Circuit Weight Training *vs* Jogging in Metabolic Risk Factors of Overweight/Obese Women

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Summary

Background: Resisted and aerobic exercises are recommended to reduce weight and improve health, but which exercise modality offers the best results is still unclear.

Objective: The aims of this study were to compare circuit weight training (CWT) with jogging (JOGG) on multiple cardiovascular disease (CVD), metabolic risk factors and fitness of overweight and obese women (body composition, lipid profile, uric acid, glucose, metabolic equivalent (MET), heart rate, blood pressure, flexibility, resting energy expenditure (REE) and nitrogen balance (NB)).

Methods: Fifty women were randomly divided in two groups, but only 26 finished it: CWT (n=14; 36±12 years old; body mass index, BMI=32±7 kg/m^2) and JOGG (n=12; 37±9; BMI=29±2). The first month of training consisted of 60 min x 03 days/week and the second month of training consisted of 04 days/week for both protocols and a dietary reeducation.

Results: Both groups reduced total body mass, fat body mass, BMI, plasma uric acid and increase in MET ($p<0.05$); there was no change in lean body mass, REE and resting heart rate. CWT reduced total cholesterol, plasma triglycerides, NB and increased flexibility; JOGG reduced waist/hip ratio, glucose, systolic blood pressure, high-density lipoprotein cholesterol, and increased the total cholesterol/high-density lipoprotein cholesterol ratio ($p<0.05$).

Conclusion: Both protocols improved CVD and metabolic risk factors. The CWT presented favorable changes regarding lipid profile and flexibility; JOGG on glucose, waist/hip ratio and blood pressure. These results suggest that resisted exercise combined with aerobics should be considered for obese people. Nevertheless, regarding some basal differences between the groups , it was not possible to conclude that changes were due to exercise type or intra-group variability. (Arq Bras Cardiol 2009; 93(5) : 480-486)

Key words: Overweight; obesity; uric acid; physical fitness; energy metabolism.

Introduction

Obese individuals present an impaired lipid profile, increased plasma uric acid, a higher incidence of diabetes type 2, risk factors for cardiovascular disease (CVD) and chronic diseases in general[1,2]. Moreover, the waist/hip ratio (WHR) and body mass index (BMI; m/kg^2), are positively correlated with dyslipidemia and CVD[1,2], negatively correlated with endothelial function[3] and with a low physical fitness and effort tolerance, which are associated with an increased risk of death[1,4].

Around one third of the American population is currently trying to lose weight, but not all people who would benefit from weight loss are making an attempt at it[5]. Despite an increased investment in weight reduction programs, these efforts have been unable to prevent the increase in overweight and obesity[6]. In addition, 33.5% of the individuals regain the lost weight over a one-year period[7], and up to 90 to 95% gain it back later[1]. One reason that contributes to this is that diets to reduce weight are associated with a reduction in resting energy expenditure (REE, kcal/day)[1] as well as in lean body mass (LBM), which is positively associated with REE[8].

On the other hand, increased physical activity also favors a better weight maintenance[9], and weight regain is two times higher in those with sedentary life styles[7]. Regular physical activity reduces abdominal fat, the mortality risk[5], even over the caloric intake[10] and additionally, weight loss is associated with the reduction in metabolic risk factors[2,11]. However, the increase in domestic physical activity is not associated with a reduction in obesity and other CVD risk factors[12].

Jogging is a low- to medium-intensity type of aerobic training, habitually used for weight control[13]. CWT involves mixed metabolic characteristics and produces good results regarding body fat reduction, physical fitness and functional capacity improvement[14-17], but it is still not clear which of the two types of training is more efficient.

Thus, the main purposes were to determine the influence of each exercise over:

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1) body composition;

2) lipid profile, uric acid and glucose levels (mg/dL);

3) REE and nitrogen balance (NB; g/d);

4) physical fitness; and,

5) the qualitative and quantitative diet profile before and after the interventions.

Methods

The volunteers were invited to participate in the study through fliers containing the body mass index (BMI, kg/m^2) formula, distributed at University of São Paulo, Ribeirao Preto, SP, Brazil. At the first meeting, the women filled out an information sheet with name, weight and height, which was used by the staff to randomly divide them in two groups, respectively submitted to circuit weight training (CWT, *n*=25) or jogging (JOGG, *n*= 25). The subjects were initially evaluated (time 1, T1 or baseline), submitted to training and to a low-calorie diet for eight weeks, the time needed for program adaptation[17,18], and then re-evaluated at the end of the study (time 2, T2) (Table 1).

