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INFLUENCE OF DIET (LE PANSE METHOD) AND RELAXATION ON THE FUNCTIONAL STATE OF PEOPLE WITH DIFFERENT LEVELS OF PHYSICAL FITNESS: PHYSIOLOGICAL JUSTIFICATION

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Aim. To analyze such means of impact on the body as balanced nutrition and psychophysical self-regulation techniques from a physiology perspective. **Materials and Methods.** The paper covers the data of multi-year research involving the participants of different age and levels of physical fitness. The study used analytical review of the modern academic literaure and psycho-physiological methods: electroencephalography, electrocardiography, and recording of neurodynamic indicators. **Results**. Features of metabolism influenced by various types of nutrition are analyzed; metabolic effects produced on the hormone activity at different phases of circadian rhythms are described. It is shown that psychophysical relaxation exercises have a positive impact on the functional state of the heart and central nervous system in athletes and people not engaged in sports. The results allowed the authors to give exact recommendations on the balanced nutrition and relaxation exercises, for athletes as well. **Conclusion.** The effective means of the functional state control are impacts on the hormone system (balanced diet) and central nervous system (psychophysical relaxation system).

Keywords: *metabolism, hormones, circadian rhythms, functional state, psychophysical self-regulation, heart, central nervous system, relaxation.*

Introduction. In order to succeed in sports you should comply with the principles of balanced nutrition and self-regulation of the functional state.

The functional state may be corrected with the help of special techniques, generally based on relaxation exercises [1, 27]. Balancing your diet means having the appropriate amount of proteins, carbohydrates, lipids, adapted to a regular sports practice or any of your activities; and ingesting a little of everything, with individualized quantities [19].

The contribution of food energy before, during and after physical effort, as well as the combination of periods of strain and relaxation, is essential in terms of performance. The everyday basic notions of health, customization, and performance depend on a varied, simple and balanced diet, in order to provide the body with all it needs at a particular time [11, 31]. We also have to take into account thoughts on the importance of recovery time, the development of specific protocols, initiating weight loss plans, preparing to reach a goal at a given date. However, any recommendations or guidelines should be individual. No diet or relaxation can replace an individual follow-up composed of questioning, biological tests, and laboratory tests.

Each individual, regardless of his experience or level, can suffer from factors of sustained stress, either mental or physical. The diet rebalancing, for athletes or non-athletes, must be combined with a psychophysical regulation of one's state. The approach to lose weight has to be gradual and controlled [18]. No total deletion of foods. Too many injuries or sudden moments of grogginess are due to bad nutrition, daily and/or before, during and after an effort. Athletes should be warned to the necessity of balancing their diet in order to improve their performances, push back the fatigue limit, and constantly keep in mind the notion of pleasure, throughout the sports training.

The practice of psychophysical self-regulation of the functional state is far ahead of theory; for example, there are a lot of techniques allowing the impact on the human body. However, the basic knowledge of psychophysiological mechanisms of these techniques has not been obtained yet. Thus, it is absolutely necessary to conduct a thorough study of these mechanisms with a particular attention to the individual features and peculiarities of a person, including the level of his/her physical fitness [21].

In the literature there are many recommendations on the balanced diet at physical loads.

However these recommendations are very general and do not take into account that the glandular activity as well as the properties of hormones depend on the circadian rhythm to the same extent as other functions of the body do [2]. A simple and balanced diet should be developed in order to provide the body with all it needs at the particular time.

So, the formulated problem concerns the study of the mechanisms associated with changes in the functional state after intensive physical loads; correlation and interdependency of central and hormone influences are of especial interest. Solving this problem will help in scientific justification of the psychofunctional state control means.

Aim of the research is to analyze such means of impact on the body as balanced nutrition and psychophysical self-regulation techniques from a physiology perspective.

Applied methods included both experimental studies of psychophysiological features of participants and a detailed analysis of psychophysiological data from the literature for the last 15 years. Psychophysiological examinations involved electrocardiography, electroencephalography, and recording of neurodynamic indicators. The analysis of metabolism influenced by various types of nutrition considered the specific of its impact on hormone activity at different phases of the circadian rhythm.

Physiological analysis of the balanced diet considering the circadian rhythm of hormone activity. *Hormones*are chemical messengers that relay messages to cells, information that harmonizes organism responses. Physical activity and food are the source of a stimulation or inhibition of all the hormones, whatever their function [13]. The hormonal process is very complex, especially since each hormone interacts with the others antagonistically or synergistically [22]. Hormones which are essential in metabolism and the day/night cycle of which is understood are cortisol, growth hormone, and insulin.

The circadian rhythm can be disturbed by time difference and by a fat-rich diet that disrupts sleep and therefore brings the production of a hormone: adiponectin. This latter plays a main role in the storage of lipids by regulating fat burning via an insulin sensibility increase, thus generating the fat storage.

