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Testosterone and Cortisol Hormones Response and Some Functional Variables to Escalated Aerobic Physical Exercise with the Difference of Biological Timing

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Abstract

The current study aimed to: Detect the effect of physical effort of increasing intensity on a number of functional variables: testosterone, cortisol, heart rate, and systolic blood pressure in morning and evening times. As well as detecting the effect of the difference in morning and evening biological timing at times of rest and effort on a number of functional variables: testosterone, cortisol, heart rate, and systolic blood pressure rate. The descriptive approach was used for its suitability for the nature of the study. The sample consisted of (8) individuals selected randomly, aged between (21-23 years) who practiced sports activity. The final experiment was conducted from 14/1/2024 until 18/1/2024 It included conducting two tests on a moving treadmill. The researcher took into account the sequence in which they were conducted in both morning and evening tests. To process the data, The researcher used the T-test to determine the differences.The researcher reached: The physical effort of gradual intensity in the conditions of the morning and evening periods led to a clear increase by observing the value of the arithmetic mean and the standard deviation for the two periods, in the stages of rest and the end of the physical effort, respectively, in the testosterone hormone 7.09 (±1.17)-- 8.97 (±1.80) in the morning, and 5.21 (±1.14)-- 6.16 (±1.86) in the evening, heart rate 70.25 (±6.51)-- 187.25 (±4.02) in the morning, and 69.12 (±4.99)-- 183.00 (±3.11) in the evening, and systolic blood pressure 10.93 (±0.86)-- 14.31 (±2.06) in the morning, and 11.06 (±0.86)-- and 14.56 (±1.14) in the evening. It also physical effort of gradual intensity under conditions of morning and evening periods caused a noticeable decrease in cortisol hormone when moving from rest stage until the end of physical effort. It reached respectively 18.01(±1.38) -- 14.09(±3.87) in the morning, and 5.17(±1.17) -- 3.94(±1.02) in the evening. Biorhythm leads to a noticeable increase in the concentration of testosterone and cortisol in the blood in the morning compared to the evening, by noting the value of the arithmetic means, which reached (morning, evening) (7.09, 5.21) at rest, respectively, and after completing physical effort, they reached, respectively (8.97, 6.16) for testosterone. As for the hormone cortisol, it reached at rest, respectively (18.01, 5.17), while after completing physical effort, it reached respectively (14.09, 3.94). and this achieves one of the sustainable development goals of the United Nations in Iraq which is (Good Health).

Keywords | **testosterone- cortisol –hormones -biological timing- aerobic physical**

Introduction:

Researchers in physiology of sports training in particular and various sciences in general have been studying various phenomena that science has observed in ancient and modern times, research in the field of training physiology is still trying to understand various physiological phenomena in all their aspects related to their nature and changes

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associated with time, biological age, gender and their relationship to environmental variables. Physical exertion, illness, etc. Among those phenomena that we are trying to study are biochemical, respiratory, and functional variables at different times of the day by placing an individual under two influences: the first is physical effort, and the second is the difference in time for performing exercise (difference in biological time). As it is known among specialists in physiology of physical exertion, physical exercise leads to many instantaneous changes that are clearly visible or through the use of some devices to measure these changes that occur in various organs of the body. This effect varies according to the nature of the activity performed or other influences surrounding the individual, whether from external or internal environment, as the activity of each cell of the body varies from one period to another during the day. nervous and hormonal factors and the body's metabolic rate subject to many factors, so their effect on body's organs varies. Many studies have recently indicated that time of day in which exercise is performed affects achieving good physical performance. Physiological processes were studied, including studying the relationship between circadian rhythms and physical performance according to type of activity practiced. Recent randomized studies have indicated that the effect of exercise may vary depending on time of exercise, that is, whether the exercise is performed at morning or evening. As a study (Mirizio & et al, 2020) (9). indicated: To effects of biological timing on performance of short-duration maximal exercise, and study (Teo et al, 2011) (10), which dealt with circadian rhythms in exercise performance: the effects on hormonal and muscle adaptation, the (Hayes et. al, 2010) (4), dealt with interactions of some hormones with resistance training: effect of circadian rhythms. By reviewing these studies, the researcher noticed that there are many variables that may affect performance in one day. There are known and clear rhythms for many body functions, such as blood pressure and pulse, and there are hidden rhythms, such as secretion of various hormones from the endocrine glands. These rhythms come as ripples in the rise and fall of the level of efficiency of vital organs during the daily cycle when working and resting. The change in biological rhythm of many body functions is related to the difference in timing throughout the day, including the activity of the central nervous system, metabolic processes, the work of the circulatory and respiratory systems, body temperature, heart rate speed, effectiveness of muscle contractions, arterial blood pressure, blood pressure dynamics, the maximum rate of oxygen consumption, and the rate increases and decreases of breathing due to changes occurring inside our bodies as a result of secretion of some hormones or changes in metabolic rates and energy production. There is a dynamic change in some physiological characteristics of an individual over the course of (24 hours). The nervous and hormonal system regulates chemical activity of various cells and tissues of the body, which is of great importance for the metabolism process and the completion of other functional processes, as well as adaptation before, during and after processes related to physical activity. Therefore, it is necessary to determine the biorhythm of an athlete's functional systems, as it helps in scientific planning of physical preparation programs, which must coincide with the timing of the athlete's performance of those programs in order to achieve the greatest benefit and bring out the player's latent reserves. Biorhythms during the morning or evening performance affect the efficiency of an athlete's performance, which depends on the time of day in which the sport activity takes place, which can be exploited during planning training programs, and here lies the importance of the research.

