

## Review Article

# Cannabis and Sport: A Concise Overview

Michael Kennedy\*

*Department of Clinical Pharmacology and Toxicology, St Vincent's Hospital Sydney, Australia*

## \*Corresponding author

Michael Kennedy, St Vincent's Clinical School, UNSW Medicine, UNSW Sydney and Clinical Pharmacology and Toxicology St Vincent's Hospital Darlinghurst, Sydney NSW 2010, Australia, Email: drmkenn@ozemail.com.au

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## Abstract

Cannabis has been used by sportspeople for millennia. The effects of tetrahydrocannabinol the principal psychoactive component in relation to aerobic exercise, strength or pharmacokinetics has been evaluated on a total of 15 occasions. Aerobic exercise performance is impaired, exercise induced bronchospasm is inhibited and strength is decreased. Plasma concentrations rise by <1ng/ml with exercise. Cannabis alters numerous psychological measures which accounts for the reported value for its use before during and after exercise. Cannabis has a spectrum of adverse effects on numerous psychological and physiological parameters which are ignored by those promoting its use in sport. The cardiovascular effects pose potential risks in individuals with any underlying cardiac pathology.

## ABBREVIATIONS

NCAA: National Collegiate Athletic Association; THC: Tetrahydrocannabinol;  $\dot{V}O_2$ : Rate of Oxygen Consumption; WADA: World Antidrug Agency

## INTRODUCTION

The widespread use of cannabis for recreational purposes is evidenced by an Australian household survey which found that one third of participants over the age of 22 had used cannabis at least once and at about the same time in 2015 the United States there were 22.2 million Americans 12 or older, or 8.3% of the adult population who were regular users [1,2].

The recreational use extends to sportspeople some of whom claim to obtain benefits to sporting activity. Decriminalization of use in Australia resulted in increasing use by the younger members of the population [3]. Legalizing use for recreational purposes would probably result in much greater community use.

The prevalence of cannabis use in sportspeople is the subject of a recent systematic review of 15 studies in 7 countries. From surveys there was considerable variation in use. For example, the US National Collegiate Athletic Association (NCAA) found 30.3% use in participants, French Sport Science found 12.5% of students used marijuana to improve sporting performance and 3.2% of Australian elite athletes reported having used marijuana in the preceding 12 months. The temporal prevalence varied, with higher cannabis consumption for recreational purposes during year than taken during sporting activity. There were a number of additional findings in the investigation. Cannabis has taken the place of tobacco as the most widely used drug and use begins in the early teens. Objective testing for cannabis reveals higher use

than may be disclosed in a questionnaire. Use was more common in sports such as skeleton, bobsledding and ice hockey but these sports reflect the European bias in the countries investigated. None of the studies included the older sportspeople in Masters events and other noncompetitive activities [4].

There are a number of reasons why drugs are used in sport. The commonest are: to relieve pain, assist in training, remove anxiety, enhance concentration during exercise and improve recovery. Improving performance seems to be a lesser indication for use. High profile sportspeople often feature in the social and other media promoting the use of cannabis.

Of the over 66 cannabinoids in marijuana  $\Delta^9$  tetrahydrocannabinol (THC) is the most psychoactive and most investigated. There are numerous published general reviews, opinion pieces and policies relating to cannabis in sport. A recent systematic review found there are only 15 published articles in the refereed literature reporting the effects of THC on numerous parameters related to exercise most being conducted prior to 2000 [5].

## INVESTIGATIONS IN PATIENTS WITH SYMPTOMATIC CORONARY DISEASE

These investigations were performed a decade prior to present era of coronary angioplasty and at a time when coronary bypass surgery was in its infancy. While quite appropriate at the time it is unlikely that such investigations would now be approved by an institutional ethics committee.

