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EFFECTS OF SMOKING CIGARETTE ON AEROBIC FITNESS IN ATHLETE

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ABSTRACT

The aim of this research was to determine the effects of smoking on heart rate at rest and during exercise, maximal oxygen consumption ($\dot{V}O_{2max}$) and physical working capacity 170 (PWC170) in student-athlete. Two groups of students from the third level of the Faculty of Physical Education and Sport (now college of Sport Sciences and physical activity) were subjected to two experiments on the measurement of resting heart rate, maximal oxygen consumption, physical working capacity 170, and monitoring changes in heart rate during exercise. The first experiment consisted 12 students non- smokers and 12 students smokers, while the second experiment, only 8 students non-smokers and 8 students smokers were experimented. Results showed a significant reduction in maximal oxygen consumption for absolute value (p = 0.004) but not significant when it is relative to the weight (p= 0.054) in smokers; a significant reduction in physical working capacity 170 (PWC170) (p= 0.004) in smokers compared with non-smokers and a significant increase in heart rate during exercise in smokers than non-smokers at the first minute (p = 0.029), second (p = 0.006), third (p = 0.006), fourth (p = 0.015), and fifth (p = 0.020), no, non-significant at rest (p = 0.185). This research has led that smoking affects negatively on heart rate during exercise, maximal oxygen consumption and physical working capacity 170 in students' athletes.

Keywords: *Heart rate, maximal oxygen consumption, physical working capacity 170, smoking.*

1. INTRODUCTION

Cigarette smoking is associated with many diseases and death. Many people think that fatal consequences of smoking can be avoided by practicing sports without quitting smoking. Smoking is one of the social scourges, sanitary and natural disasters, which have changed the way of life during the last century. It causes

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pollution of air and spread of many diseases that were not previously known, and many deaths.

According to the report of World Health Organization, smoking is responsible for the deaths of 5.4 million people each year, including 600,000 persons indirectly, and 31% of children (World Health Organization, 2009). The number of smokers worldwide is estimated at one billion and 300 thousand people (Guindon & Boisclair, 2003). The proportion varies from a state to another, where two-thirds of smokers in the world are located in the following countries: China (about 30% alone), India, Japan, Indonesia, Bangladesh, the United States of America, Brazil, Germany, Russia and Turkey (World Health Organization, 2008). In the United States of America 430000 persons die each year, including 38,000 by passive smoking, 27,000 women and 10% of children (World Health Organization, 2008). In Russia, more than 60 percent of men and nearly 22 percent of women smoke (World Health Organization, 2009). In France 73,000 persons die each year due to smoking, including 14,000 women (Hill, 2012). It is even estimated that 32% of doctors smoke (Mialle, 2010).

Regarding athletes unfortunately this epidemic is spreading among them, but in all athletes smoke less than others (Abdennbi & Bolinder, 2008), as follows: In sportsmen: athletics 10%, 9% cycling, boxing 9%, football 45%, rugby 47%, basketball 30%, tennis 17%, shooting 23%, horse riding 42%. In sportswomen: athletics 9%, cycling 9%, tennis 23%, shooting 29%, horse riding 37%. The problem of this research is that many people think that fatal consequences of smoking can be avoided by practicing sports without quitting smoking. The aim was to determine the effects of smoking on heart rate at rest and during exercise, maximal oxygen consumption ($\dot{V}O_{2max}$) and physical working capacity 170 (PWC_{170}) in student-athlete.

2. METHODS AND MATERIALS

2.1 Subjects

Investigator have done a descriptive study of some physiological parameters among the group of students comparing smokers and other group parameters of students' non-smokers (control group). This was done through two experiments: In the first experiment, the population was composed of two third-level student groups of the Faculty of physical education and sports (now College of Sport Sciences and Physical Activity). The first group included 12 non-smoking students with mean age 21.00 years (20 - 23), mean height 171.41 cm (161 - 180), and mean weight 63.91 kg (47 - 84). The second group included 12 student smokers, with mean age of 22.25 years (21 - 26), mean height 171.83 cm (159 -

180) and mean weight 66.58 kg (49 - 94). In the second experiment, the number of non-smokers was reduced to 8 and 8 smokers also, because of the absence of others.