Research problem:

Many studies are needed to know the effect of different biological rhythms on humans during the day, over the course of (24) hours, the extent to which human functional systems are affected by them and what are the effects that these changes show at rest and when exercising at different times per day? From what was mentioned above, the

P-ISSN: 1992-0091
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Modern Sport
Vol.23 No.2 ,2024
Published 30/06/2024 Open Access

problem of the study is determined by asking the following questions:

- Does physical effort of escalated intensity (aerobic effort) have a clear effect on hormones such as testosterone, cortisol, heart rate, and systolic blood pressure?
- Does the biological rhythm cycle (biological timing) have a clear effect on the hormones testosterone and cortisol?

Research objectives:

- Detecting the effect of physical effort of escalated intensity on a number of functional variables: testosterone, cortisol, heart rate, and systolic blood pressure during morning and evening times.
- Detecting the effect of the difference in the morning and evening biological timing during rest and effort on number of functional variables: testosterone, cortisol, heart rate, and systolic blood pressure rate.

Research hypotheses:

- There are no significant differences in the effect of physical effort of escalated intensity between rest and effort conditions on a number of functional variables: testosterone, cortisol, heart rate, and systolic blood pressure for morning and evening times.
- There are no significant differences in the morning and evening biological timing during rest and effort conditions on a number of functional variables: testosterone, cortisol, heart rate, and systolic blood pressure.

Research areas:

- Human field: A sample of (8) fourth-year students in the Department of Physical Education and Sports Sciences - College of Basic Education.
- Spatial field: Physiology Laboratory at the College of Basic Education - Department of Physical Education and Sports Sciences at the University of Mosul.
- Time frame: from 24/12/2023 until 12/2/2024.

Method and procedures:

The researcher used the descriptive, comparative method with a one-group design, due to its suitability and the nature of the research problem.

Research sample:

Research sample included (8) individuals from the College of Basic Education - Department of Physical Education and Sports Sciences at the University of Mosul in the fourth stage. Their ages ranged between (21-23 years), and they were selected randomly. The coefficient of variation showed that there is acceptable homogeneity among the individuals in the research sample, table (1) shows some information about the individuals in research sample.

Table .1 It shows the means, deviations, and coefficient of variation for the variables age, weight, height, body surface area, and body mass index

Variables Statistical		*age (year)*	*Height (cm)*	*the weight (kg)*	*Surface area of the body (kg/m²)*	BMI
Sample	*Arithmetic mean*	22.68	173.664	75.328	1.91	24.77
	Deviations	3.14	6.847	6.481	0.118	3.731
	coefficient of variation	13.844	3.942	8.603	6.178	15.062

Table (1) shows the mean, standard deviation, and coefficient of variation for the variables under study. If the value of the coefficient of variation is less than 30%, this indicates the homogeneity of the sample.

The researcher used measurements, tests, and technical devices as means of collecting data, The following devices and tools were used: tread mill device for testing (American-made), a blood pressure measuring device, a sensitive scale for measuring height and weight (Detecto), a pulse oximeter device, a digital thermometer (Thermo-Hygrometer) to measure the temperature and relative humidity, and tapes or CT (American origin) to measure testosterone and cortisol hormones. Mindray, an American hormone

P-ISSN: 1992-0091
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Modern Sport
Vol.23 No.2 ,2024
Published 30/06/2024 Open Access

measuring device, and a stopwatch, and sterilizers were also used.

Description of Measurements and Tests:

Body Measurements:

Height and weight of research sample members were taken using a Detecto-type height and weight measurement) device. The individual stands on the base of the device to measure his weight bare footed, resting his back on a metal pole installed vertically on base of device, the number represents weight of individual in kilograms and is rounded to the nearest 100 g. Then the same person moves a metal plate to touch individual's head, and after fixing it reads the indicator that represents the person's height in centimeters.