Two studies investigated the effect of 18.9 and 19.8 mg THC Vs placebo or a nicotine cigarette in 10 males with >75% narrowing in one coronary artery. Exercise was performed on

a stationary bicycle testing until the development of angina. Angina developed after at shorter time with THC  $p < 0.001$ . The peak double product (systolic pressure x heart rate) at which it developed was similar indicating that the oxygen demands of the myocardium developed earlier with THC as a result of the earlier rise in blood pressure and heart rate [6,7].

## INVESTIGATIONS INVOLVING ENDURANCE AND STRENGTH.

There are two investigations in this category. 18 of 20 male subjects aged 21-27 received either placebo or 18.2mg THC completed a submaximal exercise on a bicycle ergometer and had an evaluation of strength in the dominant hand using a metered hand grip. The peak work capacity ( $PWC_{170}$ ) fell from 1099.2 +/- 55.01 with placebo to 829.9 with THC [8]. A second investigation designed to ascertain the effect of increasing doses of THC and an synhexal (a THC analog) on alcohol withdrawal in 17 males aged 21-44 included a finger ergograph measure of strength. Doses were increased to a median of 50mg THC and 100mg synhexal. The investigators did not publish quantitative data but reported "weakness was clearly demonstrated on the finger ergograph" [9].

## STUDIES INVOLVING EXERCISE

In one study 6 males aged 21-27 received THC 7.5 mg or placebo cigarettes and exercised to about 50% of a predicted  $VO_2$  (750kg/min at 50rpm) for 15 minutes. The peak double product (BP X systolic pressure) was higher for THC than placebo (THC 22,348. placebo 19,536) the control value being 18,980. All considered the exercise was harder with THC [10]. In another study, a modified Masters Step test was used in the evaluation of increasing doses of THC in 12 chronic users of cannabis aged 20-27. Doses increased to 210mg and testing was undertaken on six occasions. Chronic dosing resulted in falls in both systolic and diastolic pressure. When tested there was a blunting in the early haemodynamic response but the same maximal heart rates were obtained. Two could not complete all phases of the study because of dizziness and impaired blood pressure responses [11]. In another study, three females and six males aged 20-24 undertook maximal exercise on a bicycle ergometer 17 minutes after receiving THC 7mg. When compared to a smoke free study there was a decrease in maximal work duration from 16.1 +/- 4 minutes to 15.2 +/- 3.3 minutes  $p < 0.05$  as well as increased leg fatigue after THC [12]. Shapiro and colleagues administered 20mg THC or placebo and using a bicycle ergometer work-load from an initial 150 Kg/min and increased by 150 kg/min each 5 minutes until exhaustion. Initially seven subjects were reported [13]. In the complete study one subject became "stoned" after 9.9 minutes (control 29.4) and all but two ceased because of fatigue at lower levels of exercise [14].

## PHARMACOKINETIC STUDIES

There have been concerns that exercise may elevate cannabis concentrations in plasma and urine resulting in positive tests where drug testing is conducted. Two investigations have been conducted involving regular cannabis users. Both used bike exercise one to 50% of  $VO_2$  max for 35 minutes and the other for 45 minutes at 60-75% of  $VO_2$  max. There were slight elevations

in plasma THC concentrations at a  $p < 0.001$  level but the rises are very small and would not have any effect on drug testing [15,16].

## EXERCISE INDUCED ASTHMA

THC has bronchodilatory properties. These were investigated in 5 males and 3 females with bronchospasm induced by bicycle exercise for 6-10 minutes at work load of 200-650 kpm or by treadmill at 1.6-3.5 kmph. The THC formulation was shown to inhibit exercise induced bronchospasm [17]. A later study by the same investigator in 11 healthy men and 5 asthmatics found that its use sometimes caused bronchospasm, cough and chest discomfort. [18]. The  $\beta_2$  agonists in use today are considerably superior to THC as therapeutic agents so there is no therapeutic value for the use of cannabis in asthma or exercise induced asthma.

