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Article

Beta-Endorphin Responses to Varying Exercise Intensity

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Abstract: This study aims to explore the response of beta-endorphins to variations in exercise intensity in the context of exercise physiology. Beta-endorphins, endogenous opioid peptides produced in the pituitary gland, play an important role in the regulation of pain and mood. The study involved 30 active participants who underwent an eight-week exercise program with a frequency of three times a week. The research method included measuring beta-endorphin levels before and after the exercise intervention using the ELISA technique. The results showed that at low to moderate intensities (40% and 60% VO2max), beta-endorphin levels did not increase significantly, with values of about 4.8 pmol/l and 6.3 pmol/l, while at high intensities (80% VO2max), levels increased significantly to about 16.1 pmol/l. In addition, a comparison between HIIT (High-Intensity Interval Training) and moderate aerobic exercise showed that HIIT resulted in a greater increase in endorphin release, although participants also reported discomfort during high-intensity sessions. The beta-endorphin response appears to be consistent between the sexes, but the catecholamine response shows significant differences, with higher levels in men. These findings emphasize the importance of considering gender, duration, and gender factors in research on hormonal responses to exercise, as well as its implications for long-term mental and physical health through regular physical activity.

Keywords: Beta- Endorphin; Exercise; High Intensity Interval Training

1. Introduction

The study of beta-endorphin responses to varying exercise intensities is a significant area of research within exercise physiology (Tolentino et al., 2023), as it explores the biochemical and physiological effects of physical activity on the body (Pilozzi et al., 2021). Beta-endorphins are endogenous opioid peptides produced in the pituitary gland, primarily involved in pain relief and the regulation of mood (You et al., 2020). They are released into circulation during physical exertion (Amri et al., 2023), contributing to what is often referred to as the "runner's high.

Beta-endorphins are a type of endorphin, which is a peptide that functions as a neurotransmitter in the central nervous system (Roschina et al., 2021). Endorphins are produced by the pituitary gland and hypothalamus in the brain, and have an important role in regulating pain and mood (Flora et al., 2020). Beta-endorphins are made up of 31 chains of amino acids, making them one of the most researched endorphins (Schoenfeld & Swanson, 2021). Beta-endorphins function as natural pain relievers, which work by binding to opioid receptors in the brain, similar to the morphine effect, but with a lower risk of dependence (Cravana et al., 2017). When the body experiences stress or pain, beta-endorphins are released to block pain signals sent to the brain (Ramírez-Expósito et al., 2021). In addition, beta-endorphins also play a role in increasing feelings of happiness and comfort, as well as helping to reduce anxiety and stress (Özer & Ateş, 2021) Beta-endorphins are an important component of the human pain and mood regulatory system (Kapıkıran & Özkan, 2021) With its ability to reduce pain and increase feelings of happiness, this hormone plays a vital role in mental and physical

health (Wang et al., 2022) Activities that stimulate the release of beta-endorphins such as exercise, laughter, and meditation are highly recommended to improve overall quality of life.

Research has consistently shown that exercise intensity plays a crucial role in modulating beta-endorphin levels. For instance, studies indicate that while moderate exercise may not significantly elevate plasma beta-endorphin concentrations, high-intensity workouts can lead to substantial increases. This relationship suggests a curvilinear response where maximal exertion elicits the most pronounced beta-endorphin release, potentially due to enhanced metabolic stress and lactate production associated with anaerobic activity.

Furthermore, the impact of exercise on beta-endorphin levels may vary based on several factors, including the type of exercise performed (aerobic vs. anaerobic), duration, and individual characteristics such as gender and fitness level. For example, anaerobic exercises have been shown to produce higher beta-endorphin responses compared to aerobic exercises at similar intensities. Additionally, understanding these responses can provide insights into how exercise can be utilized therapeutically for mood enhancement and pain management. In summary, this research aims to elucidate the relationship between different intensities of exercise and the corresponding beta-endorphin responses, thereby contributing to a deeper understanding of the physiological adaptations to physical activity and their implications for health and well-being.

2. Materials and Methods

The Materials and Methods should be described with sufficient details to allow others to replicate and build on the published results. Please note that the publication of your manuscript implicates that you must make all materials, data, computer code, and protocols associated with the publication available to readers. Please disclose at the submission stage any restrictions on the availability of materials or information. New methods and protocols should be described in detail while well-established methods can be briefly described and appropriately cited. Research manuscripts reporting large datasets that are deposited in a publicly available database should specify where the data have been deposited and provide the relevant accession numbers. If the accession numbers have not yet been obtained at the time of submission, please state that they will be provided during review. They must be provided prior to publication. This study uses an experimental design with pre-test and post-test approaches to explore the beta-endorphin response to variations in exercise intensity. The research subjects consisted of active individuals who participated in a physical exercise program at the university. A total of 30 participants who meet the inclusion criteria, such as having no history of cardiovascular disease and being willing to participate in the entire series of studies, will be involved.

Training Procedure

1) Duration of the Research: The exercise program lasts for 8 weeks.
2) Workout Frequency: Workouts are done three times a week.