Heart Rate (H_R) Measurement:

Heart rate was measured by a Pulse Oximeter device of German origin. The device is placed on the left forefinger of the individual for the laboratory measurements after the device is operated, and then the reading on the screen is taken.

Systolic Blood Pressure Measurement:

Systolic blood pressure was measured by a sphygmomanometer device. The examiner sits on a chair after which the blood pressure measurement is placed around the arm. After that, air is pumped using a manual pump and then the valve opens to slowly remove the air from the cuff. As a result, the blood pressure decreases, and at this decrease, the systolic blood pressure is measured when the pulse is heard for the first time.

Measurement Testosterone and Cortisol Hormones

The two hormones were measured at the time of rest and after exertion using the same mechanism. After blood is drawn from the subject, the blood sample is placed in a Seal Tube and then placed in an incubator at a temperature of (37) degrees Celsius to coagulate. After that, the sample is separated with a centrifuge device for (5 minutes) at a speed of 50,000 rpm, after which the serum is taken and placed in a Hitachi cup device, then the sample is placed in a Mindray hormone device.

Graded Aerobic Physical Stress Test (Bruce Test):

The (aerobic exercise test) in the current study is an application of Bruce protocol. The test begins with a simple load level, then load increases over certain units of time until the test ends when the individual is exhausted.

- **Aim of the test**: to make the individual achieve the maximum value of oxygen consumption ($\dot{V}O_{2max}$).
- **Tools:** a treadmill, a gas analyzer, a mask, and a rubber tube.

- **Test specifications**:

- The individual warms up for (5) minutes, by jogging lightly on the treadmill at a specific speed and incline. Speed (km).
- A rest of (5) minutes is taken.
- The test begins after giving the device operator the command to set a speed and incline, as shown in Table (4).
- When the individual starts running, the timer starts and the stopwatch.
- After every three minutes, we raise the degree of incline and speed, according to a certain protocol.
- The test continues with increasing speed or incline until the individual reaches the stage of exhaustion and fatigue.
- The test stops after the individual reaches volitional stress through a stop button on the computer on the treadmill.

Test specifications: the test consists of seven stages, each stage has a speed and slope, and each stage takes three minutes to perform. Table (2) shows stages of testing: (Al-Hazzaa) (2).

P-ISSN: 1992-0091
E-ISSN: 2708-3454
Modern Sport
Vol.23 No.2 ,2024
Published 30/06/2024 Open Access

Table .2 Shows the phases of the Bruce Protocol test

Testing stages	Time (min)	Speed (Km/h)	Slope (%)
The first stage	1-3	2.7	10 %
The second stage	3-6	4.7	12 %
The third stage	6-9	5.5	14 %
The fourth stage	9-12	6.8	16 %
Fifth stage	12-15	8.0	18 %
Sixth stage	15-18	8.8	20 %
Seventh stage	18-21	9.6	22 %

The Reconnaissance Experiment:

This experiment was conducted on 10/1/2024 to ensure the validity of devices and tools used in the experiment, as well as a simplified explanation for assistant work team about stages in which the experiment will be carried out, training them on devices and tools, how to use them, method of measurement, and distributing the tasks related to the experiment procedures on them, as well as identifying the obstacles that may appear when performing test application procedures, and knowing the approximate time required for the test.

Main Experiment:

The final experiment was conducted from 14/1/2024 until 18/1/2024 and included two tests on a moving treadmill. The first test was conducted on 14/1/2024 from 8:00 to 10:00 am, with an ambient temperature ranging between 22-24 degrees Celsius. The second test was conducted four days after the first test, i.e. on 18/1/2024, from 8:00 until 10:00 pm, with an ambient temperature ranging between 22-24 degrees Celsius. The researcher took into account sequence of the two tests in both morning and evening. tests included the following procedures for each laboratory:

- Drawing blood from subject in a completely resting position before performing the aerobic stress test to of analyze hormones.
- Measuring heart rate at complete rest.
- Measuring systolic blood pressure at rest.
- Giving physical effort (Bruce aerobic exercise test).
- The procedures are repeated in the sequence (1, 2, 3) immediately after the end of the aerobic effort of gradual intensity.

Most Important Procedures that the Researcher Took to Implement the Experiment:

- Ensure the health status of sample members and their safety from all diseases that may lead to a negative impact on the experiment during the experiment's implementation.
- All procedures of the two experiments were identical in terms of their implementation times and the sequence in which they were conducted on sample members.
- Providing the greatest possible protection for sample members while carrying out the two experiments, by allocating a person from the assistant work team to stand behind sample members on the moving treadmill to prevent them from falling from the device.
- Not eating food 3 hours before taking tests in both experiments.
- The two experiments were conducted in morning and evening times under the same conditions in terms of time and place, and the devices and tools used, as well as the sequence of procedures for measuring variables.

