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Prevalence and Correlates of Cannabis Use Among Athletes—A Systematic Review

Maria Beatriz Brisola-Santos, MD,[1] João Guilherme de Mello e Gallinaro, MD,[1] Felipe Gil, MD,[1] Bernardo Sampaio-Junior, MD,[1,2,3] Matheus Cheibub David Marin, MD,[1,4] Arthur Guerra de Andrade, MD, PhD,[1,4] Kimber Paschall Richter, PhD,[5] Ira David Glick, MD, PhD,[6] Danilo Antonio Baltieri, MD, PhD,[1,4] João Mauricio Castaldelli-Maia, MD[1,2,4,5]

[1]Departament of Neuroscience, Medical School, Fundação do ABC, Santo André, São Paulo, Brazil
[2]ABC Center for Mental Health Studies, Santo André, São Paulo, Brazil
[3]Service of Interdisciplinary Neuromodulation (SIN), Department and Institute of Psychiatry, Medical School, University of São Paulo, São Paulo, Brazil
[4]Interdisciplinary Group for Studies on Alcohol and Drugs (GREA), Department and Institute of Psychiatry, Medical School, University of São Paulo, São Paulo, Brazil
[5]Department of Preventive Medicine and Public Health, University of Kansas Medical Center, Kansas City, Kansas
[6]Department of Psychiatry and Behavioral Sciences at Stanford University School of Medicine, Stanford, California

Background and Objectives: Despite scientific evidence that marijuana impairs performance and mental health, there is evidence that some athletes are at higher risk for use. This review aims to identify possible risk factors associated with marijuana use in athletes.
Methods: A search was conducted in the PubMed database with the keywords: (*marijuana OR cannabis OR tetrahydrocannabinol OR delta-9-tetrahydrocannabinol OR THC*) AND (*sports OR sport OR athlete OR athletes*). We retrieved 186 studies. After applying the inclusion/exclusion criteria, 15 studies remained for review.
Results: The review revealed a number of potential risk factors for marijuana use among adult athletes, including being male, Caucasian, using sport performance-enhancing drugs, using marijuana to enhance recreation or non-sport performance, and practicing specific types of sports including skeleton, bobsleding, and ice hockey. Contrary to use patterns in the general population, among athletes marijuana appears to take the place of tobacco as the second most widely used drug, after alcohol. Many elite athletes denied the use of marijuana, which suggests that toxicological testing is an important tool for identifying users, because it is more accurate than self-report. Geography appears important, as in areas of high consumption, prevalence among athletes appears to be greater as well.
Conclusion and Scientific Significance: Contrary to the image that athletes do not use psychoactive drugs, this review suggests that a number of athletic subgroups are at increased risk for marijuana use. Surprisingly, a common rationale for use appears to be to enhance sports performance. As in the general population, experimentation starts early—in pre-adolescence—at an age that prevention and guidance programs could have positive influences. (Am J Addict 2016;XX:1–11)

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Address correspondence to Castaldelli-Maia, Departamento de Neurociência, Avenida Lauro Gomes, 2000—Vila Sacadura Cabral—Santo André, SP, Brasil, 09060-870.
E-mail: jmcmaia2@gmail.com

INTRODUCTION

The phenomenon of "sport" is a socio-cultural development of the twentieth century.[1] Good mental health can help the athlete in the pursuit of high performance.[1] Problem solving, concentration, attention, motivation, anxiety control, and creating a winning mentality are all keys to success at sports.[1] Paradoxically, epidemiological data demonstrate a high prevalence of substance use and/or abuse in this population.[2] Marijuana is the second most commonly consumed substances among athletes, behind alcohol and ahead of tobacco.[2]

Marijuana, or *Cannabis sativa*, is one of the oldest plants known to mankind. It contains approximately 400 chemicals, including at least 60 alkaloids known as cannabinoids, which are responsible for the psychological effects of marijuana. The Delta-9-THC (Tetrahydrocannabinol) is the most abundant and powerful of these psychoactive compounds and was first isolated in the sixties.[3] Studies of Delta-9-THC have demonstrated that its action in brain physiology, through regulating multiple neurotransmitter systems may affect cognition, perception, motor function, appetite, sleep, neuroprotection, neurodevelopment, hormone release, and consequently physical performance.[4,5] These same studies suggest

that marijuana has a high addiction potential. It has also been closely associated with the onset of several psychiatric disorders such as schizophrenia and other psychoses, mood disorders, and anxiety.[3,4]

The World Anti-Doping Agency (WADA) was established as an international independent agency composed of and funded by sports and governments of the world. Its key activities include scientific research, education, development of anti-doping capacities, and monitoring of the World Anti Doping Code[6]—the document harmonizing anti-doping policies across sports and countries.

