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AEROBIC TRAINING COMBINED WITH NUTRITIONAL GUIDANCE AS AN EFFECTIVE STRATEGY FOR IMPROVING AEROBIC FITNESS AND REDUCING BMI IN INACTIVE ADULTS

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ABSTRACT

The aim of this study was to examine the impact of a 33-week program, which included two weekly intensive running sessions, on aerobic capacity, BMI, waist circumference and body composition in overweight and obese, inactive adults. An additional aim was to examine the additional impact of lifestyle modification education. Twenty-four participants in the Training Group (exercise only) and 27 in the Nutritional Guidance and Training Group (exercise + nutritional guidance) completed the study. Anthropometric measurements (BMI, waist circumference, visceral fat, muscle mass and fat percentage) and 3000 m running time were measured at start, after 15 weeks (BMI, waist circumference and 3000 m running time) and after 33 weeks of intervention. Significant reductions in BMI, waist circumference, fat percentage and 3000 m running time were found for both groups. A small, but insignificant, increase was found for muscle mass in both groups and visceral fat in the training group. A significant interaction effect for visceral fat was also found. Both groups improved their running time and anthropometric measurements. No significant differences were found between the groups.

Keywords: *Interval training, overweight, waist circumference*

INTRODUCTION

Overweight, obesity and physical inactivity can lead to health problems, including hypertension, type 2 diabetes, cardiovascular diseases (CVD), stroke, colon cancer and breast cancer [38,44,52]. Physical activity (PA) gives positive health effects [13, 37,41,43,47] and there is dose-response relationship between PA and mortality in all age groups [42,48]. The Norwegian Directorate of health recommends a minimum of 150 minutes of moderate-intensity PA weekly, alternatively 75 minutes of vigorous PA, or a combination of these. Only 31% of the adult population (>20 years old) in Norway meet this requirement [16]. Inactive people are more often overweight and obese compared to physical active people [40].

Body mass index (BMI) and waist circumference (WC) are two commonly used parameters for defining general and abdominal obesity. In recent decades, BMI has increased in the population [24]. In the Norwegian adult population, 25% of men and 21% of women suffer from obesity (BMI > 30 kg/m^2) [20,36]. There are also indications that abdominal obesity increases more than the increase in BMI can explain [10,20,36]. This can lead to an underestimation of the obesity-related health burden, when considering the observation that ectopic body fat (i.e. fat stored in the abdomen) is related to a range of metabolic abnormalities that are type 2 diabetes and CVD risk factors [18].

According to Luke and Cooper [32], PA has positive health-promoting benefits, but an increase in PA will not prevent weight gain for the majority of people and *"only reduction in calorie intake will result in weight loss, whether done in isolation or together with increases in exercise"*. Blair et al. [1] criticized this assertion by referring to numerous studies showing that PA alone prevents weight gain. A study by Hankinson et al. [11] examined seven follow-up measurements over 20 years (3554 men and women) and concluded that those who maintained recommended levels of PA had smaller increases in BMI and WC compared to inactive men and women. Cross-sectional studies have also shown that a combination of low intensity activities (i.e. walking) and high intensity activities is optimal for weight control [35] and prevention of CVD [34]. Moreover, individuals who spend around 30% of their PA time engaged in vigorous activities such as running were most successful in maintaining body weight over time [26]. According to a review published by Clark [5] that examined weight-loss and changes in fitness for obese adults aged 18–65 years, reduced energy diet and exercise were found to be more efficient than diet or exercise alone. Regardless of general and abdominal adiposity, inactive and moderately active groups reduce all-cause mortality when starting PA [8,36]. Regular PA is also associated with a lower risk of death regardless of BMI [31]. Lavie [29] describes the "the obesity paradox", indicating that fit, obese people have reduced CVD risk compared to unfit, slim people, and that greater emphasis should be placed on improving fitness rather than just focusing on weight. Even without significant weight loss, significant health benefits can be achieved [2,3,12,25,40,49].

The objectives of the present study were to: 1) examine the impact of a 33-week program that included two weekly intensive running sessions on aerobic capacity and anthropometric measurements in overweight and obese adults, 2) examine if there were any additional effects of lifestyle modification education on aerobic capacity and anthropometric measurements.