## INDUSTRIAL WORKERS

Because of concerns of fitness and health in an industrial setting in Milwaukee, 300 males volunteered for objective evaluation. The selected sample was aged 19-33 of which 18 smoked cigarettes and cannabis, 13 smoked cannabis alone, 17 smoked cigarettes alone and 17 were non-smokers. Exercise was undertaken on a stationary exercise bike with a warm-up at 50 watts and gradually increased by 25 watts to exhaustion. All four groups achieved the same work-load [19].

## EXERCISE IN CANNABIS REHABILITATION

Two studies have been undertaken to assess the effect of exercise on the craving for cannabis. The first involved 8 females and 4 males undertaking 10 sessions of treadmill exercise for 30 minutes at 60% of a maximal tolerated work-load. The second involved 10 subjects for 30 minutes of light or moderate aerobic exercise or moderate exercise for 30 days. Both reported favorable findings at least in the short-term [20,21].

There have not been any investigations of cannabis in a sports setting. Running time on a track has been done with amphetamine, strength in weightlifting has been done with anabolic steroids and fine motor control has been done in shooting with  $\beta$  blocking agents. From the published data it is highly unlikely that cannabis would ever prove superior to placebo should any of these experiments ever be undertaken. It can be concluded from these data that cannabis will not improve exercise performance or increase strength.

## PRESENT STATUS IN COMPETITION SPORT

Cannabis has been used in sport since the classic Olympics when cannabis was one of the components of "Fuscum Olympionico inscriptum" or the Olympic Victors Dark Ointment used for the relief of pain [22]. The World Antidrug Agency (WADA) prohibits use of a drug if it enhances performance, poses a risk to the athlete or is contrary to the spirit of sport [23]. Cannabis has been placed on the banned list since 2004. Cannabis use is detected by quantifying the principal metabolite THC-COOH in urine. The initial concentration was set at 15ng/ml but later raised to a detection threshold of 150ng/ml with an uncertainty of 15ng/ml and a decision limit of 180ng/ml. Prior to increasing the threshold cannabinoids were second or third after anabolic steroids or stimulants but have now dropped to

around the 6<sup>th</sup> position in the 2017 WADA Annual report [24]. It is not possible for the present concentration to be reached by passive exposure [25]. There is no quantified level for analog cannabinoids and their detection is reported as positive.

Acute cannabis exposure produces a unique dose dependent behavioural spectrum including euphoria, enhanced perception, sedation, relaxation altered perception, panic reactions, paranoia and impaired psychomotor activity. This broad spectrum of symptoms explains the claims of its psychological effects in relation enhancing concentration in training to recovering from bouts of exercise. Cannabis also has negative effects on coordination, movement, perception and time estimation as well as increased reaction time all of which would make a sports person more prone to accidents and injuries [25]. These properties also alter driving skills could have serious consequences in car racing or other high-speed sports [26].

Cannabis is an approved indication for medical use in some states in the USA and is available in Australia for specific approved medical indications. Numerous investigations have shown both positive and negative effects of cannabis in pain relief and its place in therapy is not yet established [27]. The only reported case of therapeutic use in sport is use in the reduction of a dislocated shoulder in a mountain climber [28]. The association of cannabis with acute vascular events is of concern. Acute myocardial infarction has been described in a soccer player aged 24 during soccer match has been associated with occlusions in the cardiac cerebral circulations in nonsporting situations [29,30].

There are increasing numbers of sportspeople over 50 and well into the 70's engaging in strenuous aerobic sport many of whom will have asymptomatic coronary disease. Others are exercising as a component of cardiac rehabilitation for diagnosed cardiac conditions. Clearly these are situations where cannabis use is contraindicated. In conclusion cannabis will retard rather than enhance any exercise requiring strength or high levels of aerobic performance. The central mood altering properties account for the benefits claimed before during and after exercise. Cannabis consumption is not without adverse effects and these are either ignored or minimized by promoters of cannabis use. Older sports persons and patients with known cardiac conditions are at risk for potentially fatal cardiac arrest.

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