Efficacy of Lifestyle Machines on Fat Reduction

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Abstract

With the increasingly prevalent trend of obesity in today's society, the need for easier methods of weight loss have grown exponentially. To harness the potential benefits of this market, new technology targeted at weight loss has been developed. Such lifestyle machines claim to stimulate fat reduction, despite the lack of conclusive scientific evidence. For the current study, five healthy subjects were exposed to 20Hz on a vibration platform for a continuous period of 20 minutes. Various parameters including heart rate, energy expenditure, fat oxidation, carbohydrate metabolism, oxygen uptake and carbon dioxide output were measured (1) at basal level and (2) during exposure to vibration. A statistical approach was taken to test our earlier induced hypothesis that the vibration platform stimulates a significant increase in fat catabolism. The student's t-test was used to assess whether the means of the two independent data groups, including basal and vibration values of the different parameters for the various subjects, are statistically different from each other. Overall, the results of the student's t-test were found to be at the $p < 0.1$ level, indicating that the means are significantly different at the significance level as reported by the p-value. This indicates that fat metabolism in subjects undergoes a significant increase when exposed to the vibration platform, validating our earlier hypothesis which was derived through a case study approach.

1. Introduction

Statistics have reflected a rising epidemic of obesity, reflecting the profound changes in society and in behavioural patterns of communities over recent decades. In terms of statistical evidence, (BM Popkin, 1998)[1] currently reported more than 1 billion overweight adults - with at least 300 million of them being clinically obese. This worrying trend in society has induced among the populace a desire for easier and more practical methods of weight loss. As such, new technology has cropped up on the market to tap into this highly profitable health and wellness industry.

Based on data extrapolated from our previous study on the efficacy of lifestyle machines (vibration platform, elliptical motorized saddle and twisting motorized saddle) on fat reduction, the hypothesis that fat metabolism is most significant on the vibration platform was formulated (Tiffany, Ashley, Ashima, 2008)[2].We postulated that this could be due to the fact that the different lifestyle machines adopted different approaches which put the user into different exercise zones (Figure 1). The vibration platform made use of the "muscle-toning approach", putting the user in the desired fat-burning zone, and thus fulfilling the objective of ideal weight loss.

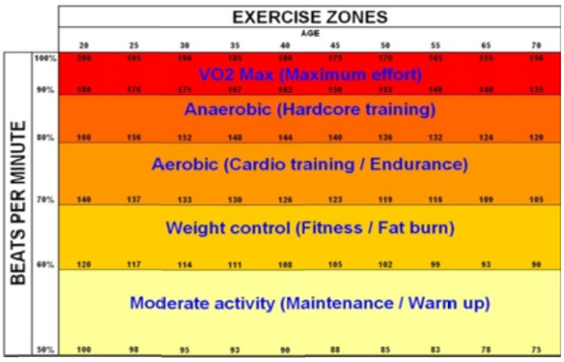

Figure 1. Exercise Zones

In fat catabolism in our body, (D Voet, 1990)[3] explained that triglycerides are hydrolyzed into fatty acids and glycerol. In the liver the glycerol can be converted into glucose via dihydroxyacetone phosphate and glyceraldehyde-3-phosphate by way of gluconeogenesis. In many tissues, especially heart tissue, fatty acids are broken down through a process known as beta oxidation which results in acetyl-CoA which can be used in the citric acid cycle.

In a comprehensive scientific report, (BM Balsiger, 2000)[4] emphasized that weight loss occurs when an individual is in a state of negative energy balance, as it spends more energy than it gains from the nutritional supplements. Indeed, it must be noted a variety of factors may contribute to weight loss. However, ideally, loss in weight should be attributed to reduction in fat.

For the current study, we have chosen to focus on the hypothesis generated from our earlier study, that fat metabolism undergoes the most significant increase when users are exposed to the vibration platform, versus the twisting and elliptical saddles. In the previous study, the hypothesis was induced based on a case study approach. For the current study, the hypothesis generated in our earlier study was tested with a statistical approach, using significance tests and with emphasis on the data extrapolated from subjects exposed only to the vibration platform. The student's t-test was used to assess whether the means of the two independent data groups, including basal and vibration values of the different parameters for the various subjects, are statistically different from each other. In this, the problems associated with inference based on "small" samples were dealt with, ensuring that the differences in averages of the two data sets are real and not by chance. This is due to the fact that in a small sample size, the calculated mean (X_{avg}) and standard deviation (σ) may deviate by chance from the mean and standard deviation derived from a larger sample population (Mankiewicz, 2003)[5].