MATERIAL AND METHODS

Design

The present study was initiated by the University of Stavanger in cooperation with the largest newspaper in the southwest region of Norway. Participants were recruited from the newspapers readers. A total number of 72 participants (49 women) with a mean age of 46.1 (±10.4) years were included after meeting the inclusion criteria: previously untrained and inactive adults in all age groups, BMI ≥ 25 kg/m^2, desire to become fitter and reduce BMI. Participants were randomized, using Research Randomizer, into a Training Group (TG) (n=40) or a Nutritional guidance and Training Group (NTG) (n=32). All participants followed a training program with two weekly, supervised training sessions consisting of interval running/walking and ending with general strength training. In addition, participants were encouraged to do two weekly alternative training sessions at moderate intensity of minimum 30 min each (e.g. resistance training, walking, swimming, spinning, aerobics). Activity and duration were reported in training diaries. In addition to training, the NTG also received nutritional guidance and practical cooking lessons. In total 51 participants completed the study, 24 (17 women) in the TG and 27 (17 women) in the NTG. The most important reasons for drop-out were health problems not directly related to the intervention. All participants provided signed, written, informed consent. The Regional Committees for Medical and Health Research Ethics in Norway approved the study. Characteristics for the participants at start of the intervention are presented in Table 1.

Table 1. Characteristics for the participants at start of the intervention (T1). Data presented as Mean±SD.

Measure	Total (n=74)	NTG (n=34)	TG (n=40)
Age (year)	46.1±10.4	47.8±9.1	44.6±11.2
Body weight (kg)	97.1±14.7	98.1±14.0	96.3±15.5
High (cm)	171.0±8.9	171.6±9.0	170.6±8.9
BMI (kg/m^2)	33.1±3.9	33.8±3.9	33.0±3.9
WC (cm)	108.7±14.6	110.2±17.5	107.5±11.7
Fat per cent (%)	39.95 ± 6.74	40.20 ± 6.64	39.72 ± 6.92
Muscle mass (kg)	32.80 ± 6.91	32.97 ± 7.14	32.66 ± 6.78
Visceral fat (cm^2)	149.06 ± 45.83	157.15 ± 43.18	141.83 ± 47.48

SD – standard devaitaion; BMI – Body mass index; WC – Waist circumference; NTG – Nutritional Guidance and Training Group; TG – Training Group.

Training and nutritional guidance

In this study, participants from the TG maintained their usual diet and were offered education in theoretical and practical themes after the intervention. Participants in NTG received nutritional guidance but were not committed to following a specific diet. They received group lessons concerning different theoretical themes and practical cooking (Table 2). Both theoretical and practical nutritional guidance were based on recommendations from the Norwegian Directorate of Health [14,15]. The Norwegian Directorate of Health recommends that 10 to 20% of total calories should be from protein, 45 to 60% from carbohydrate (max 10% from sugar) and 25 to 40% from fat (with maximum 10% from saturated fat). Participants in NTG were recommended to reduce their energy consumption to 1500–1700 kcal/day. Recommendations from The Norwegian Directorate of Health [15] emphasize intake of large quantities of high-bulk, low energy-density foods (like vegetables, fruits and high-fiber grains) and moderation in the consumption of high energy-density foods (like meat, cheese, sugar and fat). During the project-period, NTG attended ten 80-min theoretical sessions and eight 140-min practical cooking sessions. In between group education NTG used Facebook as a communication channel. Establishing a group for invitees only made it possible to ask questions and publish relevant information. All recipes and theoretical presentations were available at this site.

Table 2. Education themes in the lifestyle intervention program.

Week number during the program:	Education concerning: 1 = theoretical theme, 2 = practical cooking
1	1 (Introduction to nutrition and training)
3	1 (Nutrition/training)
4	2 (Breakfast)
6	2 (Soups)
8	1 (Nutrition/training)
9	1 (Nutrition/training)
10	2 (Calories and Temptations)
15	1 (Cognitive therapy)
16	2 (Alternative snack)
18	1 (Cognitive therapy)
19	2 (Chicken and fish I)
21	1 (Nutrition/training)
23	1 (Nutrition/Cognitive therapy)
24	2 (Chicken and fish II)
26	2 (legumes)
30	2 (Simple, healthy dishes)
32	1 (Nutrition)
33	1 (How to sustain the new lifestyle)

