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Inserm Collective Expert Review

Summary and recommendations

Doping and doping practices in sport

Manuscript

This document was translated into English from the original French version of the collective expert report published in April 2026.[1]

It presents the summary and recommendations of the work of a group of experts, brought together by the French National Institute of Health and Medical Research (Inserm) as part of the collective expert review procedure (see Annex 1), in response to a request from the Ministry of Sports regarding doping and doping practices in sports.

This work is primarily based on data from the international scientific literature available as of the end of December 2024. More than 3,800 documents were compiled through the interrogation of different bibliographic databases (PubMed, Scopus, Web of Science, SocINDEX, etc.; see Annex 2).

The work was coordinated by the Collective Expert Reports Unit of Inserm, which is part of its Public Health Thematic Institute.

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Introduction

The use of substances intended to enhance athletic performance already existed in the Olympic Games of ancient Greece, but it was during the 20th century that the identification, definition, and condemnation of doping gradually took shape. Doping is disruptive, and the drive to regulate the use of doping substances emerged as a result of changing social norms. Indeed, doping was perceived as a threat to amateurism within the Olympic movement, and the production of athletic performance was exploited by certain countries in the context of the Cold War. Following the first definitions of doping in the 1960s and the involvement of the International Olympic Committee (IOC) and certain states, the creation of the World Anti-Doping Agency (WADA) in 1999 marked a turning point in the process of harmonizing rules within the Olympic movement. However, some singularities remain; for example, North American professional leagues do not apply the rules laid down by WADA. But a large number of countries have adopted the World Anti-Doping Code by incorporating some of its provisions into their own legal and administrative frameworks. In France, for example, the mission of the French Anti-Doping Agency (AFLD) to enforce WADA rules for the prevention and fight against doping is governed by the French Sports Code.

The use of scientific methods, particularly the advances made by accredited laboratories specializing in the detection of doping substances or methods, and the increase in testing have raised hopes that the problem of doping in sport might be solved. However, despite all the measures put in place, this is not the case, and doping cases continue to affect the world of sport, as evidenced by their media coverage in recent decades.

These challenges are not surprising, as the issues raised by doping are numerous and multidimensional, extending beyond the sporting world to involve governments committed to protecting public health and implementing measures to prevent and combat doping. These issues cut across many dimensions, including ethical, political, health-related (both physical and mental), sociological, and economic. They concern a wide range of sporting populations, including high-level athletes subject to anti-doping controls in national or international competitions, and also amateur (or recreational) athletes who may compete at departmental or regional levels, or who do not compete but practice for their own pleasure or well-being. As the use of substances has spread across this spectrum of athletic populations, research has adopted a broader concept of doping, one that extends beyond the violation of a rule in the WADA Code. Consequently, the terms doping behavior and doping practices, used in various publications, reflect the desire to understand the phenomenon of doping in a more comprehensive manner.

Moreover, athletic performance—which is at the heart of doping issues—transcend the strictly sporting realm and has become a symbol of identity affirmation with multiple dimensions (national, local, political, gender, etc.). It is all the more important because sport has become an emblematic practice of a society that promotes performance as an ideal.[6]

Consequently, studying doping involves addressing issues relating to individual choices as well as geopolitical issues. Understanding doping therefore requires multidisciplinary research to grasp its many facets and complexity, which is what this collective expert review sets out to do.

[6] Ehrenberg, A. Le culte de la performance. Paris : Hachette Littératures, 2003 : 323 p.

Confronted with the challenges associated with preventing and combating doping, the Ministry of Sports commissioned the French National Institute of Health and Medical Research (Inserm) to review the available literature on the subject of "doping and doping practices in sports", and in particular to take stock of current knowledge regarding the health effects of consuming performance-enhancing substances. This report draws on data from the scientific literature, focusing on the last ten years. It was authored by a multidisciplinary group of 12 experts from various fields including epidemiology, sociology, political philosophy, psychosociology, psychology, prevention science, cardiology, psychiatry, exercise physiology, and sports medicine. The corpus reveals considerable heterogeneity and a focus on certain issues, with, for example, extensive data on substance detection but much less on the health effects of doping. The body of work dealing with the detection of substances, as well as that exploring their ergogenic properties, was not addressed in the framework of this expert review, whose main objective was to provide insights for improving doping prevention.

The need for an assessment of current knowledge on doping is all the more justified given that this is a relatively new area of research in which the quality of publications varies greatly. Efforts to structure research have been undertaken with the support of WADA, other anti-doping organizations, and private and public funding. This distribution of support, however, invites questions about the degree of autonomy in this field of research. In addition, there is a lack of research on certain topics, for example on female athletes or athletes with disabilities. This situation can have particular implications, since doping is a domain where science plays a decisive role in the regulations and sanctions imposed. Finally, it should be noted that the topic of doping and its resonance in the media may attract researchers who venture outside their disciplinary field, running the risk of producing analyses that are at best simplistic and at worst flawed, or of applying their own disciplinary field to a complex area that requires a multidisciplinary approach. They then run the risk of falling out of step with existing knowledge and producing highly simplistic analyses of doping-related issues, but with the potential advantage of challenging specialists in the field with an innovative and more independent perspective.

This report summarizes the findings of the analysis, carried out by the experts in each of their disciplines, of the literature that was provided to them and discussed collegially. To better grasp the extent of the phenomenon, it begins with chapters addressing the prevalence of doping: these analyze methods for estimating prevalence and examine data on the prevalence of doping and doping practices in sports and para-sports. A second series of chapters is devoted to an analysis of the health and social harms of doping and doping practices. These deal with the effects of doping substances on physical health (cardiovascular, renal, endocrine, reproductive, hepatic, cutaneous-mucosal, musculoskeletal systems, risk of cancer or infection) and mental health, followed by a chapter analyzing the social harms associated with doping. A third series of chapters deals with the determinants of doping and doping practices from a psychosocial and then a sociological perspective, and also presents an analysis of doping prevention programs. Finally, the last series of chapters presents an analysis of anti-doping policies and their social consequences, and explores the ethical dimensions of the fight against doping.

The expert group also heard from speakers who shared their experiences or presented their research or actions in the prevention and fight against doping. These complementary contributions appear in the form of "communications" at the end of the complete expert report.[7] These, together with the literature analysis enriched by the collective reflections of the expert group, allowed the panel to make a number of recommendations. The first, termed "structural recommendations", are designed to propose an organizational structure and broad

[7] The analyses and opinions expressed in the communications are solely those of their authors.

principles to facilitate the implementation of accompanying recommendations for action for the prevention and the fight against doping, as well as recommendations for research. This summary and the recommendations were developed and validated collectively by the expert group.

Summary

Prevalence of doping: reflections on methodological approaches

The prevalence of doping and doping practices is a subject of constant interest, as estimating the true extent of the phenomenon remains a pressing yet unresolved concern, despite the regular publication of literature reviews. To estimate this prevalence, it is necessary to establish a ratio between the number of individuals meeting a given definition of doping and the total population from which these individuals are drawn, over a defined period of time. The challenge in determining the prevalence of doping from the available data lies mainly in the definition of the phenomenon of interest and that of the target population.

In the international literature, the notion of "doping" generally corresponds to the World Anti-Doping Agency (WADA) definition of doping, i.e., the violation of anti-doping rules. On the other hand, that of "doping behavior" is understood as a behavior linked to a motivation to enhance performance, a notion that the group of experts, in the context of this expert review, has chosen to characterize as a "doping practice". Likewise, in studies aimed at estimating prevalence, the definition of the target population can be extremely heterogeneous depending on whether it consists of high-level athletes or the general population, that includes recreational, amateur, or leisure athletes (according to the terms used in the literature).

These questions around the definition of the phenomenon (doping or doping practices) and the population concerned call for a consideration of the different sources of information used to estimate the prevalence of doping.

Using anti-doping rule violations poses a major methodological problem for estimating "prevalence"

Among the different sources of information used are data from WADA antidoping rule violations. The anti-doping testing figures, as reported by WADA-accredited laboratories, have been published annually by the Agency since 2003. Transparency regarding this data has improved over the past decade. This data directly reflects the proportion of biological tests that may constitute a violation of the World Anti-Doping Code, without prejudging the existence of doping behavior. These results concern adverse analytical findings, that might not be confirmed by a second analysis, and that could also correspond to legitimate therapeutic use. An additional problem in estimating the prevalence of anti-doping rule violations concerns the imprecise nature of the denominator, which is presented in terms of the number of samples and not individuals (an athlete may be tested several times over a given period).

Despite these obvious and well-known limitations, far too many publications report estimates of doping prevalence based on anti-doping test results, which are almost exclusively derived from international competitions. Considering these data as a relevant estimate of prevalence poses a major methodological problem, since the probability of being tested varies according to sport, level of competition, and country. Several reviews of the literature on the prevalence of doping have summarized anti-doping testing figures, and overall, these report a prevalence of positive tests between 1 and 2%. For some sports, these testing data are supplemented by information from the athlete biological passport, which continuously and therefore more intrusively monitors biological parameters, allowing abnormal profiles (hematological or steroid) to be detected using Bayesian analysis. Some authors have estimated the likely prevalence of blood doping in endurance sports, based on biological passport results, to range

from 15 to 18% depending on the events in which the athletes subjected to this type of testing participated. This approach appears attractive, as it allows a situation to be assessed over an extended period of time by measuring abnormal individual variability in doping biomarkers rather than specific exposures with substance identification. However, it is important to bear in mind the intrusive nature of the biological passport, which makes its acceptance difficult and its extension problematic, with more than two-thirds of these tests relating only to cycling and athletics.

The analysis of sanctions is also used to estimate prevalence, but in this case, the denominator is not defined (whereas prevalence is a ratio), and the proportion of anti-doping rule violations resulting in sanctions depends on the sport: for example, the proportion of violations that result in a sanction is lowest in fencing, skating, and tennis, while it is highest in weightlifting, wrestling, and volleyball.

The randomized response method: an alternative to direct questionnaire surveys?

Another source of data for estimating prevalence relies on specific surveys of the populations concerned.

Analysis of the literature reveals very little published data derived from population-based surveys using self-administered questionnaires, even though such studies were conducted before and at the very beginning of the 2000s, including in France. In these direct questionnaire surveys, subjects are most often asked about their consumption of substances in a sports context over a defined period (e.g., the past 12 months or in their lifetime).

The main limitation of these self-administered and direct questionnaires is the (unknown) probability of false responses in a context of social desirability. Specialists in the humanities and social sciences have therefore proposed exploring this phenomenon using indirect questioning based on the randomized response method.[8] Indeed, nearly all studies published since the 2000s, whether focusing on high level or recreational athletes, are based on this approach that yields extremely variable prevalence estimates. According to the authors, these estimates are higher than those obtained through direct questioning (though direct comparisons within the same population are rare), but they are closer to reality. Several variants of the randomized response method have been developed to refine this estimate, though they do not compensate for the limitations of these indirect approximations. As with direct questionnaires, the same limitations persist with regard to the time windows and the intrinsic nature of doping substances or methods. The design (question models) and interpretation of these randomized response methods have a marked influence on the estimated prevalence rates, sometimes leading to substantial variations (from simple to tenfold) in prevalence estimates within the same population depending on the choices made by the authors. It therefore seems imprudent to recommend these methods for estimating the extent of doping.

Are there other conceivable methodologies?

Other much less robust approaches have been proposed and are often detailed in general reviews of the prevalence of doping. These include analyses comparing athletic performance based on the existence of sanctions for anti-doping rule violations in a given sport, but this approach is hindered by the lack of a clearly defined denominator and, above all, by the wide variability in sanctioning decisions. Some studies report an estimate of the "perceived"

[8] In the randomized response method, direct questions on sensitive topics are replaced by a questionnaire designed so that the interviewer cannot identify which (randomly selected) question the respondent has answered. This approach was developed to provide respondents with a greater guarantee of the anonymity of their responses.

prevalence of doping by asking athletes or sports staff, via questionnaires or interviews, for their own estimate of the prevalence of the phenomenon. This approach tends to overestimate doping prevalence in the sport practiced (respondents consider that competitors in their discipline are more likely than themselves to resort to doping, or they are aware of doping practices among peers – or opponents), as well as in other sports or other countries. This type of prevalence estimate is difficult to rely on, as are statements made by "repentant" athletes.

To estimate the prevalence of doping with anabolic steroids in the UK general population, researchers have used a Delphi method, which led to a consensus among experts on prevalence ranges for this practice, based on a comparison of multiple independent data sources.

To complete the panorama of sources used to estimate the prevalence of doping, wastewater epidemiology has been proposed. A few targeted studies, focused on specific geographic areas, have analyzed local wastewater treatment plants for the presence of substances potentially used for doping during sporting events. This indirect approach, which consists of measuring the sum of excreted substances from an undetermined number of individuals in a given environment, could serve as a complementary method for population-level epidemiological insights into doping. Although this type of analysis cannot provide an estimate of the prevalence of doping, it could be used for health monitoring purposes to identify the doping substances most commonly used during sporting events (by athletes and the public).

Based on these heterogeneous sources, which have significant limitations in providing methodologically sound estimates of prevalence, several literature reviews rely on WADA reports, which represent the primary source of information on doping. Although some authors highlight the challenges of synthesizing these heterogeneous data, they generally give a prevalence range of 0 to 5%, but which can reach 73% in specific contexts. Analysis of this literature underscores the limited relevance of attempting to determine a single common parameter for the prevalence of doping.

An analysis of the various methods used to estimate doping prevalence, and the heterogeneity of the populations studied, tends to confirm that the doping prevalence cannot be captured by a single approach or a single value. While the available data suggest that a multi-source approach could compensate for the difficulties associated with each approach, no such study was found in the literature. This observation applies to the population of high-level athletes, who are the target of anti-doping controls. In the context of recreational sport, the available studies most often explore the prevalence of substance use reported in sports, with a very broad definition of the substances involved, most often outside the scope defined by the WADA Prohibited List.

Prevalence of doping and doping practices in sport

Research on the use of performance-enhancing drugs (PED) initially developed with the field of high-level sport and involved, for example, athletes competing at the national or international levels. These studies, however, provide only an incomplete picture of the prevalence of the phenomenon in high level sport for the methodological reasons outlined above. The section below will present the main findings on this category of athletes in order to enable comparison in the following sections, that will focus on amateur athletes.

Heterogeneous "prevalence" figures in high-level sport

A literature review, published in 2015, examined the different approaches used to estimate doping prevalence in elite sport. The authors evaluated the results of anti-doping tests between 1987 and 2013, which showed a positive test rate of between 0.96 and 2.45%, as well as data from a study based on the athlete biological passport (ABP) that estimated the overall prevalence of doping in athletics between 2000 and 2010 at 14%. Noting that direct questionnaire surveys are very rarely used among high-level athletes, they described the first study based on the randomized response method which found a prevalence of doping among German athletes of between 20 and 39%. Based on these studies, the authors concluded that the overall prevalence of doping among adult elite athletes is between 14 and 39%.

