EFFECT OF HIGH INTENSITY INTERVAL TRAINING VERSUS INTERMITTENT FASTING 16/8 PROTOCOL ON FUNCTIONAL CAPACITY AMONG OVERWEIGHT SUBJECTS

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ABSTRACT

Objective: The study aimed to compare between the effect of high intensity interval training and intermittent fasting on improving functional capacity and body weight among overweight subjects.

Methods: Clinical trial. Thirty subjects of both sexes with an age range from 25 to 35 years old selected from out-patient clinic, faculty of physical therapy, Horus University-Egypt in New Damietta city, assigned into two groups of equal numbers (group A and group B). Group A: participated in high intensity interval training (HIIT) three times/week for 2 months, Group B: followed intermittent fasting (IF) 16/8 protocol for 2 months. The subjects were assessed by Weight and height scale (BMI) to get body mass index (BMI), blood pressure (systole and diastole) by mercury sphygmomanometer and stethoscope, heart rate by pulse oximeter, waist circumference by tape measures and estimation of VO2 max by Bruce protocol.

Results: Comparing both groups post-treatment revealed there was no statistically significant difference in all measured variables between both groups (P>0.05). However, when comparing pre/post treatment mean value of both groups a statistically significant improvement is shown in all measured variables (P<0.05), except in (Waist circumference and waist hip ratio) there was no significant improvement in group A.

Conclusion: It was concluded that:

- 8 weeks of HIIT or IF can significantly improve functional capacity index (VO2 max) and improve body composition among overweight subjects.
- Intermittent fasting can improve functional capacity but is not as significant as exercise training but still can help subjects with exercise limitations.

Keywords: High intensity interval training, Intermittent fasting, Functional capacity, Overweight.

I. INTRODUCTION

Obesity is an increasing public health concern around the world, which is associated to cardiovascular disease and death. The increasing prevalence of obesity is largely due to overall increased food consumption, and decreased energy expenditure associated with work or leisure [1,2]. Obesity increases the risk of metabolic diseases such as type 2 diabetes, hypertension, dyslipidemias, and cardiovascular disease, which prevents healthy aging. Since dyslipidemia may affect atherosclerosis and these are associated with cardiovascular diseases [3].

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Regular exercise improves cardiorespiratory fitness, insulin sensitivity, muscular strength, endurance and body composition and reduces visceral fat [4]. High intensity interval training defined as “vigorous exercise performed at a high intensity for a brief period interspersed with recovery intervals at low-to-moderate intensity or complete rest [5]. High-intensity interval training (HIIT) has shown its effectiveness in improving body composition, cardio-respiratory fitness and lipid profile in obese adults [6].

Diet improves exercise capacity, glucose, lipid, blood pressure control, inflammation markers, body composition, and skeletal muscle function [7]. Intermittent fasting diet is the diet that focuses on eating within a particular window of time. Protocol may vary according to individual preferences and lifestyle. It may be used in three variants: 16/8, 18/6 and 20/4. 16:8, consisting of a 16-h fast, and then an 8-h nutritional window [8].

II. METHODOLOGY:

Ethical considerations and approval:
The steps of evaluation and designs of the study have been approved by The Research Ethics Committee of the Faculty of Physical Therapy, Cairo University (No: P.T.REC/002976) and were registered in clinical trials registry with approval number (NCT04950062).

Study design: clinical trial, thirty subjects of both sexes with an age range from 25 to 35 years old selected from outpatient clinic, faculty of physical therapy, Horus University-Egypt in New Damietta city, assigned randomly into two groups of equal numbers (A&B). Group A: Fifteen subjects (7 male and 8 female) participated in HIIT three times/week for 2 months. Group B: Fifteen subjects (6 male and 9 female) followed intermittent fasting 16/8 protocol for 2 months. Inclusion criteria were: Overweight subjects with age from 25 to 35 years, Body mass index ranged from 25 to 29.9 kg/m2, Waist circumference ≥ 80 cm2 for female and ≥ 90 cm2 for male, A minimum of 70% of exercise program and diet regimen compliance required to be included. Exclusion criteria were: Musculoskeletal or cardiovascular disorders, asthma, chronic obstructive pulmonary diseases, any systemic disease or condition that might reduce adherence or tolerance to exercise or fasting, history of stroke.