The same physician from the staff of the University Hospital of the School of Medicine of Ribeirao Preto, University of São Paulo (UHFMRPUSP) examined all the women. The blood pressure and RHR were measured at this time. Inclusion criteria were: a BMI >25 kg/m^2, no history of chronic metabolic diseases in addition to obesity itself, no smoking, no alcoholism (>15 g ethanol equivalents/day), no use of medications such as beta blockers or sympathomimetic drugs, no orthopedic limitations and a sedentary life style. All women were informed about the procedures of the study and signed a free and informed consent form approved by the Research Ethics Committee of UHFMRPUSP (process HCRP # 5317/2002).

Total body mass (kg) and height (cm) were measured with a Filizola® electronic scale ID1500 (São Paulo: SP, Brazil) with a precision of 0.1 kg and 0.5 cm, respectively. Skin folds (triceps, suprailiac and thigh) were assessed for body composition[19,20] using a Lange® caliper (Beta Technology INC, Santa Cruz: CA, USA) with a constant pressure of 10 g/mm^2 on the contact surface and a precision of 0.1 mm, with a 0-65 mm scale. The WHR was obtained by dividing the circumference of the abdomen at the height of the umbilicus by that of the hips at their largest perimeter, in cm. A Quantum® BIA-101Q, Serial n Q 1559, RJL Systems, Inc, apparatus (RJL Systems, Clinton: MI, USA) was used for bioelectric impedance analysis (BIA), at a frequency of 50 kHz. The body composition was calculated by the formula of Segal et al.[21].

Triglycerides (Tg), total cholesterol (TC) and high density lipoprotein cholesterol (HDL) were estimated in the Nutrition Laboratory. Low density lipoprotein cholesterol (LDL) was calculated:

$$LDL=TC - HDL - Tg/5$$

Uric acid was estimated by the uricase method and glucose levels by hexokinase-glucose-6-phosphate in the Central Laboratory all of UHFMRPUSP (mg/dL to all).

Indirect calorimetry was measured for 30 minutes after 12-hour fasting, with the patient lying down in absolute rest, also avoiding conversation and sleep (Vmax 29® Sensor Medics, Yorba Linda, CA, USA). The dietary reeducation was based on the calculation of a calorie supply similar to REE for both groups, ranging from 1100 kcal/d (4605 kJ/d) to 1700 kcal/d (7117 kJ/d), and the following proportion of macronutrients: 20% of fat; 20% of protein; 60% of carbohydrate[22]. The habitual ingestion was obtained by means of a one-week dietary record performed before (T1) and after (T2) the interventions[23]. The subjects were instructed to follow these guidelines in their homes and to have a weekly meeting with the staff (two physical educators, one nutritionist and one physician).

To measure the nitrogen balance (NB, g/day), the first morning urine was discarded and all the urine excreted thereafter was collected up to the first urine of the subsequent morning. The NB was estimated by subtracting excreted

Table 1 – Anthropometry and bioimpedance results for overweight/obese women before (T1) and after (T2) eight weeks of a moderate low-calorie diet and circuit weight training (CWT; n=14) or jogging (JOGG; n=12)

	CWT			JOGG		
Variables	**T1**	**T2**	**Δ**	**T1**	**T2**	**Δ**
Anthropometry						
Body mass (kg)	89±20	84±18‡	-5±4	75±11*	70±11‡	-5±2
BMI (kg/m^2)	32±7	31±7‡	-1±0.4	29±2	26±1‡	-3±0.2
% Fat mass	44±6	38±7‡	-6±1	40±5	33±5‡	-7±1
Waist/Hip ratio	0.93±0.10	0.92±0.08	-0.00±0.0	0.88±0.06	0.87±0.07*	-0.02±0.2
Bioimpedance						
Lean mass (kg)	53±5	52±5	-1±0.5	46±7*	45±7	-1±0.5
Fat mass (kg)	45±15	41±15†	-4±2	28±6*	24±6†	-4±2
% Fat mass	45±6	43±6†	-2±0.5	38±2†	34±3†	-3±4

*Means±SD; Comparisons in each group were T1xT2; between groups were T1xT1 and Δ=T2-T1; significant effects at *p<0.05; †p<0.01; ‡p<0.001; BMI - body mass index.*

nitrogen from total ingested nitrogen (each gram of nitrogen represents 6.25 g of ingested protein from food record). The additional nitrogen loss in the stool was estimated with the addition of 2 g/d[24].

