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# Effect of Deception for Intensity of Exercise during Maximal Exercise Test on Fatigue in Female Students

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## Abstract

**Aim:** The Aim of this study was to investigate the effect of deception to intensity of exercise on fatigue in female students.

**Methods:** Sixteen subjects were selected randomly among 30 students who volunteered to participate in the study and they performed maximal exercise test (Bruce) in two states. In the first state, the increase in exercise intensity during steps of Bruce test was correctly announced to the subjects, but in the second state, they were dictated that the increase in exercise intensity was less than in the first state. Dependent variables were measured at the end of the test and the data were compared to paired t-test using SPSS 23.

**Findings:** The results showed that there was a significant difference for median frequency of rectus femoris muscle (p=0.043), maximium heart rate of the subjects at the end of Bruce test (p=0.001) and time to reach exhaustion (p=0.001) between the first state in which the actual increase in exercise intensity during steps of Bruce test was announced to the subjects and the second state in which they were dictated that the increase in exercise intensity, was less than the first state. However, no significant difference was observed for median frequency of vastus medialis (p=0.736) and vastus lateralis (p=0.762) muscles, as well as for rate of perceived exertion (p=1.000).

**Conclusion:** According to the results, it seems that by deception for intensity of exercise during maximal exercise test, the amount of fatigue can be reduced and the time to reach fatigue can be increased.

**Keywords**: Exhaustion, Deception, Fatigue, Rate of perceived exertion.

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## Introduction

One of the problems that has always plagued athletes is fatigue, and coaches always try to postpone it (Buonsenso et al., 2022). There are many definitions for fatigue. Muscle fatigue is generally defined as a decrease in the ability of muscles to produce the desired force, which occurs as a result of interrupting the chain of events from the central nervous system to muscle fibers (Tornero-Aguilera et al. 2022). The central nervous system is probably one of the places where fatigue occurs. It has been observed that the athlete's muscles, which are almost exhausted, can be made to produce and maintain more force through verbal encouragement, shouting or electrical stimulation (Belkhiria et al, 2018). Researchers have shown that there are two types of fatigue: 1- Central (general) fatigue, 2- Peripheral (local) fatigue. Central fatigue is related to the central nervous system and connections from the brain to the peripheral nerves that are involved in muscle contraction (Al-Mulla et al., 2011). In other words, central fatigue is related to the upper parts of the brain and the activation of alpha motor neurons and involves the whole body (Dietmann et al, 2023). Peripheral fatigue is pertained to the muscle's ability to perform physical work (Al-Mulla et al., 2011). In peripheral fatigue, the motor commands do not change or may even increase, but in central fatigue, the motor commands sent to the muscle are reduced, thereby leading to a decrease in muscle tension or force (St Clair Gibson et al, 2018).

The most widespread and common way to examine researches related to fatigue during exercise is the maximal exercise test ($VO_2$max test). Some researchers support the idea that oxygen availability is a limiting factor for maintaining exercise (Sierra, 2015). In fact, aerobic capacity ($VO_2$max) is the point at which the body is no longer able to consume oxygen despite increasing the intensity of exercise. This index is one of the oldest indicators of physical fitness which can be used to evaluate the performance of activities or the maximum physical ability (Rodahl, 1970; Wong et al., 2011). In tests that are used to measure $VO_2$max, the subject is often instructed to exercise to the point of exhaustion. Therefore, it is clear that the individual's motivation to continue the test, can affect the results (Nordhoff et al., 2010). The maximum heart rate, Rate of Perceived Exertion (RPE) and muscle electrical activity are variables that can be used to determine the level of fatigue at the end of the $VO_2$max test (Sierra, 2015).

RPE is defined as the subjective intensity of effort, pressure of fatigue, or discomfort experienced during an exercise and is influenced by the situation in which the exercise is performed and the condition of the subject. The psychological aspect of fatigue can be analyzed using the RPE scale developed and validated by Borg (Borg, 1970).

Fatigue affects the electrical activity of muscles. Central fatigue is caused by a disturbance in the transmission of messages between the central nervous system and the muscle membrane. This results in a decrease in the ability of the central nervous system to drive the alpha motor neurons, use of fewer motor units and a decrease in the frequency of fire in the motor units. (Silva et al., 2006). Surface electromyography (EMG) is a non-invasive method to measure the activity or duration of muscle activity.