Statistical and Computational Means:

The following statistical and computational means were used:

Arithmetic mean, Standard deviation, Coefficient of variation, Paired Sample T-Test, Body Mass Index (BMI).

So, the body mass index = height (in meters) squared / body weight (kg). The Body surface area (BSA) is calculated as: 0.007184 x weight 0.425 x height 0.725.

The data were processed using the statistical package SPSS version (11).

P-ISSN: 1992-0091
E-ISSN: 2708-3454

Modern Sport
Vol.23 No.2 ,2024

Published 30/06/2024 Open Access

Results:

Table .3 shows the arithmetic means, standard deviations, and the T-value calculated for the effect of physical exertion of graded intensity on testosterone, cortisol hormones, heart rate, and systolic blood pressure before and after physical exertion for morning and evening periods.

Variable (measuring unit)	Biological timing	Rest ($\bar{x}$) (σ (±))	after effort ($\bar{x}$) (σ (±))	T- Test	Significance level
Testosterone (ng/ml)	Morning	7.09 (1.17)	8.97 (1.80)	6.140	*0.001
	Evening	5.21 (1.14)	6.16 (1.86)	3.904	*0.006
Cortisol (µg/dL)	Morning	18.01 (1.38)	14.09 (3.87)	4.114	*0.004
	Evening	5.17 (1.17)	3.94 (1.02)	5.528	*0.001
Heart rate ($f.min^{-1}$)	Morning	70.25 (6.51)	187.25 (4.02)	36.107	*0.000
	Evening	69.12 (4.99)	183.00 (3.11)	75.065	*0.000
Systolic blood pressure (mm Hg)	Morning	10.93 (0.86)	14.31 (2.06)	6.148	*0.001
	Evening	11.06 (0.94)	14.56 (1.14)	10.693	*0.001

Significant when error rate < (0.05)

Table .4 shows the arithmetic means and standard deviations and calculated T-value and significance values of the effect of the biological rhythm cycle on testosterone, cortisol hormones, heart rate, and systolic blood pressure before and after exertion between morning and evening times.

Variable (measuring unit)	Nature of work morning (M) – evening (E)	Arithmetic mean & standard deviation	T- Test	Significance level
Testosterone (ng/ml)	Before the effort (M)	7.09 (±1.17)	4.285	*0.004
	Before the effort (E)	5.21(±1.14)		
	After the effort (M)	8.97(±1.80)	4.919	*0.002
	After the effort (E)	6.16(±1.86)		
Cortisol (µg/dl)	Before the effort (M)	18.01 (±1.38)	18.586	*0.001
	Before the effort (E)	5.17(±1.17)		
	After the effort (M)	14.09(±3.87)	7.346	*0.001
	After the effort (E)	3.94(±1.02)		
Heart rate (f.min-1)	Before the effort (M)	70.25(±6.51)	0.420	0.687
	Before the effort (E)	69.12(±4.99)		
	After the effort (M)	187.25(±4.02)	1.151	0.068
	After the effort (E)	183.00(±3.11)		
Systolic blood pressure (mm Hg)	Before the effort (M)	10.93(±0.86)	1.00	0.351
	Before the effort (E)	11.06 (±0.94)		
	After the effort (M)	14.31(±2.06)	0.519	0.620
	After the effort (E)	14.56(±1.14)		

Significant when error rate < (0.05)

Discussion:

Discussing results of the effect of physical effort of graded intensity on testosterone, cortisol hormones, heart rate, and systolic blood pressure before and after physical effort for morning and evening periods.

It is clear from Tables (3) regarding the testosterone variable that there is an increase in the value of these variables when moving from the rest stage, all the way to the end of the physical effort, by noting the calculated (t) value and the significance value, as these results agree with many research studies, including:

The researcher attributes this increase to the effect of physical effort, which is characterized by its increasing intensity, and this has led to an increase in the need for oxygen due to the muscles' need for energy. Thus, the nervous system secretes many hormones, directly or indirectly, to increase muscle mobilization with energy, and this is confirmed by (Kraemer & Ratamess, 2005)

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E-ISSN: 2708-3454
Modern Sport
Vol.23 No.2 ,2024
Published 30/06/2024 Open Access

(Vingren, et al, 2010). Testosterone secretion generally increases when exercising, but gradual-intensity aerobic exercise (aerobic exercise) is considered one of the most effective types of increasing testosterone secretion, for several reasons:

Gradual-intensity aerobic exercise increases physical activity in general, and this leads to an increased secretion of growth hormones, which include testosterone. Aerobic exercise also increases the body's need for energy, and this leads to an increased secretion of adrenaline and noradrenaline hormones, these hormones activate the central nervous and hormonal systems and stimulate secretion of other hormones such as testosterone. Aerobic exercise also increases the body's oxygen consumption, and this leads to increased hormonal stimulation that increases secretion of testosterone. It is important to note that temporarily increasing testosterone secretion after aerobic exercise does not necessarily mean permanently increasing testosterone levels in the body (6). (14).