In 1999, WADA included marijuana in its list of banned substances. They deemed that marijuana met the second two of their three exclusion criteria: (i) the substance causes an improvement in performance; (ii) use of the substance may have health risks; (iii) use of the substance goes against the "spirit of sport."[2] Athletes have continued to consume marijuana despite WADA's ban and evidence that it impairs psychomotor and psychiatric functioning.[7] This review aims to identify possible risk factors associated with marijuana use in athletes in order to develop strategies to reduce marijuana consumption within this group.

METHODS

Search Strategy

We perfomed a systematic review in PubMed. We included articles published in or after 2001. Keywords used in the search included terms related to marijuana and its active ingredient, Delta-9-THC. We combined these with terms related to sports or athletes as follows: (*marijuana OR cannabis OR tetrahydrocannabinol OR delta-9-tetrahydrocannabinol OR THC*) AND (*sports OR sport OR athlete OR athletes*).

Eligibility

The review included articles that investigated risk factors associated with marijuana use in athletes and were published in English, Portuguese, or Spanish. Articles excluded from review include literature reviews, articles based on data published in other articles (non-original articles), guidelines, historical articles, commentaries, conference abstracts, articles published before 2001, studies that used animals, and human investigations whose population were not athletes.

Study Selection

The second and last authors (JGMG; JMCM) read the title/abstracts of the articles independently, applying the inclusion and exclusion criteria. They compared their results; the concordance rate was above 95%. A third author (MBBS) reviewed articles on which JGMG and JMCM disagreed and determined whether these articles should be included or excluded. JGMG and JMCM read all selected articles in full to extract data on risk factors associated with marijuana use in athletes. Figure 1 shows identification, screening, selection and inclusion of the studies.

