

## Effect of Circadian Rhythm on Peak of Maximal Fat Oxidation on Non-Athletic Men

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Article information	Abstract
<p>Article history: Received: 21 Dec 2012 Accepted: 15 Apr 2013 Available online: 3 Jan 2014 ZJRMS 2014; 16 (6): 8-11</p> <p>Keywords: Fat Oxidation Exercise Circadian rhythm</p> <p>*Corresponding author at: Department of Physical Education and Sport Sciences, Shahid Chamran University of Ahvaz, Iran. E-mail: hassan_darvakh@yahoo.com</p>	<p><b>Background:</b> The aim of this study is to investigate the effect of circadian rhythm on the maximal fat oxidation (MFO) and FATMAX in students without practice.</p> <p><b>Materials and Methods:</b> The subjects of this study were ten non-athletes male students (N=10), with the body mass index and maximal oxygen consumption below 50%, who were selected randomly. Run test was performed with three-minute stages and increased speed and slope to exhaustion at 6-8 am , 5-7 pm ,and 9.5-11 pm. Post hoc LSD test was used for describing the analytical findings and repeated measures to compare data in three times of morning, afternoon, and night.</p> <p><b>Results:</b> The results generally showed that average of maximal fat oxidation at night is more than evening and morning) .There is a slight difference between the afternoon and morning (<math>p=0.006</math>), but MFO and FATMAX mean in evening is more than morning and night. There is a slight difference between the morning and night (<math>p=0.002</math>)</p> <p><b>Conclusion:</b> So it can be concluded that circadian rhythm influences the maximal fat oxidation and fat oxidation is significantly higher in the evening than in the morning and it is good for fats.</p> <p>Copyright © 2014 Zahedan University of Medical Sciences. All rights reserved.</p>

### Introduction

It is necessary to pay attention to the important intrinsic factor called biological clocks and its impact on the physiologic condition and consequently on physical functionality especially in different times of the day. Recent findings in chronobiology (understanding the impact of time on physiologic variables) show that human body bears enormous amount of changes during the day and has a specific ability in every hour [1]. The ability to stimulate and use fat as a fuel source is important for different people. The strong connection between fat acids oxidation capacity and athletic functionality is considerable for endurance athletes [2, 3]. It might help decrease body mass for the obese and overweight people to increase the amount of fat oxidation [4]. Therefore, the exercise methods so intense that the utmost fat oxidation occurs and at a time of day in which the highest fat oxidation occurs, are useful to cure and prevent obesity, and maintain the weight of metabolic syndromes and increases athlete's capacity to oxidize fat. Studies show that the biological clock regulates the activity of enzymes and hormones involving in metabolism [5]. Recently, scientific evidence shows that metabolism feedbacks, food intake, and time of meals enter inside the biological clock. So, a change in biological clock can result in changes in hormonal and metabolic responses [6]. Studies have also shown that the circadian rhythm controls some metabolic and hormonal factors affecting metabolism. The rate of body heat and oxygen intake is at its minimum at 4 am, and reaches to its maximum at 3-4 pm [7]. Output as well, especially tropic anterior pituitary

hormones have a circadian rhythm. Some endocrine secretion (prolactin and testosterone) reach to their maximum in the night. Peak of the GH level is during night. Epinephrine and norepinephrine levels reach the peak in the early afternoon [8]. Cortisol secretion is controlled by circadian rhythm. Its concentration is in the highest level in the early morning before waking up. Cortisol secretion decreases gradually throughout the day and the concentration reaches its lowest level at night [9]. Due to hormonal and metabolic changes during the day, substrate oxidation is expected to change too. Review of research backgrounds suggests that circadian rhythm has a significant impact on substrate oxidation. Jiro et al. reported that fat oxidation was higher during morning activity than in the afternoon [10] but Galion et al. [11] reported that there are no significant differences in metabolic and hormonal responses toward exercises in morning and afternoon. Chwalibog et al. reported that the main oxidative fuel is carbohydrate during the day, while the intake fuel to fat increases in the night [12]. Rahmani et al. also reported that circadian rhythm influences on intake energy and energy consumption in the afternoon is significantly more than morning. Miles et al. has observed no increase of energy during three levels of measurement. Sawyer et al. has also reported that resting energy expenditure in the morning and afternoon had no significant difference [13]. Due to hormonal and metabolic differences observed at various times of day, fat oxidation may vary in resting time and in response to exercises, and due to the contradictions in previous results