Supervised interval running and strength training sessions

The two weekly, supervised training sessions consisted of 10-min warm up followed by 20–21-min effective interval running (or fast walking for the most unfit). Typical sessions were: 1) 8 × 3 min running, with one-minute walking recovery. 2) 20 × 1 min running with 30 sec walking recovery. 3) 6 min, 5 min, 4 min, 3 min, 2 min and 1 min running with one-minute walking recovery. The aim was that running should be performed with a heart rate of 85–90% of maximum heart rate. Sessions were concluded with ten minutes of whole body strength training consisting of 15–20 chest flies, 2 × 10 walking lunges, 2 × 10 squats, 2 × 10 push-ups, and exercises for back and stomach muscles.

Tests

Measurements of BMI, WC and 3000 m running time were performed at the start of the project (Time 1 (T1)), after 15 weeks (T2) and at the end of the project (T3). Measurements of fat percentage, muscle mass and visceral fat were performed at T1 and at T3. Twelve participants (9 women) from both groups (TG=7 and NTG=5), performing around average in 3000m running test at T1 also did a $VO_{2\,max}$ test at T1 andT3.

3000 m running test

All participants ran 3000 m test around a local lake. The surface is firm cinder and the difference between highest and lowest points is less than 3 meters. To become familiar with the test distance, the participants ran a pilot test round the lake one week before T1.

VO_{2max} test

The test was performed as a modified Balke test [7]. Woodway treadmill (Woodway, ELG 2, Weil am Rhein, Germany) was used as ergometer. The test person (TP) was connected to the analyzer (Vintus CPX CareFusion, USA), which was calibrated with room air and certified calibration gases before each test. The test started with a four min warm up on the treadmill at a pace of 4.8 km/h with a 4% incline, and then the incline increased every minute by 2% until a maximum incline of 20% was reached. If TP was able to continue, the speed was increased by 0.5 km/h per min until the TP reached exhaustion. Borg's Rating of Perceived Exertion [4] was used to register exertion at the end of the test. Exhaustion criteria were Borg Rating ≥15 and R-value ≥1.1. Polar Sport tester (Polar Electro Oy, Kempele, Finland) registered heart rate (HR). The highest HR during the test was defined as HR_{max}.

Anthropometric measurements

Height and weight were measured with participants lightly clothed and without shoes. BMI and WC were measured at T1, T2 and T3. The participants were in standing position during all body measurements. A calibrated digital scale (Seca, model 770, Seca Corp, Hamburg, Germany) was used for the body weight measure. Waist circumference was measured from the point midway between the inferior margin of the last rib and the crest of the ilium. InBody 720 (Biospace Co., Ldt, Seoul, Korea) was used for the measure of body fat percentage, muscle mass and visceral fat at T1 and T3.

Training registration

Self-recall training diaries are a frequently used tool to quantify training load and training information. Type and duration of all training sessions were reported. Participants who followed ≥75% of the supervised interval training sessions and in addition reported minimum two individual sessions per week, including alternative sessions, were included in the study.

Registration of training intensity

In order to describe the intensity during the interval training sessions HR was registered by Polar Sport tester during four weeks (eight interval sessions) for the 12 participants who performed the VO_{2max} tests at T1.

Statistical Analyses

Mixed design with two-way multivariate analysis of variance (MANOVA) was conducted to assess the effectiveness of the intervention. In this design, the effect of two factors (between-subjects and within-subjects) on a group of dependent variables was investigated simultaneously. This makes it possible to investigate the multivariate as well as the univariate effects of within-subjects and between-subjects factors along with the interaction between them on a group of dependent variables [46]. The analysis was done in two phases. First, the effects of independent variables were examined on the combined group of dependent variables. Second, the effects of independent variables were investigated in each of the dependent variable separately [46].

The dependent variables in this study were BMI, fat percentage, muscle mass, running time, visceral fat and WC, with Time (T1, T2 and T3) as the within-subjects variable, and Group (TG and NTG) as between-subjects variable. Two different two-way MANOVAs were conducted. For the first MANOVA, Time had three levels: pre-test (T1), test after 15 weeks (T2) and post-test after 33 weeks (T3). Group had two levels (TG and NTG), and the dependent variables were BMI, running time and WC. For the second MANOVA, Time had two levels (T1 and T3), Group had two levels (TG and NTG), and the dependent variables were fat percentage, muscle mass and visceral fat. If the multivariate interaction was non-significant, the multivariate main effects of the between-subjects and within-subjects variables on the group of dependent variables were investigated.