Today, the method of deception to intensity and duration of exercise is considered to reduce fatigue and improve performance (Matsura et al., 2013). Manipulation of central psychological mechanisms, including the presence of a rival (Corbett et al. 2012, Eston et al. 2012), hypnosis (Williamson et al. 2001), as well as psychological skill training (Barwood et al. 2009), have been reported to improve performance. It has also been shown that most people stop the maximal exercise test before they reach physiological exhaustion and they can be encouraged to continue their activity (Bigland-Ritchie, 1978). Therefore, the aim of this study was to investigate the effect of deception for intensity of exercise during maximal exercise test on fatigue in female students.

## Methods

The present study was approved by the ethics committee of Ardabil University of Medical Sciences and has the ethics code IR.ARUMS.REC.1398.080. The research method in the current study is semi-experimental and the research design is repeated measurement. The statistical population was female students of physical education in University of Mohaghegh Ardabili aged 20 to 30 years. The sample size was estimated using the software (G*Power 3.1). Total sample size by statistical power of 0.95 in the effect size equal to 0.90 with the alpha level of 0.05 was determined as 15 subjects. After announcement, 30 students volunteered to participate in the study and among the qualified volunteers, 16 people were randomly selected as the statistical sample of the research. They got acquainted with the research protocol in writing and verbally in a meeting one day before the start of the research and signed the consent form. The general health of the participants was confirmed by a physician. The criteria for entering the research included not having musculoskeletal abnormalities, movement limitations, mental and nervous diseases, and metabolic diseases. Exclusion criteria included non-participation in all stages of the research and failure to reach the exhaustion during maximal exercise test.
The maximal exercise test used in this study to induce fatigue was the Bruce test. All subjects performed the test twice separated by 15 days. Subjects were invited to be present at health center laboratory located in Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili at the designated time. Initially, the increase in exercise intensity during steps of the Bruce test was correctly informed to the subjects, but in the second state they were told and dictated that the exercise intensity during steps of the Bruce test will increase less compared to the first state. In both states, dependent variables (time to exhaustion, maximum heart rate, rate of perceived exertion (RPE) after completing the test, and electrical activity of lower limb muscles during walking) were measured after the test.

Subjects sat on a chair for 15 minutes while the breathing mask of the gas analyzer and heart rate monitor (chest belt) were connected to them. The subjects were then asked to run until the point of exhaustion on a treadmil which was programmed to increase intensity every 3 minutes. During the implementation of the protocol, the subjects were encouraged to continue running. After the subjects declared that they were unable to continue, the test was stopped and the time from start of the test until this point was recorded. The mask and pacemaker were separated from the participants. Immediately after the performance, the subjects were asked to rate the perceived pressure from 6 to 20

using the Borg scale. Based on the Borg scale the lowest pressure is 6 and the highest perceived pressure is 20.
To measure electrical activity of muscles, the electrodes of the electromyograph were installed on the muscles of the right lower limb (Vastus medialis, Rectus femoris, Vastus lateralis) based on the European SEMIAM protocol. Initially, the hair on the lower limb was completely shaved and the skin was cleaned. Cotton and medical alcohol were used to reduce the electrical resistance of the skin. Raw electromyography signals were recorded at a sampling rate of 1000 Hz and transmitted to a computer via Bluetooth for further analysis. After connecting the electromyography device, the subjects performed maximal isometric voluntary effort (MVIC) for all three muscle groups. Then, electromyography signals were recorded during the slow walking task.

After 15 days, the participants were dictated that all the steps are the same as the first time, with the difference that the increase in exercise intensity during the Bruce test will be less. But in reality all the steps and measurments were done in the same way as the first time.

The Shapiro-Wilk test was used to check the normality of the data distribution, and the Levene test was used to check the homogeneity of the data variance. The Paired t-test was used to compare the dependent variables measured in two times. A significance level was considered as $p < 0.05$.

## Results

Demographic characteristics of the subjects have been shown in Table 1.