It is known that when *cortisol* is taken as a drug, with doses far higher than physiological standards, it has an action on mineralocorticoids that enhances water retention. Cortisol secretion thus follows a rhythm called circadian rhythm. The maximal peak is situated between 6 am and

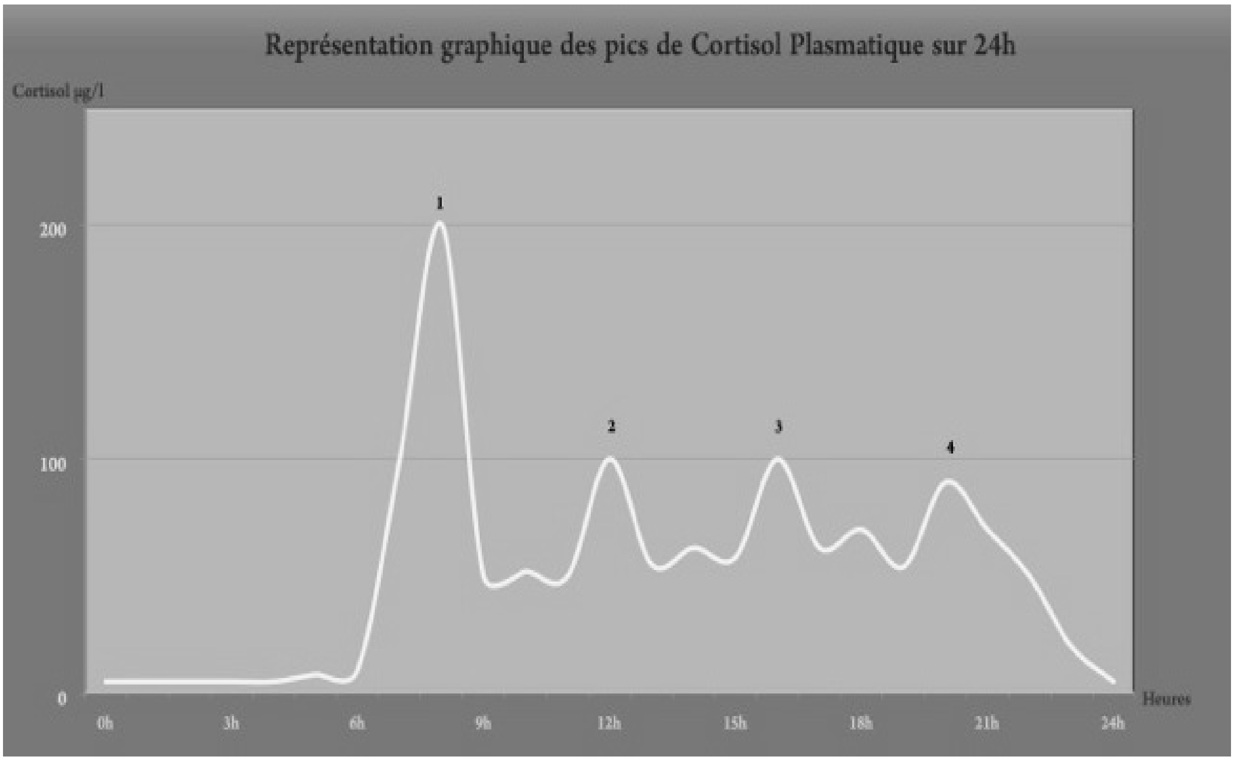


Fig.1. Cortisol variation in a day (in µg/l). E.Herduin, 2014

8 am, and then decreases until it becomes very low in the middle of the night before increasing again to reach a new peak the following morning around 8 am. Therefore, on a typical day, this cortisol is very high in the morning but also shows other lower peaks between 12 am, 4 pm, and 8 pm. The most important peaks arise during meals, snack included, and is maintained even if we skip a meal (Fig. 1).

Cortisol increases the formation of enzymes called proteases, thus increasing the catabolism of muscle tissue proteins with release of amino acids in the blood. Moreover, this hormone reduces the transfer of amino acids to the cells, except for the liver: as a result, there is an increase of amino-acids in the blood and in the liver, which brings a stimulation of gluconeogenesis from amino-acids. To sum up, cortisol, especially in the morning, causes a protein loss in favor of glucose synthesis, or in other words sugar formation [6]. Naturally, it is therefore important to have a food intake rich in proteins for breakfast, which will help avoid the proteolytic action of cortisol (catabolism).

Cortisol increases blood sugar from 8 am, even if the person does not eat, both because of gluconeogenesis (formation of glycogen by amino-acids) and hydrolysis of hepatic glycogen (destruction of sugar reserve in the liver). This blood sugar-elevating effect of cortisol is synergistic with the adrenaline and glucagon action. Carbohydrates intake will favor a decrease of the gluconeogenesis. Cortisol activates enzymes called lipases, triggering a lipolysis with a release of free fatty acids and glycerol. Therefore, lipids intake in the morning decreases the lipolytic action and these fats will allow, the following night, the repair of cellular membranes that help the hormonal system to work properly. Indeed, the cellular membranes are made of a phospholipid layer; when fed by the proper lipid intake, it is this layer which will allow your hormonal system to work properly, depending on the essential needs of the body [10].