It is also clear from Table (3), related to the variable of cortisol hormone, that there is a decrease in the concentration of this hormone in the blood when moving from the rest stage, all the way to the end of physical effort, by noting the calculated (t) and the statical values. This can be explained according to what was mentioned by McArdle et al. (2015), where they confirm that when practicing physical exercise, another hormone called endorphins is secreted, and this hormone works to reduce the level of cortisol in the body. This is done by activating the central nervous system, which stimulates the adrenal gland to secrete smaller amounts of cortisol into the body (8). This is also confirmed by many researchers: Hill et al. (2008), Hackney & Koltun (2012), Mastorakos & Pavlatou (2005), Viru et al. (1992) as they indicated that the cortisol hormone decreases after physical exercise of graded intensity. (Aerobic exercise) is a result of several factors:

The level of the cortisol hormone decreases immediately after ending exercise due to stimulation of the sympathetic nervous system, which works to regulate vital functions in the body and controls secretion of various hormones, including cortisol. When the sympathetic nervous system is stimulated, the autonomic nervous system is activated, which regulates basic body functions such as heart rate, blood pressure, breathing, digestion, and hormonal secretion. Stimulating sympathetic nervous system helps regulate cortisol levels in the body and improves its secretion and metabolism.

After the end of exercise, the level of cortisol hormone is directly reduced as a result of stimulating the sympathetic nervous system, which works to regulate the level of cortisol in the blood and reduce it to normal levels. Therefore, it can be said that the decrease in the cortisol hormone directly after the end of exercise reflects the activity of the sympathetic nervous system and its stimulation to control various body processes. It also stimulates the production of happiness hormones known as endorphins, hormones that work to reduce cortisol levels in body and improve mood and feelings of comfort. (5). (3). (7). (15).

It is also evident from Table (3) regarding the heart rate variable that there are significant differences when moving from the rest stage, all the way to the end of physical effort, by noting the calculated (t) and statistical values. This can be explained by the fact that heart rate increases significantly after exercise or intense effort, and the increase in heart rate after effort depends on the intensity of effort, duration, and type of exercise. When exercising or exerting intense effort, the body needs to increase the supply of oxygen and food to the muscles used, and this requires an increase in heart rate. When muscles are exercised intensely, nerve signals are sent from the muscles to the central nervous system to promote more blood, oxygen, and food for working muscles and so the heart rate is naturally accelerated to cope with this increased demand. This is caused by the nervous system that controls heart rate, especially the sympathetic

P-ISSN: 1992-0091
E-ISSN: 2708-3454
Modern Sport
Vol.23 No.2 ,2024
Published 30/06/2024 Open Access

nervous system that controls basic body functions such as heart rate, blood pressure, and breathing (1) (Al-Dabbagh et al.). As can be seen from Table (3) regarding the systolic blood pressure variable, there are significant differences when moving from the rest stage, all the way to the end of physical effort, by noting the calculated (t) and statistical values. This increase is attributed to the fact that when practising physical exercise, the body needs to increase blood flow to working muscles to meet their needs for oxygen and nutrients. To achieve this, the cardiovascular system increases heart rate and the force of blood pumping from the heart to arteries, which leads to an increase in systolic blood pressure (13) (Vandergriendt, Carly). In addition, exercise increases the secretion of hormones such as adrenaline and noradrenaline, which contribute to increased systolic blood pressure. These hormones stimulate the sympathetic nervous system, which contributes to increasing heart rate and force of blood pumping (5) (Hill et al., 2008). In addition, during exercise of graded intensity, increased venous return of blood expands large veins, stimulating the pacemaker, which will spread the action potential throughout the entire atrial muscle mass. This will lead to an increase in heart rate and force of heart contraction, which increases the amount of blood pushed to muscles, and thus pressure on the walls of blood vessels increases and the systolic pressure increases (1) (Al-Dabbagh et al.).

Discussing results of the effect of biological rhythm cycle on testosterone, cortisol hormones, heart rate, and systolic blood pressure before and after exertion between morning and evening times.