More recently, in 2021, other authors, based on a systematic review of more studies (105 studies conducted in 39 different countries, published between 1975 and 2019), concluded that the overall doping rate was less than 5%. They note that there are disciplines where doping is non-existent (0%) and others, much rarer, where it is widespread (73%).[9] They highlight the extreme heterogeneity of substances, sports disciplines, levels and intensity of practice, as well as the methodologies used, calling for caution in interpreting the results.

Based on this observation of heterogeneity, these authors focused on a shorter period between 2016 and 2021 and concluded that the overall prevalence of doping in competitive sports was less than 5%, but reached up to 30% in certain sports or depending on the methodology used. They analyzed the published WADA data summarizing the results of anti-doping controls between 2016 and 2019 and show anti-doping rule violation rates of less than approximately 1%, with the highest rates occurring in strength sports such as weightlifting or wrestling (between 1.0 and 1.2%), as well as boxing (between 0.7 and 1.1%). Anabolic steroids are the most commonly detected class of doping substances (43 to 45% of samples depending on the year), followed by stimulants (13 to 15%), and diuretics and masking agents (12 to 16%).[10]

Limited data on high-level athletes with disabilities

In 2024, there were nearly 100,000 people in France who were licensed or associated with French parasport or adapted sport federations, and several hundred athletes with disabilities potentially subject to anti-doping controls due to their high-level status. Doping in this population is an issue in the same way as for non-disabled athletes.

Anti-doping testing data show a relatively low but non-negligible prevalence of anti-doping rule violations in parasports. Between 2013 and 2022, the rate of violations in relation to the total number of samples analyzed ranged from 0.43 to 0.96%, with para-athletics and para-powerlifting being the most affected sports. It should be noted that athletes with disabilities are not generally subject to the same level of anti-doping monitoring as their non disabled counterparts, which complicates comparisons of prevalence data between these populations.

Parasports are confronted with distinct doping practices, including "boosting". This dangerous practice is used by athletes with spinal cord injuries at the cervical or thoracic level to enhance their performance by inducing autonomic dysreflexia. However, it poses serious health risks, including strokes and heart attacks. According to a 2010 survey, 17% of Paralympians report using this practice, which is difficult to detect and considered doping by the International Paralympic Committee.

[9] The prevalence rate of 0% reported in the systematic review by Gleaves et al. (2021) is unrealistic and reflects the methodological limitations of the studies included. The rate of 73%, on the other hand, corresponds to the self-reported use of anabolic steroids in a study of competitive bodybuilders (n=48) competing at the national or international level. This marked difference illustrates the wide variability in estimates of doping prevalence in the literature.

[10] A substance that can mask the use of other prohibited substances.

Performance-enhancing drug use also extends to the world of recreational sport

The use of PED is not limited to high-level sport; it is also observed in amateur sports, both competitive and recreational. But how can we measure a phenomenon within a population that is not subject to biological testing? The answer has mainly come in the form of surveys (cross-sectional or longitudinal), based on self-reported questionnaires often using the randomized response method.

While the vast majority of studies focus on amateur athletes, some studies examine doping within the general population, particularly among younger individuals. In the ESPAD survey,[11] for example, one in fifteen French high school students (7%) reported having used one or more substances in the past 12 months in the context of sports in order to improve their physical performance, including 2.3% who used banned and illegal substances, most often cannabinoids or stimulants such as cocaine, and 6.1% who used a mixture of banned and legal substances.

The literature has recently focused on the tendency for doping in recreational sports, as evidenced by the FAIR (Forum for Anti-Doping in Recreational Sport) projects, which have produced the most recent and comprehensive studies on the subject. This project is based on a survey of recreational athletes (n=7,260) in eight European countries, covering more than 200 disciplines. The prevalence of individuals classified as "dopers"[12] was estimated at 0.4%, with a distribution of 3.1% among men and 0% among women. While relatively few recreational athletes appear to use illicit substances, it should be noted that 10.3% of respondents report using over-the-counter medications to improve their athletic performance. Moreover, 43.7% of respondents used them in connection with their sporting activities (training or competition) for reasons other than performance enhancement (for pain relief, recovery from injury, or control of sleep, mood, or menstrual cycle). These estimates have faced methodological criticism (e.g., sample representativeness) and should be interpreted with caution. Other studies conducted in several European countries (Germany, Italy, Portugal, Switzerland, Norway, etc.) have all reported PED use among recreational athletes, with estimates ranging from 2 to 39% depending on the sport and investigation methods, showing that even recreational sport is not spared from doping.

Anabolic-androgenic steroids: changing motivations for use

Much of the literature on doping focuses on anabolic-androgenic steroids (AAS) which are synthetic substances, similar to testosterone, used to increase muscle mass and strength.

They have been the subject of studies aimed at estimating their prevalence of use in the general population. In 2014, a meta-analysis of 187 studies conducted between 1974 and 2013 estimated the global lifetime prevalence of AAS use at 3.3% (95% CI [2.8-3.8]), with a significantly higher rate among men (6.4%; 95% CI [5.3-7.7]) than in women (1.6%; 95% CI [1.3-1.9]). In this study, prevalence was higher among recreational athletes (18.4%, 95% CI [11.2-28.6]), than among high school students (2.3%, 95% CI [2.1-2.5]) or non-athletes (1.0%, 95% CI [0.7-1.3]).

Based on data from the *National Household Survey*, other authors estimated that in 2013, between 2.9 and 4 million Americans aged 13 to 50 had used steroids during their lifetime. Among this population, up to a quarter may have experienced dependence, and 22% had their first experience with steroids before the age of 20.

[11] *European School Project on Alcohol and other Drugs*.

[12] The subjects termed "dopers" refers to individuals who reported using substances they considered to be banned in their sport.

Numerous studies have been conducted in Nordic countries (Sweden, Norway, Finland, Iceland, and Denmark), and these report a rate among men of 2.9% (95% CI [1.7-4.8]), which is significantly higher than that among women (0.2%; 95% CI [0.1-0.4]). Prevalence rates by country were 4.4% in Sweden, 2.4% in Norway, 0.8% in Finland, 0.7% in Iceland, and 0.5% in Denmark.

Use of AAS among young people has been estimated at between 1.5 and 2.7% based on two prospective cohort studies conducted in the United States, the *Eating and Activity in Teens and Young Adults* study conducted between 1999 and 2004, and the *National Longitudinal Study of Adolescent to Adult Health* conducted between 1994 and 2002. The *Canadian Study of Adolescent Health Behaviors*, conducted in 2023, reported a lifetime prevalence of AAS use of 1.6%, a rate in line with other studies conducted in Western countries. Half of users report having more than one symptom of dependence. The *Monitoring The Future* project, which also permits prospective monitoring of AAS use, shows that prevalence rates (lifetime, annual, and monthly) among American youth were increasing in 2022. The authors hypothesize that this is due to the spread of fitness and weight training among young people in recent years, particularly during the COVID-19 pandemic.

The prevalence of AAS use among athletes who frequent gyms is on average higher than in the general population and it varies across studies, the majority of which were conducted in countries of the Arabian Peninsula and in Iran, at between 9.8 and 35%. A study conducted in the Netherlands among young adults compared, for the first time, the use of AAS and selective androgen receptor modulators (SARMs) and reported rates of 9 and 2.7%, respectively.

The use of AAS now extends beyond the traditional male demographic and has been gaining popularity among women for several years. A Brazilian study reports a lifetime prevalence of AAS use of more than 13% among female gym users, aged 25 years on average, often in combination with other PIED[13] (creatine and diuretics were used by 20.8% and 18.7% of subjects using AAS, respectively). All studies reveal a shift in motivations for use, with aesthetic ideals supplanting physical strength gains, even among the youngest users.

Use and misuse of painkillers: a challenge in endurance sports

While the primary reason for using doping substances among athletes is to enhance athletic performance, pain management is also commonly cited. Here, it is useful to differentiate between painkillers used to reduce the sensation of mild pain (antalgics; such as nonsteroidal anti-inflammatory drugs, NSAIDs) and those used to relieve or suppress sensitivity to moderate or severe pain (analgesics; principally morphine-based opioids).

The use of painkillers does not constitute doping *per se*, as defined by WADA. It reflects a practice that reduces or eliminates pain during performance or improves recovery after competition, particularly in endurance sports. However, certain opioid analgesics (e.g., tramadol, morphine, and oxycodone) are included on the WADA Prohibited List.

Three recent systematic reviews of the literature show that the use of NSAIDs and analgesics to manage pain and improve recovery is widespread in sports, both among elite and amateur athletes, and particularly in endurance and contact sports.

Studies report varying prevalence of NSAID use depending on the sport and level of practice. Among young athletes and in professional soccer, rates are quite high, sometimes exceeding 50%. In endurance sports, consumption tends to increase with the duration and length of events. For example, prevalence rates ranged from 3.1% for half marathons to 9.2% for 56 km races, reaching rates of over 60% for races longer than 100 km. It should be noted, however,

[13] Performance and image enhancing drugs.

that estimates of painkiller use vary greatly from one survey to another. Studies also document the concurrent use of multiple NSAIDs, at dosages higher than those prescribed, and multiple routes of administration.

Two French studies on substance use during the *Ultra-Trail du Mont-Blanc* (UTMB) and the *Infernal Trail des Vosges* found that NSAIDs are the most commonly used class of substances. In the UTMB, NSAIDs were the most commonly detected legal substances (22.1%), followed by acetaminophen (15.5%) and opioids (6.6%). In a study of an ultramarathon in Spain, one in two participants reported taking NSAIDs just before, during, or just after the event, with prevalence increasing with the distance covered.

With regards to opioids, although less widely used than NSAIDs, studies reveal varying prevalence rates depending on the sport, and early adoption in amateur sports, characterized by misuse (self-medication, inappropriate dosage, lack of medical supervision).

Finally, athletes with disabilities have different prescription drug use patterns than non-disabled athletes due to their specific health issues. The studies analyzed, most of which were conducted among Paralympic athletes, report increased use of analgesics and NSAIDs, with prevalence rates of around 20% and even higher among athletes with limb deficiency or spinal cord injury.

Recreational use of psychoactive substances?

Athletes, like the general public, use psychoactive substances, and this phenomenon is also observed among those competing at the highest level. In general, for most sports disciplines, the prevalence rates of substance use are lower than those observed in the general population. Among the psychoactive substances that could potentially enhance athletic performance, some are licit such as nicotine and certain stimulants, and others illicit such as cannabis, cocaine, and other drugs classified by WADA as "substances of abuse". Many of these substances are included on the Agency's Prohibited List and, as such, are banned in competition.

The use of cannabis among athletes has drawn particular attention in recent years. WADA has ruled on the substance several times and, in 2022, it decided to maintain the prohibited in-competition status of cannabis. However, its approach to cannabis has evolved over time; for example, the urinary concentration threshold of THC required for a positive test was raised in order to limit the number of doping cases resulting from out-of-competition use. Three reviews have examined cannabis use among athletes; two of these, despite the extreme heterogeneity of the studies analyzed, estimated the prevalence at around 25%. The third review estimated the rate to range from 2.7 to 66%. The authors agree, however, that the scientific literature does not support the idea that athletes use cannabis with the intent to enhance athletic performance. A French study surveyed students in sports science[14] about their cannabis use and reported prevalence rates comparable to those put forward by the authors of the three reviews and also to those observed in the general population. In this study, only subjects who reported regular and intensive use of both cannabis and alcohol, used cannabis for the purpose of enhancing athletic performance. Finally, a study conducted in the United States shows that cannabis use among older athletes (over 40 years of age) is motivated by different reasons than those of adolescent or college athletes, with 71% of subjects using it primarily for medical reasons, particularly to relieve pain or anxiety.

The prevalence of cocaine use, the most commonly used illicit substance after cannabis among elite athletes, ranges from 0.1 to 3.8%. Other stimulants are regularly detected during anti-

[14] STAPS: Science and technology of physical and sports activities.

doping tests. These include amphetamines and their derivatives such as methamphetamine, as well as other substances such as methylphenidate, ephedrine, and methylenedioxymethamphetamine (MDMA or ecstasy). For methodological reasons, it is very difficult to estimate the prevalence of use of these different substances.

Finally, the use of traditional or electronic cigarettes, or smokeless tobacco products,[15] is observed among athletes. Nicotine, although included in the WADA monitoring program since 2012, is not classified as a doping substance. Scientific evidence on whether nicotine enhances athletic performance remains equivocal. While athletes primarily report recreational use as their reason for using nicotine, its stimulant effects have led some to question its growing use within this population. Indeed, several studies report high rates of nicotine use in certain athlete populations. For example, an Italian study of high-level athletes found that, among the disciplines considered, 90% of team sports and 40% of individual sports exhibited rates of nicotine use exceeding that observed in the general population (20%).

Use of dietary supplements: A widespread practice in sports

The consumption of dietary supplements (DS) is a widespread phenomenon among athletes. Like painkillers, they are increasingly used by athletes seeking to improve their performance. Dietary supplements contain a wide variety of components including vitamins, minerals, proteins and amino acids (β-alanine, glutamine, whey), ergogenic substances (creatine, caffeine, taurine, nitrates), substances aimed at reducing body fat (choline, L-carnitine), plant extracts, etc. These products are not medicines and, as such, do not undergo the same rigorous evaluation of quality, efficacy, and safety to which products claiming medicinal status are subject. Their composition is regulated by a decree,[16] and this regulation is overseen by the Directorate General for Competition policy, Consumer Affairs, and Fraud Control (DGCCRF). They are subject to European standard NF EN 17444, which is specific to DS intended for athletes. This standard sets out good development and manufacturing practices aimed at preventing the presence of substances prohibited by WADA in food supplements, and thereby improve the information provided to consumers. However, concerns persist regarding the health risks and risks of unintentional doping posed by certain products, particularly those that claim to promote muscle development or fat loss.

Two systematic reviews and meta-analyses on the prevalence of DS use were identified. The authors highlight the moderate methodological quality of the included studies, which makes it difficult to provide a reliable estimate of prevalence. The first review examines a variety of sporting populations, including elite athletes, high school and university students, and gym users. The authors estimate the prevalence of DS use, all types combined, among athletes to be 60% (95% CI [55-64]; n=61 studies). The most commonly consumed products are vitamins, minerals, and proteins. The prevalence rates observed vary greatly depending on the sport, level of practice, and types of DS considered. The authors note that the highest prevalence rates are observed in body building and soccer; in general, the prevalence is higher among athletes than in the general population; and it is much higher among elite athletes than among amateur or recreational athletes. They also note that the consumption of supplements has not changed significantly over time. The second meta-analysis, conducted on some 30 studies involving Iranian athletes, again with a high degree of heterogeneity, reports similar data.