*Insulin*is a hormone that, along with glucagon, has a major role in the control of energetic substrates, principally glucose, fatty acids and ketones (breakdown of fatty acids in order to obtain carbohydrates which are in insufficient number).The major role of insulin is the glucose-lowering effect it brings (lower the blood glucose). This insulin is secreted according to the nutrient status and to the physical activity. Insulin will stimulate the activation of enzymes essential to the uptake of glucose from blood into cells and energy production (glycolysis).

Insulin usually stimulates the gluconeogenesis, which is the process of glycogen synthesis, in which glucose molecules are transported to both liver and muscles to be used as energy or stored as glycogen. After a meal, insulin is stimulated by the elevation of blood sugar levels but also under direct influence of presence of food in the digestive tract; this allows glucose storage, ultimate product of carbohydrate foods digestion. When there is abundance of food, insulin stimulates the conversion of fatty acids, to store them in the fat tissue. In this food excess situation, after the meal, insulin blocks glucose production by the liver. Blood glucose levels are reduced, thanks to glucose storage and the stop of glucose production by the liver.

Between meals, the insulin secretion decrease allows the release of glucose reserves (hepatic glycogenolysis) and once more the formation of glucose in the liver (gluconeogenesis). During a prolonged fast, insulin decrease will cause the production of ketone bodies, derivatives of fatty acids in the adipose tissue cells [26].

Insulin also inhibits the protein degradation and enhances amino-acids uptake; this hormone decreases lipases activity (enzymes that help in the digestion of fat).Insulin inhibits lipolysis and stimulates lipogenesis, in other words, the formation of triglycerides from fatty acids. Hence it helps fat storage. Insulin has immediate results on the flow regulation of energetic substrates, but it also shows long term results on growth: it is an anabolic hormone.

The insulin's circadian rhythm is studied only in few scientific works. Moderate hyperglycaemia, caused by cortisol, is followed by an insulin peak around 9 am. Its secretion is thus delayed compared to that of cortisol. The highest peak of insulin is around 2 pm. At snack time (4–6 pm) and around 8–9 pm, the peaks are lower, almost non-existent. Insulin rises usually start before meals, probably under the influence of small cortisol peaks. Hypothalamic Glucose Sensing, responsible for hunger pangs, is probably stimulated by hypoglycaemia brought by the primary insulin secretion.

Besides the insulin secretion fluctuations, a second important factor emerges because of its effect on carbohydrates: variations in sensitivity of hormone receptors. Indeed, in the morning those receptors are sensitive: So that's when risks of hypoglycaemia are the highest, even though insulin secretion is low (cases of hypoglycaemia around 11 am for those who have a very light breakfast or no breakfast at all). 2 pm is the time when the most important insulin secretion occurs: receptors are not very sensitive. For that reason, a meal less rich in carbohydrate than in the morning is recommended (which does not mean no carbohydrates at all!). At 8 pm, carbohydrates needs are minimal because the insulin peak is smaller and receptors are resistant.

Insulin as we saw it is also the hormone of lipogenesis. This lipogenesis occurs during the day. At night, blood insulin levels being at the lowest, the opposite occurs: lipolysis. This lipogenesis takes places in the adipocyte, and the substrate at the origin of its development is glucose. Nevertheless, carbohydrate intakes adapted to insulin response in the morning, at lunch time, or at snack time (around 4-5 pm), represent a significant source of energy, and therefore won't be useful for lipogenesis [5]. In the evening energetic needs are low; an important carbohydrate intake results in a strong lipogenesis that the lipolysis occurring at night will not be able to compensate, and will consequently cause weight gain. However, depending on the intensity of training and of the aims of each athlete, the carbohydrate intake does not necessarily result in weight gain. For instance, if the carbohydrate intake occurs within one hour following the training, the carbohydrates will be treated by an enzyme which will transform them into glycogen which will not be stored (of course, quantities have to be determined according to each person).

So as far as proteins are concerned, all year long insulin works in opposite manner to cortisol, it increases the transfer of amino acids across membranes and acts like an anabolic agent (Fig. 2).

Growth hormone is usually called GH or also ST (Somatotropin hormone). This growth hormone secretion is pulsatile: there are peaks during the night, mainly after falling asleep (during the slow wave sleep phases); during the day also, there are spontaneous peaks or favored by different stimuli such as stress, training, hypoglycaemia. Growth hormone effects are anabolic, and reflect the 3 metabolisms: protein, carbohydrate and lipid [34]. If calorie restriction is reduced, the production of IGF-1 (insulin-like growth factor-1) is reduced and the level of GH increases, which reduces anabolism. Indeed, when the calorie intake is small, growth hormone levels increase, but the production or the IGF-1 and insulin does not increase. In that case, the role of the GH is to allow an energetic use of fat, with no impact on muscular growth.

