THE EFFECTS OF HIGH INTENSITY TRAINING ON SALIVARY MARKERS OF THE SYMPATHETIC NERVOUS SYSTEM

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ABSTRACT

High-intensity interval training (HIIT) is a type of exercise training characterized by brief, intermittent bursts of vigorous activity, interspersed with periods of low intensity activity. HIIT in a variety of forms is today one of the most effective means of improving cardio-respiratory and metabolic function. HIIT have a significantly impact on sympathetic nervous system (SNS). During these intensive trainings, there are a number of physiological changes on the SNS. The most important effect of HIIT is activation of the cardiovascular system. However, the effects of HIIT are very variable among individuals. One of the most non-invasive reliable methods of evaluating HIIT on SNS are dosing salivary markers. The saliva is a hypotonic fluid in relation to plasma, containing compounds produced in the salivary glands (immunoglobulin A and α-amylase) as well as compounds diffused in the plasma (water, electrolytes, proteins, metabolites and hormones). Its production and composition depend on the sympathetic and parasympathetic nervous system activity. Another strong SNS activator able to alter the concentrations of α-amylase in saliva is physical exercise. Several studies have demonstrated increases in the concentration of salivary α-amylase. Physical exercise of varying intensity and duration may change saliva ionic concentration. These changes may be credited to sympathetic stimulation, which induces changes in salivary flow, reabsorption and secretion of electrolytes in the secretory cells. This article explains the effects of HIIT on SNS and the possible mechanisms underlying its positive effect. Furthermore, dosing salivary markers can be used as a diagnostic tool in sports medicine and understanding the impact of HIIT on health. This will play a role in developing appropriate physical exercise and exercise guidelines.

KEYWORDS: *saliva; physical exercise; sports medicine; cardiovascular system.*

INTRODUCTION

The human body and its functions are extremely complex. In order to maintain its physiological functions and optimal activation capacity, the human organism must undergo physical activity.

Through physical exercise and sport, there is good coordination of the various organs and systems of the human body. In this context, physical exercise has often been considered a natural "medicine" that is available to anyone.For this reason, physical activity can maintain the health of the body, prevent and treat certain pathologies.

While most people know that physical activity is healthy, it is estimate that about 30% of people worldwide do not get enough exercise.

It is well establish that factors such as poor cardiorespiratory health, adiposity, low glucose tolerance, high blood pressure and arteriosclerosis are independent health threats. Also physical inactivity increases the risk of premature death and increases the incidence of unhealthy conditions previously mentioned, which in combination may be consider risk factors for chronic diseases. [1]

A pronouncement from the American College of Sports Medicine concludes that between 150 and 250 min of moderate physical activity per week is sufficient and effective to prevent weight gain [2]. The Centers for Disease Control and Prevention publish national guidelines on physical activity and public health as well as the Committee on Exercise and Cardiac Rehabilitation of the American Heart Association have previously endorsed and supported these recommendations for healthy adults to improve and to maintain health [3].

However, several studies have shown that highintensity interval training (HIIT), is superior to moderate physical activity for improving cardiorespiratory fitness, endothelial function and its markers, insulin sensitivity, markers of sympathetic activity, arterial stiffness and blood glucose and lipoproteins in hypertensive patients and normotensive individuals [4].

So HIIT is today one of the most effective means of improving cardio-respiratory and metabolic function and have a significantly impact on sympathetic nervous system (SNS).

The results of recent studies support the hypothesis that non-invasive sympathetic nervous system evaluation includes important information on acute and chronic physiological processes before, during and after high intensity training.Moreover, we try to show that evaluating

the effects of HIIT with non-invasive methods (salivary markers) on the sympathetic nervous system could serve as positive indicators of the human body.

1.1. High Intensity Interval Training (HIIT)

HIIT is a broad term for workouts that involve short periods of intense exercise alternated with recovery periods.One of the biggest advantages of HIIT is that you can get maximal health benefits in minimal time [5].

HIIT involves short bursts of intense exercise alternated with low-intensity recovery periods. It is probably the most effective way to do exercise versus time allocated to them.[6].

Usually a HIIT training will vary from 10 to 30 minutes in duration. Despite the fact that the time spent on the training is short, it can bring health benefits similar to a moderate intensity exercise but with a twice as long duration [7].

The specific amount of time you exercise and recover will vary based on the activity you choose and how intensely you are exercising. Regardless of how it is implemented, high-intensity intervals should involve short periods of vigorous exercise that make your heart rate speed up[8]. Not only does HIIT provide the benefits of longer-duration exercise in a much shorter amount of time — it can also provide health benefits:

- Can burn many calories over a short period [9].
- The metabolic rate is higher for several hours after the end of the exercise [5].
- Can help lose fat [5].
- Get muscle strength [10, 11]
- Can improve oxygen consumption [5].
- Can reduce heart rate and blood pressure primarily in overweight or obese individuals with high blood pressure [12].
- Blood sugar can be reduced in both healthy and diabetic individuals [5].