The relationship between VO_{2max} and 3000 m running test at T3 was determined using Pearson product-moment correlation coefficient. A paired samples t-test was conducted to evaluate the impact of the intervention on participants' scores on 3000 m running time from T1 to T3.

Preliminary analysis was performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. Values for skewness and kurtosis were between ±2 (kurtosis for running time was ±4), indicating a normal univariate distribution. Data are presented as mean (M) ± standard deviation of the mean (SD). The alpha level for significance was set to $p<0.05$. For pairwise comparisons, Bonferroni correction was applied for correcting the level of significance (0.05/3=0.017). Effect size was calculated with Partial Eta Squared (η^2) statistic and was defined as small (0.01), medium (0.06), or large (> 0.138) [6]. All analyses were performed using IBM SPSS Statistics Version 25.0.

RESULTS

BMI, 3000 m running time and WC

The multivariate effect of Group (TG and NTG) on the combined dependent variables of Time (T1, T2 and T3) was statistically non-significant irrespective of Group. However, there was a significant multivariate effect of Time in the combined dependent variables irrespective of Group: Wilks $\lambda=0.376$, $F(6,34)=9.39$; $p<0.001$ and partial $\eta^2=0.62$. This indicates a very large effect size. There was a non-significant multivariate effect across the interaction between Group x Time: Wilks $\lambda=0.780$, $F(6,34)=1.60$; $p=0.177$ and partial $\eta^2=0.22$, indicating a large effect size.

The main effect of Group was statistically non-significant ($p>0.017$) on any of the Group characteristics, that is, TG and NTG irrespective of the dependent variables. The main effect of Time was significant irrespective of the Groups for BMI: $F(1,64)=16.92$; $p<0.001$, running time: $F(1,67)=34.27$; $p<0.001$, and WC: $F(1,71)=19.67$; $p<0.001$. Partial η^2 were 0.30, 0.47 and 0.34, respectively, indicating large effect sizes. The interaction effect of Time × Group was non-significant in any of the dependent variables. Figures 1, 2 and 3 show estimated marginal mean plots for BMI, 3000m running time and WC respectively at T1, T2 and T3 for both groups.

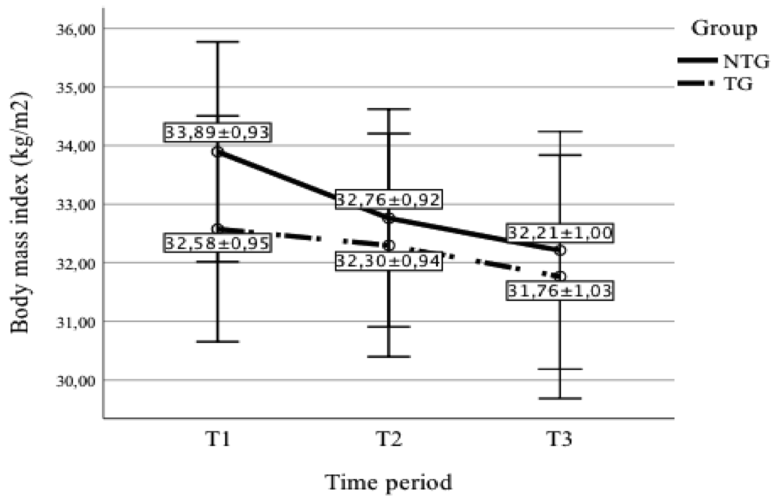

Figure 1. Estimated marginal means plot at T1, T2 and T3 for data on BMI for both groups. Data are presented as M±SD. Error bars 95% CI.

Figure 1 shows that BMI decreased from T1 to T3 ($p<0.017$). Analysing data by combining both groups, the difference between T1 and T2 is statistically significant ($p<0.017$), whereas the difference between T2 and T3 is non-statistical significant ($p>0.017$).