On the contrary, if the calorie intake is high, the production of GH will bring an increase

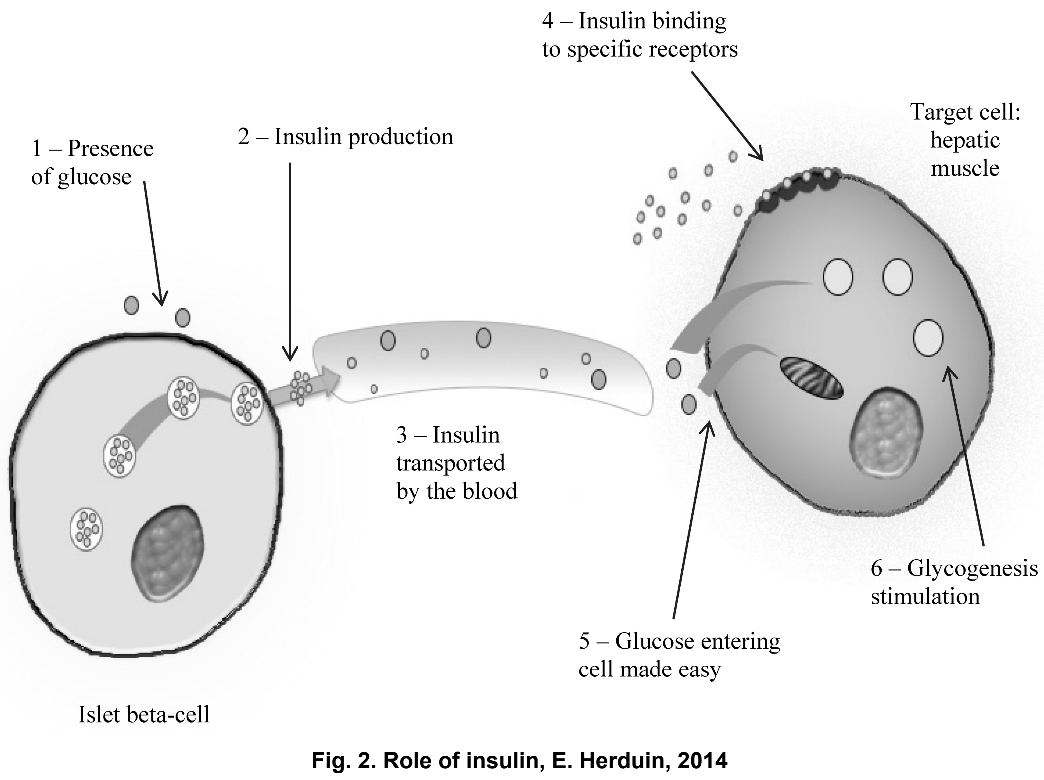


Fig. 2. Role of insulin, E. Herduin, 2014

of IGF-1 and insulin levels. On this basis, the role of the GH will increase your anabolism, and consequently your muscle mass [25]. In general, the GH raises glycaemia. It's called a diabetogenic effect, it is therefore blood sugar-elevating. The GH inhibits carbohydrate oxidation in the cells. It enhances the glycogen breakdown into glucose (glycogenolysis) and inhibits glycogenesis.

This hormone induces lipolysis, which means it increases the release of free fatty acids (FFAs) by adipocytes (fat cells), and their oxidation, in order to feed the body's energy needs. The GH peak occurs around 2-3 am. It's during the night that GH stimulates the repair of phospholipids in cell membrane and increases cell multiplication around 1 am.

Based on these scientific data, food rebalancing should be adapted to the biological rhythms of these 3 main hormones which also have a significant impact on thyroid hormones that are responsible for regulation of metabolism (Fig. 3).

Breakfast should include a portion of slow carbohydrates but no high glycemic carbohydrates: bread, cheese, butter, deli meats, and eggs. This food will be well used as fuel for the body. Enzymatic activity, triggered in the morning between 6 and 8 am, will help the body to correctly metabolize food and transport it for cell repair. This food will also help prevent the increase of insulin and the 10 am drowsiness.

For lunch it is recommended to have a portion of meat and carbohydrates, calculated depending on your needs and your sport activity. At lunch avoid fruits and any sweet foods. Indeed, the risk of eating a food with a high glycemic index after the meal will increase insulin level, which will be followed by drowsiness (the famous "tired after a meal because of digestion").

It is necessary to consider the development of fatigue especially if the training is after the meal. The aim of rebalancing is to manage healthy blood sugar level continuously, all day long. If the insulin level quickly raises due to the sugar consumption a drop will follow as sugar calls for more sugar. In this case insulin may not function properly. High blood sugar levels are better to be maintained at 4–5 pm.

