

Less Muscle Strength in the Upper and Lower Limbs, Aerobic Capacity and Core of Smoking Athletes: A Review of the Literature

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Abstract. Knowing the variables that can help improve performance in different disciplines is what coaches and group directors look for. Tobacco use and sports performance are part of the fundamental pillars of a study of health and performance in athletes. That is the reason why the studies of sports performances have increased over recent years.

Objective. Carry out a literature review on the impact of tobacco use on sports performance, clarifying its consequences.

Methodology. A search was made in the Scopus, Pubmed and ScienceDirect databases, using the keywords "smoking"; "sport performance" and "athletic performance" and limiting the time interval to the 2010-2018 period. A total of 10 articles were selected.

Results. The results of each of the selected articles are presented in this study.

Conclusions. The results suggest a worsening of muscle strength in both the upper and lower limbs as well as in the variables related to cardiorespiratory endurance in smoking athletes.

Key words: adults, sports performance, physical performance, revision, tobacco.

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I. Introduction

Tobacco use is one of the main issues of this study as it constitutes a serious health problem [1]. Specifically, Spain is one of the leading European countries in tobacco use, in such a way that the Spanish Observatory of Drugs and Drug Addiction [2] considers tobacco as one of the most consumed substances [3]. In addition, it is known that more than 10 million people will die from smoking in 2020 due to the continuous increase in the rate of smokers, besides this, its consumption carries a great risk to health in terms of development of cancer as well as cardiovascular diseases [4]. Smoking is so harmful to health that cigarettes are considered a drug by the FDA classification.

In the area of sports, the study of drug use has received considerable attention due to the benefits it provides [5]. According to data from the Ministry of Education, Culture and Sport [6] there are studies regarding the practice and consumption of substances among young people and adolescents, but there are fewer studies focused on sports performance. Throughout the scientific literature conflicting opinions regarding tobacco consumption and sports performance are found. Although some studies that suggest the association between sports practice and a reduction in tobacco use were found initially [7].

The studies in Spain are inconclusive as they do not show a clear association between physical-sport practice and the use of tobacco [9], consequently further investigation has to be carried out on the relationship between tobacco use and sports practice [8]. In addition, differences are found when looking for relationships between the practice of collective and non-competitive sports with a higher consumption of tobacco, while if the intensity of the sport is moderate or vigorous, sport becomes a preventive measure of cigarette consumption [10].

Tobacco use represents a risk factor related to many chronic diseases, such as COPD "Chronic Obstructive Pulmonary Disease" [11], bronchitis, stroke (stroke), cancer and it is also a risk factor related to cardiovascular diseases [4].

In relation to this, the cessation of the smoking activity is related to a reduction in cardiovascular risk of up to 47% and a reduction in mortality ratios of 36% [12]. This cardiovascular risk is halved after a year of abstinence and continues to decline gradually. These enhancements seem to be related in part to an improvement in the cardiovascular fitness that follows when giving up smoking.

In addition to all these changes, at the muscular, bone, hormonal and endocrine levels, effects of tobacco use on cognitive processes related to physical activity are also found, such as information processing, attention and memory and improvement of performance when accomplishing simple tasks in non-smokers. The speed and accuracy improved in smokers when executing choice reaction time task tests.

There are numerous data of the benefits in both cases, in the processes of selective attention and in the processes of sustained attention. Selective attention is evaluated through the "Stroop Test", while sustained attention is evaluated through vigilance tasks in which there can be various sources of stimulation. The reviewed literature makes it clear that smoking improves attention processes. On the other hand, concerning the memory or memory processes, the above statement it is not so clear, since it is said, that smoking by itself, does not produce improvements or losses in these processes, but it depends on when tobacco is used [13].

All these effects, produced by smoking tobacco and its components, are related to changes in sensitive processes involved in the performance of tasks of a physical nature, in a way that can determine the physical condition or fitness when practising sports or athletics activities. In this work the relationship between all these processes as well as the changes produced by the habit of smoking will be established. In order to evaluate this relation, the performance of aerobic or muscular tasks, as well as the performance in isolated tasks of lower or upper limbs and the performance in sports tasks, will be assessed.