Procedures: subjects were assigned randomly into two equal groups in numbers, group A and group B. Both groups had an assessment of Body weight (Kg) and height (m) were measured by using weight and height scale, to calculate body mass index (Kg/m2) before starting the study to determine the inclusion criteria as regards BMI to include the overweight subject only in this study. BMI = Weight (KG) / Height2 (M2).9 Then, waist and hip circumference have been measured in all the subjects by tape measure by the same clinicians one for male and one for female after getting training for this to be used for calculation of the waist hip ratio. VO2 max estimated by standard Bruce protocol.10

Group A: (High intensity interval training). The HIIT program has been performed in an individualized method as the intensity of the exercise for each subject has been calculated according to Karvonen formula:

\[
\text{Target heart rate} = [(\text{max HR} - \text{resting HR}) \times \% \text{ Intensity}] + \text{resting HR11}. 
\]

- **Max HR**: heart rate that the subject reached at his maximum effort during the test.
- **Desired intensity %**: 80-90%.

All the subjects were trained for 2 weeks before starting the program to increase their fitness and compliance. At this period of training, the subjects were trained at lower limit intensity (80%) before increasing the intensity levels toward the upper limit (90%)12. All the subject was allowed to start the exercise session with a warm-up period for 5 min at an intensity corresponding to (65-75% of the heart rate reserve) in addition to some flexibility and stretching exercises before the active phase of training on treadmill. Training phase for 30 min has been divided into four sets of exercise in the form of 4-min of high intensity (80-90%) of HR reserve interspersed by 3 minutes of low intensity walking at the level of 65-75% of HR reserve. During the exercise training the speed of the treadmill was increased in a way that allow the subjects’ heart rate to raise progressively to reach 90% of HR reserve throughout the first 1-3 minutes of the intervals at the end of the first 4-minute period. Every exercise session has been ended by Cooling down period for 5 min of at 50-60% of the HR reserve.
**Group B:** (Intermittent fasting 16/8 protocol). Every subject was instructed to fast fixed 16 hours, followed by 8 hours of eating every day through the whole study period based on their life and sleeping style. During fasting, zero-calorie coffee, tea and water intake were permitted. Beverages containing calories were consumed during the feeding hours each day. All subjects were instructed about their optimum caloric requirement based on their basal metabolic rate that was calculated in advance to avoid over consumption of food on severe caloric restriction as we like to investigate the effect of this way of fasting on reducing weight and improving functional capacity.13 Caloric prescriptions were calculated by using the Harris- Benedict equation, which is a method used to estimate the subject basal metabolic rate (BMR).

For male: BMR= 66.5+ (13.75× weight in kg) + (5.003× height in cm) - (6.755× age in years).

For female: BMR=655+ (9.563×weight in kg) + (1.850×height in cm) - (4.676× age in years).

### III. STATISTICAL ANALYSIS

Statistical analysis was conducted using SPSS for windows, version 26 (SPSS, Inc., Chicago, IL). Prior to final analysis, data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculations of the analysis of difference. Preliminary assumption checking revealed that data was not normally distributed for all measured variables, as assessed by Shapiro-Wilk test (p < 0.05). Accordingly, non-parametric statistics were used. The Mann-Whitney U test was used to compare whether there is a difference in the dependent variable for the two independent groups. While, Wilcoxon test was used to compare whether there is a difference within the same group. Unpaired t-test was used to compare whether there is a difference pre-treatment in the demographic characteristics for the two study groups. The alpha level was set at 0.05.

### IV. RESULTS:

#### Demographic and clinical characteristics of participants:

The baseline characteristics of the participants showed that no statistically significant differences existed between both the groups (P>0.05), as shown in Table 1. There was also, no significant difference between both groups by gender, the χ2 value was 1.36 (P>0.05).