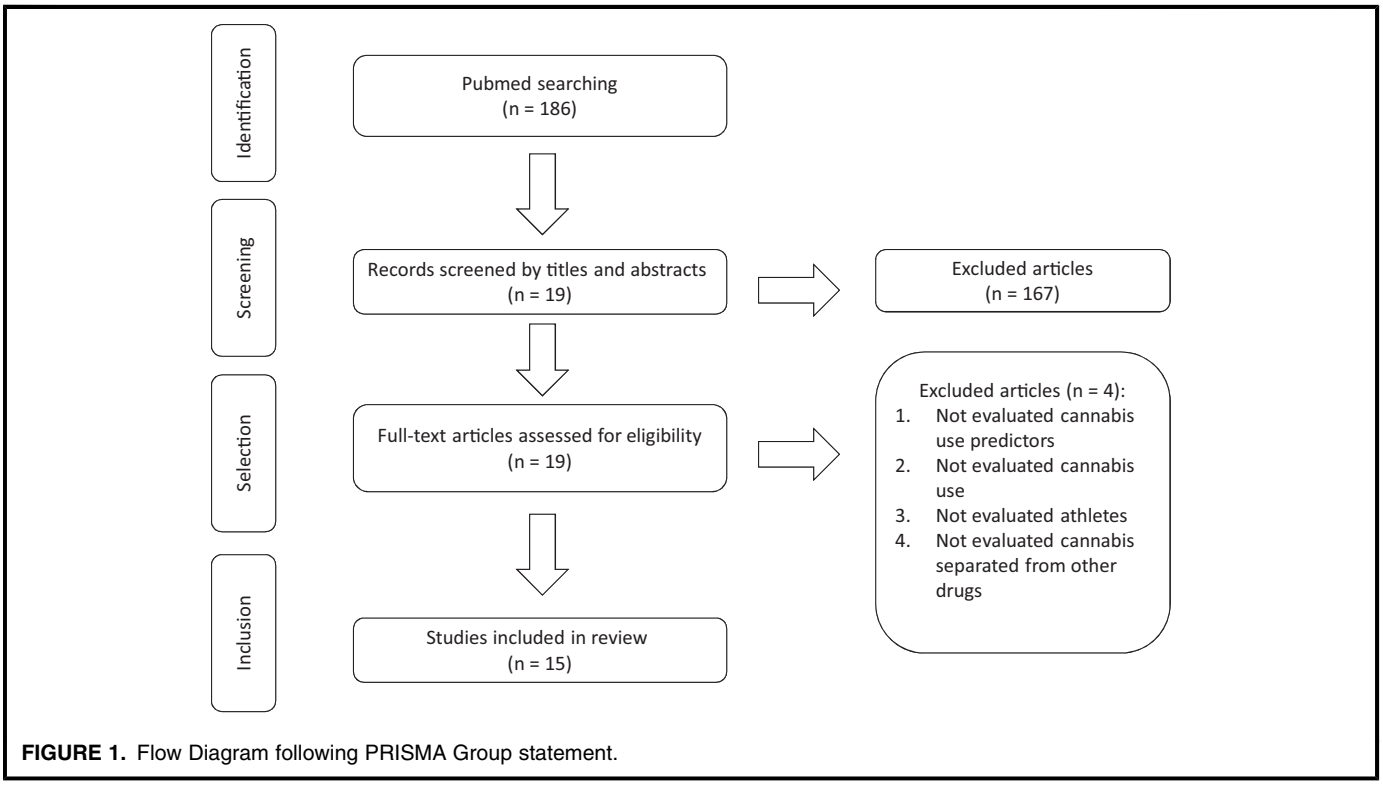

FIGURE 1. Flow Diagram following PRISMA Group statement.

Data Extraction

The second author (JGMG) tabulated data from the selected studies (Table 1). As with study selection, a third author arbitrated in cases of disagreement between the first and last author regarding the information to be presented in the review. Table 1 displays study authors; year of publication; country; sample characteristics; type of study and methodology; study objectives; marijuana use measures; measures related to sport; and results. We did not attempt to conduct meta-analyses or in other ways manipulate data due to the large differences in measures and designs across studies.

RESULTS

Table 1 depicts the main characteristics of the studies included in this review. Most (10) were cross-sectional studies, conducted in the United States and Europe, that included athletes from various sports in the same study. Of these, most (7) focused on adult athletes.[8–14] Buckman et al.[8] found a higher prevalence of marijuana use among users of performace enhancing drugs (PEDs), confirming data from a previous smaller sample study.[9] Green et al.[10] found a wide variability of consumption patterns in all sport divisions of the U.S. National Collegiate Athletic Association (NCAA) and across ethnic groups and type of sport played. Most student athletes used some form of substance, most frequently alcohol (82.6%), followed by marijuana (30.3%). This same study found substance use to be higher among caucasians and in lower divisions (within groups of schools with smaller student populations and fewer resources for sports). The most common reason given for use was "recreational or social" (61.2%).[10]

In Germany, Thevis et al.[11] found 11.2% positive urine samples for banned substances in a sample of Sports Science students who praticed sports outside of class. The most frequently detected compound was tetrahydrocannabinol (9.8%)—the psychoactive compound in marijuana.[11] Despite these data, no participant had self-reported marijuana use, which suggests that questionnaire-based studies may suffer from under-reporting bias.[11] In France, Lorente et al.[12] also conducted a study with Sports Science students who praticed sports outside of class. Most (66.8%) had tried marijuana; however, only a minority used marijuana to improve sport (12.5%) or non-sport (36%) performance. Men were more likely to use marijuana to improve both sport and non-sport performance.[12] Study analyses suggested that the use marijuana for both reasons (sport and non-sport performance) displayed a direct, positive relationship with marijuana use. Participants who reported using marijuana to improve sports performance tended to compete in high level (national and international level) winter sports including skeleton, bobsled and ice hockey.[12] In Australia, Dunn et al.[13] found that one in five (21%) of elite athletes reporting using marijuana in their lifetime with 3.2% reporting use in the past year. Using a large drug testing sample from the Ghent laboratory (one of the few laboratories accredited by the International Olympic Committee), Van Eenoo and Dalbeke[14] found a higher incidence of positive urine tests for marijuana among athletes in Flanders, compared to other regions, which suggests there could be geographical influences on consumption. They also found that trends in prevalence increased significantly in more recent years.[14]