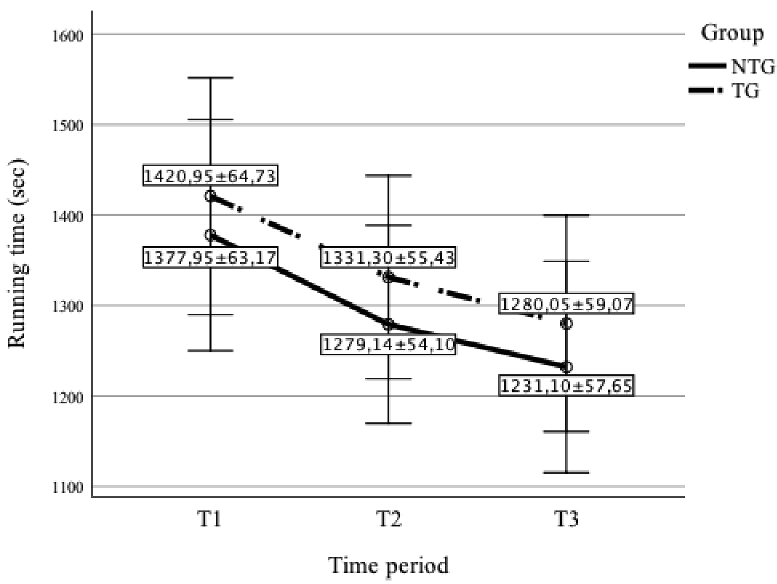

Figure 2. Estimated marginal means plot at T1, T2 and T3 for data on running time for both groups. Data are presented as M±SD. Error bars 95% CI.

Figure 2 shows that running time decreased from T1 to T3, from T1 to T2, as well as from T2 to T3 (both groups combined). The difference between all times is statistically significant ($p<0.017$). For all participants the mean decrease in running time was 145 sec (±129 sec) with a 95% confidence interval ranging from 106 to 184. The eta squared statistic (0.56) indicates a large effect size.

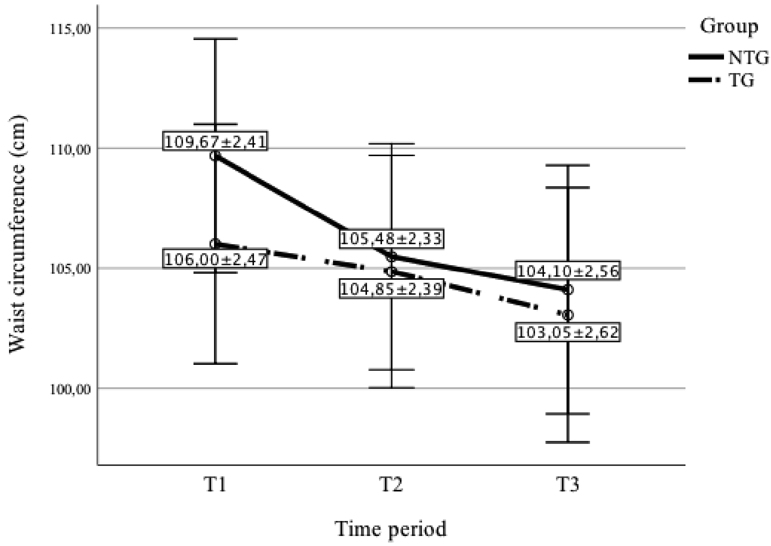

Figure 3. Estimated marginal means plot at T1, T2 and T3 for data on WC for both groups. Data are presented as M±SD. Error bars 95% CI.

In figure 3, WC decreased from T1 to T3 ($p<0.017$). The difference between T1 and T2 is statistically significant ($p<0.017$), whereas the difference between T2 and T3 is statistically non-significant (both groups combined).

Fat percentage, muscle mass and visceral fat

The multivariate effect of Group on the combined dependent variables of Time was statistically non-significant irrespective of Group. However, there was a significant multivariate effect of Time in the combined dependent variables irrespective of Group: Wilks $\lambda=0.548$, $F(3,40)=11.00$; $p<0.001$ and partial $\eta^2=0.45$. This indicates a large effect size. There was a non-significant multivariate effect across the interaction between Time and Group: Wilks $\lambda=0.857$, $F(3,40)=2.23$; $p=0.099$ and partial $\eta^2=0.14$, which indicates a large effect size.