It is clear from Table (4) regarding the testosterone variable that there is an increase in the concentration of this hormone in the blood when comparing this variable between morning and evening periods, whether these measurements are (pre-pre) and (post-post), and in favor of the morning period by noting the calculated (t) value and the significance value. The researcher attributes this increase to the effect of the biological rhythm cycle, where the concentration of this hormone increases in the morning and gradually decreases until it reaches its lowest level in the evening. This is confirmed by Hayes et al. (2010), Teo et al. (2011), Urbanski (2011), who stated that the percentage of testosterone is higher in the morning than in the evening due to natural rhythm of the biological clock for hormonal regulation in the body.

Circadian rhythm plays a role in this feedback loop, as the body produces more testosterone during the early morning hours, and it gradually decreases throughout the day, reaching its lowest point in the evening. In the early morning, testosterone levels rise in the blood due to the natural activity of the sympathetic nervous system, which controls the body's functions during the waking period. This system stimulates the pituitary gland in the brain to secrete testosterone, while in the evening testosterone levels naturally decrease due to a reduction in the natural activity. For the sympathetic nervous system. The body also begins to prepare for sleep and other hormones are secreted, such as melatonin, which works to calm the body and stimulate sleep.

The nervous system and endocrine glands control the regulation of the body's hormones by issuing signals to the pituitary gland to secrete luteinizing hormone (LH) and follicle-stimulating hormone (FSH). These hormones then stimulate the testicles in males to produce testosterone. However, hormone secretion is regulated through a complex feedback loop. When testosterone levels become too high, the hypothalamus and pituitary gland sense this and reduce the secretion of LH and FSH, which in turn lowers testosterone levels. Conversely when testosterone levels become too low the hypothalamus and pituitary gland increase the secretion of LH and FSH, which leads to increased testosterone production. In addition, external factors such as nutrition, sleep, exercise, and stress can affect testosterone levels in the body. These factors can vary between morning and

P-ISSN: 1992-0091
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Modern Sport
Vol.23 No.2 ,2024
Published 30/06/2024 Open Access

evening and affect hormone levels in the blood. (4). (10). (12).

It is also clear from Table (4) regarding the variable of the cortisol hormone that there is an increase in the concentration of this hormone in the blood when comparing this variable between the morning and evening periods, whether these measurements are (pre-pre) and (post-post), and in favour of the morning period. By observing the calculated (t) and the significance values, the researcher attributes this increase to the effect of the biological rhythm cycle, where the concentration of this hormone increases in the morning and gradually decreases until it reaches its lowest level in the evening. This is confirmed by Hayes et al. (2010) (4), Thau, L., Gandhi, G., and Sharma, S. (11).

The concentration of cortisol hormone in the blood differs in the morning period from that in the evening due to many different physiological factors that affect the secretion of the hormone. Early in the morning, levels of the cortisol hormone rise in the blood due to the natural activity of the sympathetic nervous system, which controls the body's functions while being awake. This system stimulates the adrenal gland in the kidneys to secrete the cortisol hormone. In the evening, cortisol levels naturally decrease due to the reduced natural activity of the sympathetic nervous system. The body also begins to prepare for sleep, and other hormones are secreted, such as melatonin, which works to calm the body and stimulate sleep. In addition, external factors such as nutrition, sleep, exercise, and stress can affect the levels of the cortisol hormone in the body. These factors can vary between morning and evening and affect the levels of the hormone in the blood. In general, an accurate physiological explanation for this phenomenon depends on many different physiological factors that affect the secretion of the cortisol hormone in the body, which differ between morning and evening. Generally, the relationship of the endocrine glands with the central nervous system depends on many different factors and is affected by many different diseases, medications, and environmental factors. It is important to understand this relationship and its impact on the body's health and functions. (4). (10). (11).

As shown in Table (4) for heart rate variable, there are no significant differences between measurements (pre-pre) (post-post) by observing calculated (T) and statistical values, the pre-test values of (T) test for both periods regarding heart rate were (0.420) with a significant value (0.687), while the post-test values of (T) test for both periods regarding heart rate were (1.151) with a significant value (0.068).

It is also evident from Table (4) for systolic blood pressure variable that there are no significant differences between measurements (pre-pre) (post-post) by noting calculated (T) and significance values. pre-test values of (T) test for both periods regarding systolic blood pressure were (1.00) and a significant value (0.351), while post-test values of (T) test for both periods regarding systolic blood pressure were (0.519) and a significant value (0.620).

Conclusions:

The physical effort of gradual intensity under conditions of morning and evening periods produced a noticeable increase when moving from the rest stage until the end of physical effort in testosterone, heart rate, and systolic blood pressure. In contrast, the physical effort of gradual intensity under conditions of morning and evening periods caused a noticeable decrease in cortisol hormone when moving from the rest stage until the end of physical effort.