[15] Finely ground or crushed tobacco that is consumed by snorting (*dry snuff*, snuff) or placed between the cheek and gum *(moist snuff*, snus, chewing tobacco).

[16] https://www.legifrance.gouv.fr/loda/id/JORFTEXT000000638341

A more recent scoping review, that does not take gym users into account, reports similar consumption rates of around 60% in two-thirds of studies considered, and notes higher rates among older athletes and men.

Among athletes with disabilities, some studies report prevalence rates of DS use as high as 100%. The products concerned are mainly vitamins, minerals, and protein powders.

Studies of young people in the general population find widespread use of DS, with a prevalence of protein consumption of up to 55% among Americans aged 12 to 18, which is higher among young men than among young women. The prevalence rates among young athletes varies greatly depending on the populations studied and the methodology used: 45% of American NCAA (National Collegiate Athletic Association) athletes consume DS, as do 84% of elite Swiss athletes and 15% of Australian athletes.

A 2021 review of creatine use among children and adolescents highlights a widespread phenomenon that begins at an early age, both in the general population and among athletes. The authors note that prevalence tends to increase with age and is higher among athletes and boys than girls. For example, in the *Canadian Study of Adolescent Health Behaviors*, a recent study of young people aged 16 to 30 (n=2,731), half reported using creatine and more than 8 out of 10 male subjects reported consuming protein.

A few studies have looked at a new practice termed "dry scooping", which involves ingesting undiluted powdered supplements (with high caffeine content) before training. In the *Canadian Study of Adolescent Health Behaviors*, more than 16% of subjects reported having done so in the past 12 months. This practice is more common among male subjects, and among those who reported weight training, greater time spent on social media, and those at higher risk of muscle dysmorphia.

Finally, several determinants are common to both high-level and recreational athletes: *i)* prevalence rates vary by gender, with men being overall more frequent consumers; *ii*) the use of DS increases with age; *iii)* DS consumption varies according to the type of sport practiced, with the highest prevalence rates found among those who practice strength or endurance sports. Several studies have highlighted, among amateur athletes, some specificities: DS use increases with the frequency of practice or training, and the reasons for using DS vary according to gender, with men emphasizing gains in strength, endurance, performance, and recovery, while women tend to mention health improvement. Among young athletes, studies show that use also increases with age and training frequency. Some authors also highlight the positive association between consumption of DS and participation in team sports, noting muscle gain as a motivation for use.

Risks of contamination of dietary supplements

Since they are foodstuffs and not medicines, DS are not subject to strict quality controls that are repeated over time. A non-negligible proportion of these products, even if sold on the legal market, may be adulterated, thus posing a health risk to recreational and high-level athletes, with the latter also being exposed to the risk of unintentional doping.

Several studies have analyzed the composition of DS and identified the presence of AAS or their derivatives in these products. A 2015 review estimated that between 10 and 15% of DS contain prohibited substances, and that the use of contaminated products by high-level athletes could be responsible for 6 to 9% of doping cases. Some more recent studies have suggested contamination rates of 28% of samples, while others advance higher rates, of around 12% to 50-58% of DS samples containing AAS or other prohibited substances likely to result in a positive test.

In a recent study of adolescent gym users (60% of whom consumed DS), the authors showed that 9% of subjects consumed products contaminated with AAS, SARMs, or aromatase inhibitors, even though they were marketed as natural products intended to increase protein synthesis or muscle development.

Is there a link between dietary supplement use and doping?

The early initiation and widespread consumption of DS among adolescents and young adults have led to the hypothesis that these products could be a gateway to the use of illicit doping substances. Several studies have explored this question, but their methodologies have generally been insufficiently robust to establish a causal relationship. This research often refers to the gateway theory, a controversial hypothesis dating back to the 1970s that posits the existence of a pattern of progression from licit to illicit drug use. While the general principle of this theory is now widely challenged, experimenting with or using one substance nonetheless increases the risk of experimenting with another.

The question of such a gateway effect was examined in a meta-analysis of 12 studies reporting data on both doping and DS use among 8,822 recreational and high-level athletes participating in competitions and subject to the WADA Code. The prevalence of doping among DS users was approximately twice as high as among non-users. Other studies, not included in the meta-analysis, have also showed that DS users were significantly more likely to report having used prohibited doping substances than those who did not use DS. However, as all of these studies were cross-sectional in nature, it is impossible to draw conclusions about causality in cases where an association was identified.

Two cohort studies, the *Longitudinal Study of Adolescent to Adult Health* and the *Eating and Activity over Time*, allowed exploration of a potential gateway effect. The first showed that male respondents who reported use of DS in the past year were more likely to also report AAS use. However, no significant association was found among young women. The second study showed that protein supplementation during adolescence was associated with the initiation of AAS and other muscle-building substances (creatine, amino acids, HMB,[17] DHEA,[18] or growth hormone) in adulthood, both in men (adjusted RR=2.09; 95% CI [1.29-3.39]) and women (adjusted RR=4.81; 95% CI [2.01-11.48]).

While acknowledging the methodological limitations of their work, the authors of these studies suggest that use of DS may increase the risk of subsequent use of doping substances. However, apart from the work of the group of researchers who used a longitudinal approach, all these studies are based on a cross-sectional approach, and the associations identified do not support the hypothesis that DS could be considered a gateway to subsequent doping behavior or to use of illicit doping substances. It should be noted that, while several studies highlight associations between use of DS and doping substances (AAS in particular) among a minority of athletes, none formally demonstrates that DS use precedes doping substance use. Furthermore, the results of these studies provide little insight into the individual vulnerabilities that may trigger the behavior. Intentionality is a necessary but not sufficient condition for the transition to action, and other factors may increase the risk, such as demographic factors (men being systematically more at risk than women), personal beliefs, the degree of trust placed in coaches and the influence they exert on the athletes under their responsibility.

[17] Hydroxyl methylbutyrate.

[18] Dehydroepiandrosterone.

Given the relatively high prevalence of performance-enhancing substance use in sports, whether among high-level, amateur, or recreational athletes—and despite the heterogeneity of these data— it appears important to emphasize the present need for greater awareness of the risks associated with substance use in sport, as well as for further research to better understand the motivations behind the use of different products and the consequences of these practices.

Health effects of doping and doping practices

Doping can have harmful effects on health, affecting many organs and body systems to varying degrees depending on the nature of the substances used and the protocols practiced (duration of use, dosage, combination of substances, etc.). Studies examining the effects of doping on the health of athletes are sometimes insufficient in terms of methodology and level of evidence (cross-sectional or retrospective studies based on small samples, clinical cases, etc.), and most of them have been conducted on specific populations (men, AAS users, strength athletes, etc.). In addition, the effects of doping described in the literature are often extrapolated from the results of experimental studies or clinical cases involving substances on the WADA Prohibited List, in a therapeutic and/or non-sporting context. This regularly leads to the health effects of doping being called into question. It is therefore essential to take all these limitations into account in order to rigorously interpret the results of the available scientific literature.

Effects on the cardiovascular system

Most substances and methods used for doping purposes pose cardiovascular risks. The main classes of substances concerned are first and foremost AAS and selective androgen receptor modulators (SARMs), modulators of oxygen transport or release, and metabolic and sympathomimetic modulators acting on respiratory function. In addition to these are illicit and licit psychoactive substances (cocaine, cannabis, nicotine), and non-prohibited but commonly used ergogenic aids or drugs (anti-inflammatories, analgesics).

As with the other body systems analyzed in this expert report, and due to the same constraints, there are no controlled studies directly exploring the effects of doping substances or methods on the cardiovascular system. The available data come from case studies and a few longitudinal studies on athletes, as well as work carried out on patients undergoing drug treatment or with endocrine disorders. These studies often have limitations: small sample sizes, data based on self-reporting, and a mixture of substances. In addition, there are methodological differences, particularly in imaging, whose sensitivity has evolved over time, making it difficult to interpret and compare results across studies. Thus, most of the results concerning the effects of doping on the cardiovascular system require further confirmation.

Anabolic-androgenic steroids

AAS are by far the most studied substances. Their overall impact on mortality has been examined in a few Scandinavian cohort studies conducted in the general population or in athletes. One study shows a doubling of cardiovascular mortality and morbidity rates among former AAS users. Another, more recent, study of male fitness centre members who use AAS shows that mortality and the prevalence of non-ischemic heart disease (cardiomyopathy, atrial fibrillation) are three times higher, and the prevalence of thromboembolic disorders five times higher, than in the general population.

There is a wealth of literature reporting numerous harmful effects of AAS, reflecting both indirect and direct effects of these agents on the cardiovascular system. Indirect effects include dyslipidemia promoting atherosclerosis and the risk of stroke (high blood levels of LDL-C and low levels of HDL-C and lipoprotein (a)), particularly in connection with the use of oral AAS. Other indirect effects include high blood pressure (affecting up to 50% of AAS users) and polycythemia (increased hemoglobin and hematocrit levels in the blood). It should be noted that, although a link between hyperviscosity and increased risk of thrombosis is known, and several studies report thrombotic events in athletes using AAS, a causal link has not been demonstrated. These various indirect effects appear to be generally reversible after discontinuing AAS use.

Other harmful effects of AAS, which are more numerous and better documented, directly affect the heart and/or blood vessels (Figure 1). The most typical myocardial abnormality associated with taking AAS at supraphysiological doses is left ventricular (LV) hypertrophy, which is almost always associated with functional alterations. These abnormalities appear to be due to the direct toxicity of AAS on the heart muscle. Coronary circulation disorders may also be observed. Atheromatous lesions on the epicardial arteries are the most common. However, vasospasms of these large arteries and coronary microcirculation dysfunction, which can lead to chronic ischemic lesions, have also been reported. AAS may cause arrhythmias, especially atrial (atrial fibrillation) or, more rarely, potentially serious ventricular arrhythmias and hypertensive crises. Fibrotic arrhythmogenic foci are secondary to AAS use, and the onset of arrhythmias is promoted by the effects of circulating catecholamines and other exercise-related stresses (acidosis, dehydration, electrolyte changes). As it has not been formally proven that athletes using AAS are more prone to rhythm disorders than non-users, the role of doping substances in cases where arrhythmia is discovered in an athlete, except in clear-cut cases, must remain a diagnosis of elimination.

The reversibility of morphological and functional cardiovascular changes after discontinuing AAS use remains controversial and appears to be related to the duration of exposure, the cumulative dose of AAS, and the length of time since discontinuation. It may also depend on the individual sensitivity of users. Current data do not rule out the possibility that AAS users, when they reach middle or old age, may be at increased risk of developing cardiovascular disease, including severe heart failure.

Sudden death related to sport is very rare. Induced by exertion, it reveals an unknown cardiac pathology: after the age of 35, it is mainly due to coronary heart disease, and before the age of 35 to congenital or genetic diseases, with no specific cause being found in nearly 40% of cases. When it comes to doping, the combination of intense physical training and the harmful cardiovascular effects of AAS is often cited as the main cause of premature death, particularly in bodybuilding. However, it should be noted that there is little evidence to formally confirm a causal link between doping and cardiovascular events. Data from autopsy studies may help clarify the potential links between pathological hypertrophy induced by chronic AAS use and sudden death in athletes. The cause of death in athletes who use high doses of AAS appear to be dominated by acute myocardial infarction due to premature atherosclerosis, with cases of occlusive thrombus in the left coronary artery being very rarely reported. Myocardial infarction without significant coronary atherosclerosis has also been reported, which may be linked to a disease (intimal hyperplasia) of the intramural arterioles. Other causes, such as isolated LV hypertrophy or hypertrophy with functional impairment, arterial thrombosis, or pulmonary embolism have also been described. Finally, it should be noted that when AAS are combined with other drugs such as cocaine or amphetamines, the risk of cardiovascular events is greatly increased. Despite its contribution to determining the cause of death, toxicological analysis is unfortunately not yet routinely performed in the assessment of sudden death, particularly in young athletes.

Longitudinal studies, both older and more recent, converge in showing that the longevity of athletes with long-term participation in intense sport is increased compared to the general population and that these athletes do not show an increase in cardiovascular events or diseases. However, this trend does not seem to apply to all sports disciplines. Bodybuilders constitute a sporting population in which, for reasons intrinsic to their practice, the prevalence of AAS use and the doses consumed are particularly high. This raises the question of whether the high rates of cardiovascular morbidity and mortality reported in this population, compared to other sports, can be attributed to the use of AAS. Although there are many confounding factors specific to bodybuilding that may be involved, it is very likely that the use of AAS contributes significantly to this increased risk, although current data do not allow us to determine its exact extent.

All of the clinical data at our disposal therefore highlights a clear association between AAS use and numerous harmful cardiovascular effects. Although a causal relationship cannot be formally established due to methodological limitations, we can conclude that AAS use promotes the occurrence of potentially serious, even fatal, cardiovascular events. These events are most often reported in the context of intense weight training, almost always in connection with taking doses well above physiological norms of a mixture of several AAS and other more or less illicit products. Variable individual susceptibility among users is very likely.

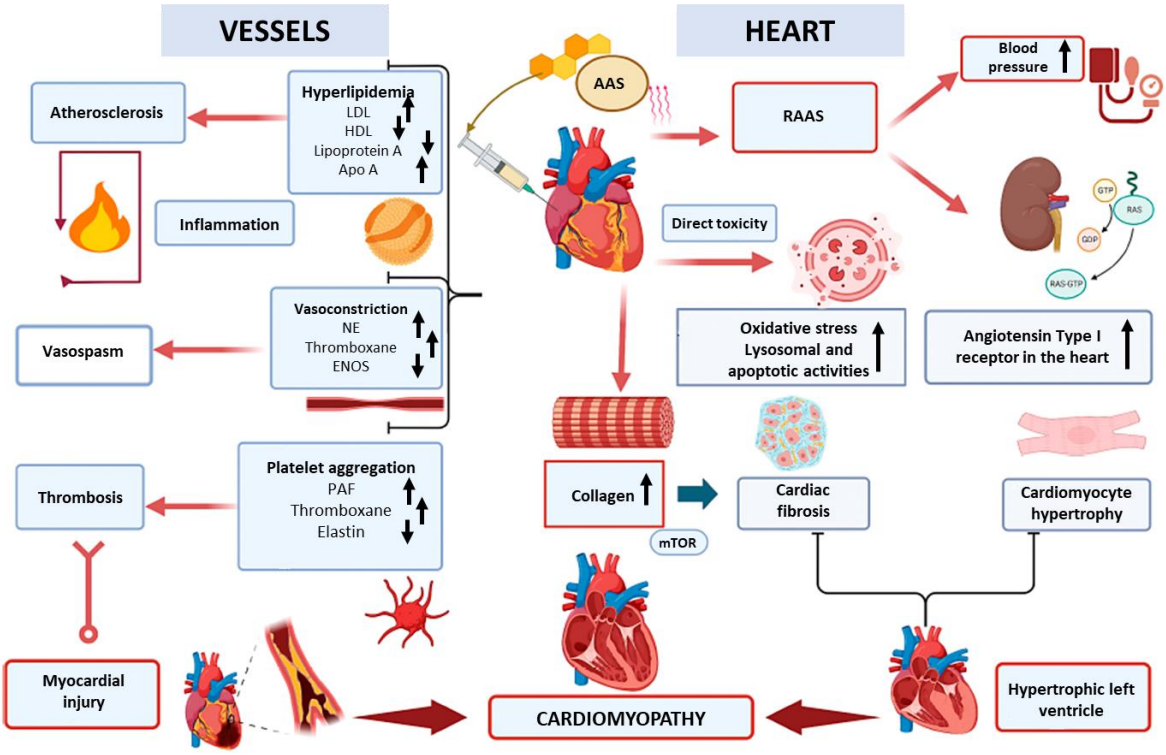

Figure 1: Summary of the main mechanisms explaining the harmful cardiovascular effects of anabolic androgenic steroids (Source: Fadah *et al.*, 2023)

Adapted from "Anabolic androgenic steroids and cardiomyopathy: an update" by Fadah K, Gopi G, Lingireddy A, *et al*. Front Cardiovasc Med 2023; 10: 1214374. © The Author(s) 2023. This article is licensed under a Creative Commons Attribution License.