The three studies conducted among adolescents evaluated athletes from various sports.[7,15,16] Two of these studies were conducted in France.[15,16] Peretti-Watel et al.[15] found a significantly lower prevalence of marijuana use among athletes (16–24 years) than in the general population (two to three times lower). Among elite athletes, the practice of a team sport was positively correlated with alcohol use; the practice of a snowboarding, skiing, parachuting, sailing, and kayaking were positively correlated with the consumption of marijuana as well as alcohol. Compared to less competitive athletes, females who competed at international levels were more likely to use tobacco and marijuana. Compared to younger elite athletes, older elite athletes were more likely to use marijuana at least once a year. Education at a boarding school and the practice of snowboarding, skiing, parachuting, sailing, and kayaking were positively correlated with current marijuana use for both females and males. In a recent study with a sample of younger students (mean 16.6 years), Laure et al.[16] found that 19% of students enrolled in sports clubs used marijuana, with average use of 1–3 joints per day in the last 2 months. Athletes who consumed marijuana were mostly male, aged between 15 and 17, and practiced 4–12 hours of sports per week.[16] In Germany, Diehl et al.[7] found an increased risk of marijuana use in non-elite athletes compared to elite athletes aged 14–18 years. However, the overall prevalence of marijuana use was quite low (2.7%). Of those who had reported using marijuana in the past 12 months, 50% also reported episodes of binge drinking.[7]

We also found two studies[17,18] that compared athletes to non-athletes. In the United States, Buckman et al.[17] found that, for student athletes and non-athletes of both sexes, being white, having used cigarettes in the previous year and reporting high sensation seeking were associated with previous year marijuana use. Male student athletes who continued to use marijuana during their competitive seasons were significantly more likely to use of marijuana as a coping mechanism compared to to athletes who did not report use during the season.[17] In France, Peretti-Wattel and Lorente[18] analyzed the Escapad survey conducted among individuals aging 18 who attended the "Roll Call Day of Preparation for Defence" in France. Respondents who had engaged in formal sporting activities (athletes) were less likely to use marijuana regularly, while informal sports practice was positively correlated with consumption of marijuana.[18]

We found two studies that investigated samples of athletes who practiced selected sports. Maquirriain[19] used a large sample of professional tennis players using data released by the ITF (International Tennis Federation). Marijuana was the second most commonly found substance (23.7% prevalence)

TABLE 1. Main characteristics of the studies included in the systematic review of risk factors for marijuana use in athletes, held in Pubmed database

Reference, author, year, location	Characteristics of the sample	Study design and methods	Study goals	Marijuana use measures and sporting activity	Results
(7), Diehl et al. (2014), Germany	• $n = 1138$ • 56.1% male • 51 sports • Elite athletes • German teenagers • Study: "German Young Olympic Athletes' Lifestyle and Health Management Study"	Cross-sectional study. This population was contacted and asked to answer a questionnaire self-administered between February 2010 and January 2011.	To test the hypothesis that the elite athletes have a lower prevalence of all risk behaviors compared to non-elite athletes.	Marijuana: use in last 12 months. Athletes: inclusion criteria for athletes were: (a) having engaged in any sport of the 2010 Winter Olympics or the 2012 Olympics (b) born between 1992 and 1995, and (c) compete in one of the four highest levels of the national team or the corresponding level.	Nonelite athletes showed a higher risk of alcohol consumption, cigarette and marijuana. Marijuana use was low (2.7%). Of those who reported using marijuana in the past 12 months, 50% reported binge drinking.
(8), Buckman et al. (2013), United States of America	• $n = 11,556$ • All male • Aged 18–23 years • 23 sports • College athletes • Study: "2008–2009 National Study of Substance Use Trends"	Cross-sectional study. All data were collected by the NCAA (National Collegiate Athletic Association) using a survey.	To assess whether PES (performance enhancing substances) users specifically use these substances to enhance performance or in a manner consistent with psychoactive drug use.	Marijuana: never used; used in the last 30 days; used in the last 12 months; used, but not in the last 12 months. Athletes whose university were members of the NCAA.	The prevalence of marijuana was significantly higher in PES users than in non-users.
(9), Buckman et al. (2009), United States of America	• $n = 234$ • All male • Average age of 20.1 years • College athletes	Cross-sectional study. Recruitment occurred during a mandatory education seminar on alcohol. A 30-minute anonymous questionnaire.	To determine if PES users have higher risk patterns for the consumption of alcohol or other drugs and demonstrate risk behaviors associated with substance use.	Marijuana: modified questionnaires were used to evaluate drug use, based on studies the "Rutgers Health and Human Development Project (1984)" and "Monitoring the Future (2007)."	PES users were more likely to use cigarettes, marijuana and cocaine in the last year. PES users demonstrated high sensation seeking and marijuana use to improve performance and coping.