The metabolic equivalent (MET; 3.5 ml $O_2 \cdot kg^{-1} \cdot min^{-1}$), was assessed on an electric treadmill (model E17A®, Del Mar Reynolds Medical, Inc. Irvine: CA, USA) using the Ergo PC13® program of Micromed, the ECG digital Micromed program (Micromed Biotecnologia Ltda, Guara II, Brasilia: DF, Brazil) and the Bruce protocol, provided by the Service of Cardiology of UHFMRPUSP. The flexibility was accessed through the seat and reach test, of which the result was the maximal distance achieved in cm[19].

Training intensity was adjusted according to 70 to 80% of the Karvonen heart rate reserve (HRR) calculated through the following equation:

HRR = ((HR max - HR basal) x 0.7 ou 0.8) + HR basal

and by the modified Borg scale (between three and five; moderate to strong)[18,19]. Training consisted of 1 h per session (45 min of activity and 15 min divided between warming-up and cooling-down), with three sessions per week during the first month (180 min/week), and 4 sessions during the second month (240 min/week) for both groups.

CWT consisted of 15 stations of resisted exercises for all the main muscle groups with a thirty-second duration (10 to 20 repetitions per exercise) alternated with 30 seconds of walking or jogging. The maximum number of repetitions, which increased with conditioning, was performed to maintain the intensity that each subject was able to reach in the above range. The stations were arranged in a circle in a 10 x 15 m room with tatami pads on the floor. The jogging training took place on an athletic track with the subject performing the exercise continuously for 45 min at the programmed intensity.

Statistical analysis

The Kolmogorov-Smirnov test was used to analyze data for normality of distribution and the paired Student *t*-test was used for the comparison of the two times (T1 *vs.* T2) in each group. Comparison between groups at baseline (CWT T1 *vs.* JOGG T1), and for variations (delta, Δ=T2-T1), was performed by the unpaired Student *t*-test. Data are reported as mean±SD and the statistical analyses were carried out at the 5% level of significance, with the determination of the 95% confidence interval. The power of test was estimated as $\gamma(\theta) = 0.915$ (91.5%), considering the variation of two units of BMI and a number of participants equal 10.

Results

One-hundred-and-twenty women contacted us; of the selected 72, 50 started the program and 26 completed it (CWT, *n*=14; JOGG, *n*=12). The age of the volunteers was 36±12 years old for the CWT and 37±9 for the JOGG groups. The other characteristics are presented in Table 1. The reasons for the 24 dropout cases were: little adherence to protocols (*n*=10; 06 in CWT and 04 in JOGG group), difficulties with the training schedule due to work or family reasons (*n*=6; 03 in CWT and 03 in JOGG group), family disease (*n*=1; in JOGG group), a fall (*n*=1; in JOGG group), and depression and/or anxiety (*n*=6; 02 in CWT and 04 in JOGG group).

Total body mass, BMI, body fat percentage from anthropometry, body fat percentage by BIA and body fat were

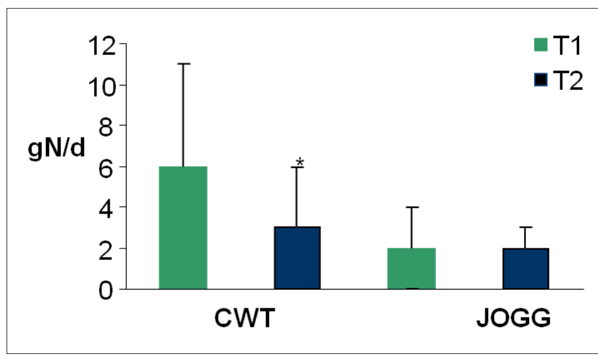

*Figure 1 - Nitrogen balance (NB) results for overweight/obese women before (T1) and after (T2) eight weeks of a moderate low-calorie diet and circuit weight training (CWT; n=14) or jogging (JOGG; n=12). Statistical: Mean±standard deviation; *p=0.031.*