The evening meal should include a portion of meat or fish together with cooked vegetables. If a training takes place in the evening it is better to replace cooked vegetables by a legume. Legume bring less carbohydrate intake than starches,

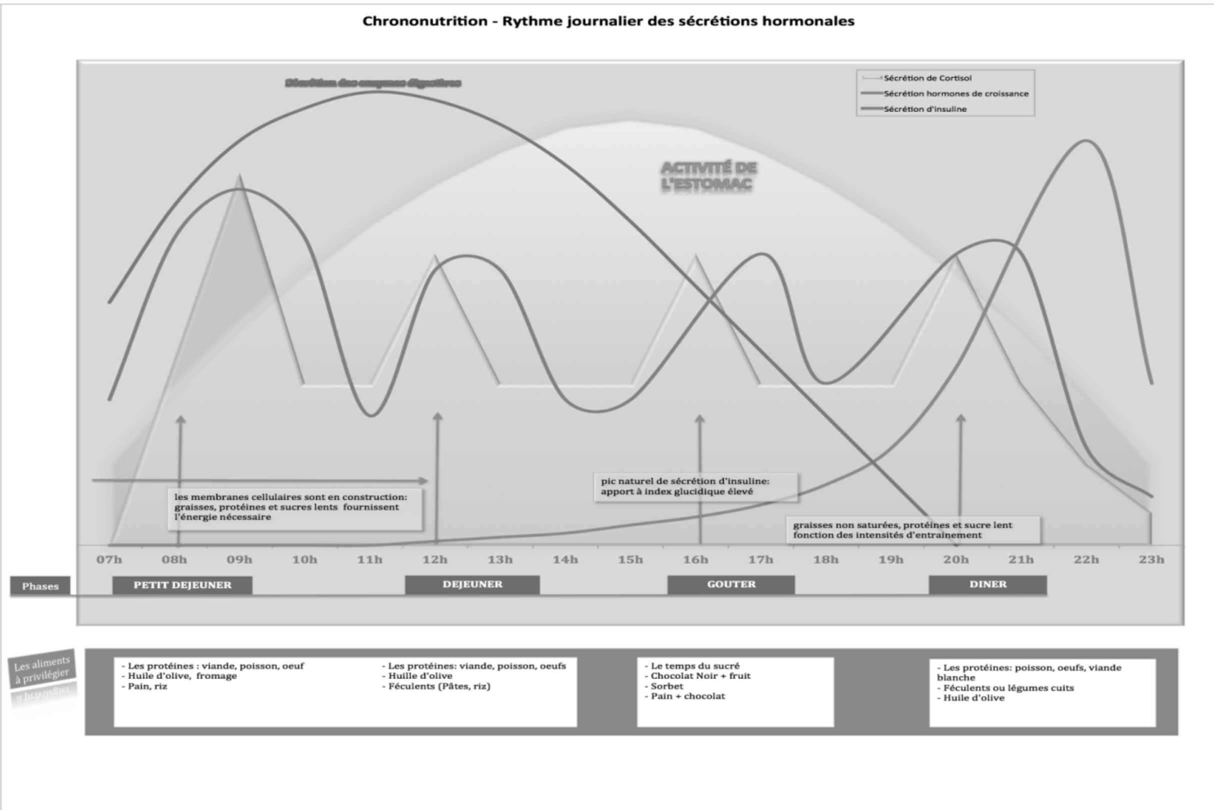


Fig. 3. Hormone rhythms and metabolism. (E. Herduin, 2014)

but will trigger the transformation of sugar reserve you have spent during training (glycogen).

During training a snack is welcomed. If the training happens a long time before or after meals then, about 45 minutes before the training it is recommended to have a snack containing proteins and carbohydrates (depending on your activity and its intensity) – for instance, bread with a slice of chicken.

After training it's important to reload your body with the sugars it lost during training: an enzyme is secreted at the end of your training – glycogen synthase that prevents the consumed nutrients from being stored in the body, but provides the fast recovery.

Hormonal system and physical activity. Physical activity is being accompanied by an adaptation of the different functions involved in the energy metabolism. Hormones are known to play an important role in these different adaptations in order to bring enough substrates to the muscles, especially to muscle fibers [8, 21]. The energy necessary for contraction comes from the adenosine triphosphatase (ATP). For short-duration workouts, it is the degradation of sugars that will provide energy (glycolysis), as long as glucose and glycogen reserves (in liver and muscle) are not depleted. During longer workouts, and to spare minimum glycogen reserves, the lipids will intervene.

So during workout, and depending on its duration, the energy comes from glycolysis, then from glycogenolysis, then from lipolysis, and finally from gluconeogenesis. All these metabolic chains involve hormones which operate in the liver, to increase glycogenolysis and gluconeogenesis, in order to maintain a normal blood glucose level even though it is being captured by muscles [17, 37]. Hormones also operate in the lipolysis (fat cells) to increase free fatty acids and their use [20].