(*Continued*)

TABLE 1. Continued

Reference, author, year, location	Characteristics of the sample	Study design and methods	Study goals	Marijuana use measures and sporting activity	Results
(11), Thevis et al. (2008), Germany	• $n = 964$ • 439 women and 525 men • Average age of 22.1 years • University students in sports sciences	Cross-sectional study. Between 1998 and 2000, urine samples were collected from 964 students. Sampling was carried out under compulsory medical examinations, but with free and informed consent from the participants that the urine samples could be subjected to studies on drugs. Urine tests were not announced beforehand to the applicants.	(1) What is the prevalence of use of stimulants, anabolic steroids and other illicit substances among the included students, and (2) how these data correlate with those of other national and international studies?	Marijuana: Use of the substance of the last 24 hours. Athletes: college students of sports sciences. Sports included: basketball, handball, athletics, tennis, swimming, gymnastics, badminton, cycling, table tennis, hockey, snowboarding, skiing, taekwondo, rowing, karate, rugby, skateboarding, climbing, baseball, skydiving, volleyball, surfing, diving.	In total, 11.2% of the urine samples was positive for banned substances. The compound that was more frequently detected was the tetrahydrocannabinol (9.8%), followed by various stimulants related to amphetamines and cocaine (1.0%). Despite these data, no participant had reported prior use of marijuana.
(12), Lorente et al. (2005), France	• $n = 1{,}305$, • Students from six French universities of Sports Science	Cross-sectional study. The questionnaire included 87 items that characterized the population in terms of demographics (three items), sports (five items), alcohol consumption and intoxication (13 items), and use or abuse of other drugs (66 items).	To evaluate the prevalence of marijuana use to improve the sporting and non-sporting performance of French students in Sports Universities to investigate factors associated with performance.	Marijuana use during life, the main reason for marijuana use, frequency of use of marijuana during the previous 30 days, the average number of marijuana joints smoked and marijuana use to improve sports performance or non-sport performance (for example, before an examination). Athletes: Main sport practiced and competitive level.	It was observed that 66.8% of participants had already used marijuana, however, only a minority used marijuana to improve non-sports (36%) or sports (12.5%) performance. Men were more likely to have used marijuana. The use of marijuana to improve sports performance was positively related to the competitive level of the athlete and specific sports.

(*Continued*)