2.2 Research Plan

The plan was divided into two parts: the first part was to measure maximal oxygen consumption and the physical working capacity 170 (PWC_{170}). The second part was the measurement of resting heart rate and tracking changes in the heart rate during exercise. Then proceeded to comparison of data obtained between two groups. Heart rate was measured in the morning with a pulse meter type POLAR (made in Finland). Maximal oxygen consumption ($\dot{V}O_{2max}$) was indirectly assessed by the method of the known Astrand - Ryhming Step Test which was developed as a submaximal variation of the Harvard test. Physical working capacity was evaluated by extrapolation of the Karpman's formula (Karpman, 1987):

$$\dot{V}O_{2max} = 1.7 \times PWC_{170} + 1240$$

Where $\dot{V}O_2max$ is expressed in l / min; and PWC_{170} - in kg m / min.

In the second section students have attempted a continuous physical effort with a stable intensity on a step 50 cm height with a rate of 80 steps per minute for a period of up to 10 minutes (Karpman, 1987).
Note: Regarding smokers, only four of them have followed the work until the tenth minute, 2 have stopped working in the fifth minute and 2 in the sixth minute. Therefore, the comparison was made only for data from the first five minutes.

2.3 Instruments used

2.3.1 Pulse meter POLAR Type (made in Finland) was used to measure heart rate.

2.3.2 Compact scale SECA Type (made in Germany) was used to measure the body height and weight in the same time.

2.3.3 One stool (step) of 40 cm height was used to evaluate maximal oxygen consumption.

2.3.4 One stool (step) of 50 cm height was used to evaluate changes in heart rate during exercise.

2.3.5 Stopwatch CASIO type (made in Japan) to measure the time of work and its sequences.

2.3.6 Mechanical metronome (made in Japan) which regulates the frequency of uphills and downhills per minute giving beeps stabilizer and the intensity of exercise.

The experiment was conducted in the laboratory of Exercise Physiology, Faculty of Physical Education and Sport (now College of Sport Sciences and Physical Activity, King Saud University).

2.4 Statistical Analysis

It was used the IBM SPSS Version 22 statistics program, where calculated the arithmetic mean, the standard deviation and paired *t*-test to evaluate the statistical significance between the two groups.

3. RESULTS

Table 1: Values of maximum oxygen consumption (VO_{2max}) and physical working capacity 170 (PWC_{170})

	VO_2max (ml. min^{-1}.kg^{-1})	VO_2max (l.min^{-1})	PWC_{170} (kg. m.min^{-1})
Smokers	41.94 ± 9.25	2.75 ± 0.59	891.66 ± 349.30
Non-smokers	51.33 ± 7.80*	3.37 ± 0.34	1256.17 ± 205.45*

Note: Values represent the arithmetic mean ± the standard deviation.
* Indicates significant difference between the two groups.

From the results of table 1 it can be seen that a reduction in maximal oxygen consumption among students smokers compared to nonsmokers. This difference is statistically significant for the absolute value (p = 0.004), and not significant when it is relative to the body weight (p = 0.054). A significant reduction in physical working capacity 170 (PWC_{170}) (p = 0.004) in smokers compared with non-smokers by about 363 kilograms meters per minute.

Table 2: Values of heart rate at rest and during exercise

	Smokers	non-smokers
heart rate (bpm)		
at rest	75.00 ± 12.28	66.62 ± 5.57
during exercise		
1st min	133.62 ± 10.01	120.25 ± 8.68

2nd min	147.62 ± 12.36	126.87 ± 10.76*
3rd min	154.37 ± 13.98	133.12 ± 11.70*
4th min	158.25 ± 15.58	138.12 ± 14.13*
5th min	162.50 ± 16.11	141.75 ± 15.00*
6th min	-	146.25 ± 14.84
7th min	-	149.62 ± 17.27
8th min	-	153.75 ± 15.34
9th min	-	154.75 ± 16.35
10th min	-	154.12 ± 16.86

Note: Values represent the arithmetic mean ± the standard deviation.
* Indicates significant difference between the two groups.

From the results of table 2 we can note that a non-significant increase in heart rate at rest in smokers than in non-smokers by about eight beats per minute (p = 0.185). A significant increase in heart rate during exercise in smokers than non-smokers from 7 to 21 beats per minute as follows: at the first minute (p = 0.029), at the second minute (p = 0.006), at the third minute (p = 0.006), at the fourth minute (p = 0.015), and at the fifth minute (p = 0.020).