#### Pre-treatment comparison between both the groups:

No statistically significant differences were noticed regarding pre-treatment between the two groups in all measured variables (P>0.05), as shown in Table 2.

#### Pre-treatment and post-treatment comparison in each group:

There was a significant improvement in all measured variables (P<0.05) in both groups, except in (Waist circumference and waist hip ratio) there was no significant improvement in group A as shown in Table 2.

#### Post-treatment comparison between both the groups

There was no statistically significant improvement in all measured variables between both groups (P>0.05) as shown in Table 2.

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (Years)</strong></td>
<td>27.86 ± 1.68 (0.43)</td>
<td>27.93 ± 1.75 (0.45)</td>
<td>0.916</td>
</tr>
<tr>
<td><strong>Height (cm)</strong></td>
<td>174.13 ± 11.59 (2.99)</td>
<td>169.53 ± 9.57 (2.47)</td>
<td>0.246</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>82.52 ± 11.04 (3.49)</td>
<td>86.86 ± 13.52 (2.85)</td>
<td>0.344</td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>28.42 ± 1.33 (0.43)</td>
<td>28.54 ± 1.17 (0.30)</td>
<td>0.785</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7 (46.66 %)</td>
<td>6 (40 %)</td>
<td>0.713</td>
</tr>
<tr>
<td>Female</td>
<td>8 (53.33 %)</td>
<td>9 (60 %)</td>
<td></td>
</tr>
</tbody>
</table>

*P-value: probability value; *Significant at P<0.05*
Table 2. Comparison between both groups in all measured variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Time</th>
<th>Group A</th>
<th>Group B</th>
<th>P- Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( \bar{x} \pm SD )</td>
<td>( \bar{x} \pm SD )</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>Before</td>
<td>82.52 ( \pm 11.04 )</td>
<td>86.86 ( \pm 13.52 )</td>
<td>0.344</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>78.08 ( \pm 10.52 )</td>
<td>81.68 ( \pm 13.75 )</td>
<td>0.428</td>
</tr>
<tr>
<td>% of change</td>
<td></td>
<td>5.38%</td>
<td>5.96%</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m(^2))</td>
<td>Before</td>
<td>28.42 ( \pm 1.33 )</td>
<td>28.54 ( \pm 1.17 )</td>
<td>0.785</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>27.67 ( \pm 1.26 )</td>
<td>27.0 ( \pm 1.16 )</td>
<td>0.144</td>
</tr>
<tr>
<td>P Value</td>
<td></td>
<td>0.023*</td>
<td>0.014*</td>
<td></td>
</tr>
<tr>
<td>% of change</td>
<td></td>
<td>2.63%</td>
<td>5.39%</td>
<td></td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>Before</td>
<td>100.86 ( \pm 7.07 )</td>
<td>101.66 ( \pm 10.33 )</td>
<td>0.806</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>99.38 ( \pm 8.44 )</td>
<td>96.03 ( \pm 9.62 )</td>
<td>0.144</td>
</tr>
<tr>
<td>P Value</td>
<td></td>
<td>0.112</td>
<td>0.001*</td>
<td></td>
</tr>
<tr>
<td>% of change</td>
<td></td>
<td>1.46%</td>
<td>5.53%</td>
<td></td>
</tr>
<tr>
<td>Waist hip ratio (score)</td>
<td>Before</td>
<td>0.905 ( \pm 0.05 )</td>
<td>0.90 ( \pm 0.06 )</td>
<td>0.913</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>0.90 ( \pm 0.055 )</td>
<td>0.88 ( \pm 0.06 )</td>
<td>0.0486</td>
</tr>
<tr>
<td>P Value</td>
<td></td>
<td>0.552</td>
<td>0.000001*</td>
<td></td>
</tr>
<tr>
<td>% of change</td>
<td></td>
<td>0.5%</td>
<td>2.22%</td>
<td></td>
</tr>
<tr>
<td>Vo(_2) Max (mL/kg/min)</td>
<td>Before</td>
<td>20.35 ( \pm 9.03 )</td>
<td>25.84 ( \pm 14.55 )</td>
<td>0.225</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>27.06 ( \pm 9.42 )</td>
<td>33.04 ( \pm 14.51 )</td>
<td>0.192</td>
</tr>
<tr>
<td>P Value</td>
<td></td>
<td></td>
<td>0.006*</td>
<td></td>
</tr>
<tr>
<td>% of change</td>
<td></td>
<td>↑ 32.97%</td>
<td>↑ 27.86%</td>
<td></td>
</tr>
</tbody>
</table>