Apo A: apolipoprotein A; PAF: proaggregating factors; HDL: high-density lipoproteins; LDL: low-density lipoproteins; mTOR: mammalian target of rapamycin; NE: norepinephrine; AAS: anabolic androgenic steroids; ENOS: endothelial nitric oxide synthase; RAAS: renin-angiotensin-aldosterone system.

Other substances

Although less abundant, the literature on the effects of other doping substances on the cardiovascular system also points to numerous harmful effects. There is very little data on the effects of growth hormone (GH) in athletes, but its administration to healthy subjects causes LV hypertrophy, an abnormality also seen in cases of acromegaly, a disease caused by overproduction of endogenous GH. The harmful effects of SARMs are increasingly documented in the literature, with recent studies reporting direct cardiotoxicity and cases of myocarditis in athletes.

Among psychoactive substances, amphetamines and cocaine—two illicit stimulants that have marked deleterious cardiovascular effects—can lead to complications such as heart failure, acute myocardial infarction, myocardial fibrosis, valvular heart disease, pulmonary hypertension, and stroke. Nicotine, although legal and widely used, is another psychostimulant with harmful effects on the heart. A powerful adrenergic stimulant, it can promote the onset of heart attacks or sudden death during physical exertion. It is therefore advisable to avoid tobacco in all its forms before and after exercise. Finally, although cannabis has long been considered to have few adverse effects on the heart, an increasing number of cases of cardiovascular events, particularly heart attacks, are being reported. However, the level of evidence for a direct association remains low.

Blood doping and oxygen transport modulators, including erythropoietin (EPO), are ways of increasing oxygen supply to skeletal muscle. Although autologous blood transfusion poses a risk of thromboembolic events, the potential negative cardiovascular consequences, particularly thromboembolic events, of EPO use in athletes have not been proven.

Little data is available on the effects of various metabolic modulators (glucocorticoids, thyroid hormones, meldonium) apart from that from clinical studies, which indicate minor effects on the cardiovascular system. With regard to sympathomimetics, a few case studies report deleterious effects in athletes (arrhythmias and myocardial lesions) attributed to the use of clenbuterol, a beta-2 agonist bronchodilator misused for its anabolic and lipolytic effects.

Nonsteroidal anti-inflammatory drugs commonly used by athletes for self-medication, can have adverse cardiovascular effects. The same is true for painkillers such as paracetamol or tramadol, the latter being banned by WADA. In the general population, the most significant reported effects of NSAIDs are high blood pressure, arrhythmias, and thromboembolic events, while tramadol, in high doses, can cause blood pressure problems and severe bradycardia. Although there currently exists little data on the occurrence of cardiovascular events in athletes who use these painkillers, it seems justified to raise awareness and inform this population about the potential adverse effects of these drugs, the use of which should not be trivialized.

Finally, caffeine, used by athletes as an ergogenic aid, can have undesirable cardiovascular effects, especially during intense training. Caffeine can alter physiological responses to exercise and increase the risk of arrhythmias. Although most healthy individuals do not experience major risks with high caffeine consumption, energy drinks, which are widely consumed and may contain very high doses of caffeine, can cause significant cardiovascular problems, including arterial hypertension and tachycardia at rest, particularly in predisposed individuals. It is important to inform athletes about the risks associated with excessive consumption of these products.

In conclusion, the cardiovascular risks associated with doping are undeniable, but they are also preventable, and it is essential to continue to raise awareness and educate athletes about the potential dangers of substances and methods used for doping purposes.

Effects on the endocrine and reproductive systems, cancer risk, and focus on the health of adolescent and female athletes

As in the cardiovascular field, the vast majority of studies in the corpus examining the effects of doping substances on the endocrine and reproductive systems focus on AAS. These studies are mainly conducted in male subjects, even though the deleterious effects appear to be partly sex-dependent.

Anabolic-androgenic steroids

One of the main repercussions of AAS use, observed in both men and women, is hypogonadism with alteration of the hypothalamic-pituitary-gonadal axis. Hypogonadism is characterized by insufficient synthesis of sex hormones due to decreased secretion of pituitary gonadotropins, luteinizing hormone (LH) and follicle-stimulating hormone (FSH), following inhibition of secretion of pituitary gonadotropin-releasing hormone (GnRH) in the hypothalamus. Generally, this impairment leads to infertility and significant changes in libido, as well as acne and alopecia. In men, AAS use can also cause gynecomastia and testicular atrophy. In women, these effects include menstrual cycle disorders, significant hirsutism, permanent dysphonia, marked and possibly permanent clitoral hypertrophy, breast atrophy, and teratogenic effects. The harmful effects of AAS thus appear to be more pronounced in women, with significant repercussions on both their personal and professional lives (Figure 2).

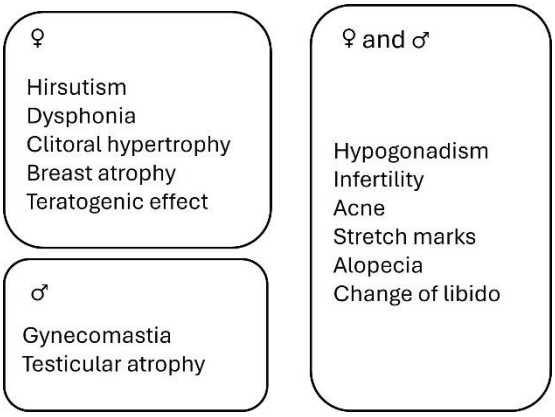

Figure 2: Main harmful effects of AAS by sex

The reversibility of the effects of AAS on endocrine and sexual function has been the subject of several studies in male subjects. The return to normal functioning of the gonadal axis, estimated to take between 3 months and several years after discontinuation of AAS, depends on the duration of AAS use (the longer the duration, the longer the recovery period), and the cumulative dose from the multiple cycles, with the individual's age also playing a role. The return to baseline levels of spermatogenesis varies from 12 to 18 months, while recovery of libido is more rapid. Gynecomastia, however, may remain partially present permanently. It is surprising to note that no published study has thoroughly investigated the kinetics of recovery in female athletes after stopping AAS use, whether in terms of hypogonadism, fertility, libido, or even changes in quality of life.

The prevalence of AAS use is lower among women than among men, and the patterns of consumption are different, with women favoring lower doses and fewer combinations. Moreover, the routes of administration also differ, with women preferring oral forms of AAS, while men favor injectable forms. This difference modulates the harmful effects of AAS, as oral administration is associated with increased hepatotoxicity. Finally, in terms of substance

choice, women prefer AAS with less androgenic impact. These specificities in AAS use highlight the need to promote specific studies in female athletes.

There is a consensus in the scientific literature that the harmful effects of AAS are greater in certain populations of recreational athletes who use AAS in high doses and over long periods, most often through self-medication and without medical supervision. These athletes are not subject to anti-doping controls, unlike high-level athletes whose health is, in a sense, "preserved" by these controls and regular medical monitoring. It should also be noted that women who use AAS seek healthcare services more frequently than men or adolescents.

Various substances are used after (and sometimes during) AAS use to combat the undesirable side effects mentioned above. According to studies conducted exclusively in men, the various objectives are to: *i*) restore spermatogenesis and testosterone production; *ii*) restore the functioning of the gonadal endocrine axis; *iii*) prevent gynecomastia during treatment; *iv*) limit erectile dysfunction. Human chorionic gonadotropin (hCG), aromatase inhibitors, selective estrogen receptor modulators (SERMs), and phosphodiesterase 5 inhibitors are the most commonly used agents. Adverse effects associated with the use of aromatase inhibitors or SERMs have been reported, such as joint pain, altered growth hormone (GH) pulsatility, and cases of venous thrombosis, particularly with clomiphene. It should be noted that for the latter substance, visual disturbances are known side effects, including scotomas (blind spots in the visual field), phosphenes (flashes in the visual field), or blurred vision that can lead to blindness.

SARM and other substances

Other anabolic agents, belonging to the category of selective androgen receptor modulators (SARMs), have been developed for therapeutic applications with the aim of separating the desired anabolic properties from the undesirable androgenic side effects. Among the SARMs used for doping in sport are, for example, andarine, enobosarm (ostarine or GTx-024), LGD-4033 (ligandrol), RAD140, S-23, and YK-11. Classified by WADA as "other anabolic agents" in the Prohibited List, these substances are sought after by athletes because of their negligible androgenic effects. However, clinical studies in patients treated with SARMs, as well as a study in athletes, show that certain substances in this class have an impact on the gonadal axis and can cause alterations in testosterone, dihydrotestosterone (DHT), estradiol, FSH, or LH levels at high doses. As SARMs are a relatively recent development, data is unfortunately very limited and studies are needed to investigate their effects on the gonadal axis in both sexes.

Hormones other than androgens are also used for doping purposes, including GH, somatomedin C (IGF-1), and EPO, as well as hormone derivatives such as glucocorticoids (GC). Few studies have explored the potential harmful effects of the abuse of these substances by athletes, and the available data primarily come from studies in patients treated with these substances for various conditions. Administration of GC, whether oral or injectable (particularly intra- or peri-articular), can lead to inhibition of the hypothalamic-pituitary-adrenal axis, the duration of which varies depending on the route of administration, the dose administered, the biological half-life of the GC, and individual sensitivity.

Cancer risk

Finally, the idea that athletes who use performance-enhancing drugs are at increased risk of cancer is widely held. However, to date, there have been only a few epidemiological studies that have specifically examined this issue in athletic populations, and the evidence remains limited. *In vitro* and animal model studies indicate a carcinogenic potential for AAS due to their ability to disrupt gene expression and cell signaling pathways involved in carcinogenesis. Data from clinical studies and the few epidemiological studies conducted in athletes, however,

do not show any overall or specific (prostate, testicular) increased risk of cancer associated with AAS use. In female athletes, extrapolation of clinical data does not appear to suggest an increased risk of breast or endometrial cancer. However, this conclusion should be interpreted with caution, as the doses used in the context of sports doping are likely to be higher than those administered therapeutically. On the other hand, there may be an increased risk of liver tumors (adenomas and carcinomas) in male bodybuilders who have used multiple AAS in cycles, at high doses and over long periods of time. The steroids most frequently implicated are nandrolone and several 17α-alkylated substances taken orally and known for their hepatotoxicity, including stanozolol and oxymetholone. With regard to the use of other classes of doping substances, the limited data available, largely derived from clinical studies, does not seem to point to an increased risk of cancer from doping with EPO in healthy individuals. The same applies to GH and IGF-1, substances which could, however, promote the progression of already transformed cells through the various phases of the cell cycle.

Given the glaring lack of literature on the effects on the endocrine and reproductive systems and the risk of cancer, it seems necessary to conduct detailed and specific studies on the repercussions of AAS use (alone or in combination with other doping products) in athlete populations, particularly adolescents, women, and recreational athletes. Furthermore, new investigations into the various SARMs, GCs, EPO, GH, and IGF-1 appear necessary in order to identify more precisely their harmful effects and the mechanisms of action involved, taking into account potential interactions with the level of athletic activity.

Effects on the hepatic, cutaneous-mucosal, musculoskeletal and renal systems, and infections

Sports doping can have harmful effects on the liver and pancreas, skin and mucous membranes, muscles and skeleton, kidneys, as well as posing a risk of infection.

The liver is an organ that is particularly affected by doping. In addition to the increased risk of tumors such as hepatic adenoma and hepatocellular carcinoma described above, other conditions have been reported, including cytolysis, cholestasis, and peliosis. While there are many confounding factors (for example, variability of protocols and substances used, frequent polysubstance use, rhabdomyolysis associated with exertion), steroid hepatotoxicity is frequently documented. Numerous cases of hepatic cytolysis have been described, characterized by elevated transaminases (a sign of liver damage that could progress to more serious disease). These involve mainly populations of bodybuilders who have used AAS (though use of SARMs has also been reported to a lesser extent), with highly variable durations and dosages. Cases of hepatic cholestasis have also been reported, again most often in bodybuilders who have used AAS, but sometimes with other substances as well (thyroid hormone, SARMs). However, larger-scale data do not appear to confirm a causal link between AAS use and the occurrence of cholestasis, which calls for caution when interpreting the data. Rare cases of hepatic peliosis or acute pancreatitis have been attributed to AAS use in bodybuilders, although the level of evidence for these remains low. While AAS are the substances most often incriminated, SARMs have also recently been increasingly suspected of causing liver damage, ranging from cytolysis to clinically and biologically confirmed cholestasis with histological evidence on liver biopsy.

Skin conditions such as simple lesions (papules and pustules), acne, or exacerbation of pre-existing dermatological disease are also described in the literature. Here again, AAS are the substances most often implicated, and bodybuilders the athletes most commonly affected. Acne is the most frequently reported skin condition, affecting approximately one-third of athletes who test positive for AAS. In some cases, acne can be fulminant, either from the outset

or as an exacerbation of pre-existing acne vulgaris. Isolated anecdotal cases of psoriasis and Stevens-Johnson syndrome have been reported, as well as gingival disease.

Infectious complications resulting from the use of doping substances administered through nonsterile injection practices have been reported. AAS and bodybuilders are the substances and athletes most frequently involved. Abscesses at the injection site, which affects up to 6.8% of athletes who engage in the practice, can sometimes lead to complications such as loss of muscle tissue or musculocutaneous necrosis. Isolated cases of septic arthritis and necrotizing myofasciitis have also been described. As with recreational intravenous drug use, injection of performance-enhancing drugs carries a risk of blood-borne infections, including HIV, HBV, and HCV. In some cases, this risk may be comparable to that observed in populations of people who inject drugs.