Training Session Structure:

1) Warm up for 10 minutes.
2) Intensive training intervals of 30 seconds followed by active recovery for 1 minute, repeated 8-10 times.
3) Cool for 10 minutes.
4) Measurement of Beta-Endorphins

Measurement of beta-endorphin levels was carried out before and after the exercise intervention using the blood sampling method. Blood samples will be analyzed to determine beta-endorphin concentrations using ELISA (Enzyme-Linked Immunosorbent Assay) techniques. The data obtained will be analyzed using descriptive statistics to describe the

characteristics of the subjects. A normality test will be conducted to determine the appropriate type of statistical analysis. Pearson or Spearman correlation analysis will be used to evaluate the relationship between changes in beta-endorphin levels and variations in exercise intensity. The significance level was set at $p < 0.05$.

3. Results

The results of this study are as follows:

1) Intensity and Beta-Endorphin Levels
   a. Low to Moderate Intensity: Studies indicate that plasma beta-endorphins do not significantly increase at lower intensities (40% and 60% VO2max), with values around 4.8 pmol/l at 40% and 6.3 pmol/l at 60% compared to a resting level of 3.8 pmol/l.
   b. High Intensity: At 80% VO2max, beta-endorphin levels significantly rise to approximately 16.1 pmol/l, indicating a curvilinear relationship between exercise intensity and endorphin release.
2) Comparison of Exercise Types

   A study comparing HIIT to moderate aerobic exercise found that HIIT resulted in a more substantial increase in endorphin release, particularly in brain regions associated with pain and reward. Participants reported feelings of euphoria after moderate exercise but experienced negative feelings during high-intensity sessions, suggesting that while endorphin release can enhance mood, it may also be linked to discomfort at higher intensities.
3) Gender Differences

   The response of beta-endorphins appears consistent across genders; however, catecholamine responses (like norepinephrine) show significant gender-related differences, being generally higher in men.
4) Duration of Exercise

   Long-term studies indicate that both aerobic and anaerobic exercises can elevate beta-endorphin levels over time, with anaerobic exercises yielding higher levels than aerobic ones when performed regularly

4. Discussion

This study explored the relationship between exercise intensity, type of exercise, gender differences, and exercise duration on beta-endorphin levels. The findings provide important insights into how beta-endorphins function as mediators in the body's response to physical activity.

1) Intensity and Levels of Beta-Endorphins

   The results showed that there was a curvilinear relationship between exercise intensity and beta-endorphin release. At low to moderate intensity (40% and 60% VO2max), beta-endorphin levels did not increase significantly, with values of about 4.8 pmol/l and 6.3 pmol/l, respectively, compared to resting levels of 3.8 pmol/l1. However, at high intensity (80% VO2max), beta-endorphin levels increase significantly to reach around 16.1 pmol/l. This indicates that in order to achieve a substantial increase in beta-endorphin levels, exercise must be done at a higher intensity level. These findings are in line with previous research that suggests that aerobic exercise performed for more than 30 minutes can significantly increase beta-endorphin secretion (Purnomo et al., 2020). These findings have important implications for coaches and individuals who want to take advantage of the positive effects of beta-endorphins in sports. By understanding that higher exercise intensity can result in increased beta-endorphin levels, exercise programs can be designed to optimize mental and physical health

benefits. However, keep in mind that while HIIT or high-intensity exercise can increase endorphin levels, they can also cause discomfort that may reduce motivation to exercise in the future (Flora et al., 2020).

2) Comparison of Types of Exercises

A comparison between HIIT (High-Intensity Interval Training) and moderate aerobic exercise showed that HIIT resulted in a greater increase in the release of endorphins, especially in areas of the brain associated with pain and reward. Although participants reported feeling euphoric after moderate exercise, they also experienced discomfort during high-intensity sessions. This suggests that although the release of beta-endorphins can improve mood, there is the potential to feel discomfort at higher intensities. Although HIIT increased beta-endorphin levels, participants also reported experiencing discomfort during high-intensity exercise sessions. This suggests the existence of duality in the emotional response to exercise: while the release of beta-endorphins can improve mood, higher intensity can also cause pain or discomfort. Research by Rauchbauer (et al., 2023) notes that at very high exercise intensities, the release of endorphins can be associated with negative feelings and pain, which may be necessary to manage the emotional and physical challenges faced during exercise.

3) Gender Differences

The beta-endorphin response appears to be consistent among the sexes, but the catecholamine response (such as norepinephrine) shows significant gender-related differences, with levels generally higher in men. Previous research has also supported these findings, suggesting that women have a similar beta-endorphin response to men when exercising at high intensity, although their levels tend to be slightly lower under certain conditions. This highlights the importance of considering gender factors in research on hormonal responses to exercise. This may be due to differences in hormonal and metabolic composition between the sexes, where men have stronger sympathetic nervous system responses (Davis et al., 2000).

4) Duration of Exercise

Long-term studies show that both aerobic and anaerobic exercise can increase beta-endorphin levels over time, with anaerobic exercise producing higher levels compared to aerobic exercise when done regularly. These findings indicate that the type and duration of exercise play an important role in the regulation of beta-endorphin levels, as well as the potential long-term health benefits of regular physical activity. This suggests that anaerobic exercise, which involves high-intensity intervals and repetitions, is more effective at stimulating the release of beta-endorphins compared to more stable and sustained aerobic exercise (Schwarz & Kindermann, 1992).

5. Conclusions

This study provides a better understanding of how various factors affect beta-endorphin levels in the body. Increased levels of beta-endorphins are associated with higher exercise intensity and certain types of exercise such as HIIT, as well as suggesting gender differences in hormonal responses. By taking these factors into account, exercise programs can be designed to maximize mental and physical health benefits through proper physical activity arrangements.

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