\( \bar{x} \): Mean; SD: Standard deviation P-value: probability value; *Significant at P<0.05

### V. DISCUSSION:

In the current study, comparing both groups post-treatment revealed statistically significant improvement in all measured variables (P<0.05) in both groups, except in (Waist circumference and waist hip ratio) there was no significant improvement in group A. There was no statistically significant improvement in all measured variables between both groups (P>0.05).

In the current study, 8 weeks of HIIT had improved functional capacity (VO\(_2\) max) by 32.97% which is agreed by 15 who reported that HIIT can improve VO\(_2\) max in healthy adults. Moreover, 16 stated that in healthy overweight subjects who trained only one bout of 4-minute HIIT at 90% of HR max 3 times per week was sufficient for improving VO\(_2\) max. Similarly, 17 reported that HIIT improve VO\(_2\) max in young healthy women compared to baseline.

The possible explanation of this improvement of functional capacity is that HIIT highly associated with an increase in oxygen supply and demand chain (the mass of mitochondria) which is indicated by citrate synthase (CS) activity. 18 CS is an enzyme for mitochondrial density in skeletal muscle, and it is also a biochemical marker of skeletal muscle oxidative adaptation to training. The mitochondrial content of skeletal muscle is determined by CS activity at its maximum, which is enhanced by aerobic training especially HIIT. 19 Another scientific explanation about HIIT can improve functional capacity is its ability to increase ATP production by increasing the density of mitochondria leading to more force production. 20

One of the main purpose of this study was to compare between HIIT and IF to determine the concept that if we have a group of subjects which contribute almost the majority of our population who are inactive and have several limitations to perform exercise as age, morbid obesity, arthritis or even do not have time to practice any activity, are they able to increase their physical fitness (VO\(_2\) max) by just lowering the body weight and modify their body composition by IF which have been proved in this study, as the results revealed that VO\(_2\) max showed statistically significant in favor to group A (HIIT) than showed in group B (IF). Focused on advising overweight or obese subjects to decrease their body weight and improve body composition as to improve their physical fitness. This is can be explained by 21 who revealed that intermittent fasting has a greater impact on VO\(_2\) max. An increase in cardiac output due to increased sympathetic activation during exercise or a stronger oxidative capacity in fat adapted muscle could be one explanation for the improvements in VO\(_2\)max with IF.

The results of the current study revealed that there was a statistically significant difference in body weight regarding subjects in (group A) who participated in HIIT. These results
came in concordance with a study conducted to determine the influence of HIIT on anthropometric measures in healthy overweight subjects. The study revealed that HIIT leads to reduction in body weight and waist circumference. Which is in line with and who reported that body weight, BMI and body composition significantly decrease after 12 weeks of HIIT. These results showed that HIIT is an effective way for controlling body composition in both genders.

The intervention of intermittent fasting caused a 5.96 % weight loss, reduced BMI, waist circumference which used as an indirect indicator of visceral fat mass, waist/hip ratio. The result of this study agreed with who reported that 8 week of IF in overweight or obese individuals can experience greater reduction in body weight and composition.

Many biological explanations can explain this effect. One is the increase in adiponectin which act in the brain to increase energy expenditure which cause weight loss. Fasting for 16 to 18 hours appears to be favorable in terms of increasing the breakdown of stored triglycerides and fat oxidation. Greater lipolysis may enhance fatty acid mobilization and use in adipocytes, as well as absorption and oxidation in other tissues, resulting in increased energy expenditure and a possible target for management obesity.

VI. CONCLUSION

It was concluded that both high intensity interval training and intermittent fasting 16/8 protocol improved functional capacity among overweight subjects.

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