Table 2 – **Blood test results for overweight and obese women before (T1) and after (T2) eight weeks of a moderate low-calorie diet and circuit weight training (CWT; n=14) or jogging (JOGG; n=12)**

	CWT			JOGG		
Variables	T1	T2	Δ	T1	T2	Δ
Glu	91±9	88±8	-3±8	98±7	91±5‡	-8±7
UA	5.3±1.0	4.7±1*	-0.6±0.7	4.5±1*	4.0±1‡	-0.5±0.6
TC	203±27	186±31†	-17±16	174±15*	171±20	-3±20
LDL	117±32	106±21	-11±17	96±15	104±18	8±14*
HDL	58±17	52±12	-6±12	58±10	53±12†	-5±3
TC/HDL	3.6±1.0	3.5±0.7	-0.2±0.2	3.0±0.8	3.4±1.0†	0.4±0.1*
Tg	122±74	91±39*	-31±60	87±32	75±21	-12±28

*Means±SD; Comparison in each group were T1xT2; between groups were T1xT1 and Δ=T2-T1; significant effects at *p<0.05; †p<0.01; ‡p<0.001; Glu - fasting glucose, UA - uric acid, TC - total cholesterol, LDL - low-density lipoprotein, HDL - high-density lipoprotein; TC/HDL - total cholesterol/HDL cholesterol ratio; Tg - triglycerides (all in mg/dl).*

significantly reduced in both groups; WHR was significantly reduced in JOGG and lean mass showed no statistically significant difference in either group as well as no delta differences (Table 1).

Uric acid was significantly reduced in both groups; CWT also presented a significantly reduction in TC and Tg and JOGG presented a decrease in glucose and HDL levels and an increase in the TC/HDL ratio. LDL and TC/HDL deltas where significantly reduced in the CWT compared to JOGG group (Table 2).

The REE decreased slightly in both groups, but there was no statistical difference (CWT: T1=1600±240 (kcal/d), T2=1450±270; JOGG: T1=1510±160, T2=1400±160). The NB decreased significantly in the CWT, remained the same in the JOGG and was positive in both groups (Figure 1). Diet evaluation regarding macronutrients was: T1=31% fat, 16% protein and 53% carbohydrate; T2=24% fat, 19% protein and 57% carbohydrate for both groups.

Both groups significantly increased the MET and total time of treadmill maximal test. The CWT increased flexibility and JOGG reduced systolic blood pressure ($p<0.05$), but no changes in RHR were observed in either group. The flexibility delta was significantly higher in the CWT group (Table 3).

Discussion

In spite of some baseline differences between the groups, the initial mean BMI, which was the criterion for inclusion in the study, was considered to be statistically equal. This was due to the fact that two groups cannot be accurately paired in random experiments. However, we would like to point out that our objective was to perform a global analysis of the groups. To minimize the initial variation of some variables, we also analyzed the changes occurring between deltas of each group.

The present study observed improvement in body composition, biochemical parameters, physical conditioning, and maintenance of REE, LBM and NB in both groups, similar to what was observed in others studies of the same nature, in which CWT or JOGG training was used[13,15]. Longer studies (12 weeks) with a slightly less caloric diet or with the same duration and very low-calorie intake had similar results regarding body composition and biochemical parameters[25]. However, regarding CWT, other studies observed that this type of training resulted in marked improvement in physical conditioning[26-28], cardiorespiratory endurance[15] and a modest improvement[26], or no change[27,28] in body composition. Compared to these studies, the present study observed better improvement in body composition in the CWT group. When comparing CWT and JOGG, Gettman et al.[29], similarly to the present study, did not find differences in body composition or VO_2 max between these two types of exercise. These results show that the issue is not unanimous in literature.

Another important aspect for obese people is the association of diet reeducation with physical activity[30]. It has been demonstrated that a moderate reduction in total calorie intake, as proposed in the present study, causes better subject compliance than programs involving a very low calorie diet[6]. The patients were advised to choose whole carbohydrates with higher fiber content and lean protein. In the present study, the diet had an increased carbohydrate and protein content and a reduced fat content. This qualitative approach should have had a positive impact on body fat reduction[6].