As we have seen above, *insulin* impacts on two target organ: the liver and the muscles. It inhibits the breakdown of glycogen into glucose (glucogenolysis) and it triggers glycogenesis. Its effects are the opposite of those of glucagon, another hormone, with blood sugar elevating effect [31]. During workout, level of insulin in the blood declines to increase glycolysis. Glucagon level, on the other hand, increases. These two hormones help keep blood sugar levels balanced, through exercise consistent with a balanced diet (Table 1).

The adrenal medulla produces: the catecholamines, noradrenaline and adrenaline. The adrenal cortex produces 3 types of steroid hormones: mineralocorticoids (aldosterone), glucocorticoids (cortisol), and androgens. These hormones stimulate degradation of glycogen into glucose (glycogenolysis) and thus increase the blood glucose level [37]. They also increase lipolysis, and consequently the release of free fatty acids from triglycerides; they increase the heart rate and the strength of myocardial contraction, a bronchodilatation of the lung, and oxygen consumption.

During exercise, they only increase after a certain effort intensity: noradrenaline only starts increasing after a workout similar to 50% of your maximum oxygen consumption (VO_2max), whereas adrenaline increases after a workout similar to 75%.

These increases are in turn responsible for the decline of insulin levels and the raise of blood sugar levels (Table 2).

Another factor essential for a high performance at physical loads is using the self-regulation methods. It has been reported about many examples of a positive effect of relaxation methods of self-regulation on the body. Among different properties of the body one of the most important is the ability to psychophysical regulation (PPR) used for mobilization of the body reserves for health promotion, sports etc. [12, 16].

Table 1

Role of insulin and glucagon during workout

Endocrine gland	Hormone	Target organ	Functions
Pancreas	Insulin	Liver Muscle Fat tissue	↘Blood glucose ↗Glucose use ↗Fat synthesis
Pancreas	Glucagon	Liver Muscle Fat tissue	↗Blood sugar Accelerates the degradation of fats and proteins

Table 2

Role of the medulla and the adrenal cortex during workout

Endocrine gland	Hormone	Target organ	Functions
Medulla	Adrenaline	Liver Muscle Fat tissue Heart Lungs	Triggers glycogen ↗Muscular blood flow ↗Heart rate ↗VO_2max
	Noradrenaline		↗Blood pressure
Adrenal cortex	Glucocorticoids (cortisol)	Liver Muscle Fat tissue	Control of the 3 metabolisms : protein, carbohydrate and lipid Anti-inflammatory effect
	Mineralocorticoids (aldosterone)	Kidneys	↗Sodium retention (Na+)
	Androgens and estrogens	Ovaries Testes Mammary glands	Stimulation of sex characteristics

Physiological analysis of the functional state influenced by relaxation. At the present moment the PPR mechanisms and related altered state of consciousness (ASC) are being studied both theoretically by psychophysiologists, neurophysiologists, psychoendocrinologists, and philosophers, and practically in medicine, sports, and educational science. PPR is based on relaxation induced by various concentration techniques. Ample observations in physiology provide the idea of the assumed structure of PPR impact on the functional state of the body [27, 36]. EEG performed during psychophysical exercising showed prevalence and synchronization of alpha activity, and the reduced amplitude of so called “readiness potentials” [15, 33]. Studies also present the capacity of vegetative functions and muscle tone, especially when biofeedback is used [36].

Neuronal mechanisms of functional states activate electrochemical reactions involving neurotransmitters. The brain is known to have four neurotransmitter systems: dopaminergic, noradrenergic, serotonergic, and cholinergic. The results of interaction of these systems influence the physiological properties of neurons and, eventually, the specifics of the functional state that has a lot of various forms of external manifestations and internal mechanisms [7, 30]. The revealed effects laid down a basis for further fundamental study of different PPR systems. The main aim of PPR exercising is to create a positive and comfortable psychoemotional state in human. The determination of PPR mechanisms and their impact on individuals of different age, gender, and levels of physical activity is essential for justification of recommendations on their application in sports, medicine, and educational science [11, 14, 35]. We developed a program of psychophysical relaxation regulation meant to teach the methods of fast and deep relaxation of the body. The program included the techniques for teaching the muscle relaxation, psychophysical exercises (PPE) based on “local expiration” method by Popova, concentration and visualization PPE, plastic movements of arms and fingers, recreational meditations, elements of hatha yoga, and breathing exercises with concentration on energy channels and centers.

We studied the influence of the relaxation program practicing on the representatives of 8 age groups of both genders; the age of the examined ranged from 4–5 to 40–50. The groups included both athletes and untrained people; both healthy and with a sensory impairment.