Therefore, the aim of the present study is to further corroborate the previously induced hypothesis, by means of using tests statistical in nature, to ascertain that the data extrapolated does indeed point to the fact that fat metabolism undergoes a significant increase when exposed to the vibration table.

2. Methods

2.1. Participants

Written informed consent was obtained from five healthy subjects, three female and two male (mean±S.D.: age 20±10 years, mass 47±7 kg, and height 1.58±0.03 m). Subjects led varying forms of lifestyle, with varying amounts of physical exercise per week. The study was approved by the Institutional Review Board (IRB) at the Ministry of Education (MOE).

2.2. Equipment

For the current study, a vibration platform (vibration table, OTO, Singapore) was used as the lifestyle weight loss machine in question. To measure the respiration process and respiratory exchange ratio (RER), a gas analyser (Cortex Metalyzer 3B, Model 63530606) was utilised. A polar heart rate monitor was used to record subjects' heart rate. Finally, parameter values were obtained through application of a software (Metasoft Version 3.0).

2.3. Protocols

2.3.1. Parameters Measured

Parameters measured throughout the experimentation process include heart rate, energy expenditure, fat oxidation, carbohydrate metabolism, oxygen uptake and carbon dioxide output.

2.3.2. Measuring parameters at baseline
Prior to exposure to oscillation, parameters at basal level for each subject were taken. Subjects were required to sit still for 5 minutes, for their resting heart rate, energy expenditure and fat oxidation to be taken.

2.3.3. Exposure to vibration
Subjects were exposed to vibration on the vibration table for a continuous period of 20 minutes. According to the American College of Sports Medicine, this is the stipulated time in order for the ideal exercise intensity for maximum aerobic workout to be reached (BA Franklin, 2000)[6]. Each weight loss machine required subjects to position themselves in an optimum position for maximum exposure to vibration.

The vibration table moved in a way similar to a see saw, except at a higher frequency (20Hz). Subjects stood with their feet planted firmly on the platform, about a shoulder's width apart. Use of the handle-bars was permitted. Legs were to be kept relatively straight, with knees relaxed. For this machine, the frequency was chosen with the comfort of the subjects in mind. To ensure safety, subjects were allowed to stop engaging in the experimentation process at any time.

2.3.4. Statistical Analysis
The software Microsoft Office Excel 2007 was utilised to make the relevant t-test calculations. A p-value was derived through the t-test statistic, which indicated how likely the results could have been gotten by chance.

3. Results

Overall, a significant increase in heart rate, energy expenditure and fat oxidation was observed when subjects were exposed to vibration as compared to the resting measurements (Figure 2.1). The results of the significance tests have revealed a p-value of < 0.1. The t-test values were 0.018, 0.011 and 0.063 for subjects' heart rate, energy expenditure and fat oxidation respectively.

In deriving the percentage change for the various parameters from basal to vibration rates, the resting rate was used as the original reference point.

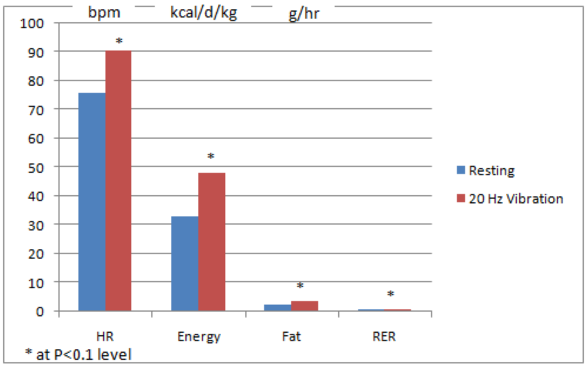

Figure 2.1 Averages of subjects' parameter values

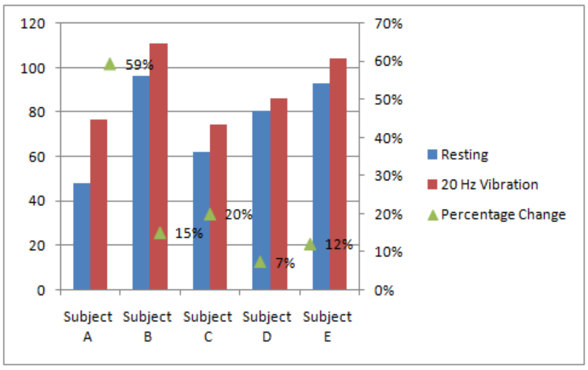

Figure 2.2 Heart rate (bpm)