TABLE 1. Continued

Reference, author, year, location	Characteristics of the sample	Study design and methods	Study goals	Marijuana use measures and sporting activity	Results
(13), Dunn et al. (2011), Australia	• $n = 974$ • 75.6% male • Mean age of 23.1 years, • Elite athletes.	Cross-sectional study. The research process was coordinated by sports organizations and completed in teams meetings and competitions. The athletes completed a questionnaire to be returned to their mentors in a sealed envelope without identification.	1. To investigate the prevalence of illicit drug use among the Australian elite athletes; 2. To explore the opinions of athletes in relation to specific drugs; 3. To investigate predictors of drug use in the past year.	Marijuana: Use during life or use in the last 12 months. Issues related to substance use were adapted from "National Drug Strategy Household Survey (2009)" and "Drug Use in English Professional Football (2005)." Athletes: The athlete was considered elite if eligible for national or state selection in their particular sport.	7% ($n = 68$) of the sample indicated having used at least one illicit drug under investigation. A fifth of the sample (21%) reported "lifetime use" of marijuana and 3.2% reported use in the last year ("recent use"). Factors associated with consumption of substances were: older age, the opportunity to use drugs in the past, being a full-time athlete, to know personally other athletes that used illegal drugs and less education.
(14), Van Eenoo and Dalbeke (2003), Belgium	• $n = 14995$ • 13,224 males and 1771 females • Mainly from Flanders region • Age not provided	Cross-sectional study. Samples taken by the doping control laboratory of Ghent (Belgium) in the period 1993–2000 were compared to samples taken by International Olympic Committee (IOC) from 1996 to 2000.	To investigate the prevalence of sports doping in Flanders, compared to international bodies.	Marijuana: presence or absence of substance in the sample. Athletes: Cycling, football, athletics, volleyball, basketball, bodybuilding, swimming, judo, handball, weightlifting, tennis, table tennis, football, "indoor." Samples were analized in and out of the competition period.	Within 363 positive cases for prohibited polysubstance use, marijuana was the ninth substance most found (14 times). Unfortunately, the authors did not report on the prevalence of marijuana in the 520 positive cases just for one substance.
(15), Peretti-Watel et al. (2003), France	• $n = 460$, • Aged between 16 and 24 years, • Young elite student athletes (ESAs), • Recruited from 40 public centers in	Cross-sectional study. Respondents answered a questionnaire about the use of legal and illegal	Study the relationship between sporting activity and use of alcohol, cigarettes and marijuana among	Items related to drug use were based on existing questionnaires (Escapad and ESPAD, Beck, Peretti-Watel and	As a whole, the practice of sports among ESAs was negatively correlated with the use of cigarettes, alcohol and marijuana. However,

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TABLE 1. Continued

Reference, author, year, location	Characteristics of the sample	Study design and methods	Study goals	Marijuana use measures and sporting activity	Results
	France, • 30 different sports.	drugs, sports practice and other aspects of their lifestyles.	adolescents and young adults, focusing on ESAs.	Legleye, Hibell). Marijuana: use at least once or no use during the last 12 months. Athletes: The 30 sports were grouped in three unique types: team sports (handball, rugby, volleyball), sliding sports (snowboarding, skiing, parachuting, sailing, kayaking) and other individual sports (judo, squash, cycling, track, and field, gymnastics, etc.).	this relationship depended on the type of sport practiced and the level of competition. Older ESAs were more likely to use marijuana at least once a year. Education at a boarding school and snowboarding, skiing, parachuting, sailing, kayaking were positively correlated with current marijuana use for girls and boys.
(16), Laure et al. (2004), France	• $n = 1459$ • 846 male and 613 female • Average of 16.6 ± 1.7 years • Students enrolled in sports clubs	Cross-sectional study. A semi-structured questionnaire adapted from previous studies, containing 63 questions.	To identify the consumption pattern of adolescent athletes, doping behavior, psychological and sociological factors associated with substance use.	Marijuana: ever used; average cigarettes per day, in the last 2 months. Athletes: All competitors were students, most in team sports (volleyball, basketball and judo, among others). A minority practiced individual sports (gymnastics, athletics, judo, etc.).	19% used marijuana, the average 1–3 joints a day for the past two months. Athletes who consumed marijuana were mostly male, aged between 15 and 17, practiced sports 4–12 hours per week.
(17), Buckman et al. (2011), United States of America	• $n = 896$: • −392 student athletes, 60% male, aged 19.9 [±1.3], and • −504 non-athletes, 37% male; aged 20 [±1.4]. • 17 different sports.	Cross-sectional study. Athletes were asked to complete questionnaires before an educational seminar related to alcohol. Non-	This study analyzed the risk factors that can lead or restrict the use of marijuana in college athletes and non-athletes.	Marijuana: Modified questionnaires were used, based on the studies "Rutgers Health and Human Development Project (1984)"	For athletes and non-athletes of both sexes, being white, past-year tobacco use and higher scores sensation-seeking were associated with past-year marijuana use.