4. DISCUSSION

Regarding the increase in resting heart rate in smokers compared to non-smokers, I think that is the effect of smoking on heart function specially nicotine and carbon monoxide. According to Abdennbi and Bolinder (2008), nicotine is an activator of the sympathetic system (Alyan, Kacmaz, Ozdemir, Maden, Topaloglu, Ozbakir, …, & Ilkay, 2008). It quickly infiltrates into the circulation to achieve the heart thereby accelerating the propulsion of blood, which causes an increase in heart rate. This has been mentioned by other studies (Alyan *et al.*, 2008; Asthana, Piper, McBride, Ward, Fiore, Baker, & Stein, 2012; Cagirci, Cay, Karakurt, Eryasar, Kaya, Canga, …, & Akdemir, 2009; Papathanasiou, Georgakopoulos, Georgoudis, Spyropoulos, Perrea, & Evangelou, 2007; Papathanasiou, Georgakopoulos, Papageorgiou, Zerva, Michalis, Kalfakakou, & Evangelou, 2013; Zhao, He, Hu, Ding, Yu, Wang, …., & Zhuang, 2013). Some researchers have estimated the increase from 10 to 20 beats per minute (Renders, 2010). In further nicotine causes other damage such as hypertension (Papathanasiou *et al.*, 2007; Pandey, Shreevastva, & Neupane, 2014), narrowing of arterioles (Hanna, 2006) and blood vessel damage (Rahman & Laher, 2007), as is the case at the lower limb arteries, angina pectoris (Barthel,1991; Billing, Eriksson, Hjemdahl, & Rehnqvist, 2000), and cerebrovascular accident (Fujii, Hosomi, & Matsumoto, 2013). Regarding carbon monoxide found in cigarette smoke 3 to 5%, it passes directly into blood, and the oxygen excess, occupying its place and associates with the hemoglobin because of a higher affinity for

hemoglobin 200 times that of oxygen (Abdennbi & Bolinder, 2008). According to some studies (Arcavi & Benowitz, 2004) 10 to 20 percent of red blood cells are found ineffective for the transfer of oxygen to the tissues, leading to a decrease in the percentage of oxygen in tissues (Abdennbi & Bolinder, 2008). In response to this oxygen deficiency the body shall take measures to compensate such as the activation of the circulatory system where the heart is forced to pump a quantity of blood even more than usual. Consequently, the heart rate increases. This was confirmed by some researches that indicate that a person who consumes a pack of cigarettes per day feels as if it is at an altitude of 2000 or 2500 meters, with the lack of oxygen, the feeling of suffocation and all the physiological changes that occur at different heights (Taylor & Katomeri, 2007).

During exercise, the effect of smoking becomes worse and can significantly affect athletic performance (Abdennbi & Bolinder, 2008; Tchissambou, Massamba, Babela, Mouanou, Mboussa, & Senga, 2004; Flurin, 2001). This is what was indicated by the results in Table 2, where the difference in heart rate between smokers and non-smokers who was at rest around eight pulses per minute was raised to 21 beats in the fifth minute.

With regard to the significant reduction of maximum oxygen consumption and physical working capacity 170 (PWC170) in smokers compared to nonsmokers, in my opinion this is due to the effect of nicotine that causes narrowing of airways and lung alveoli damage. This results in a lack of gas exchange in particular oxygen and forced expiratory volume air (Cagirci *et al.*, 2009), thereby reducing the capacity of the respiratory system (Misigoj-Durakovic, Bok, Soric, Dizdar, Durakovic, & Jukic, 2012). In addition, as mentioned above carbon monoxide binds to hemoglobin in the blood and takes the place of the oxygen, thus leading to an oxygen deficiency in the organism as a whole. This limits the maximum aerobic capacity (Lee & Chang, 2013), reduced physical working capacity (Asthana *et al.*, 2012; Ricci, Francisco, Rebelatto, & Rebelatto, 2011; Misigoj-Durakovic *et al.*, 2012; Leyk *et al.*, 2012; Macera *et al.*, 2011) and athletic performance in general (Abdennbi & Bolinder, 2008; Taylor & Katomeri, 2007; Akbartabartoori, Lean, & Hankey, 2005; Myers, 2010).

Work interruption at around five minutes in smokers shows that they were tired quickly because functional abilities are limited, especially cardio-respiratory function. This is consistent with previous studies (Asthana *et al.*, 2012; Papathanasiou *et al.*, 2007; Alexopoulos, Jelastopulu, Aronis, & Dougenis, 2010).

5. CONCLUSION

The results showed that smoking has a negative impact on the physiological parameters studied, hence the increase in heart rate at rest and during exercise,

which is consistent with the first hypothesis. We also note a decrease in maximal oxygen consumption and physical working capacity 170 (PWC_{170}) in the student-athlete, which is consistent with the second hypothesis.

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