Since sphericity assumption was not violated for the data on any of the three dependent variables for comparing performance across Time × Group, no correction was applied. The main effect of Group was statistically non-significant ($p>0.05$). The main effect of Time was significant irrespective of Group only for fat percentage: $F(1,42)=28.53$; $p<0.001$ and partial $\eta^2=0.41$, which indicates a very large effect size. The interaction effect of Time × Group was statistically significant only for visceral fat: $F(1,42)=4.19$; $p=0.047$ and partial $\eta^2=0.09$, indicating moderate to high effect size.

Table 3 gives descriptive statistics for each test for both Groups, while table 4 shows pairwise comparisons based on descriptive statistics. Estimated marginal means of Time x Group for data on visceral fat are shown in Figure 4.

Table 3. Descriptive statistics, Marginal means for each test for both Groups.

Measure	Group	M±SD	95% CI
Fat percentage	TG (n=20)	39.29±1.57	36.12–42.46
	NTG (n=24)	39.38±1.43	36.48–42.27
Muscle mass	TG (n=20)	31.87±1.44	28.97–34.78
	NTG (n=24)	32.72±1.31	30.07–35.37
Visceral fat	TG (n=20)	142.95±8.98	124.83–161.07
	NTG (n=24)	146.28±8.20	129.74–162.81

Table 4. Pairwise comparisons based on estimated marginal means.

Measure	Time (I)	Time (J)	Mean Difference (I–J) ± SD	Sig.[b]	95% CI[b]
Fat percentage	1	3	2.50±0.47*	<0.001	1.55 – 3.44
Muscle mass	1	3	–0.13±0.12	0.299	–0.37 – 0.12
Visceral fat	1	3	7.54±6.22	0.232	–5.02 – 20.09

Based on estimated marginal means
I – Time 1 (pretest); J – Time 3 (posttest); CI – Confidence intervals.
* The mean difference is significant at the p<0.05
[b]Adjustment for multiple comparisons by Bonferroni

Visceral fat measurement in NTG decreased from T1 to T3, while it increased in TG from T1 to T3 (Figure 4).

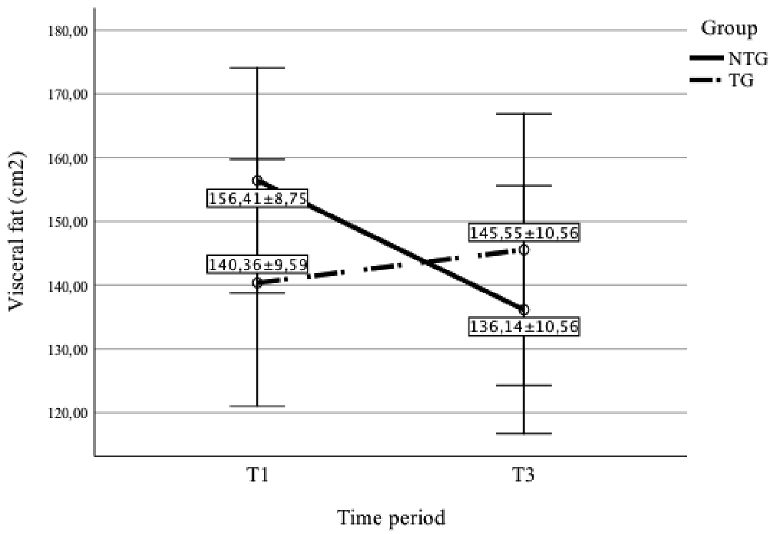

Figure 4. Estimated marginal means plot at T1 and T3 for data on visceral fat for both groups. Data are presented as M±SD. Error bars 95% CI.

VO_{2max}

The 12 participants who tested VO_{2max} had an increase of 2.86 (±3.84) ml/kg/min in VO_{2max} from T1 to T3, from 29.21 (±2.95) to 32.07 (±6.16) ml/kg/min. Their average reduction in 3000m running time from T1 to T3 was 181 sec (±121 sec), from 1405 sec (±91 sec) to 1224 sec (±149 sec). Figure 5 shows the relationship between T3 VO_{2max} and T3 3000 m running time for 12 participants. There was a strong, negative correlation between the two variables, $r=-0.89$, $n=12$, $p<0.001$.

Heart rate during the interval running sessions

The 12 participants who measured HR during eight interval sessions had a HR from 85 to 92% of HR_{max} when running the intervals. The HR dropped to 70–75% of HR_{max} during the recovery periods.