Therefore, HIIT is a very efficient way to exercise. Overall, HIIT produces many of the same health benefits as other forms of exercise in a shorter amount of time.

1.2. Sympathetic Nervous System

The autonomic nervous system (ANS), composed of two primary branches, the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS) plays a critical role in regulating the processes necessary to maintain physiological homeostasis and response to acute stressors, and has often been considered functioned quite independently of other adaptive systems [13].

Sympathetic and parasympathetic nerve systems usually do opposite things in the body. The sympathetic nervous system prepares the body for physical and mental activities. The heart beats faster and stronger, the airway opens so that it can breathe easier and digestion is inhibited. The parasympathetic nervous system is responsible for bodily functions when we are at rest: it stimulates digestion, activates various metabolic processes and helps us to relax. However, the sympathetic and parasympathetic nervous systems do not always work in opposite directions; they sometimes complement each other too [14] (Table 1).

Table 1. Effects of the sympathetic nervous system and the parasympathetic nervous system

System/Function	Sympathetic	Parasympathetic
Cardiovascular	Increased contraction and heard rate; increased cardiac output	Decreased cardiac output and heard rate
Pulmonary	Bronchial dilatation	Bronchial constriction
Musculoskeletal	Muscular contraction	Muscular relaxation
		Constriction
Pupillary	Dilatation	Sphincter relaxation
Urinary	Sphincter contraction	Increased motility of stomach and
Gastrointestinal	Decreased motility of stomach and gastrointestinal tract; decreased secretions	gastrointestinal tract; increased secretions
		No involvement
Glycogen to glucose conversion		No involvement
	Increased	
Adrenal gland	Release epinephrine and norepinephrine	

Activation of the sympathetic nervous system exerts a number of physiological responses directly through stimulation of postganglionic sympathetic nerves localised either in target organs or indirectly through the activation of powerful humoral systems. While the importance of sympathetic tone is readily acknowledged for cardiovascular and blood pressure regulation it is less well appreciated that activation of the sympathetic nervous system forms an integral part of energy homeostasis and can exert profound metabolic effects.

Insufficient physical activity and excess energy intake, coupled with genetic programming, have been attributed to the rising incidence of obesity, hypertension, dyslipidemia, insulin resistance, and hyperglycemia [15].

1.3. Saliva and the salivary markers

The need to collect venous blood samples at different times is a disadvantage for laboratory

monitoring, as long as the procedure is inconvenient for many people.

Interest in less invasive biological fluids instead of blood has increased exponentially in recent years. In this context, saliva is a biological fluid that has several distinct advantages: it is a noninvasive procedure, that requires relatively simple collection instructions. In addition, they do not represent major risks during collection, which allows for safer management [16].

Saliva previously contains a certain level of circulating elementes / molecules that are consistently secreted and can be measured using biological tests. Immune, inflammatory and neuroendocrine biomarkers can be accurately measured in saliva [17].

Publications assert that these salivary constituents may actually be effective indicators of both local and systemic disorders. These revelations have formed the foundation of the field of salivary diagnostics and hence sparked investigations that culminated in the identification of saliva-based biomarkers [18].

The fluid present in the oral cavity originates mainly from three salivary glands: parotid, submandibular and sublingual.Each salivary gland secretes a characteristic type of saliva, with different ionic and protein concentrations.

The flow and composition of saliva are regulated mainly by the activity of the autonomic nervous system: the sympathetic nervous system and seromucous glands control the serous glands by both sympathetic and parasympathetic systems [16].

In our case, the salivary marker of the sympathetic nervous system is alpha –amylase (sAA).Catecholamines, secreted as part of the acute SNS stress response, are difficult to assess in saliva because of the low concentrations and rapid degradation of epinephrine and norepinephrine and the difficulty of stabilizing these hormones in the sample. Alpha -amylase can serve as an alternative index of adrenergic activity within the SNS and can be reliably measurable in saliva owing to their greater stability. Saliva analysis of this enzyme may offer an interesting alternative for SNS activity testing. Assessment of salivary alpha-amylase (sAA) as a non-invasive biomarker for the SNS, offers a multitude of possibilities in different areas and may well become an important parameter in research [17].