Muscle and tendon lesions are also often reported in cases of sports doping, with evidence suggesting an alteration in muscle structure and function. AAS and SARMs are the main substances implicated. Cases of rhabdomyolysis have been reported following the use of AAS, growth hormone, and other doping substances such as SARMs in bodybuilders. An increased incidence of tendon rupture was reported in two studies of AAS users, with a good level of evidence, including one in bodybuilders and the other in high-level Swedish athletes (wrestling, weightlifting, hammer throw, discus throw, javelin throw). Finally, some authors have suggested that sports doping may be associated with an increased risk of osteoporosis, but this has yet to be proven.

Various kidney disorders ranging from mild impairment to acute renal failure have been described in cases of sports doping, particularly among bodybuilders. These involve a number of substances on the WADA Prohibited List. Although AAS are the most commonly reported substances, it is often difficult to isolate the causality (direct or indirect) of any one substance in the pathology, especially since there are many other confounding factors. Elevated plasma urea and creatinine concentrations are inconsistently observed in bodybuilders who regularly use AAS. Histological analysis in some studies has helped to clarify the nature of the renal lesions, which may include focal segmental glomerulosclerosis, nephroangiosclerosis, chronic or acute interstitial nephritis, nephrocalcinosis, and isolated glomerulopathies. A single case of renal infarction in an amateur bodybuilder has also been reported. While there are undeniable deleterious effects of certain prohibited substances on the kidneys, the scientific evidence of renal function impairment in athletes (primarily bodybuilders) is weak.

Effects on mental health

Doping can have multiple effects on physical health, but it can also lead to psychiatric, addiction-related, and neurological complications, the nature of which depends on the substance concerned, the individual, and the context in which it is used. In the literature, the most widely documented complications are those related to AAS. The substances prohibited by the World Anti-Doping Code also include psychoactive substances frequently encountered in psychiatric and addiction-related contexts, such as opioids, cannabis, and psychostimulants. While there is a wealth of data on the impact of the use of illicit substances and/or psychoactive medications on mental health, most studies do not directly address their use in the context of sports doping.

Anabolic-androgenic steroids

The psychiatric effects of AAS must be considered both during active use and when discontinuing use. During use, the main effects described, particularly at high doses, are anxiety disorders, (hypo)manic symptoms, irritability, aggression, psychotic symptoms, and neurocognitive symptoms (e.g. impaired emotion recognition and executive dysfunction). The

nature of the relationship between AAS use and psychopathology is complex and bidirectional, raising the question of the role of underlying personality traits. Indeed, athletes with pre-existing personality disorders, such as narcissistic, antisocial, or borderline disorders, may be more prone to AAS use. Non-medical use of AAS has been associated with aggressive behavior that can trigger violent acts, colloquially known as "roid rage". Studies have described violent acts during exposure to AAS in men with little or no history of psychiatric disorders or criminal behavior prior to using the products. In most of these cases, the behavior appeared to be associated with hypomanic symptoms.

An association between AAS use and suicidality has also been reported in some studies, although a causal link has not been definitively established, and concurrent use of other substances may be a contributing factor. In addition, AAS use has been associated with muscle dysmorphia (also known as reverse anorexia or bigorexia), a form of body dysmorphia in which an individual worries about not being muscular enough and perceives themselves as thinner than they actually are.

Symptoms may also occur when the dosage of AAS is reduced or in the context of withdrawal. Prolonged exposure to AAS leads to suppression of the hypothalamic-pituitary axis, causing a chronic decrease in circulating testosterone and estradiol that can persist for several months or even years. This hypogonadism can manifest as fatigue, decreased libido, anxiety-depressive disorders, binge eating, dysmorphia, and insomnia. These symptoms are very important to consider because of their direct effects, but also because of their potential to increase the risk of relapse into AAS use.

The link between doping with AAS and addiction is another important issue, and one that can take various forms: it may concern the specific effect of AAS as addictive substances, but also the broader addiction-related risks associated with their use. The addictive potential of AAS has been well described in the literature, with a reported 30% risk of developing dependence among individuals using AAS illicitly. The various factors that can lead to AAS dependence have been summarized into three pathways. The first is the "body image pathway", in which men with muscle dysmorphia turn to AAS use and are then reluctant to stop using them for fear of losing muscle mass. The second is the "neuroendocrine pathway", in which symptoms of hypogonadism secondary to prolonged AAS use lead to continued consumption. The third is a "hedonic pathway", based on rodent models suggesting an effect of AAS on the reward circuit. It should be noted that AAS dependence is responsible for most of the public health problems posed by AAS use.

Another consequence of AAS use is an increased tendency to use and misuse other substances such as alcohol, psychotropic medications, painkillers, and illicit substances. A frequently described association in the literature is that of AAS with opioid drugs for their analgesic action on muscle pain caused by overtraining, but also to help combat insomnia, irritability or anhedonia induced by AAS withdrawal.

More recently, the use of high doses of AAS has been associated with a significant acceleration of brain aging processes and cognitive dysfunction. This neurological impact of AAS has been described in both animals and humans. It should be noted that this effect appears to be dose-dependent, as physiological concentrations of testosterone may have a neuroprotective effect.

Due to the masculinizing effect of AAS, the majority of AAS users are men, and AAS use among women remains an under-explored area of research. The fact that fewer women use AAS, and the stigma surrounding their use in this population, makes it difficult to recruit women for studies. Nevertheless, women who use AAS are not exempt from psychiatric and addiction-related complications. Some authors also report specific motivations for consumption in this population, such as AAS use in the context of gender dysphoria, or for self-defense following sexual assault.

Other substances

Little data is available on the mental health impact of psychoactive substance use in the context of sports doping, and the information presented below is based on their use in the general population. Broadly speaking, psychoactive substances used for doping can be divided into three categories according to the desired effect: psychostimulants, psychodysleptics (substances that alter perception and mental activity), and psycholeptics or sedatives.

Psychostimulants, including methylphenidate, modafinil, cocaine, and amphetamines, can be used to reduce feelings of fatigue, improve reaction times, increase concentration and attention, or for weight loss. In terms of safety, they can cause insomnia and increased anxiety, but also, in more serious cases, (hypo)manic syndrome and/or psychotic episodes.

Psychodysleptics include opioids, cannabinoids, and alcohol. The use of opioids is particularly concerning due to the risk of serious adverse effects (respiratory depression in case of overdose, psychiatric decompensation, drug dependence). With regard to cannabinoids, the effects sought in the context of doping include resistance to physical fatigue and pain, improved muscle relaxation, reduced anxiety, and improved sleep. However, cannabinoid use can also lead to neuropsychiatric effects including euphoria, sedation, attention disorders, anxiety, impaired judgment, and even psychotic decompensation and amotivational syndrome.

Psycholeptics include GHB[19] and benzodiazepines. GHB is a powerful CNS depressant that is subject to misuse for its euphoric, relaxing, and disinhibiting effects. Its use in doping was documented in the 1980s among bodybuilders aiming to enhance nocturnal GH release. From a psychiatric standpoint, it exposes users to adverse effects including euphoria, disinhibition, aphrodisia, altered consciousness, anterograde amnesia, and loss of control. Benzodiazepines may be used to reduce anxiety or improve sleep, but they also carry risks related to their CNS depressant effect, such as sedation, cognitive impairment, and memory disorders.

It should be noted that all of these substances can be habit-forming, with varying addictive potential depending on the product in question.

Principles of management

To provide individualized care, the management of an athlete who dopes requires a comprehensive, multidisciplinary assessment integrating somatic, psychological, psychiatric, and/or addiction-related approaches. This assessment cannot be carried out effectively without a solid foundation of knowledge about the issue of doping. Indeed, many authors highlight the reluctance of users of doping substances to seek help from healthcare professionals, who they perceive as insufficiently informed on the subject.

During the interview, the medical history should focus on gathering several pieces of information: the patterns of use (substances used, route of administration, dosages, duration of use, number and duration of cycles, if applicable), the reason(s) for use, the context in which it takes place and the objectives, as well as personal and family history of addiction and psychiatric disorders. These elements are important to consider in order to tailor an individualized approach to care.

The clinical assessment must then look for the presence of a psychiatric disorder, including muscle dysmorphia. Similarly, in cases where psychoactive substance use is reported, a systematic evaluation of substance use disorder (SUD) criteria, according to the DSM-5,[20] is essential to better characterize potential addiction issues.

[19] Gamma-hydroxybutyrate.

[20] Diagnostic and Statistical Manual of Mental Disorders (5th ed.).

Little data is available on the specific management of psychiatric or addiction-related disorders that arise in the context of sports doping. In the absence of specific data, it is generally advisable to rely on standard care and treatment. In general, and regardless of the type of use, support for athletes who dope must be individualized.

Social harms caused by doping

The negative effects of doping are not limited to health-related harms, and it is essential to consider all forms of harm, and in particular social harms, even though these are difficult to measure. Whether economic, symbolic, or psychological, the identification and assessment of harm varies depending on the actors involved. The sanctions imposed by WADA or national legal systems have complex and contradictory effects: they may meet the expectations of certain populations (anti-doping stakeholders, non-doped athletes, etc.) or lead to various forms of exclusion (ban from competition, end of athletic career, etc.). Depending on the point of view adopted—that of WADA, sports organizations involved in anti-doping, sanctioned athletes, nations involved in state-sponsored doping, etc.—judgments differ on the type and severity of harms, the individuals and organizations impacted, and how anti-doping should be regulated. It is clear that the harms are not perceived uniformly. One example is the supposed harms caused by doping to audiences and fans. But can a decline in sporting event attendance really be considered a harm? One could very well argue that a reduction in spectator travel would be rather virtuous in terms of sustainability. Furthermore, as estimates of the prevalence of doping are highly uncertain, it is difficult to assess the harms it causes. Nevertheless, based on surveys, case studies, and hypotheses, research has identified different types of harm and cautiously assessed their extent.

Social harms affect four main groups of stakeholders: organizations involved in the sports economy, non-doped athletes,[21] doped athletes, and the general public.

With regard to the first category, the literature shows that economic and image damage, while difficult to quantify, are nonetheless identifiable. For example, the image and reputation of international sports organizations or sponsors may be affected by doping. National sports organizations, such as National Olympic Committees, suffer symbolic damage (e.g., a drop in the medal table) that has consequences for their economic attractiveness to the media and sponsors. Doping thus constitutes a threat to the entire ecology of sport because of the interdependence between sports organizations, audiences, sponsors, and the media. That said, the idea that doping mechanically leads to long-term economic consequences for clubs is not supported by research. Rather, the consequences seem to be more short-term, given the current configuration of doping and anti-doping at the beginning of this century.

The primary victims of doping appear to be those who comply with anti-doping rules. Indeed, these athletes are deprived of their titles, rankings, and medals in favor of doped athletes who skew the competitions. The impact is symbolic, as a victory brings far greater recognition than other rankings, but it is also economic, since the higher the ranking, the easier it is to convert it into earnings, whether through direct earnings, image rights, or sponsorship. Lost earnings are difficult to estimate accurately, as these depend on multiple variables (sports, countries, rankings, etc.), but research shows that many athletes may be affected, and that the economic consequences can be significant. To fully understand the impact of doping, research suggests taking a broader view. For example, when the prevalence of doping is high in a sport, or when the history of that sport has been marked by doping, as in cycling, non-doped athletes pay the

[21] Meaning those considered non-doped, since it is possible to prove that an athlete has doped, but impossible to prove that an athlete has not doped.

price because they suffer damage to their image without being able to really prove that they are not doping. Finally, the well-being and quality of life of athletes who do not dope are affected by anti-doping for three main reasons: they must coexist with doped athletes and suffer the consequences; they may have doubts about the commitment of anti-doping organizations to creating an environment conducive to "doping-free" sport; they feel threatened by a complex anti-doping system that sanctions errors that could lead them to violate anti-doping rules (unintentional doping), due to contamination or because they do not report teammates or coaches to whom they wish to remain loyal. For these reasons, research identifies athletes' ambivalent relationship with anti-doping: they are convinced of its necessity, yet uneasy with its implementation.

When considering the harms affecting doped athletes, we tend to focus on the consequences for their health, without recognizing that they also experience social harms. Being sanctioned for doping is a difficult ordeal for athletes who face sudden exclusion, loss of income, suspension of their professional career, they must radically change their lives, and their social network is disrupted. Moreover, there are no support and reintegration mechanisms in place, such as those available for other forms of deviance. This is a significant problem for all sanctioned athletes, but even more so in cases of unintentional doping (estimated at around 40% of all cases), who must also live with a sense of injustice. This is compounded by the fact that athletes are often the only ones to suffer the consequences of doping, even when states, teams, or coaches bear the main responsibility; research shows that doping is rarely an individual act and more often a collective process. In addition, doped athletes are often stigmatized, even when no other athletes are harmed, as in amateur bodybuilding. Bodybuilders are sometimes equated with drug addicts,[22] their performances are devalued by the public, and their hyper-developed muscles are presented as a monstrosity. Female bodybuilders are particularly targeted by this stigmatization as they face anatomical changes that deviate from traditional norms of femininity, which can cause embarrassment, shame, and lower self-esteem.

Research has also addressed the broader social harms of doping, beyond sport, particularly in relation to crime, mainly due to the supposed effects of AAS on violent behavior. Several studies identify correlations between AAS use and criminality: compared to the general population, AAS users are at much higher risk of being convicted of a crime. However, these correlations between AAS use and interpersonal violence are questioned due to a lack of reliable data, for example on the concept of steroid-induced rage (roid rage), which is often invoked to explain violence. Building on these criticisms, other research points to confusion between correlation and causation, and call for greater consideration of confounding factors such as age and lifestyle.

Finally, the question of the harms of doping must also be considered by asking what the situation in sport would be like without anti-doping organizations. This is extremely difficult to assess. Caution is therefore necessary, and when estimating the scale of the social harms of doping, one must avoid hasty judgments about the supposed failures or successes of anti-doping.

While the studies are very heterogeneous, vary greatly in methodological quality and level of evidence, and are few in number in France, the first part of this summary sought to assess the scale of the phenomenon and analyze the effects of doping in all its dimensions. The next section of this summary addresses the determinants of doping, approached from the disciplines of social psychology, where there is abundant literature, and sociology, to try to

[22] The term "drug addict" is stigmatizing. In the field of substance use, this term was used before the term "people who use drugs" came into common use.

identify and understand the factors that may influence an athlete and the path that may lead them to use doping substances. Prevention of doping will then be examined, by considering the effectiveness of programs that have been evaluated.