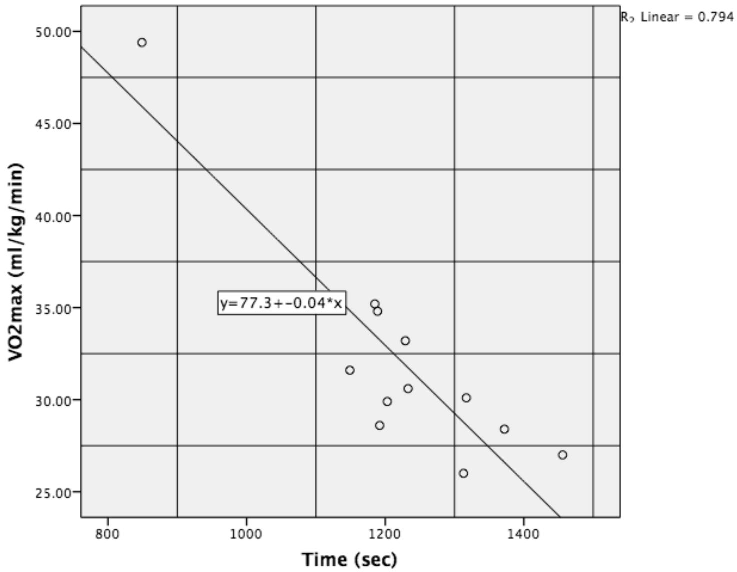

Figure 5. Relationship between post-test VO_{2max} and post-test running time over 3000 m (n=12).

DISCUSSION

Changes in aerobic capacity

The best predictor of aerobic fitness is proven to be VO_{2max} [39]. An increase in VO_{2max} of 3.5 ml/kg/min is associated with a 13% reduction in all-cause mortality [27]. The present study shows an average improvement in VO_{2max} of 2.9 ml/kg/min (9.2%) and average improvement in 3000m running time (for the twelve average participants) of 186 sec (12.9%), which can be reflected in their weight loss. The three subjects with the highest amount of reported total training sessions had an average increase in VO_{2max} of 7.4 ml/kg/min (22.1%), which is associated with large health benefits. Two of these participants were in the NTG and one was in the TG. The two participants in NTG had a weight reduction of 9.8 and 19.6%, and the participant in TG had 2.0% reduction in weight.

As shown in Figure 5, there is a strong negative correlation between running time and $VO_{2max.}$ Running time for 3000 m can therefore be used to estimate VO_{2max}. No multivariate effect was found between groups with regards to running time, but for pairwise comparisons based on estimated means we found a significant reduction between T1 and T2, as well as between T2 and T3 ($p<0.017$). Results describe a continuous improvement in running time throughout the intervention period. The HR during the interval sessions was between 85 and 92% of VO_{2max}. During warm up and recovery, the HR never fell below 70% of HR_{max}. None of the studies as Verheggen et al. [45] have referred to have been performed with such high intensity. In contrast to previous studies, participants in the present study achieved a significant decrease in weight and significant reduction in WC. High intensity exercise, which entails greater post-exercise energy consumption, can be an explanation. In a systematic review and meta-analysis consisting of 13 articles, Wewege et al. [50] compared the effects of high-intensity interval training and moderate-intensity continuous training on body composition in overweight and obese adults. They found no difference between the groups based on intensity but running resulted in a significant effect on body composition while cycling did not. The use of high-intensity interval running is characteristic for the present study and findings indicate that this type of training has positive effects on body composition in overweight and obese adults.

Changes in BMI

Core intervention targets for the NTG were to establish regular eating patterns, focusing on eating breakfast, reducing portion size (and plate size) and replacing high calorie beverages with water. Participants were advised to use an online calorie counter (MyFitnessPal/Lifesum) and special attention was given to continuous registration of energy intake and expenditure.

The use of social media in intervention projects has helped individuals lose weight [21]. In this intervention, Facebook was used in combination with classroom lessons. The NTG experienced a mean weight loss of 3.8% of initial body weight, 1.7% greater than the TG (non-significant). Despite the fact that we found no significant differences between the TG and the NTG in the present study, obtained results may give successful practical outcomes. For example, a 5% reduction in total body weight can provide clinically significant changes to CVD factors [9] and it is likely that even a smaller reduction will give some benefits. A lower BMI is associated with a lower cancer mortality risk and even short-term changes in BMI are associated with lower mortality from any type of cancer [43]. Although no significant differences were found between the groups, BMI was significantly reduced from T1 to T2 ($p<0.017$) for both groups. No significant reduction was found from T2 to T3, indicating that major weight loss does occur during the first weeks of PA, which was also confirmed by Lv et al. [33]. Results indicate that major reductions in BMI are due to exercise and only minor changes by nutritional guidance. However, another explanation of the lack of significant differences might be an increased interest in food and nutrition by both groups, because of an overall increased focus on exercise and health.