Sports physical participation plays an important role in the health and professional performance of future health and sports professionals [3]. The use of tobacco is a relevant health problem that every year increases the demands of smoking cessation as well as the needs of cardio circulatory controls. Consequently the aim of this work will be to make a literature review looking for the effects of smoking on physical performance with the purpose of identifying the harmful effects of this addiction in activities related with physical condition, physical fitness or physical performance.

II. Method

Scopus, Pubmed and ScienceDirect databases were used to carry out the literature review. The search criteria have been the following keywords: "smoking"; "sport performance" and "athletic performance". The time interval and the language of the article have been established as inclusion criteria: articles published between 2010 and 2018 in English or Spanish; as well as performing a sporting activity, whether it was of a non-competitiveness or performance activities.

Subsequently, those articles in which the sample was of sedentary people, children or elderly population were excluded. There were also excluded articles that did not treat the subject under study or were not specific of tobacco use and performance or if they were theoretical articles that just provide general information.

After this screening, 26 articles were found, 10 of which were adapted to the criteria of this specific search. After the selection process the bibliography of each of them has been reviewed and Microsoft Excel 2016 has been used to create a database in which the following data were incorporated: name of the author and year of publication of the article, characteristics of the sample, method used, type of activity carried out (amateur / professional sport and active / inactive) and the most relevant conclusions obtained from each of the studies selected for this work.

III. Results

The results of the literature review are shown down below. The main result is a review of 10 articles related to the practice of smoking and sports performance (Table 1). In this data table, the information provided by each article can be found in more detail. As for the objectives of the studies, most of them seek to establish a relationship between smoking and cardiorespiratory or muscular function. Participants in the different studies were mostly militaries, active or recently retired from the different peace corps to which they belonged.

In relation to the age of the subjects, the vast majority of the studies were focused on adolescents, a large part of them being between 18 and 27 years old, only a small number of studies were made considering older people, never exceeding 50 years old. Regarding the method of quantification of the different variables, several types of tests were used, including isokinetic tests of knee flexion and the countermovement jump (CMJ) for measuring the muscle strength in the lower train and through manual dynamometers for measuring the upper body force.

Finally, in terms of the measurement of cardiorespiratory function, or measurement of variables of an aerobic nature, they are mostly performed through spirometry (gas analyzer) in a treadmill, with the use of different protocols: Bruce test, YO- YO, Test of Course-Navette (Leger test) and Wingate test (all out). Regarding the questionnaires or written tests that were used, it can be concluded that the great diversity of questionnaires used made it impossible to establish a general protocol to implement, since several general questionnaires that include items related to the habit of smoking were used. The only two questionnaires cited as such are the IPAQ (International Physical Activity Questionnaire) and the PARFQ (Physical Activity Risk Factor Questionnaire) regarding physical activity.

The results in each of the studies show the relationship between the use of tobacco and the variables related to physical effort and performance in different tasks. As it has already been discussed above, in most of the studies, a negative relationship is established between the habit of smoking and the different functions,

whether they were muscular or cardiorespiratory. Nevertheless, an article was found where there are no significant differences between the groups of smokers and non-smokers. In very few articles, it was found that the group of smokers had better values than the group of non-smokers; this could be possible due to a learning process when accomplishing the different tasks. The main characteristics of the studies observed are shown in the table below.