According to the results of studies, there are changes observed in electroencephalograms while the participants are performing PPE. For example, in examined 20-year-old K-va the background recording showed alpha activity in all leads, predominantly in the occipital region (O1A1). With eyes closed the significant increase of alpha activity was seen in frontal, central, and occipital leads (Fig. 4).

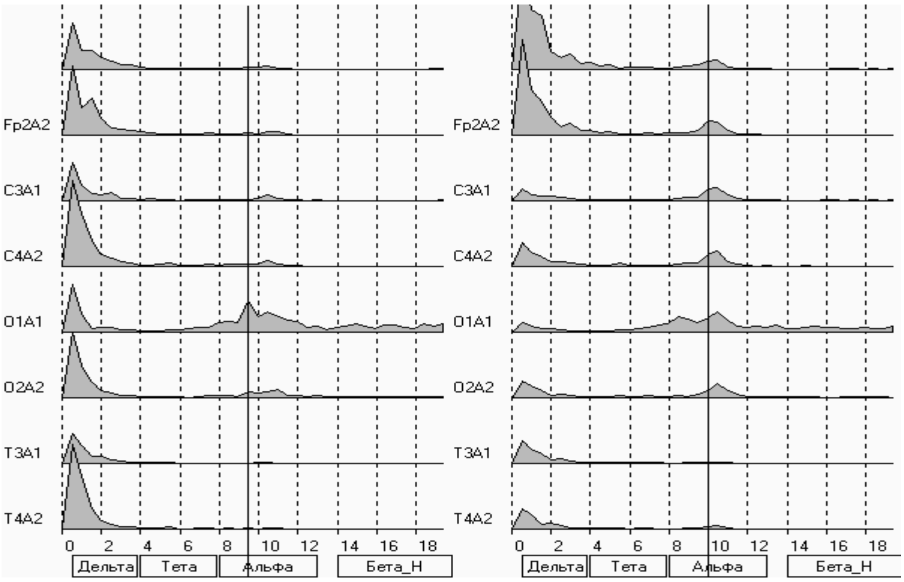
At the second stage (start of visualization) the significant growth of alpha activity in the occipital region was observed. Together with that, the increase of low-frequency alpha activity continued.

Many studies of the PPE influence on the body in people of different age revealed changes in heart rate (HR), blood pressure (BP), and cardiac rhythm structure during psychophysical exercising. For example, in the group of 15–20-year old participants systolic BP after psychophysical exercising reduced from 107+3.3 down to 97+1.8 ($P < 0.05$), and HR and diastolic BP tended to decrease (Table 3).

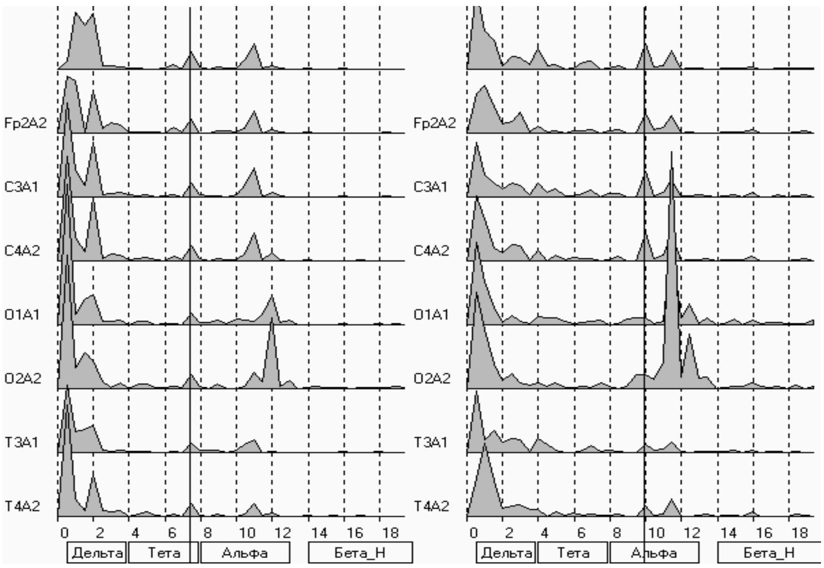
The results of observati on son the individuals only starting their PPE course showed that PPE involving music led to significant decrease of HR, and without music HR remained almost the same.

These data indicate that psychophysical exercising combined with music, scents, and colors change the functional state leading to normalization of vegetative functions and cortical-subcortical interactions as well as of psychoemotional state [4, 24]. However, according tour studies, the PPE effects depend on exercising character and duration, and also on individual peculiarities and fitness of the examined.

The introduction of psychophysical relaxation program sin swimmers' training orshaping results in high rate of the cardiovascular system adaptation to sport loads and in the improvement of athletes' psychoemotional state [29].



