance indices (fasting insulin and glucose levels and insulin resistance index HOMA-IR) following restricted calorie intake and a combination of calorie restriction and aerobic exercise are more striking than when there is only an exercise routine [31]. Most studies that have assessed the effect of physical activity levels on blood pressure were longitudinal and were conducted on subjects showing symptoms of hypertension or who were about to be afflicted with this disease [7, 29]; however, results of cross-sectional studies have also been contradictory, with some confirmingthe relationshipbetween the number of steps per day and blood pressure [22, 23] and others not finding any significant relationships between them [24]. In the present study, the systolic blood pressure in both groups was in the normal range and no significantdifference was therefore observed; however, blood pressure was lower in the active elderly women compared to the women inthe sedentary group (1.5-2.5 mmHg).

Findings of our study indicate that, in terms of physical activity levels,increasing the number of steps per day in elderly women reveals, to some extent,a correlation by way of reducing therisk factors of chronic diseases such as increased HDL-C and controlling anthropometric risk factors such as WHR, BF% and BMI. Based on a potential mechanism of hastened metabolism of free fatty acids (FFA) in esterified adipose tissue, it can be argued that the amount of this substrate release depends on two factors, namely, plasma FFA metabolism and transportwhen performing light and moderate aerobic exercises at an intensity of less than 50% Maximal Oxygen Consumption (Vo2MAX) [32,33]. The hastened musculoskeletal tissue FFA metabolism occurs after the intervening of catecholamine stimulating β1-adrenergic receptors and through the adenylatecyclase pathway activity within the tissue for producing cyclic AMP molecules in the cytosol [33, 34]. In addition, enhanced mitochondrial FFA metabolic capacity is indicative of increasing activity of the key enzymes β-oxidation and krebs cycle, such as hydroxyacyl-CoA dehydrogenase and citrate synthase [35]. Meanwhile, the mediatory role of malonyl COA in inhibiting carnitine -acyltransferase I (CAT I) is essential to the regulating of FFA oxidation speedof fit muscles during light and sub-maximal exercises. The reason is that the

Malonyl- COA cellular levels in the muscle are reduced with the gradual increase of exercise pressure in light but long aerobic exercises (over 30 minutes). Higher levels of long-chained FFA substrates find their way into the β-oxidation pathway, and, when faced with such an exercise pattern, the body inhibits the CAT1 enzyme and becomes more dependent on the energizing FFA source, which in the end leads to the storing of intramuscular and liver carbohydrate reserves. Nevertheless, the profile of the process of cardiometabolic factor changes in response to different endurance or aerobic exercise patterns is reported to be greater in some studies and smaller in some others. Such contradictory findings could be due to other factors such asdietary restriction and habits, type of exercise, intensity, duration andlevel of physical activity, age, gender, body composition(overweight and obese) and baseline levels of blood lipid components at the start of the aerobic exercise routine [35, 11 and 26]. Given the researcher's lack oftotalgrasp over the subjects inretrospective human subject research, longitudinal and manipulated studies are required in order to obtain more accurate results.

Conclusion

Based on findings of this study, it can be argued that a mean number of 8000 steps taken per day by active elderly women regularly exercising aerobics does not show a significant correlation with the profile of cardiometabolic risk factor changes (baseline levels of fasting glucose and insulin, HOMA-IR, TG, TC and LDL-C); it is possible that, in order to stimulate the lipid substrate β-oxidation metabolism process in the systemic blood circulation or subcutaneous adipose tissue reserves, greater levelsof daily physical activity are required (the threshold of 10000 steps per day), which is in line with recommendations of the American College of Sports Medicine (ACSM).

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Contributions

Study design: FN, FN
Data collection and analysis: ZH
Manuscript preparation: FN
Conflict of interest
"The authors declare that they have no competing interests."

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