Psychosocial approach to the determinants of doping

In the field of social psychology, doping behavior depends on the dynamic interaction between an athlete's beliefs and their assessments of relevant interpersonal experiences. Doping is considered prohibited and socially unacceptable behavior, which is therefore difficult to measure directly, given the constraints and difficulties inherent in implementing doping tests. Because doping can be conceptualized as a premeditated and intentional action in which athletes choose to engage in this type of behavior with the aim of improving their performance, the decision to dope is not binary but rather reflects a progressive movement toward a final decision. Thus, studies that have examined doping have largely measured self-reported doping behavior, intention to dope, judgments of doping acceptability, and attitudes toward doping. It is also important to note that the measures used to assess the role of the entourage are the same as those developed to examine the individual psychosocial determinants of doping. The tools used in the vast majority of studies are self-reported questionnaires or hypothetical scenarios with underlying questions.[23] This section examines situations of vulnerability, followed by the psychosocial mechanisms that explain doping through sociocognitive theories, integrative models, and more recently introduced "dual" models that incorporate implicit processes. It goes on to explore the role of the entourage (in particular coaches and parents) on the psychosocial determinants of doping. Finally, this body of knowledge is synthesized to approach it from a more integrative perspective of risk and protective factors for doping.

Individual-level psychosocial determinants

The individual-level psychosocial determinants of doping have been examined in qualitative studies that sought to explore in depth, through athletes' accounts, their beliefs and experiences, notably by identifying situations of vulnerability.

Situations of vulnerability to doping

Situations of vulnerability are understood as periods of weakness during which a person's integrity is, or may be, compromised, diminished, or altered. These can be described as "setbacks", tipping points, sensitive periods, or times of personal distress. The literature reveals the existence of several situations of vulnerability to doping, which can be grouped into four categories: (*i*) physical, (*ii*) psychological, (*iii*) relational, and (*iv*) contextual (Table I).

[23] For more information on measurement tools and methods, refer to the addendum at the end of the corresponding chapter.

Table I: Different situations of vulnerability to doping among athletes

Situations	Examples
Physical	Physical exhaustion, intense training, recovery Anemia, deficiencies and perceived need for supplementation (pain, fatigue) Injuries or post-injury periods
Psychological	Negative emotions: stress, anxiety, burnout, depression Maladaptive motivation: winning at all costs, controlled motivation, fear of failure, self-sabotage Tendency toward moral disengagement Reduced sense of accomplishment Doping as an addiction Eating disorders
Relational	Organized doping, social pressure from one's entourage, isolation Control, sexual or moral harassment, and trauma Social approval of doping
Contextual	Sport culture Environmental and climatic conditions Competitive stakes

Psychosocial mechanisms of doping

- Sociocognitive theories

Numerous quantitative studies have explored the psychosocial mechanisms that explain doping, by drawing on sociocognitive theories and the underlying psychological variables. This work has examined psychosocial mechanisms from the perspective of, for example, the theory of planned behavior, motivational theories (such as self-determination theory and achievement goal theory), and the theory of moral thought and action. Early research highlighted the importance of belief systems relating to behavioral outcomes, social influences, and personal control factors that affect behavioral choices, factors that are explicitly presented and formalized in the theory of planned behavior. However, these identified variables do not necessarily represent all the factors influencing doping.

Studies based on motivational models have added to the literature by demonstrating the central role played by motivation in our understanding of the mechanisms behind doping. More specifically, self-determination theory and achievement goal theory have emerged as two complementary theoretical frameworks in that they analyze motivation from different angles while converging toward a more complete explanation of the phenomenon. Self-determination theory has shown how a non-self-determined (*versus* self-determined) source of motivation favors doping behavior. Achievement goal theory, for its part, has helped explain "how" this motivation influences goals and behaviors, particularly through the adoption of performance goals (focused on social comparison; positively associated with doping) *versus* the adoption of mastery goals (learning, understanding, progressing; negatively associated with doping). These two goals each have two valences to clarify how success and competence are defined: "avoidance", i.e., avoiding demonstrating low competence, and "approach" i.e., demonstrating competence. These two valences influence doping behavior. Finally, studies grounded in the theoretical framework of moral thought and action have highlighted protective factors against doping behaviors, such as the capacities for self-regulation of emotions or social pressure. Conversely, individuals are capable of disengaging from self-sanctions linked to reprehensible behavior through moral disengagement, which increases the risk of doping.

- Integrative theories

The literature puts forward several models, incorporating some of the socio-cognitive theories applied to doping discussed above, that aim to provide a clearer understanding of the relationships between the various psychosocial determinants of doping. These include: *i*) the general theory of crime; *ii*) the sport drug control model; *iii*) the life-cycle model of performance enhancement; *iv*) integrative models of doping, and *v*) the trans-contextual model of motivation to dope. Overall, these models have attempted to prioritize the psychosocial determinants, highlighting those that appear to exert a stronger influence, such as attitudes, intentions, and motivation. Despite the added value of these integrative models, which draw on multiple theoretical frameworks often borrowed from sociocognitive theories, the results show that the variables identified explain only a small part of the variance in doping behaviors (as is often the case in the field of psychology). Thus, the percentages of explained variance observed in studies based on sociocognitive theories and integrative models point to a need to consider other factors that could explain these behaviors, particularly those that have not been fully explored through the various self-reported measures most commonly used in the scientific literature.

- Dual models and implicit processes

While sociocognitive theories and integrative models are based on the premise that human behaviors are primarily the result of reasoned evaluations and planning and are guided by the intention to act (known as explicit processes), more recent scientific literature (dual or dual-pathway models) has shown that certain behaviors are impulsive, unplanned, and emerge from specific situations (known as implicit processes). Thus, meta-analyses of health behaviors (beyond doping) indicate that sociocognitive variables explain no more than 25 to 30% of behavioral variance, prompting researchers to consider the involvement of implicit processes. In the case of doping, implicit processes consist of evaluative reactions resulting from spontaneous cognitive associations, which are automatically activated by a relevant stimulus, such as an offer to dope or easy access to a banned substance. Doping behaviors would thus be governed not only by reasoned processes and conscious goals, but also by automatic implicit processes. Although the literature on the role of implicit processes in sports doping is relatively recent, the results obtained suggest that implicit processes shed unique light on specific differences between individuals and are important to consider in order to reduce the problem of respondent honesty and social desirability bias observed in self-reported measures, which remain very much in the majority in the literature.

Role of the social environment on the psychosocial determinants of doping

There is strong consensus in the social psychology literature regarding the preventive or, conversely, harmful and incentivizing role of the athlete's entourage (primarily coaches and parents) on their attitudes toward doping and intentions to dope. This finding emerges from studies using a variety of methodologies, including quantitative or qualitative approaches, documentary analyses, and literature reviews. However, it should be noted that there exists a marked imbalance in the literature, with studies on individual-level psychosocial determinants being more substantial than those on the role of the social environment. This may partly reflect methodological difficulties or the fact that doping is primarily conceptualized by researchers as an individual act.

Quantitative studies have mainly explored the mechanisms underlying doping behavior by focusing on the relationships between the perceptions, beliefs, attitudes, and behaviors of coaches (motivational climate established by the coach) or parents (attachment, parental supervision, proactive communication about doping) and athletes' attitudes toward doping

and their intention to dope. These studies are based on contemporary sociocognitive theories (theory of planned behavior, self-determination theory) or on integrative models more specific to doping (general theory of crime, sport drug control model). Qualitative and documentary research have further explored the complexity of situations that can be experienced by athletes by describing and characterizing the harmful or protective role of the entourage through the intertwined relationships between the various actors (coaches, technical staff, parents, peers, etc.) involved in the athlete's social environment.

While this body of research provides undeniable empirical evidence of the primordial role played by the athlete's entourage in doping behavior, it has several limitations: *i*) social desirability bias related to the measurement of attitudes, intentions, and doping behaviors; *ii*) the lack of longitudinal and/or experimental studies, making it difficult to demonstrate a causal effect; *iii*) the focus of studies on coaches (and, to a lesser extent, parents), thus providing little information on other people in the athlete's circle (e.g., peers, health professionals, etc.); and *iv*) the need for replication studies in diverse populations (age, levels of practice, sports). In conclusion, the literature on the role of the entourage strongly suggests, from an applied perspective, that the entourage should be integrated/associated in the implementation of prevention programs to maximize their effectiveness.

Risk factors and protective factors

In recent years, several meta-analyses and systematic reviews have sought to synthesize knowledge on the psychosocial determinants of doping. These studies have identified various predictors of doping behavior, including risk factors and protective factors. They show that, in addition to demographic factors, the phenomenon can be explained by a combination of individual psychological, situational, and socio-contextual factors (Table II). In addition, certain situations and periods have been identified as particularly critical in the emergence of the phenomenon.

While it is important to better understand the psychological processes involved in sports doping, it is equally important to identify and understand the protective factors that can prevent the phenomenon. This summary has detailed the individual psychosocial determinants of doping, focusing on situations of vulnerability and then on the psychosocial mechanisms that explain doping through sociocognitive theories, integrative models applied to doping, and more recently dual models that highlight the key role of implicit processes. In addition, there is a strong consensus in the scientific literature that the social environment (primarily coaches and parents) can have protective effects, but also harmful and incentivizing effects on doping behaviors. Finally, synthesizing the multitude of risk and protective factors for doping identified in the social psychology literature applied to sport has enabled an integrative organization of this knowledge. These insights, derived from research on the psychosocial determinants of doping and the influence of the social environment, can guide the development and implementation of prevention programs in the field.

Table II: Risk factors and protective factors

Risk factors	Protective factors
Demographic factors	
Male sex Age: adolescence Number of years in competitive sport Type of sport Use of dietary supplements	
Personal or psychological factors	
Favorable attitudes, intentions, and norms toward doping Performance-approach goals (seeking to perform at all costs) or performance-avoidance goals (avoiding performing worse than others) Low self-esteem Controlled motivation Fear of failure Low self-efficacy/self-regulation or perceived behavioral control Moral disengagement Perfectionism High anxiety/stress, burnout, depression Low sporting integrity or moral values Body image dissatisfaction Impulsivity, low self-control, sensation-seeking, and risk-taking Risky behaviors (alcohol, drugs, etc.) Eating disorders	Strong moral identity/commitment to sporting values Self-regulatory efficacy (emotional regulation, resistance to social pressure) Autonomous motivation High self-esteem Mastery-approach goals (striving to improve) Anticipated regret, fear of detection, concern for reputation, guilt Low risk-taking tendency
Situational factors	
Career transition periods, years in high level sport Early specialization in sport Recovery periods after injury, particularly intense training sessions Sport-related health issues Seeking short-term performance improvement Contact with individuals who dope Situational temptation Trauma (harassment, abuse) Availability and accessibility of doping substances	Secure attachment throughout life Promotion of moral decision-making
Socio-contextual factors	
Influence of social environment (peers, parents, coaches) Cultural and sporting norms favorable to doping Controlling motivational climate Team organization, workload, job insecurity Rewards and financial motivation Training demands and climate Competitive or rivalrous stakes Sporting culture Climatic conditions Weak anti-doping policies	Perceived antidoping legitimacy Mastery-oriented or autonomous motivational climate

Sociological approach to the determinants of doping

The identification of the determinants of doping divides the scientific community because it involves different disciplinary approaches. While economists and some psychologists attempt to identify determinants common to all cases of doping, other research, mainly in the field of sociology, identifies a diversity of factors and takes into account the effects of cultures and contexts.

Research in the field of economics echoes the widely held idea that athletes dope in a relatively rational manner and are incentivized to cheat because of the economic or even symbolic benefits they can derive from it. The anti-doping approaches in this field then would seek to deter athletes from doping by increasing the cost of sanctions and by reducing the profits. These universalist models of rational, calculating athletes however, lack the empirical foundations to inform on the conditions under which such calculations guide athletes and, above all, they neglect the diversity of doping practices.

To move beyond these rationalist models, but without ignoring them, the determinants of doping can be classified into three sociological ideal types, which can overlap and be combined.

Thus, a first category of determinants, in which athletes' forms of rationality are taken into account, revolves around the issue of information. Doping can result from a lack of information about the World Anti-Doping Code, the complexity of which means athletes as well as coaches and sports organization leaders have only a very partial understanding of it. Indeed, a survey conducted in France among various populations in 2022 revealed substantial gaps in anti-doping knowledge (for example, 70% of students specializing in sports did not know of any national or international anti-doping institution). This creates uncertainty about the resources available to athletes to avoid the risk of testing positive. Some authors even estimate that there is a risk of unintentional doping of around 40%, particularly through contamination of dietary supplements. However, it should be kept in mind that cases of unintentional doping can be instrumentalized.

A second category of determinants focuses on what may be described as "direct" incentivizing factors, since the determinants of doping are obviously not only related to the management of information from a relatively rationalist perspective. Values are often identified as a key determinant of doping by sports organizations. The International Standard for Education of the World Anti-Doping Code is based on values that aim to "support the preservation of the spirit of sport", and is intended to play a structuring role in education programs. However, WADA addresses athletes and sports organizations that exist in very different cultural, economic, and political contexts, which it struggles to fully account for. Indeed, research in this field reveals that interpretations of the "spirit of sport" can vary significantly across cultures.

This values-centered view tends to associate values with individual characteristics and minimize the role of the athlete's entourage in doping risks. Yet, numerous studies have shown that the athlete's entourage (family, friends, etc.), coaching staff (coaches, doctors, trainers, etc.), governments (level of corruption and type of regime), and financial backers (sponsors) can play a decisive role in the direct incitement to dope. Indeed, the influence of these actors can be decisive in shaping the culture of athletic performance. Doping is learned within the context of sports practice, through direct interactions or sometimes through one’s network of social contacts that allow individuals to become part of a community. Research highlights the cultural embeddedness of doping. For example, among powerlifters, doping is part of the culture and it cements the bonds between insiders, while those who are not among the initiated become outsiders. In cycling, the most experienced athletes have played an important

role in transmitting the culture of doping. But, in these sports, it is also the interactions with federation or club officials who, through their silence or deliberate failure to question doping, may have contributed to its normalization while at the same time inconsistently condemning and rejecting athletes caught doping. Doping is often the result of a process of deviance fostered by contextual factors, such as an entourage with excessive expectations of performance.

Access to supply is also one of the determinants of doping substance use. While high-profile doping cases have made it possible to identify distribution networks, access to doping substances has been facilitated by globalization, which allows any consumer to find doping products on the Internet, including on common e-commerce platforms, and have them quickly shipped, with a limited risk of being caught by anti-doping organizations. The ease with which these products can be obtained on legal platforms can only raise questions about the potential effects of public health resulting from this form of trivialization.

The availability of fitness centers, which respond to the growing demand for body transformation, is also a factor in the normalization and spread of doping. The use of doping substances by regular bodybuilders is most often for aesthetic purposes, the main determinant of which is the desire for hypertrophied muscles. An ethnographic study on an international community of thousands of recreational bodybuilders suggests that the pursuit of a muscular physique through the use of doping substances can be explained by a "crisis of masculinity" or a "reconfiguration of masculinity". Understanding doping in this population, therefore, requires examining the social construction of a taste for muscularity and its meaning in terms of gender identity and belonging within the bodybuilding community.

This culture-centered approach makes it possible to go beyond explanations based on values as incentivizing or deterring factors for doping, and to better understand the processes that lead to the normalization of the use of doping substances and methods.