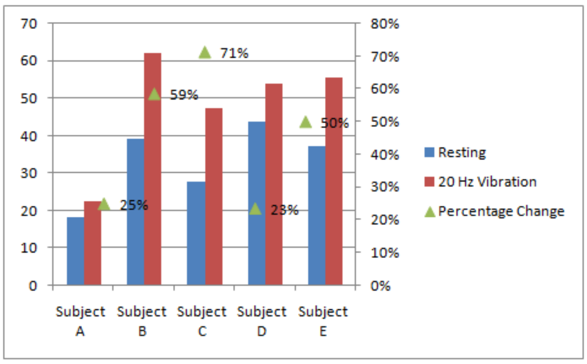

Figure 2.3 Energy Expenditure (kcal/day/kg)

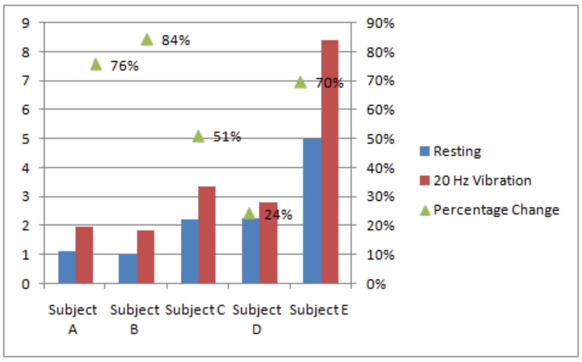

Figure 2.4 Fat Oxidation (g/hr)

4. Discussion

Prior to the analysis of the current data in this study, it is essential to briefly go over the findings of our previous project, to set the groundwork for the current study. Figures 3.1 and 3.2 show the graphical representation of the two key parameters in our previous study, energy expended and fat oxidation.

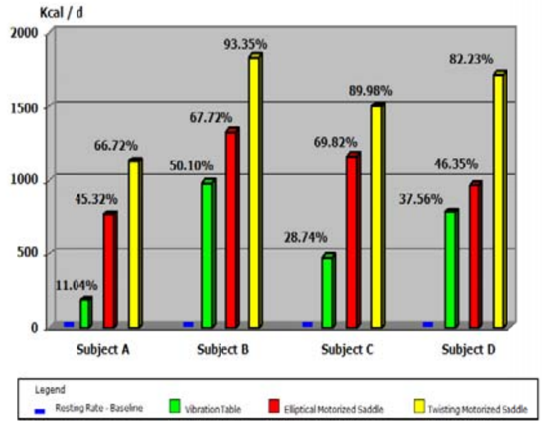

Figure 3.1 Energy Expenditure (kcal / day)

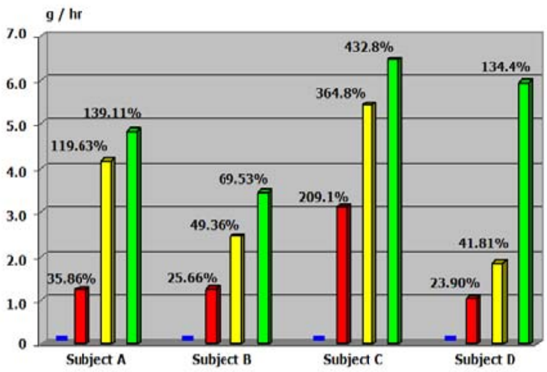

Figure 3.2 Fat Oxidation (g / hr)

4.1. Reviewing the previous study's graphical data

Based on the graph of energy expended, it is observed that the twisting motorised saddle potentially renders a higher metabolism. As such, fat oxidation levels are expected to be the highest when subjects are exposed to the twisting motorised saddle. However, based on the results, fat oxidation is highest when subjects were exposed to vibration on the vibration platform (Figure 3.2). This therefore brings into question the different weight loss approaches utilised by the respective lifestyle machines in terms of fat reduction.