Changes in WC

Lean et al. [30] proposed that WC values should be classified into three risk strata (<94, 94–102, and >102 cm in men; <80, 80–88, and >88 cm in women) and that men with WC≥102 cm and women with WC≥88 cm should reduce their weight. All participants had a WC above these limits when starting the intervention. Six participants reduced their WC to below these limits during the intervention period (one woman and three men in the NTG, one woman and one man in the TG). No multivariate effect was found for BMI and WC and pairwise comparisons are based on estimated means, which showed a significant reduction of both WC and BMI from T1 to T2 ($p<0.017$). No further reduction from T2 to T3 ($p>0.017$) was found. Although non-significant, NTG reduced their WC more than the TG. Reduction in WC for the NTG was 5.1%, which is almost twice as much as for the TG, which had a reduction of 2.8%. For both groups, the percentage reduction in WC is similar to the reduction in BMI (NTG 5%, TG 2.5%). The World Health Organization [51,53] recognizes that WC between 94.0–101.9 cm in men and 80.0–87.9 cm in women correspond to the BMI overweight range of 25–29.9 kg/m^2. According to Janssen et al. [23], WC, more than BMI, explains obesity-related health risks. Thus, for a given WC value, overweight, obese and normal weight individuals have comparable health risks. For a given health benefit, it would therefore be favourable if WC was reduced to a greater extent than the reduction in BMI, although results from the present study indicate a correspondence between BMI and WC.

Fat percentage, muscle mass and visceral fat

Examination of mean scores for each test and time period and pairwise comparisons of these estimated marginal means, show that there is a significant difference in fat percentage during the intervention period (T1 to T3) ($p<0.05$). Results indicate that measurements for fat percentage in both groups decreased from T1 to T3, and small, but insignificant, increase in muscle mass was observed for both groups ($p>0.05$). Strength training is important for maintaining muscle mass [5] and reducing risk of injuries [28]. It is well documented that large muscle mass is associated with good health regardless of BMI [29]. Strength training 2×10 min weekly was not enough to increase muscle mass, but on the other hand, participants maintained their muscle mass, despite a weight reduction, which may be a result of supervised training sessions that included resistance training. Further, there was a significant interaction effect (Time x Group) for visceral fat, which indicates a significant decrease in visceral fat for the NTG from T1 to T3 ($p<0.05$) and an increase for TG (non-significant). Different weight loss regimens might lead to different distribution of visceral fat [19]. A good indicator of having a high level of visceral fat is a high BMI and a large WC [22]. Despite a reduction in WC, the TG showed a possible increase in visceral fat. Training might have reduced their WC, but if the consumption of saturated fat was high, this might have led to a possible increased level of visceral fat. Exercise training might also direct energy storage to depots other than the viscera [17]. According to Verheggen et al. [45], reduction in visceral fat also results in great health benefits.

Limitations of the study

Although this research was carefully planned, there are some limitations and shortcomings. One limitation is that the study has no control group. And because of the resources available, for instance, access to a kitchen, this research was only conducted on a small group of people. To generalize the results for a larger group the study should have included more participants. Several participants forgot to return their training diary regularly, and this might have led to an imprecise estimation of exercise when finally filling it out. We had no control over participants' diet and participants in the TG may have focused on improving their diet, even if they were told to eat the same as they normally did when entering the project. Participants in the NTG were recommended to reduce their calorie intake, but their food intake was not supervised.

Conclusions

Untrained, inactive and overweight adults who started with two weekly intensive running sessions increased their aerobic capacity and significantly reduced their BMI, WC and fat percentage during 33 weeks of training. A strong negative relationship between VO_{2max} and running time was found. Both groups improved their running time and anthropometric measurements. Giving lifestyle modification education and cooking lessons in addition to the supervised training, resulted in only small additional changes.

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