The CWT or JOOG protocols were according to the recommendations of the American College of Sports Medicine (ACSM) for obese individuals[6]. However, Beckham and Earnest[31] showed that a training stimulus significantly below (< 32% VO_2 max) ACSM recommendations (50% VO_2 max) in a CWT protocol, significantly increased the VO_2 max result, but that HR should not be used to assess exercise intensity in these exercise modalities. To solve this problem, we also used the Borg Scale in combination with HRR, which show good association[19]. In spite of some difference in variables between the groups, both showed improvement in MET and total time of treadmill maximal test, suggesting equivalence in terms of training intensity and health improvement. The VO_2 max alone has a predictive value of all causes of mortality equivalent to that of diabetes, hypertension, high levels of cholesterol and smoking[4]. MET is equivalent to VO_2 max and is used to estimate the intensity level of the physical activity[6]. Although the HR reduction is expected with the cardiovascular improvement[18], this was not observed here. Although this is

Table 3 – **Fitness marker results for overweight and obese women before (T1) and after (T2) eight weeks of a moderate low-calorie diet and circuit weight training (CWT; n=14) or jogging (JOGG; n=12)**

	CWT			JOGG		
Variables	**T1**	**T2**	**Δ**	**T1**	**T2**	**Δ**
MET	9.5±2.5	10.7±2.6*	1.2±0.9	9.7±1.9	11.7±1.7†	1.9±1.4
Time	9.6±3.0	10.9±3.0*	1.3±1	9.7±2.0	11.8±2.0†	2.0±1.6
RHR	81±7	79±8	-2±5	72±9	72±9	0
SBP	126±14	121±13	-5±15	123±16	113±13‡	-10±8
DBP	81±5	80±7	-0.9±11	78±11	73±11	-4±8
Flexibility (cm)	12.8±8.5	20.2±12.6*	8.0±8.1	15.9±10.3	17.0±9.9	1.1±6.4*

*Means±SD; Comparison in each group were T1xT2; between groups were T1xT1 and Δ=T2-T1; significant effects at *p<0.05; †p<0.01; ‡p<0.001; MET - metabolic equivalent (3.5 ml O_2.kg^{-1}.min^{-1}), Time - minutes of maximal treadmill test; RHR - resting heart rate (pulses/min) SBP - systolic blood pressure (mmHg); DBP - diastolic blood pressure (mmHg).*

difficult to explain, these findings are in agreement with other long-term studies[18].

The flexibility was improved only in the CWT group. We speculate that the full range of motion of resisted exercise applied in present study may have contributed to this fact, as both groups followed the same stretching protocol in the start and the end of sessions. The flexibility is an important factor to facilitate activities of daily living and that is reduced with age and impaired in obese people. The poor flexibility and fitness level was associated with an increase in body fat percentage and back pain in nurses[32]. Regarding this physical valence, the CWT group showed better result for general fitness conditioning and daily activities.

The WHR was significantly reduced in the JOGG, but not in CWT group. It was expected that weight reduction would proportionally reduce the general measurements, maintaining the WHR value[33]. However, in a study performed by Wabitsch et al.[34], young women with abdominal obesity had a greater reduction in WHR, weight, TC and uric acid than women with gluteus obesity. This may have been due to the fact that the levels of the variables analyzed were higher in women with abdominal obesity, favoring a greater loss. In another study, women with abdominal obesity were found to oxidize more fat during physical activity than women with gluteus obesity, favoring a reduction in WHR[35]. Therefore, differences in fat distribution between the groups may explain the results of these studies[34,35]. However, in the present study, the CWT group had a greater mean WHR value than the JOGG group, a fact that does not support this reasoning.

Girandola[36], showed that when a high-intensity protocol and a low-intensity protocol with other exercises were applied, only the low-intensity protocol improved body composition. In this regard, the present data support a different conclusion, because the duration and intensity of the two protocols were similar, but the metabolic energy involved was different, with the JOGG predominantly utilizing aerobic and CWT group using mixed aerobic/anaerobic energy resources. One explanation is that exercises for lean body mass development[37], such as in the CWT, and increase dietary protein intake[38], as the one utilized in the present dietary protocol, would favor REE and consequently fat oxidation, justifying the CWT results. But, in the present study, REE was maintained in both groups and the NB remained positive during the intervention time, facts that could have contributed to body fat reduction in both groups. Probably, by different metabolic pathways, both groups efficiently increased fat oxidation and maintained REE, despite the differences between the groups regarding body composition.