The two motorised saddles employed the functional concept of an exercise intensive workout on the machine, as both machines require the subject to actively engage the leg and back muscles so as to keep one in a continuously upright position when on the machine. This stimulates an increase in aerobic respiration (and thus VO2 and VCO2) and liberated energy (Figure 3.1). However, this causes the catabolism of glucose molecules, having limited impact on ideal weight loss programmes, due to the potentially little effect on fat oxidation. Even if these machines are aiming for fat oxidation with the idea of an exercise intensive weight loss approach, the exercise provided by the machines is insufficient to reach the exercise zone needed (Figure 1) for the burning of fats.

In contrast, the vibration technology used by the vibration table is a potent stimulus for the neuromuscular apparatus in subjects (MJ Jordan, 2005)[7]. In these instances, the vibratory wave is propagated from distal to proximal links of muscle groups, enhancing tonic vibration reflex, which enhances voluntary muscle contractions. These muscle contractions will cause toning of the muscle to occur, changing the subject's body composition and causing fat oxidation.

Therefore, it may be speculated that a more efficient way of triggering fat oxidation would be to adopt the ‘muscle toning’ approach, as opposed to the exercise intensive approach.

4.2. Discussion of the current study

For the current study, a different sample of five subjects was put through the same conditions as the earlier case study. To test the hypothesis previously formulated in the earlier case study, a statistical approach was adopted. This would aid in assessing whether the means of the data values were statistically different from each other, giving an indication on the significance of the data obtained through experimentation.

The p-values associated with the t-tests carried out on the four different parameters have been found to be small, at the $p < 0.1$ level, indicating evidence that the means are significantly different at the significance level as reported by the p-value (O'Connor, 1999)[8]. As such, the results of the current study can be deemed to be significant, not by chance and used to prove the hypothesis formulated in the previous study.

Based on an overview of the graphs of the different parameters (Figure 2.1), a general trend of an increase in data values from resting to vibration can be observed, indicating the likelihood that vibration stimulates an increase in fat oxidation. This is supported by previous findings (MJ Jordan, 2005)[7] which indicate that vibration technology used by the vibration platform is a potent stimulus for the neuromuscular apparatus in subjects. During exposure to vibration, the vibratory wave is propagated from the distal to proximal links of muscle groups, enhancing tonic vibration reflex, causing voluntary muscle contractions. These muscle contractions help to tone the user’s muscles, changing his body composition and in turn leading to fat oxidation.

With reference to Figure 2.4,the graph illustrating the trends of fat oxidation (Figure 2.4), it is observed that levels of fat oxidation are significantly higher, with a general increase of 50% from the resting baseline, when subjects are exposed to vibration as compared to when subjects are at rest. This further supports the hypothesis that fat oxidation is increased when subjects are exposed to vibration. We surmise that this effect is due to the fact that the whole body’s weight is borne by the user when standing, as when standing with knees slightly bent, most of one’s body weight tends to be transferred to his posterior. Such a posture might be responsible for transmitting great vibration through the user’s entire body, putting the user into the fat burning zone, where heart rate was 60-70% of maximum heart rate, and thus stimulating an increase in fat oxidation.

Future studies could explore the effects of vibration on the user’s motor skills. To improve upon the accuracy of the figures in the study, a more accurate and refined method may be used or developed to estimate fat oxidation when exposed to vibration. Response for the current study depends on inter-subject and intra-subject variability. Hence, to make this study more varied and the results to be even more comprehensive, the number of subjects can be increased, with subject profiling covering a wider variety, such as a larger age group, both males and females, and people with varied levels of physical activity.

5. Conclusion

The effect of the various lifestyle machines on fat metabolism was found to be the most significant on the vibration table. This has been substantiated by statistics through application of the t-test. Therefore, this study suggests the potential usage of the vibration table as a means to facilitate fat reduction. In future studies, a more in depth analysis could be done about the effects of whole body vibration on muscle toning, and reduction of lactic acids in the muscles.

6. Acknowledgements

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