Finally, research identifies a third category of "indirect" factors, in which sports organizations and actors in the economic and media sectors, although not directly involved in the organization of doping, bear indirect responsibility if the conditions for performance, which are within their control, increase the vulnerability of athletes. Excessive workloads and demands, inadequate support, insufficient recovery time, economic insecurity (e.g., precarious contracts), moments of vulnerability linked to the difficulties of entering a professional sports career, or the threat of leaving it, can all create moments of vulnerability that fragilizes athletes during their careers and can incite them to use doping substances or methods to cope with the pressures of performance.

Sports organizations have historically been highly focused on performance. Despite changes and a relative diversity of cultures, for example around gender, prevention issues (around doping, but also around safeguarding athletes) are rarely a priority. Yet, sports organizations play a central role and have a responsibility to create a working environment that is conducive to performance without doping.

Effectiveness of doping prevention programs and doping practices

Prevention, when approached from a health perspective, is defined by the World Health Organization (WHO) as all measures "aimed at reducing the likelihood that a disease or disorder will affect an individual, interrupting or slowing the progress of the disorder or reducing disability". This can include any policy, program, or action aimed at reducing health risks—whether environmental, social, or individual—by modifying one or more of these components to prevent health problems (universal prevention), reduce their impact (selective

prevention), or address their consequences (targeted prevention). Any preventive action should be designed based on a theoretical model derived from behavioral or implementation sciences, respond to an identified health problem, act on the determinants of this problem and/or on the problem itself, incorporate validated behavior change techniques, be tailored to a target population, and include—before, during, and after implementation—a process evaluation mechanism (i.e., did the intervention proceed as planned?) and an outcome evaluation mechanism (i.e., did the intervention achieve the intended effects?). Only studies incorporating prospective, experimental, or quasi-experimental evaluations were considered in this analysis.

Comprehensive and systemic prevention

Legislation provides a legal framework that makes the physical and social environment "hostile" to doping. The first comprehensive systemic approach is "restriction", which involves regulating and controlling the supply of products that can be used for doping, thereby limiting their availability, as is the case for certain medications. Given the lack of systematic monitoring of doping, it is impossible to estimate the effect restriction measures at the global or national level. However, one experimental study demonstrated that strengthened controls and additional administrative measures imposed on pharmacies reduced the dispensing of such products.

The second ecological measure is "coercion", which consists of implementing "control and sanction" measures. The SATURN program (*Student Athlete Testing Using Random Notification*), launched in 1999-2000 with a one-year follow-up, showed a decrease in the use of doping substances and illicit drugs in high schools where random anti-doping tests were carried out, compared to "control" high schools. However, it also led to a deterioration in attitudes towards control and sanction measures. These results suggest that restrictions on access to products should be maintained as they limit doping practices. Control and sanction measures are also effective and should be part of the tools used for prevention. Some authors, however, advocate for more proactive prevention, aimed at identifying at-risk situations and anticipating their effects using specific indicators, rather than relying solely on ex post control and sanction measures. Above all, the current competitive environment—described by some as "dopogenic"—must be changed because it exceeds athletes' natural capacity for effort and recovery. A number of recommendations have been proposed in the literature: modifying the sporting calendar; ending precarious contracts; prioritizing athletes' health over performance goals. While these recommendations may seem utopian, they appear necessary if we are to have doping-free sporting competitions.

Community-based prevention

Community-based or setting-based approaches to prevention involve implementing programs in the places where individuals live and work. They leverage use of existing physical resources and social dynamics to introduce sustainable prevention measures that together target individuals, social dynamics (hierarchy, peers, etc.) and physical environments, and that are adapted to the profiles of the target populations. In the case of doping, sports programs and/or school teams in Europe or the United States are most often the subject of these interventions. Their effects are measured through controlled prospective evaluations, using self-administered questionnaires based on the theory of planned behavior, which measure the intention to dope as the primary criterion and mediating variables (attitudes towards doping, knowledge, perceived ability to refuse doping, etc.) as secondary criteria. The evaluations are carried out before and after the intervention, and sometimes at follow-up. One of the most comprehensive and detailed systematic reviews to date (including 28 studies documenting 21

interventions) revealed significant heterogeneity between interventions, their strategies and objectives, as well as their indicators, making comparisons difficult.

So-called "informative" approaches consist of providing knowledge on various topics (the role of WADA, the Prohibited List, regulations and sanctions, adverse health effects, etc.) either face-to-face, as in an Italian program conducted in 157 high schools reaching more than 20,800 high school students in 2017-2018, or online, such as "*Vive Sin Trampas*" for sport-study students in Spain, or *via* a "serious game" to teach the principles of anti-doping to young athletes from six Italian sports high schools. Regarding the mode of delivery of an intervention (face-to-face, online, or mixed), the "*iPlayClean*" program showed that positive effects were only maintained at follow-up (2 months) for the face-to-face modality. Most studies show a significant increase in knowledge after the intervention, and sometimes at follow-up. A review of prevention initiatives by 53 national anti-doping organizations highlighted the predominance of informative approaches in their programs, and their effectiveness to improve knowledge on regulations, the Prohibited List, and health consequences. However, it is widely acknowledged that informing young athletes about the negative consequences of doping is not sufficient to deter use.

Educational approaches aim to strengthen psychosocial skills (such as resilience, stress management, ethical decision-making, resistance to peer pressure, etc.) and teach alternatives for improving performance and/or adopting a healthy lifestyle (weight training, sports nutrition, health promotion, etc.). These were developed as early as 1996 with the ATLAS program (*Athletes Training and Learning to Avoid Steroids*). This was followed by ATHENA (*Athletes Targeting Healthy Exercise and Nutrition Alternatives*), aimed at young female athletes, which focused on the use of doping substances and disordered eating, as well as HERCULES, comprising theory with practical weight training sessions as an alternative to doping, and that also compared the effectiveness of these two interventions individually and in combination. These multi-component programs can include 2 to 15 theoretical and practical group sessions spread over several weeks, led by coaches and/or peers with interactive activities (role-playing, debates, project building, scenario analysis, weight training, etc.). For ATLAS, a controlled prospective evaluation of football teams from 16 "control" and 15 "intervention" high schools showed a reduction in the use of anabolic steroids, illicit drugs and alcohol, as well as a positive change in mediating processes for up to one year, but another study replicating ATLAS on a large scale reported weaker results. The ATHENA program reduced the use of doping and weight-loss products, and promoted healthy eating behaviors with effects lasting one to three years after graduation. HERCULES led to a greater increase in strength training self-efficacy in the "theory and training" group and an increase in knowledge in the "theory only" group after the intervention. However, no effect on resistance skills (ability to refuse substances) or the intention to dope was observed. Overall, these programs have a significant effect on mediating variables (knowledge, attitudes towards doping, training self-efficacy, etc.), but a more modest effect on the intention to dope.

Several programs have focused their actions on ethical and moral values, targeting themes such as the moral dangers of doping, fair play, the spirit of sport, threats to the integrity of sport and Olympic ideals, as well as the morality of doping, the use of dietary supplements, or anti-doping controls, moral agency (the ideal athlete chooses not to dope), accountability (every athlete is solely responsible for their decisions), and empathy (impact of doping on others). Assessments also include anticipated guilt (feeling guilty about a decision before even making it) and moral disengagement (justifying transgressive behavior by minimizing the act or its consequences). The sessions typically use scenarios involving fictional or real athletes faced with dilemmas (recovery from injury, decline in performance, feelings of inequality, etc.) for students to discuss and develop reasoning that leads to an ethical decision. Two programs comparing an informative approach to a values-based approach showed that both

interventions could be effective in reducing the likelihood of doping, but that the values-based approach had a greater effect on anticipated guilt and moral disengagement up to two months post-intervention. Finally, Goodform is one of the few programs to target body dissatisfaction and the use of dietary supplements for bodybuilding by deconstructing the image of the "ideal" body, or mesomorphic ideal. Implemented in nine Australian schools, this program included one session deconstructing the mesomorph ideal and three sessions on steroids and dietary supplements inspired by ATLAS. However, the analyses did not reveal any changes attributable to the intervention over time. Overall, the results examined seem to suggest that an educational approach in schools offers certain added value in raising young athletes' awareness of the health, ethical, and moral issues surrounding doping, compared to information alone. But for some authors, it is first and foremost necessary to change the social climate and normative pressure to dope *via* coaches and peers by training them in motivational communication. A controlled study conducted in three countries with post-intervention (3 months) and follow-up (5 months) measurements showed that coaches who had received training in motivational communication reported greater effectiveness in creating an anti-doping culture than those who received standard 'informative' training. Athletes whose coaches who had received training in motivational communication reported a greater reduction in willingness to dope at post-intervention, but not at follow-up, compared to those who had coaches from the control group.

Current limitations of doping prevention

Few programs have conducted process evaluations documenting the acceptability and quality of the actions implemented. In cases where this has been performed, such as for the variation of the HERCULES program in prisons, the findings emphasize the importance of establishing relationships of trust between stakeholders and participants. In the case of the *Cool and Clean* program, it was shown that the outcomes were correlated with the quality of implementation of the actions. Researchers have applied the principles of implementation science to doping prevention. They find the scientific literature is dominated by academic evaluations of programs implemented in high schools in the United States and Europe (involving student athletes or other subjects), whereas it is also necessary to address doping substance use among adult populations, in sporting environments such as gyms and amateur sports. A 2024 report surveying anti-doping measures in recreational sports in 49 countries that have ratified the Council of Europe's Anti-Doping Convention showed that only a minority of them have included anti-doping measures in gyms, and that these involve mainly education and awareness-raising, and to a lesser extent legislation. Unfortunately, there is a lack of experimental studies in this area, although the acceptability of certain educational tools has been positively evaluated by professionals. Among the few documented initiatives, STAD (*Stockholm Prevents Alcohol and Drug Problems*), has developed a program for the prevention of doping in recreational sports. This program, called "100% Pure Hard Training", is a multi-component program involving key players from various sectors. The method includes: *i*) collaboration between gym owners and staff, police officers, and prevention officers in local administrative councils; *ii*) training for key stakeholders; *iii*) improved control and sanction measures; and *iv*) certification of gyms. A qualitative study showed that the key factors for successful implementation of this program were motivation, collaboration, and skill development among all actors.

Finally, targeted prevention measures, such as those using a risk and harm reduction (HR) approach, are virtually non-existent in studies on doping. This pragmatic approach, developed to address addiction, is rarely considered for doping, revealing that this issue is perceived as distinct from other types of substance use. Several possible avenues for improving tertiary prevention and the development of a HR approach come from the field of addiction. In this

regard, the creation in France in 2001 of "Doping Prevention Medical Units" (*Antennes Médicales de Prévention du Dopage*; AMPD), whose missions include, among others, medical care and compliance, as well as health surveillance, is to be welcomed. Although the objectives of the AMPDs fully met targeted prevention needs, their insufficient coordination and implementation prevented their clinical activities from being used for scientific research purposes.

In the absence of objective and systematic measures of doping, it is difficult to accurately estimate the single or combined effect of prevention measures on this practice, or on the health of professional or amateur athletes. The community-based approach has benefited from numerous innovative experiments with the deployment of several multi-component programs in schools, but the heterogeneity of these experiments conducted over the last thirty years has prevented any scientific consensus on a "gold standard" reference program. In addition, few of these programs have used process evaluations to measure the acceptability, effective investment or appropriation of the interventions by the actors concerned (athletes, teachers, parents, coaches), and most measure their effectiveness over relatively short periods. However, taken together, the results suggest that "educational" approaches are more effective than purely "informative" approaches in raising young athletes' awareness of the health, social, ethical, and moral risks of doping, in strengthening their ability to refuse substances (doping or otherwise), and in promoting healthy behaviors. These approaches should, however, be permanently integrated into educational curricula and include coaches. Their long-term effects remain to be demonstrated, particularly during vulnerable periods in an athletic career (recovery, injury, etc.).

What are the prospects for anti-doping policies?

The fight against doping cannot be understood without understanding the social and political conditions in which it has historically been organized, nor without questioning the methods used to implement it. A body of literature seeks to precisely describe the context in which anti-doping arose—that is, how the problem of doping was defined and delimited. The identification and characterization of doping practices are inseparable from the anti-doping measures envisaged and from their implementation. Furthermore, analysis of the fight against doping suggests that attention should be paid to the actors and the social organization that enables them to prevent, control, test, sanction, and ensure that the decisions taken are actually implemented. Because gaps exist between the objectives and implementation of plans, and the reality of their application, the fight against doping is subject to much criticism in the literature. This criticism also concerns the rules decided by the relevant bodies, as well as the conditions under which decisions are made. A number of researchers call for changes in the fight against doping—for some, only marginal adjustments are necessary to improve effectiveness, whereas others advocate for a radical rupture.

What can we learn from the history of anti-doping?

The literature includes institutional narratives that present the values of sport, the determination of sporting bodies, and the legitimacy of anti-doping as unquestionable truths. While these texts certainly shed light on some aspects of anti-doping, their normativity does not allow for much insight, unless it is taken as the subject matter itself. We learn much more from socio-historical approaches that place the series of anti-doping measures within the context of events more or less directly related to policies. Further examination of the relevant series is needed to analyze the sometimes chaotic evolution of these policies.

A first reading highlights the concerns raised by physicians in the 1950s following the deaths or illnesses of athletes, which were believed to be caused by the use of doping substances. This context helps explain the establishment, in the 1960s, of a medical commission within the International Olympic Committee (IOC), as well as the emergence of the first national legislation and doping controls.

Assessments of the effectiveness of anti-doping measures are sometimes studied to explain the creation of texts (codes, charters, conventions, reports) and entities (e.g., the Court of Arbitration for Sport, and later WADA). But it is also argued that developments in the fight against doping are linked to those of doping products themselves, that passed from being the subject of research to being tested on athletes without any real precautions, and this is also argued in the case of tools for detection. The use of mass spectrometry in the 1970s was decisive for sample analysis, as was the use of techniques to detect exogenous EPO use from the late 1990s onwards.

One can also look at the range of actors entering the fray and the impact of their actions. From the creation of WADA in 1999, which organizes anti-doping activities through normative and binding texts, to the involvement of UNESCO[24] through an international Convention adopted in 2005 and of the *International Testing Agency* (ITA) at the international level, up to the creation and restructuring of national entities within the respective countries, and finally the involvement of physicians, specialist lawyers, and ethicists—examining the evolution in how doping is managed provides a better understanding of the fight against doping.

This mobilization of actors can be linked to crises that punctuate the initiatives of anti-doping institutions. The construction of a series of affairs and their consequences makes it possible to sketch an outline of a model of action where measures are triggered in response to significant events: the Ben Johnson doping case and the Dubin report, the 1998 Tour de France and the creation of WADA, the Puerto case and changes in the Spanish anti-doping system, the Russian scandal and the development of an International Standard for Code Compliance by Signatories...