Furthermore, biological rhythm leads to a noticeable increase in the concentration of testosterone and cortisol hormones in the blood under conditions of the morning period compared with the evening period. In contrast, biological rhythm did not cause a significant increase in heart rate and systolic blood pressure under morning conditions compared to evening conditions.

Recommendations:

- Educating fitness and weightlifting centers about exercising during the morning due to the increase

P-ISSN: 1992-0091
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Modern Sport
Vol.23 No.2 ,2024
Published 30/06/2024 Open Access

in the hormone's cortisol and testosterone during this period and the important functions performed by these two hormones, which help in the process of muscle growth and increase energy mobilization for working muscles. Using different effort protocols by increasing the time of physical effort to see the effect of this on research variables more clearly.

- Conducting other studies on the current study variables at different times of the day.
- Conduct other studies by comparing males and females in these variables.

Author's declaration:

Conflicts of interest: None

We confirm that all tables and figures in this article are ours and written by the researchers themselves.

Ethical-Clearance: this manuscript approved by local ethical committee of physical education and sport sciences college for women on (March /2024)

Author's contributions:

All contributions of this study were done by the researcher (O. A.) who get the main idea and work on writing and concluding also with number of experts, Bassam Ali Mohammed Amin (Department of Physical Education / Basic Education College / Mosul University) in Statistics, Aida AL-awamleh in revision, Inaam Ghalib in translating, Ibrahim Dabayebeh in proofreading

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References:

1. Aldabagh, A., & Jasem Alhyali, A. (2019). Responses of the Respiratory Ventilation and Certain ECG to the VO2 Percentage in two Aerobic Stresses depending upon Resistance and Speed. Al-Rafidain Journal for Sport Sciences, 22(69), 1-46. doi: 10.33899/rajsport.2019.163015
2. Al-Hazzaa, Hazza bin Muhammad (2009): Physiology of Physical Effort, Theoretical Foundations and Laboratory Procedures for Physiological Measurements, Part $_2$, King Saud University, Riyadh, p484.
3. Caplin, A., Chen, F.S., Beauchamp, M.R., Puterman, E. (2021). The effects of exercise intensity on the cortisol response to a subsequent acute psychosocial stressor, Psychoneuroendocrinology, Volume 131, ISSN 0306-4530, p.(6) p.p 2-10. https://doi.org/10.1016/j.psyneuen.2021.105336
4. Hayes, L. D., Bickerstaff, G. F., & Baker, J. S. (2010). INTERACTIONS OF CORTISOL, TESTOSTERONE, AND RESISTANCE TRAINING: INFLUENCE OF CIRCADIAN RHYTHMS. Chronobiology International, 27(4), 675–705. https://doi.org/10.3109/07420521003778773
5. Hill, E. E., Zack, E., Battaglini, C., Viru, M., Viru, A., & Hackney, A. C. (2008). Exercise and circulating cortisol levels: the intensity threshold effect. *Journal of endocrinological investigation*,31(7),587–591. https://doi.org/10.1007/BF03345606.
6. Kraemer, W. J., & Ratamess, N. A. (2005). Hormonal Responses and Adaptations to Resistance Exercise and Training. Sports Medicine, 35(4), 339–361. https://doi.org/10.2165/00007256-200535040-00004
7. Mastorakos, G., & Pavlatou, M. (2005). Exercise as a stress model and the interplay between the hypothalamus-pituitary-adrenal and the hypothalamus-pituitary-thyroid axes. *Hormone and metabolic research = Hormon- und Stoffwechselforschung = Hormones et metabolisme*, 37(9), p.577, 577–584. https://doi.org/10.1055/s-2005-870426.
8. McArdle, W. D., Katch, F. I., & Katch, V. L. (2010). *Exercise physiology*: Nutrition, energy, and human performance. Lippincott Williams & Wilkins , p. 412.
9. Mirizio, G. G., Nunes, R. S. M., Vargas, D. A., Foster, C., & Vieira, E. (2020). Time-of-Day Effects on Short-Duration Maximal Exercise Performance. Scientific Reports, 10(1). https://doi.org/10.1038/s41598-020-66342-w
10. Teo, W., Newton, M. J., & McGuigan, M. R. (2011). Circadian rhythms in exercise

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performance: implications for hormonal and muscular adaptation. *Journal of sports science & medicine*, 10(4),p.p 601–603. https://www.jssm.org/jssm-10-600.xml%3EFulltext