***Table 1.*** *Demographic characteristics of the subjects*

| Variables | Mean | Standard Deviation | n |
|---|---|---|---|
| Age (years) | 25.25 | 2.86 | 16 |
| Weight (kg) | 62.25 | 8.36 | 16 |
| Height (cm) | 159.58 | 7.60 | 16 |

The results of the Shapiro-Wilk test showed that all dependent variables' data had a normal distribution ($p>0.05$). Also, the results of Leven test showed that the variance of the data of all dependent variables are homogeneous ($p>0.05$). The results of the paired t-test showed that the median frequency of rectus femoris during walking was significantly higher in the second state when the subjects were dictated that the increase in exercise intensity was less compared to the first state ($p=0.043$). These results can be seen in Table 2.

***Table 2*.** comparing the median frequency of the muscles of the right lower limb during walking at the end of the exhausting Bruce test in two states

| muscle | State 1 | State 2 | t | P |
|---|---|---|---|---|
| rectus femoris* | 63.06±7.94 | 73.23±8.59 | -2.283 | 0.043 |
| vastus medialis | 62.3±8.39 | 60.82±9.49 | 0.346 | 0.736 |
| vastus lateralis | 69.62±7.61 | 68.03±7.15 | 0.310 | 0.762 |

State 1 (when the actual amount of the increase in exercise intensity was reported to them) and state 2 (when they were dictated that the increase in exercise intensity was less than the state 1).

There was not a significant difference in the amount of RPE between two states (p=1.000). These results have been shown in Fig 1.

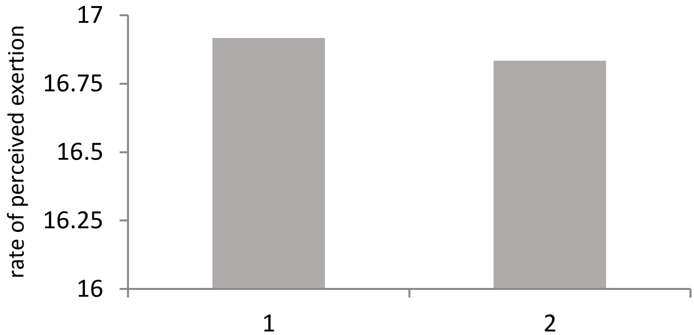


Fig 1. Rate of perceived exertion of subjects at the end of Bruce test in two states: State 1 (when the actual amount of the increase in exercise intensity was reported to them) and state 2 (when they were dictated that the increase in exercise intensity was less than the state 1).

Maximum heart rate of the subjects at the end of the Bruce test was 187 ± 9.43 in the state 1 that the actual amount of the increase in exercise intensity was announced to the subjects and was 179±9.99 in the second state that they were dictated that the increase in exercise intensity was less compared to the first state. The difference between two states was significant (p=0.001) (Fig 2).

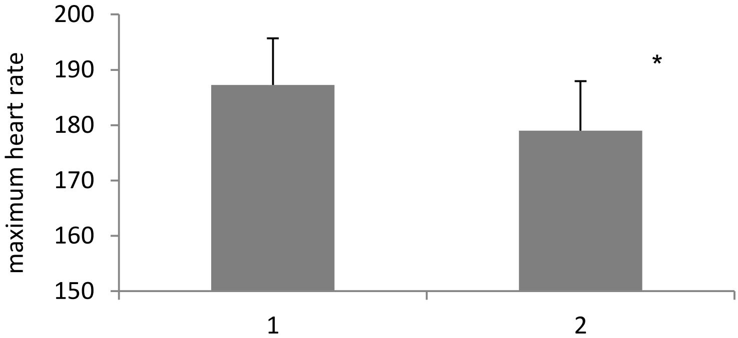


Fig 2. Maximum heart rate of subjects at the end of Bruc test in two states: State 1 (when the actual amount of the increase in exercise intensity was reported to them) and state 2 (when they were dictated that the increase in exercise intensity was less than the first state). * indicates a significant difference between the two states.

Time to reach exhaustion in the first state that the actual increase in exercise intensity told to subjects was 7.76±1.59 minutes and it increased to 9.13±1.32 min in the second state that the subjects were dictated that the increase in exercise intensity was less compared to the first state (p=0.001) (Fig 3).