Table 1. Revised studies regarding tobacco use and the practice of sports

Study	Sample	Objective	Method	Sport	Conclusion (Results)
Jang et al. (2017)	15 taekwondo fighters. (Smokers n=6, non smokers n=9).	Check the effects of regular smoking on cardiopulmonary function	Mile test with gas analyzer	Individual. Taekwondo	The HR during minutes 1 and 3 significantly lower. There are no significant differences in VO2 and HR values.
Mündel et al. (2017)	9 active men.	To determine the effects of nicotine gum on anaerobic power, strength and performance.	Chew gum or a placebo chewing gum	Training	Significant differences between chewing gum and placebos.
Chaabane et al. (2016)	108 men. Professional athletes.	To determine the effects of tobacco on selected health markers and in the lung function in professional athletes.	Sperimetry Closed answersquestionnaire	Soccer players in Qatar.	Significantly lower values in FVC
Zandonai et al. (2016)	14 healthy men	Research of the effects of oral tobacco on the perception of fatigue and the time of completeness during moderate intensity aerobic exercise.	3 experimental sessions -1: Incremental test to determine the Wmax. -2 and 3: exercise at 65% Wmax until the failure in conditions	3 participants in soccer, 3 in running, 2 in tennis and the rest of them, in gymnastics, gym, basketball and swimming.	-Significant differences -The RPE values are not significantly different -No significant differences found between groups in time to failure.
Morente-Sánchez et al. (2014)	18 men.	SNUS Effects in RD.	Agility test 5x10 meters YO-YO Test	- Amateur soccer players.	-Significant differences between the TDM and YO-YO test and between the CMJ and the YO-YO test.
Al-Obaidi et al. (2014)	Smoking men (n = 111) and non-smoking (n = 66).	Establish whether grip strength and resistance to fatigue are reduced in smokers.	Maximum strength in 5 grip positions.	Active/Inactive/Not frequent. It does not appear the activity they do.	-The fatigue index was significantly higher
Berkovich et al. (2014)	17115 men and women.	Detect an improvement of exercise tolerance	Bruce Protocol Treadmill Stress Test (EST). Health questionnaire to establish the smoker status.	-No record.	There is a 1% improvement in exercise tolerance. -Significant improvement in exercise duration during follow-up -The improvement was also significant with respect to METS, with an average improvement of 0.2.
Misigoj-Durakovic et al. (2014)	(Non-smoking n=350) (Smokers n=175).	To investigate the effect of the smoking record in young adults.	BMI Number of squats in 2 minutes. Number of push-ups in 2 minutes. Maximum number of dominated. Aerobic test all-out with treadmiller gspirometry.	Croatian military.	- Significantly fewer squats in 2 minutes
García et al. (2014)	N=43; 21 active smokers and 22	To assess young smoking men,	Course-Navette Test (Legertest).	Military.	-Significant differences - There were no significant

	non-smoking people.	apparently healthy.			differences with the BMI.
Macera et al. (2011)	n = 18.537	Assess the smoker's status and the objective change in its physical condition in 1-4 years	BMI Push-ups ABS Time spent in a 1.5 miles walk or run	Male military deployed in Kuwait and Iraq between the years 2005-2008.	-Important differences in BMI. -Significantly lower values in push-ups and significantly lower values in abdominals -Very significantly lower values in time to cover 1.5 miles
1ISO: Isometric 2EXC: Eccentric 3CON: Concentric 4FTI: Lower Train Strength 5MTE; Maximum Exercise Time 6VO2 (max); Oxygen Consumption (maximum) 7GNF; Non-Smoking Group 8GF; Group of Smokers 9UV; Ventilation threshold 10T; Time 11EM; Maximum Exercise 12 CMJ; Jump with 13TW Counter Movement; Test Wingate 14RD; Sports Performance 15FMS; Functional Movement Screen 16YBT-LQ; Y-Balance Test Lower Quarter 17YBT-UQ; Y-Balance Test Upper Quarter 18APFT; Army Physical Fitness Test 19CT; Tobacco Consumption 20EDTRD; Harmful Effects of Tobacco on Sports Performance 21FVC; Forced Vital Capacity 22FVE; Forced Expiration Volume 23PEF; Expiratory capacity Peak 24BP; Blood Pressure 25PLA; Placebo group 26W (max); Power (maximum) 27OC; Brain Oxygenation 28OTM; Oxygenation 29HIS Muscle Tissues; History 30FREC; Frequency 31CAF; Aerobic Physical Condition 32CAcF; Cessation Activity Smoking 33GFL; Group Smokers Light 34GFP; Heavy Smoking Group 35 TDM; 36 Manual IPAQ Dynamometer Test; International Physical Activity Questionnaire 37 PFT; Physical Fitness Test 38 CF; Physical Condition 39 BFT; Basis Fitness Test 40 FM; Muscle Strength 41 PARFQ; Physical Activity Risk Factor Questionnaire 42 PFA; Physical Fitness Assessment					

IV. Discussion and conclusions

The aim of this study was to carry out a literature review of the studies conducted on the influence of tobacco consumption on sports performance. The results suggest a worsening of muscle strength in both the upper and lower limb as well as in the variables related to cardiorespiratory endurance. Conversely, the decrease in tobacco use produces aerobic and muscular improvements.