Background record With eyes closed, 10.5 Hz, M:2



Relaxation start Start of vizualization

Fig. 4. Spectral analysis of electroencephalograms at psychophysical exercising

Table 3

Changes in HR and BP in 15–20-year-old participants after psychophysical exercising

№	Name	Parameters							
		Before				After			
		HR	BP (systole)	BP (diastole)	Pulse pressure	HR	BP (systole)	BP (diastole)	Pulse pressure
1	N-va	68	120	70	50	60	100	60	40
2	K-ko	82	110	65	45	50	100	60	50
3	P-na	76	90	60	30	72	90	60	30
4	P-va	88	130	80	50	85	100	65	35
5	B-la	82	100	65	35	80	90	60	30
6	K-va	80	110	70	40	72	110	60	50
7	M-na	72	90	60	30	72	90	60	30
8	M-uk	80	95	70	25	60	90	60	30
9	K-va	80	100	70	30	68	100	60	40
10	G-va	80	105	70	25	80	90	60	30
11	P-va	88	110	70	40	80	100	70	20
12	K-ok	76	120	65	55	72	105	70	35
13	B-na	80	100	60	40	72	100	65	35
14	M-ok	90	120	80	40	60	110	70	40
15	M-na	62	120	80	40	60	100	70	30
M ± m		79 ± 1.9	108 ± 3.3	69 ± 1.6	38.3 ± 2.2	71.5 ± 2.1	98.3 ± 1.8	63 ± 0.8	35.3 ± 1.8
P						< 0.05	< 0.05	> 0.05	< 0.1

Note: * – significant differences with the initial values.

The authors [37] believe that pineal gland hormones, i.e. melatonin, are essential for relaxation (so called "hormonal relaxation"). Scientists believe that the pineal gland isthemost sensitive to all external energy impacts interacting with the human energy field. The pineal gland is believed to control the hormone production at stress reactions by the chain: pituitary gland – hypothalamus – adrenal glands.

Enendemid (hormone discovered in 1993 [23]) as well as melatonin, beta-endorphins, and endogenous ligand receptors block the production of steroid hormones, thus inhibiting the vascular response to the stress impact. The production of this hormones becomes more intensive at the background of alpha (8–12 Hz) and theta (4–8 Hz) activity of the brain typical of the state of relaxation. Studies have shown that this state may be induced with the help of thought or meditation.

Conclusion. Thus, stress-relieving and restorative effects of psychophysical relaxation exercises make them very promising for a wide introduction into education, rehabilitation, and training of athletes, military officers, and rescue workers.

The existing the ories of the impact of metabolism on the working capacity consider individual aspects of carbohydrate, protein, and lipid exchanges that influence the energy processes in the body. These results laid down a basis for recommendations on the nutrition at different activities. However, it is known that the endocrine system activity depends on the specifics of metabolism. At the present moment, there are no systemic studies dedicated to the correlation between functions of endocrine glands and nutrients consumed by the body, especially considering the circadian rhythms.

This paper presents the analysis of rhythm-related processes and the analysis of the psychophysical exercising program accelerating the restoration and influencing the functional state of the reticular formation of the brain stem and the limbic system responsible for emotions [9]. Using this program in combination with the balanced (rehabilitative) diet will prominently enhance the working capacity and restorative processes while preserving health and psychofunctional reserves of the body.

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ФИЗИОЛОГИЧЕСКОЕ ОБОСНОВАНИЕ ВОЗДЕЙСТВИЯ ДИЕТЫ (ПО МЕТОДУ БЕНЕДИКТ ЛЕ ПАНС) И РЕЛАКСАЦИИ НА ФУНКЦИОНАЛЬНОЕ СОСТОЯНИЕ ЛИЦ С РАЗНОЙ ФИЗИЧЕСКОЙ ПОДГОТОВЛЕННОСТЬЮ

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Цель. Анализ таких средств воздействия на организм, как сбалансированное питание и технологии психофизической саморегуляции, с позиций физиологических механизмов. **Материал и методы.** Представлены данные многолетних исследований испытуемых разного возраста и физической подготовленности. Использовали аналитический обзор современной научной литературы и психофизиологические методики исследования:

электроэнцефалографию, электрокардиографию, регистрацию нейродинамических показателей. **Результаты.** Проведен анализ характера метаболизма при различных режимах питания, особенностей его влияния на гормональную активность в различные фазы суточных биоритмов. Показано благотворное влияние релаксационных психофизических упражнений на функциональное состояние сердца и центральной нервной системы у нетренированных лиц и спортсменов. Результаты исследования позволили авторам дать конкретные рекомендации по технологиям сбалансированного питания и релаксационным упражнениям, в том числе – для спортсменов. **Заключение.** Для управления функциональным состоянием организма эффективными средствами являются: воздействия на гормональную систему (сбалансированная диета) и центральную нервную систему (психофизические релаксационные упражнения).

Ключевые слова: *метаболизм, гормоны, суточные ритмы, функциональное состояние, психофизическая саморегуляция, сердце, центральная нервная система, релаксация.*

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