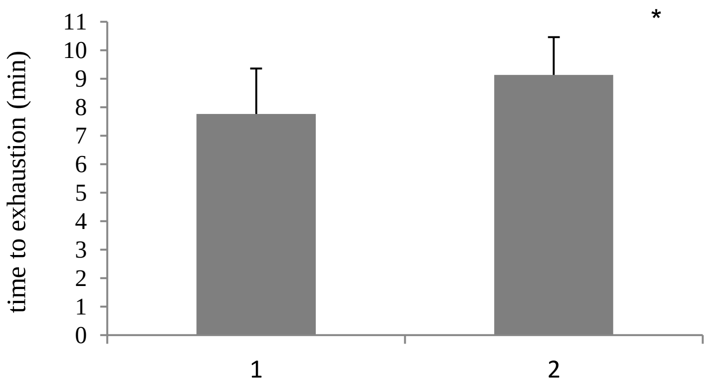


Fig 3. Time to exhaustion of the subjects in two states: State 1 (when the actual amount of increase in exercise intensity was reported to them) and state 2 (when they were dictated that the increase in exercise intensity was less than the first state). * indicates a significant difference between the two states.

## Discussion

There has always been the question of whether the point at which the subject no longer continues the exhaustion test is true fatigue or not; because sports physiologists believe that physiological fatigue occurs much later than mental fatigue (Wan et al 2017).

Therefore, with the use of psychological strategies such as encouraging the subject, we can help him stop the test at a point close to real physical fatigue. Deception for exercise intensity is also one of the solutions that seems to be able to help the sports community with its application. The present study was conducted with this aim and the results showed that the median frequency of rectus femoris muscle during walking at the end of the Bruce test was higher in the state where the subjects were dictated that the increase in exercise intensity is less compared to the first state; which indicates less fatigue of rectus femoris muscle. The central nervous system is probably one of the places where fatigue occurs, because it has been observed that the athlete's muscles, which are close to exhaustion, can be made to produce and maintain more force through verbal encouragement, shouting or electrical stimulation of the muscle (Chaffin 1973). In the present study, when it was dictated to the subjects that the increase in exercise intensity during steps of Bruce test was less, the time to reach fatigue increased significantly, which confirms that the subjects had not reached their true physiological fatigue in the first state.

Rate of perceived exertion is defined as the subjective intensity of effort, pressure of fatigue or discomfort experienced during an exercise and is influenced by the situation in which the exercise is performed and the condition of the subject. Attitudinal and situational factors such as personality type, level of motivation, concentration and attention affect RPE during exercise (Stevenset al 2020). In the present study RPE was not different between the two states. The reason for this result might be as follow: It is possible that the subjects of the present study did not get a correct understanding of the Borg scale, in other words, they may have not learned how to use it properly. In the current study, unfortunately, there was no practice to learn the use of the Borg scale before the main test, and it is recommended to the other researchers to include the practice of using the Borg scale several times before the main test in order for the subjects to learn it.

The results of the present study also showed that maximum heart rate was reduced in the state in which the subjects were dictated that the increase in exercise intensity during the steps of the Bruce test is lower compared to the first test. Heart rate increases under the influence of sympathetic nerves during exercise to increase blood supply to muscles and meet the oxygen demand of muscles (Joyner & Casey 2015). However, increased heart rate also occurs with stress and mental pressure (Immanuel et al. 2023). Before the start of the activity, an increase in heart rate and breathing rate occurs due to excitement (Migliaccio et al. 2023). Therefore, it is possible that the lower maximum heart rate in the second state is due to the reduction of anxiety and excitement.

It seems that in addition to the afferent messages that reach the central nervous system from the working muscles, other auditory messages can be sent to the central nervous system indicating lack of tiredness that affects the brain cortex and the command of the central nervous system regarding fatigue to various muscles, including the cardiac muscle, is postponed. Due to financial limitations and subjects' fear, blood samples were not taken to measure indicators of fatigue such as lactate. It is suggested that in future studies blood indicators of fatigue and electrical activity of all muscles of the lower limb be measured. According to the results of the present study, it can be suggested that in order to reach fatigue later and also to reduce fatigue in athletes, the intensity and load of exercise be announced less than the actual amount.

## Conclusion

According to the results of the present study, it can be concluded that by deception for exercise intensity during the steps of maximal exercise test, the amount of fatigue can be reduced and fatigue can be postponed.

## Disclosure Statements

The authors declare no conflict of interest.

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