MODIFICATION OF SALIVARY ALPHA-AMYLASE IN HIIT

Granger et al published a review in 2007 that focused attention on salivary α-amylase. In addition, a portable system for monitoring salivary α-amylase activity was launched in Japan at the end of 2005. The correlation between exercise and salivary alpha-amylase has been extensively investigated. The present review summarizes relevant studies published in the English and Japanese literature after 2006. A search of the PubMed and CiNii (Scholarly and Academic Information Navigator) databases identified 54 articles, from which 15 original articles were selected. The findings described in these publications indicate that exercise consistently increases mean salivary α-amylase activities and concentrations, particularly at an intensity of >70% VO2max in healthy young individuals. Thus, these studies have confirmed that salivary α-amylase levels markedly increase in response to physical stress. Salivary α-amylase levels may therefore serve as an effective indicator in the non-invasive assessment of physical stress [19]

As mentioned above, during these high intensive training, there are a number of physiological changes to the SNS. However, the effects of HIIT are very variable among individuals.

This article aims to mention the importance of using SNS markers in high intensive training. With their help, we can monitor the effects of training on SNS.

For example, one study evaluated the effects of high-intensity intermittent exercise on saliva IgA concentration and alpha-amylase activity. This type of training is commonly incorporated into the training programs of endurance athletes.. There were eight teams of well-trained men. Salivary samples were processed in the laboratory after after an overnight rest, followed by a 60-minute exercise cycle. This cycle included 20 minutes of 1 minute at 100% VO2 max, each separated by 2 minutes of recovery to 30% VO2 max. The performance of the intermittent training session did not affect the saliva IgA concentration but resulted in a five-fold increase in alpha-amylase activity. Salivary markers returned to pre-exercise values within 2.5 hours after the exercise. The increased activity of alpha-amylase in saliva after exercise can improve the protective effect of saliva, because this enzyme is known to inhibit bacterial attachment to oral surfaces. The rate of alpha-amylase secretion in the saliva was lower immediately before exercise than at any other time, which may be due to anticipated

psychological stress, although the subjects were all familiar with the exercises. [20]

Capranica et al. [21] evaluated the effects of a taekwondo competition on heart rate (HR), sAA and salivary-free cortisol in 6 males and 3 females young athletes. Salivary alpha-amylase showed a fast response with peak values at the end of fighting and a fast recovery, reflecting changes in sympathetic activity under a variety of stressful conditions. These conclusions have confirmed that taekwondo competitions induce a high level of stress on young athletes.

Another study compared the effects of HIIT versus high volume workout on salivary stress markers (cortisol, testosterone, alpha-amylase), metabolic and cardiovascular response in young athletes. Metabolic and cardiorespiratory stress during HITT was higher than in the other exercise, but based on salivary analyzes, no training did not cause catabolic effects [22].

Guilhem et al. [23] in a study, compared salivary hormone responses (salivary testosterone, cortisol, alpha-amylase, immunoglobulin A, chromogranin A) to 24 athletes during training (3 times in 3 months) and precompetitive (5 times in 5 weeks). The results showed a lower adrenocortical response and autonomous activity and an improvement in immunity status in response to reduced exercise effort and fatigue.

In another article, the authors examined acute responses of heart rate and salivary biomarkers (immunoglobulin A and alpha-amylase) following a standard training session in paralympic swimmers. Changes in heart rate and salivary markers were monitored on a Monday morning, afternoon, and Tuesday morning, over a 14-week period, which led to international competition. Normal exercise responses have led to increases in heart rate and salivary markers. Together, heart rate and salivary alpha-amylase provide coaches valuable information on physiological changes in response to training and competition [24].

In addition, DiazGomez et al. [25] analyzed plasma and salivary proteins in relation to training load in elite swimmers. During a 21-week training period, the plasma catecholamines and salivary proteins showed a significant inverse relationship with intensity and training load. Salivary alpha-amylase and total protein strongly correlated with adrenaline.

CONCLUSION

Based on the findings above, we can conclude that HIIT is a stress factor for the human body but with a number of positive effects. Physiological stress-induced reactions by HIIT include whole-body orchestrated actions, putting the body in a general state of readiness to engage in combat or flight.

In all the studies examined in this review, it has been consistently demonstrated that the activity and mean concentration of salivary alpha-amylase are increasing due to a psychological and physical stress

Thus, increased alpha-amylase activity may be one of the many actions involved in activating body resources to cope with stressful events. Moreover, its dosing can provide valuable information about the body's responses to physical activity, both in healthy people and in people with certain pathologies.

By default, it can be used as a diagnostic tool in sports medicine. This will play a role in developing appropriate physical exercise and may suggest valuable information to coaches about competitors' responses to competition.

In the future, we are trying to monitor the activity of salivary alpha-amylase in children with obesity in response to acute stress factors (physical, emotional, etc.). The research related to sAA, physical activity and obesity in children is very limited compared to the adult population.

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