11. Thau, L., Gandhi, G, Sharma, S.(29-8-2022). *Physiology, Cortisol*, This article is taken from Physiology, Cortisol - StatPearls - NCBI Bookshelf (nih.gov) .
12. Urbanski H. F. (2011). Role of circadian neuroendocrine rhythms in the control of behavior and physiology. *Neuroendocrinology*, 93(4), p.218. 211–222. https://doi.org/10.1159/000327399.
13. Vandergriendt, Carly (10/2/2023). *How Does Exercise Affect Blood Pressure*, Retrieved from:https://www.healthline.com/health/blood-pressure-after-exercise .
14. Vingren, J. L., Kraemer, W. J., Ratamess, N. A., Anderson, J. M., Volek, J. S., & Maresh, C. M. (2010). Testosterone physiology in resistance exercise and training: the up-stream regulatory elements. Sports medicine (Auckland, N.Z.), 40(12), 1037–1053. https://doi.org/10.2165/11536910-000000000-00000
15. Viru, A., Karelson, K., & Smirnova, T. (1992). Stability and variability in hormonal responses to prolonged exercise. International journal of sports medicine, 13(3), 230–235. https://doi.org/10.1055/s-2007-1021259

استجابة هرمونات التستوستيرون والكورتيزول وبعض المتغيرات الوظيفية للتمرينات البدنية الهوائية المكثفة مع اختلاف التوقيت البيولوجي

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مستخلص البحث

هدفت الدراسة الحالية إلى: الكشف عن تأثير الجهد البدني ذي الشدة المتزايدة على عدد من المتغيرات الوظيفية: التستوستيرون، الكورتيزول، معدل ضربات القلب، وضغط الدم الانقباضي في أوقات الصباح والمساء. وكذلك الكشف عن تأثير اختلاف التوقيت البيولوجي في فترتي الراحة والجهد على عدد من المتغيرات الوظيفية: التستوستيرون، الكورتيزول، معدل ضربات القلب، وضغط الدم الانقباضي. استخدم المنهج الوصفي لملاءمته لطبيعة الدراسة. تكونت العينة من (8) أفراد تم اختيارهم عشوائياً، تتراوح أعمارهم بين (21-23 سنة) ويمارسون النشاط الرياضي. أجريت التجربة النهائية في الفترة من 2024/1/14 إلى 2024/1/18 وشملت إجراء اختبارين على جهاز الجري المتحرك. أخذ الباحث بعين الاعتبار التسلسل الذي أجريت فيه الاختبارات في كل من فترتي الصباح والمساء. لمعالجة البيانات، استخدم الباحث اختبار **T** لتحديد الفروقات. توصل الباحث إلى: أن الجهد البدني ذو الشدة المتدرجة في ظروف فترتي الصباح والمساء أدى إلى زيادة واضحة من خلال ملاحظة قيمة المتوسط الحسابي والانحراف المعياري للفترتين، في مراحل الراحة ونهاية الجهد البدني، على التوالي، في هرمون التستوستيرون 7.09 (±1.17) -- 8.97 (±1.80) في الصباح، و 5.21 (±1.14) -- 6.16 (±1.86) في المساء، ومعدل ضربات القلب 70.25 (±6.51) -- 187.25 (±4.02) في الصباح، و 69.12 (±4.99) -- 183.00 (±3.11) في المساء، وضغط الدم الانقباضي 10.93 (±0.86) -- 14.31 (±2.06) في الصباح، و 11.06 (±0.86) -- 14.56 (±1.14) في المساء. كما أن الجهد البدني ذو الشدة المتدرجة تحت ظروف فترتي الصباح والمساء تسبب في انخفاض ملحوظ في هرمون الكورتيزول عند الانتقال من مرحلة الراحة حتى نهاية الجهد البدني. بلغ على التوالي 18.01(±1.38) -- 14.09(±3.87) في الصباح، و 5.17(±1.17) - 3.94(±1.02) في المساء. يؤدي النمط البيولوجي إلى زيادة ملحوظة في تركيز هرموني التستوستيرون والكورتيزول في الدم في الصباح مقارنة بالمساء، من خلال ملاحظة قيمة المتوسطات الحسابية، التي بلغت (الصباح، المساء) (7.09، 5.21) في الراحة، على التوالي، وبعد إتمام الجهد البدني بلغت على التوالي (8.97، 6.16) لهرمون التستوستيرون. أما بالنسبة لهرمون الكورتيزول، فقد بلغ في الراحة على التوالي (18.01، 5.17)، بينما بعد إتمام الجهد البدني بلغ على التوالي (14.09)، 3.94. وهذا ما يحقق احد اهداف التنمية المستدامة للامم المتحدة في العراق (الصحة الجيدة).

الكلمات المفتاحية | **هرمون التستوستيرون ، الكورتيزول ، الهرمونات ، التوقيت البيولوجي ، الهوائية البدنية**