about substrate oxidation while exercising; there is no particular answer to what is different in fat oxidation during exercise in circadian rhythm. On the other hand, most of researches concerning fat oxidation were experimented on Ergometer bicycle and there were limited researches by treadmill using increased exercises [14] and in this case, the pattern of consuming energy and fat oxidation in the aforesaid activity is dissimilar on the bicycle and treadmill. On the other hand, very few researches have examined the amount of fat oxidation and FATMAX (exercise intensity which elicits maximal fat oxidation rate) and energy intake in non-athlete individuals and in normal shapes in different times. Finding the most proper time (during the day) to exercise and the best intensity for all people to keep or lose weight, is very important. Therefore, the present study tries to find whether the amount of MFO (maximum fat oxidation) and fat max is different in non-athlete normal weighed individuals at various times of day.

## Materials and Methods

This study method is semi experimental and applied type. The subjects of this study are 10 non-athlete male students that participated voluntarily. After obtaining informed consent, physical activity background including cardiovascular diseases, pulmonary, allergy, blood pressure, diabetes were identified. Subjects who had a disease were excluded from the study. The subjects were asked to refrain from any strenuous physical activity during the test. Noting that the time of the test was about two hours on every phase (morning, afternoon and evening) and there had to be at most four individuals to be tested, the subjects were divided into 3 groups namely A, B, C and they came to the laboratory in seven days. In the first phase and a week before the test, age ( $1.597 \pm 21.37$ ), height ( $0.04 \pm 1.76$ ), maximal oxygen consumption ( $5 \pm 40$ ) were measured. Moreover, Weight ( $3.70 \pm 70.48$ ), and body mass index ( $1.66 \pm 22.72$ ) were measured and recorded by using the body composition measurement machine (In body 3.3). The increased standardized treadmill test was used to measure the MFO and FATMAX and maximal oxygen consumption (ensured by Cosmed Italy company). The method consisted of a performance of increased running activity test with 3 minute stages on treadmill (based on Achten and colleagues protocol) [15]. This protocol characterizes a running with the speed of 3.5 km/h and 1% of incline. Every 3 minutes, 1 km/h is added to the speed until it is reached the speed of 5.7 km/h. After that, the speed is constant every 3 minutes and 2% is added on the machine incline, until RER = 1. Thereafter, the speed and gradient will be simultaneously increased at each stage, until reaching the fatigue limit. Average  $VCO_2$ ,  $VO_2$  was calculated in the final 2 minutes of each stage. Then, assuming that the rate of urinary nitrogen is negligible, and by using the following element measurement equations [16], we can calculate the rate of fat oxidation.  $VO_2 \times 1.701 - VCO_2 \times 1.695 = \text{rate of fat oxidation (g/min)}$ .

Kolmogorov – Smirnov test was used to determine the normal distribution of data, statistical method LSD to describe the results of post hoc analytical and repeated major statistical method was used to compare data in the morning and afternoon and evening.

## Results

The results of the present study showed that in the subjects that did not exercise, an intensity of exercise the FAT max occurs and MFO and fat oxidation showed a significant difference between the morning and afternoon, morning and night and there was no significant difference between day and night. On the other hand, the results of this study showed that the maximal fat oxidation in the samples were significantly greater in the afternoon than in the morning ( $p=0.006$ ).

**Table 1.** Descriptive data concerning fat oxidation at different times

Time	Mean	MFO*(g/m) Mean±SD	FATMAX (ml/kg/m) Mean±SD	Fat oxidation (g/m) Mean±SD
Morning		0.1±0.29	14.92±41.17	0.056±0.17
Afternoon		0.21±0.48	13.83±57.55	0.53±0.17
Night		0.11±0.48	10.99±56.96	0.037±0.26

Values are expressed as mean ± standard deviation

\* MFO: Maximum Fat Oxidation

## Discussion

In this study, we did not find a similar research in which it compared fat oxidation through an activity during day and night. Also, there was no research which compared FATMAX and MFO in afternoon and night or morning and night.