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TABLE 1. Continued

Reference, author, year, location	Characteristics of the sample	Study design and methods	Study goals	Marijuana use measures and sporting activity	Results
		athletes were recruited from introductory psychology ($n = 70$) or communication ($n = 452$) classes.		and "The Harvard School of Public Health College Alcohol Study (2002").	Performance motivation was higher among athletes compared to non-athletes.
(18), Peretti-Watel et al. (2004), France	• $n = 15.189$, 12.512 aged 18 years (8,888 women and 3,624 men). It was used data from ESCAPAD survey conducted by the French Monitoring Centre for Drugs and Drug Addiction (OFDT)	Cross-sectional study. In France, compulsory military service was replaced by a single day of activities, called "Roll Call Day of Preparation for Defence" (RCDPD), organized in 300 civilian or military centers spread throughout the country. Once a year, all participants RCDPD respond to a strictly anonymous questionnaire designed by OFDT experts with questions about health, leisure and legal and illegal drug use.	To study the relationship between the use of marijuana, sports and other leisure activities during adolescence, as a test for sociological theory of deviant opportunities	No use of marijuana; Use in the last year; occasional use ($\geq$1 last year); recent use ($\geq$1 last month); Regular use ($\geq$10 last month). Athletes: Hours of participation in sports activities related to a team (formal practice), without a team, alone or with friends (informal practice).	Respondents who engaged in formal sports practices were less likely to use marijuana regularly, while informal sports practice was positively correlated with the consumption of the substance. This suggests that club membership reduced use, as athletes outside of club control used more.
(19), Maquirriain (2010), Argentina	• $n = 13,340$ • 8,373 male • Average age of 27.3 years • 4,967 female • Average age of 24.1 years • Tennis players	Cross-sectional study. The ITF (International Tennis Federation) published the complete list of doping cases between 2003 and 2009.	The objective of this study was to analyze cases of doping in international professional tennis circuit.	Marijuana: presence or absence of the substance in the sample. Tennis athletes linked to ITF (International Tennis Federation)	They were described 52 doping violations in the 2003–2009 period, and marijuana was the second most frequently found substance (23.07%). "Social Drugs" is the main problem of doping in tennis.

(*Continued*)

TABLE 1. Continued

Reference, author, year, location	Characteristics of the sample	Study design and methods	Study goals	Marijuana use measures and sporting activity	Results
		Data were collected from the official website of the ITF, recorded and separated by gender, nationality and type of tournament.			
(20), Ama et al. (2002), Camaroon	• $n = 1116$ • 1,037 male • 79 female • Football (soccer) players	Cross-sectional study. Players responded to an anonymous questionnaire of 30 items grouped in themes. The questionnaire was answered in training camps of several clubs or at the stadiums before games.	To investigate use and awareness of legal and illegal substances by amateur players in Yaounde, Cameroon.	Questionnaire involving questions about consumption patterns. Athletes: the male players were separated into "local players" (without National Football Federation license) and "elite players" (with license); the female players were part of various clubs affiliated to the National Football Federation.	10% reported using marijuana, of these, 8% reported using the drug before games. Local players were associated with a higher prevalence of substance use than the two other groups.
(21), Laure et al. (2007), France	• $n = 2199$ • 53.2% male • 46.8% female • Average age of 11.2 years.	Prospective, questionnare-based cohort study. The survey included sociodemographic items, sports participation, self-esteem (Rosenberg's Self-esteem Scale), anxiety (Spielberger's S tate-Trait Anxiety Inventory), and drug use.	To describe the prevalence of doping and its progression in a group of pre-adolescent athletes during 4 years of follow-up.	Marijuana: Past semester use was collected every 6 months. Sports: Time in physical activity, regularity, link to clubs or sports associations, conducting extra-school sports activities, sport and participation in competitions.	Overall, the main banned substances used to enhance physical performance were salbutamol (45.5%), corticosteroids (10.2%), marijuana—which is banned in France—(6.3%), and others, for example, other stimulants, anabolic agents, etc. (38.0%).
(23), Green et al. (2001),	• $n = 13914$, • 9,183 men • 4,722 women.	Cross-sectional study. The survey instrument	To determine the consumption patterns of	Substance use in the past 12 months. Athletes in the	Most student athletes used substances, especially alcohol

(*Continued*)