In relation to the literature, we find different results. On one side, no differences have been found between those who smoke and those who practice sports [3]. This conclusion is due to the existing variability of the type of sport practiced, its dedication or even the intensity of the sport, which all three variables could interfere in the final tobacco use [3]. In this same line, it is suggested a relationship between tobacco consumption and the time which is devoted to sports; in a way where the use of tobacco is lower as the dedication to sports increases [14]. In the same vein, in a group of smokers compared to non-smokers, a worse performance was observed with respect to muscle strength in lower limbs, measured by isokinetic or CMJ (counter-movement jump) tests [15].

On the other side, smokers possessed poor aerobic fitness when measured in treadmill and spirometry measuring the maximum oxygen consumption (VO2 max) and other variables related to heart rate (HR) [16, 17]. The importance of having a proper aerobic fitness for long-term sports or for sports that require intermittent recoveries in order to carry out the actions of power and explosive force needed for performance, reveals the difficulty that smoking can cause for this type of population, and in the same way, the difficulty for people with a low aerobic fitness caused by the use of tobacco, to be able to carry out activities of the daily life without feeling a high or excessive fatigue.

There are other studies that show the relationship between potency and tobacco use. In different studies, the aim was to measure the maximum aerobic power (Wmax) and the different variables related to it, such as oxygenation at the cerebral and muscle tissue levels, respectively, through the Wingate test [18, 19]. In the first variable discussed (Wmax) it is observed that the group of smokers had lower levels compared to the group of non-smokers. In the last two variables, the results were, as expected, lower in the group of smokers than in that of non-smokers, causing the decreased of the maximum aerobic power that the subject can generate, reason why it can be concluded that smokers will have a worse performance in daily life activities.

Among the limitations of this study is the lack of literature regarding tobacco use and sports performance in high-level competitions. It has only been found a study on professional sport of athletes participating in amateur competitions or in professional categories of secondary leagues, such as the Qatari league, where their habits of life are different from the European or American. Moreover, for the development of the study, attention should be drawn to the fact that for a high performance athlete is difficult to recognize that he/she has one of the least healthy habits of life such as smoking. In addition to this, there is difficulty in the little availability of a high performance athlete to participate in a study of these characteristics, and even more difficult when the study is to be longitudinal.

As future lines of research, the evaluation of mediating variables (stress or anxiety) between alcohol consumption and sports practice at a professional or competitive level is proposed. On the other hand, research studies should consider aspects such as the temporary dedication to sport in relation to tobacco use [14], in university population with professional orientation to health and sports.

For instance, gymnastics is often practiced in Spain (soft or intense sports physical activity in a sports centre) and/or running (running, jogging) [6], however, the time spent in both sports is high interpersonal and

even intrapersonal variability; therefore it should be kept in mind for future assessments. It would be interesting to investigate in one of these more competitive leagues or with high performance athletes in order to see the influence of tobacco use on high performance.

In addition to this, it would be highly recommended to explore if the relationship between drug consumption and sports practice could be moderated by the type of sport that is practiced. For example, sports in which a low physical demand is required such as bowling compared to other sports such as hockey or rugby that need high performance, or team sports versus individual sports. For this reason, the majority of authors in the different studies that have been reviewed speak of a lack of longitudinal studies as well as studies of a more specific nature related to competition and its relation with tobacco use.

Variables such as power, isokinetic strength of the lower limb and even variables of an aerobic nature are measured in closed activities which have nothing to do with sports competition; this is why science must continue working to establish a better defined relationship between tobacco use and performance in different sports disciplines. A possible future line of research could be to study the influence of tobacco use and sports performance on simulated tasks in training. This could be carried out through certain tasks similar to competition and with the intake of nicotine in different amounts, soda could be obtained generating a “before and an after” record, although difficult, in this way a longitudinal task would be accomplished.

This review suggests that tobacco use influences different variables that affect athletic performance, such as aerobic power, muscle strength of both lower and upper limbs, and aerobic fitness. All of the last are affected by tobacco use. Therefore, it seems an important issue to investigate in greater depth the relationship between the variables addressed in this review, through experimental and longitudinal studies that would allow visualizing and analyzing over time the different results that could be extracted between tobacco use and sports performance. Knowing the effects of tobacco use on the performance of athletes can enable coaches and other technical staff to establish strategies in order to avoid the adoption of this unhealthy lifestyle habit.

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