Results showed that during an incremental exercise protocol, there are significant differences in the MFO in the morning and evening and morning and at night in untrained male students but there was no significant difference in the amounts of MFO in the night and afternoon in students. Mohebbi et al. studies were on the effect of time of day on FATMAX, MFO during exercise in normal weight and obese women. They observed that FATMAX and MFO were more in both groups in the evening than in the morning. Results showed that during an incremental exercise protocol, FATMAX in the morning and evening and morning and at night in untrained students is significantly different, but there was no significant difference in the students in the FATMAX at night and day.

Mohebbi et al. studies were on the effect of time of day and FATMAX MFO during exercise in normal weight and obese women. They observed that in both groups, FATMAX and MFO were more in the evening than in the morning [17]. The present research results showed that during an increased exercise protocol, fat oxidation is significantly more in afternoon and night than the morning, and there is no significant difference between night and morning. Previous researches showed that the amount of body temperature, peak power and average

power [18], aerobic power [19], time to exhaustion, peak oxygen consumption, and aerobic response to activity, are higher in the afternoon than in the morning [20]. On the other hand, the results of the Borg scale showed that the amount of perceiving stress is less in the evening than in the morning that shows the decrease of stress on the subject during the exercise in the afternoon. The same point can cause fat oxidation higher in the morning than in the evening. Also, the maximum intensity of the exercise in which fat oxidation (FATMAX) occurred, was significantly higher in the evening than in the morning.

It also shows that the body might tend to use fat earlier in the evening. Therefore it is more likely to consume fat. Parallel with these findings, Chwaliboug et al. showed that the main body fuel is carbohydrate oxidation during the day, and fat oxidation is increased during the night. Hill et al. [20] conducted two studies which showed that the ability to exercise can be higher in the evening than the morning. Rahmani et al. showed that fat oxidation is significantly higher in the afternoon than the morning. GH and epinephrine being higher can be one of the main stimuli of Lipolysis and cause an increase in fat oxidation. The high concentration of plasmatic fatty acids shows that there is more substrate to oxidize in the afternoon, and body can have fatter intake than in the morning. As we know, glycerol concentration shows the whole body fat [21-22].

Due to the concentration increase of hormones affecting fat metabolism in the afternoon than the morning, and the data concerned with respiratory gases indirect measurement, we can conclude that fat oxidation is good for fats in the afternoon than morning. So, to keep or lose weight it is recommended that individuals exercise in the afternoon. As you can see, however, few studies have examined the metabolism of the substrate at different times of day and most previous studies have examined the metabolism at resting or they have emphasized more on Corticotrophin hormone responses at different times of the day (except for Notwerp and Rosemond.

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Contrary to the present findings, Giroux et al. [23] reported that session fat use decreased in the afternoon and was significantly (32.6%) lower than the morning session. Considering that the subjects were endurance runners, and had a habit of doing exercises in the morning, the above results are obtained. Moreover, according to the afternoon high intake energy, it is suggested that obese people exercise in the afternoon, because they will consume more energy in RER and they will use more fat fuel than in the morning which can be regarded in weight loss programs. This study showed that the rate of energy expenditure, and oxygen consumption was significantly higher in subjects at 6 pm to 8 am, while respiratory exchange ratio was lower in afternoon than in the morning. Previous research results showed that the body temperature and oxygen consumption while resting at 4 am is the least, and after waking up the amount gradually increases, and the peak reaches in hours of 3-4 pm [24]. In general, one can conclude that the circadian rhythm has an impact on the maximal fat oxidation and fat oxidation was significantly higher in the evening than in the morning great for fats. It is expected that similar research be conducted in other groups such as the elderly and overweight people. We hope this research can be used by researchers, coaches and sports professionals.

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## Authors' Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing.

## Conflict of Interest

The authors declare no conflict of interest.

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