TABLE 1. Continued

Reference, author, year, location	Characteristics of the sample	Study design and methods	Study goals	Marijuana use measures and sporting activity	Results
United States of America	• Student athletes competing in 991 institutions belonging to I–III Divisions of NCAA.	contained 160 variables. After selection of the institutions and sports, surveys were distributed through "Faculty Athletics Representatives" (FARs).	substance in student athletes of the National Collegiate Athletic Association (NCAA).	following sports: Baseball, basketball, cross country, fencing, football, golf, gymnastics, hockey, lacrosse, rifle, football, swimming, tennis, water polo, wrestling, field hockey, skiing, volleyball	(82.6%), followed by marijuana (30.3%). According to the survey, substance use is higher in III Division and among Caucasians. Recreational or social use was the most prevalent (61.2%).

among the few doping violations that were reported in the 2003–2009 period. Ama et al.[20] investigated a sample of soccer players in Cameroon. One-tenth reported using marijuana. Among these, 8% reported using the drug before games. Male "amateur" players reported more frequent marijuana use than male "elite" players or female players.

Last, Laure and Binsinger[21] conducted a prospective study among pre-adolescent athletes (mean age 11.2 years). The prevalence of marijuana was 6.3%.

DISCUSSION

The review revealed a number of potential risk factors for marijuana use among adult athletes, including being male, Caucasian, using sport performance-enhancing drugs, using marijuana to enhance recreation or non-sport performance, and practicing specific types of sports including skeleton, bobsled, and ice hockey. Contrary to use patterns in the general population, among athletes marijuana appears to take the place of tobacco as the second most widely used drug, after alcohol. Many elite athletes denied the use of marijuana, which suggests that toxicological testing is an important tool for identifying users, because it is more accurate than self-report. Geography appears important, as in areas of high consumption, prevalence among athletes appears to be greater as well.

Use among adolescent athletes displayed some similarities and differences in patterns. Being male and practicing specific sports such as skeleton, bobsled, and ice hockey continued to be associated with higher likelihood of use. Other risk groups emerged including binge drinking, teenage women attending international competitions, and non-elite athletes. The only prospective study demonstrated that extremely athletes are beginning to experiment at very young ages (10–14 years).

Previous authors have noted a number of methodological flaws with the existing literature,[10,17,22] such as the lack of longitudinal data and many studies reporting on convenience samples. Surprisingly, marijuana use, although under-reported, is likely common among athletes. Findings on specific risks, however, were mixed. For example, some studies[12] found marijuana use to be more prevalent at higher levels of competition and others found it to be more prevalent at lower levels.[18] This justifies future research to better determine the true prevalence. It also justifies consideration of educational strategies within sport to raise awareness of risk and prevent uptake of use.

Interestingly, some athletes reported using marijuana to enhance sport performance. This could explain use by athletes before football matches,[20] It clearly demonstrates, however, lack of information on the actual effects of the drug.[10,12] Data from studies not included in this review point to an association between depression, marijuana use and stress related to body image in athletes[24–26] In these cases, use of marijuana could have adverse effects on not just the performance but also the mental health of athletes. There are also indications that additional sports place athletes at higher risk for substance use, such as football, basketball, and cycling.[27] The finding that some sports are associated with marijuana use suggests that specific sport associations have a role in dispelling myths about the benefits of using marijuana.

Decriminalization of marijuana in countries is a topic of heated debate as it potentially increases use among youth.[28] Moreover, its use is associated with a number of possible long- and short-term physical and psychological complications, such as dependence, withdrawal, tolerance, anxiety, hallucinations, violent behavior, depression, excessive fear, psychosis induction, insomnia, memory impairment, decreased reflexes, confusion, cognitive deficits, altered time perception, amotivational syndrome, coughing, wheezing, bronchitis,

amenorrhea, and immune dysfunction.[29] Accordingly, athletes should be informed that they may be at risk for marijuana use. Risks may be due to the sport that they play or to being a member of a higher-risk subgroup, as identified in this review.[8–14]

CONCLUSION

Contrary to the image that athletes do not use psychoactive drugs, this review suggests that a number of athletic subgroups are at increased risk for marijuana use. Surprisingly, a common rationale for use appears to be to enhance sports performance. As in the general population, experimentation starts early—in pre-adolescence—at an age that prevention and guidance programs could have positive influences.

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