Harber et al.[27] demonstrated that the CWT promotes an increase in the cross-sectional area of type IIA fibers and tends to increase lean mass in sedentary men in only 10 weeks. The lean mass is correlated with REE[37] and, in a previous study[8], we observed that in obese women, when expressed as kg units, the lean mass presents the best correlation with REE, when compared to total weight, fat mass and BMI. These facts should contribute to the action of CWT in reducing fat and improving lipid profile. However, the JOGG protocol was sufficiently intense to maintain the lean body mass, contributing to the absence of REE decrease, a common fact observed in weight-loss protocols[1]. Furthermore, the training associated with dieting in both groups was sufficient to promote the positive nitrogen balance, which suggests enough energy and protein to support the protein synthesis, contributing to REE maintainence[38].

The changes observed in the lipid profile in the present study may have been influenced by the type of exercise and to a difference between groups in T1. The total cholesterol was significantly higher, and the difference in levels of triglycerides did not have statistical difference, but they were biologically higher in CWT, which could have contributed to higher reduction in this group. However, studies demonstrated that a weight reduction in 10% is associated with an improvement in metabolic risk factors[2,11], as observed here. Yet, one study with type-2 diabetes subjects reported that CWT promoted a significant reduction in total cholesterol, LDL and triglycerides[39]. In the present study, the reductions were just 6% in the CWT and 7% in JOGG group, when compared to the initial weight. It was demonstrated that the exercises are more often associated with CVD risk prevention than caloric intake[10]. Furthermore, the type of exercise could differently impact risk factors to CVD, but this was not observed in this study, may be regarding to differences between groups in basal, but which was not conclusive in the present study due to the differences in biochemical variables in T1.

On the other hand, differently from the present study, Nieman et al.[40], observed that reductions in TC and Tg were effectively associated with weight loss in obese women, but not with the exercise. However, Lee et al.[9], reported that physical activity was more important than the reduction in abdominal obesity regarding the risk of metabolic alterations. In addition, physical activity reduces intra-abdominal fat even without weight reduction[14], and the increase in the number of days of domestic physical activity do not appear to be associated with the prevention of the majority of CVD risk factors in men and women[12], supporting the idea that continuity and intensity of physical activity are determinants for that prevention, even more than the diet reeducation[10]. In this regard, both protocols reduced variables associated with CVD risk factors.

Basal glucose, diastolic blood pressure and uric acid were all reduced in the JOGG group and just uric acid in the CWT group. The weight reduction and physical activity are associated with this behavior[1,2,4,6]. These results suggest that the continuous, more than intermittent activity, had the strongest impact over blood pressure and glucose, but the importance of these factors are reduced here because these were normal values at the start of the study in both groups. Although hypertension is associated with obesity, as in the present study, others observed normal blood pressure in lean, overweight and obese eumenorrheic middle-aged women[3].

Conclusion

In summary, a combination of dietary calorie and fat reduction with regular physical exercise improved the general aspects of health and reduced metabolic risk factors in these obese women. The CWT group presented better results regarding lipid profile and flexibility and the JOGG group regarding glucose and diastolic blood pressure. However, these differences could not be attributed to the type of exercise alone, but also to the intra-group effect too, as the high number of dropouts limited the final numbers of participants and the groups had an important difference between the BMI and biochemistry variables in T1. However, even without a marked weight reduction, the changes promoted by the protocols improved the CVD and metabolic risk factors[9], suggesting that they are a good approach for obese patients that do not meet these criteria with the accumulation of domestic physical activity[12], and many of those trying to lose weight do not use effective strategies[5].

These results suggest that a combination of resisted and aerobic physical exercises is well tolerated and could present better results than aerobics alone for obese individuals, but that does not solve the problem of the low adherence to behavioral reeducation programs. Future investigations with a larger number of participants and the same dependent variables at the start of the study should help elucidate the conflicting results. Increased efforts are needed among all those trying to lose weight to promote effective strategies for weight loss, including the use of calorie reduction and increased levels of physical activity[5].

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Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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