These processes take place in parallel with political life and geopolitical issues. When doping is framed as an "atomic armament" of soft power during the Cold War, when a doctor resigns from an institution, publicly declaring that he does not want to be the "Dr. Garretta" of doping (in reference to the contaminated blood scandal), or when the Russian scandal impacts relations between the West and Moscow, this provides insight into both the evolution of anti-doping and of society.

In these conditions, the fight against doping can be read as being shaped by underlying tensions and external agendas. The development of sports medicine, together with the development of anti-doping policies, highlights the tension between geopolitical issues and the desire to protect the health of athletes.

Moreover, debates have emerged aimed at clarifying the extent of state commitment in the fight against doping. The question is whether responsibility for addressing doping should lie with states or with the sports movement. Several works highlight a shift from recognizing the political dimension of sport, to the construction of a sports policy that must find its place within the broader framework of public policy.

Accounts of the evolution of anti-doping measures often focus on the creation, implementation, and the operation of WADA. Some authors emphasize its close ties to the sports movement, which are intrinsically linked to its history. Frequently criticized in the literature, the Agency builds regulatory instruments that generate irreversibility. It is

[24] United Nations Educational, Scientific and Cultural Organization.

described as weakened by crises that call into question its legitimacy, its functioning, and even its very existence, and at the same time is described as authoritarian insofar as this Swiss private law foundation has managed—and continues to manage—to dictate to states what they must do (even to the point of imposing organic laws and challenging constitutional principles). One might speak of metastability to describe the stability of this organization: subject to disturbances, it ultimately appears to emerge stronger.

Who are the anti-doping actors and what do they do?

Some texts present the many groups of actors, but their work and interactions are unevenly. Nevertheless, these studies highlight the heterogeneity of the actors involved.

As mentioned above, the work of WADA, a foundation jointly financed and governed by the sports movement and states, is the subject of most studies on anti-doping policies. The "stakeholders", to use the institutional terminology, are entities from the sports movement, anti-doping organizations including national anti-doping organizations (NADOs), as well as testing laboratories, major sporting event organizers, etc. The studies highlight numerous criticisms levelled at WADA and make it possible to map out a large share of the actors by distinguishing between two blocs: the sports movement on the one hand, and states on the other. A distinction can also be made between external criticism (researchers, etc.) and internal criticism (for example, from those involved in the fight against doping). These criticisms concern, for example, the lack of genuine autonomy (those outside WADA's power structure have little room to act), need for compliance—which goes hand in hand with a loss of independence—cumbersome hierarchy, power struggles between the IOC and states.

Several studies, focused primarily on European countries (particularly those in Northern Europe), examine the national realities of anti-doping. Other, comparative, studies examine bi- and multilateral cooperation between anti-doping authorities across different national and regional contexts. This work highlights forms of collaboration, inequalities, but above all major cultural differences that are not sufficiently taken into account. Some suggest that this leads to forms of neo-colonialism, marked by a failure to take into account or address deeply rooted cultural practices or beliefs. The argument is critical and questions the drive for harmonization, suggesting it is closer to standardization.

The literature includes studies on other collectives (the European Union, international Federations, the sports movement more broadly, etc.), but these remain few in number. Research on actors' work, in the sense developed in the field of the sociology of work, is virtually non-existent.

Some of the texts concern the situation in France, which can be analyzed through a number of presentations and official reports, but which is the subject of relatively few studies. Among the available documents are institutional evaluations, which are rather critical (French Court of Accounts, parliamentary reports, or reports from General Inspectorates) on issues of coordination and evaluation of anti-doping efforts. It is difficult to map out the various actors due to complex and rapidly shifting relationships between numerous entities. One notes a juxtaposition of services that are both distant from one another and isolated within their respective administrations. Political responses take the form of 'plans' aimed at distributing competencies to the various actors, who are very attached to defending their scope of activities and their approaches. This is particularly evident for activities related to prevention, which are at the center of tensions. The question of the place of health in the fight against doping has not really been resolved and generates conflicts and dysfunction (the case of AMPDs is emblematic).

Within a globally harmonized anti-doping system, the question arises of how to articulate a national policy consistent with French institutions and law. The state is criticized for managing anti-doping while renouncing the possibility of defining it.

What judgments exist about anti-doping?

Many texts develop criticisms that sometimes amount to accusations. These often concern "failures", dysfunctions (that are described in considerable detail), omissions, denunciations (of the involvement of authorities but also of ideologies), and errors (potentially revealing problematic intentions).

Some authors focus their criticism on the protagonists. Others propose using a scientific approach to "objectively" evaluate the fight against doping. They then set themselves the task of establishing criteria and rigorously analyzing anti-doping policies (while disqualifying institutional tools). These can be described as critical assessments, as the argument is accompanied by accusations of a lack of transparency, or accusations of failure to use interdisciplinary research, or more generally to mobilize the full range of scientific disciplines to conduct an objective assessment of the reality of anti-doping policies. These texts are generally very prescriptive.

While the legitimacy of the fight against doping is directly questioned by researchers, there are also studies on the perception of legitimacy from the perspective of the sporting world. This literature shows that athletes most often recognize the legitimacy of anti-doping regulations while at the same time highlighting problems: excessive variability between countries, lack of data protection, lack of privacy safeguards, and exclusion of athletes from the decision-making process. These concerns could erode legitimacy if these problems are not resolved. As some authors have noted: "Power without legitimacy is dependent on strong forces and sanctions (coercion) if goals are to be achieved".[25]

Part the literature, analyzed by the field of social psychology, draws on deterrence models and examines athletes' perception of sanctions. Other authors use different models, such as the sociology of work ("Thinking about doping in sport as doping in ordinary work") or legal consciousness studies (how actors feel bound by the law or by rules) to explore the issue of legitimacy in everyday life.

Some authors discuss their own position (i.e. that of researchers) in the fight against doping, producing a form of internal criticism. The stances taken can be militant: for example, a defense of one's discipline or of interdisciplinarity, or a critique of disciplinary practices grounded in a deontological posture. They can also take the form of discussions on the ethics of anti-doping research.

Finally, there are assessments of experimental initiatives that could be described as existing at the 'margins' of the World Anti-Doping Code: large-scale anti-doping testing, testing of amateurs in gyms, the *Clean Protocol* program, etc. The results are highly critical of these measures.

Debates on anti-doping policy: which way forward?

Building on the range of judgments outlined above, a number of policy debates have emerged in the literature. These, however, can be classified into several groups.

[25] See Efverstrom A. et al. Anti-doping and legitimacy: an international survey of elite athletes' perceptions. Int J Sport Policy Politics 2016; 8: 491-514.

Some texts develop intrinsically critical positions, with the authors directly challenging approaches chosen by anti-doping decision-makers. They contest the "myth" of clean sport and the hegemony of anti-dopism,[26] discuss the translation of ethical standards in medicine to sports medicine, denounce power struggles anti-doping surveillance, and oppose those who they qualify as doping experts working to create fear as a social product. In other words, the fight against doping is caught up in an ideology whose foundations are debatable but, as these authors argue, there is no space to discuss them. Some discuss the possibility of resistance to the power embodied by WADA.

Some authors open debates and frame their arguments as controversies, rather than polemics. Debates concern, for example, the relevance of creating a moral community. From this perspective, athletes refrain from doping because they share a moral community, not because they fear being punished. The counterargument stresses that there is no possibility of a moral community if athletes are thought of as potential cheaters (the argument thus returns to a critique of the choices made by authorities). Other debates focus on the value of using moral levers. Some authors propose leveraging shame, a 'powerful' emotion, by publishing the names of cheaters and challenging their reputation. The counterargument is that the experience of shame varies across cultures. But it generates an overall negative feeling about oneself or one's essence. And it suggests the notion of guilt. There are also debates related to the issue of human rights and the argument that the suspension of individual rights is justified by the satisfaction of another (supposedly higher) social value, such as the Olympic ideal. From a moral point of view, the use of the principle of strict liability[27] to define infractions requires a clear and concise justification. It would therefore be incumbent on those seeking to restrict rights to demonstrate convincingly why they are doing so. But to what extent is this a legitimate interest? Who should define it? A state? A sports organization? Several texts question geolocation, therapeutic use exemptions (TUEs), strict liability, and the involvement of athletes in doping regulation from this perspective.

Alternatives are proposed in the literature. Several authors raise the question of liberalization. For some, this would involve a change in doctrine that could take the form of transforming WADA into a global agency for the regulation of drugs and healthcare in sport. The legalization of doping is sometimes proposed, with suggestions that it be subject to medical supervision and regulatory oversight. Some propose, at the very least, gradually reducing the Prohibited List. On these points, the debate is lively and divisive. Opposing positions are developed by authors who advocate the criminalization of doping. Others refute this approach, arguing that it would be better for criminal law to focus on broader public health services.

There are also several texts that aim not to eradicate doping but to reduce its harm. Some propose developing restorative justice. Many works call for a commitment to a harm reduction policy.

Finally, discussions also address the situation of amateur or recreational athletes, highlighting the difficulty of assigning a status to this population and developing an anti-doping policy that is appropriate for them. Indeed, extending anti-doping measures to this population raises several issues: the principle of strict liability that applies to elite athletes is not easily transposable to amateurs, as it is impossible for them to have full knowledge of the Code and many consume dietary supplements which exposes them to the risk of unintentional doping.

[26] A term used by some authors, anti-dopism acts as an ideology that supports and legitimizes the fight against doping, limiting all other conceptions and challenges...

[27] Appendix 1 of the World Anti-Doping Code defines strict liability as a principle by which "...it is not necessary that intent, fault, negligence, or knowing use on the athlete's part be demonstrated by the Anti-Doping Organization in order to establish an anti-doping rule violation."

The Prohibited List raises even more questions for amateurs than it does for elite athletes, particularly with regard to the status of recreational drugs, but also the potential of depriving athletes of substances taken for therapeutic purposes. Finally, applying the same procedures to recreational athletes to punish rule violations is problematic, even if the penalties are less severe. The authors thus point to numerous dysfunctions resulting from the transposition of global anti-doping rules—which are geared toward elite sport and are aimed primarily at ensuring fairness in competition—to the situation of amateurs, whose health should be the central concern. The experimental initiatives targeting this population are evaluated rather negatively by these authors.

Ultimately, all of these descriptions of the political organization of the fight against doping, and the judgments and debates that underpin them, unfold within a limited arena, both in terms of the list of protagonists, their backgrounds, and the resources mobilized. Certain elements recur: a form of normativity associated with authors close to institutions, activism, a well-worn argumentative pattern built on a disqualification of the current system, proposal of what would often amount to major reform but that is supported by second-hand data.

Questions around the implementation and the model of transformation are almost never addressed. The argument rests on the claim that B is preferable to A, but it (almost) never considers how B might actually be put into place. The decision-making process, the operational work, and the management of the transition period are rarely considered.

There seems to be a disconnect between these authors, who are often caught up in a form of scientific activity, and anti-doping actors, who demonstrate the capacity to consider a range of options by paying special attention to what has happened in the past, to what future opportunities have to offer and, to what is happening in the present, while themselves working on the modalities of transformation.

The recommendations put forward here aim to bring the two closer together: it is not a question of choosing between antinomic interpretative systems, but rather of having the means to assess what each dispute changes within the environments in which individuals and groups operate.

Social consequences of the fight against doping

In the field of social sciences, research on the negative consequences of the fight against doping has taken various approaches. Several traditions focus on describing phenomena rather than analyzing them, and when they do, it may be to identify one or more causes (for example, by pointing to effects that can be linked to public policy) or to seek accountability. The literature on this subject remains limited, with few studies based on theoretical models.

An examination of the arguments put forward by authors reveals that the consequences identified are mainly linked to WADA, or more generally to its policy and measures. Some of the literature focuses on analyses of the transformations, adjustments, or evolutions in practices shaped by the fight against doping. Case studies can be identified that point to shortcomings in the system. Another part of the literature focuses on the realities of anti-doping measures and leads to noting their consequences (or explore the potential consequences) or even questioning the measures beyond the strict question of their effectiveness. This separation is sometimes more difficult when certain authors describe a measure while criticizing the principles behind it: in this case, the problematic consequences are attributable as much to the measure itself as to the approach on which it is based. An analysis of the literature makes it possible to draw up a list of unexpected and deleterious consequences that, according to the authors, result from anti-doping policies and measures:

- Prevention is insufficient and curbed by the repressive approach adopted, which excludes health education and risk and harm reduction. It is based on the notion of "clean sport", which is a myth;
- The basis for the criteria used to include substances and methods on the WADA Prohibited List is debatable and has unintended consequences. For example, the issue of thresholds poses problems for women who naturally have a high level of testosterone;
- The TUE system is deemed unsatisfactory because it leads to both abuse (unjustified TUEs being issued, which penalizes athletes) and the creation of an unhealthy climate of suspicion;
- The antidoping control measures are based on a set of "surveillance technologies" that are intrusive, particularly with regard to whereabouts requirements, and that are poorly adapted for amateur athletes. Athletes are not involved in decisions regarding the implementation of these measures and are treated as second-class citizens forced into "voluntary servitude", which raises legal and ethical issues that are generally poorly addressed;
- Data from the Athlete Biological Passport poses problems because it can be interpreted as health data (which it is not) and can even be used to inform doping strategies;
- The number and organization of tests are judged insufficient and ineffective by some athletes, giving rise to contempt toward the anti-doping system. In addition, urine sampling is experienced by some as humiliating, potentially leading to psychological or physiological problems (e.g., an inability to urinate) or impairing athletic performance itself. Sampling is questionable for amateurs, and especially for minors;
- The issue of sample analysis also raises concerns: authors question the interpretation and variability from one laboratory to another, the integrity of scientists, the transparency in the dissemination of raw data and, therefore the possibility of academic debate;
- The sanctions resulting from a positive doping test are rarely considered effective. Several studies examining the severity or fairness of sanctions find them disproportionate, unjust, and even counterproductive, noting that the presumption of innocence is violated. A smaller body of work identifies darker emotional and relational consequences experienced by suspended athletes, referring to hatred, denial, despair, regret, and bitterness:
- The principle of strict liability and the obligation (for some athletes) to seize the Court of Arbitration for Sport in the event of a dispute undermine the law and deprive states of the ability to protect their citizens;
- The measures grouped within the Anti-Doping Administration and Management System (ADAMS) remain difficult to reconcile with national laws, particularly with regard to privacy protection. Furthermore, they raise issues related to the inclusion of potentially sensitive information and the inability to correct errors that may be contained in the files;
- The question of psychological support for sanctioned athletes is sometimes raised. What's more, many positive cases often involve unintentional doping, which points to both overly complex regulations and a lack of information. In all cases (unintentional doping or otherwise), the sanction seems unfair and inappropriate, especially when it affects amateurs;

- The fear of sanctions can lead to problematic practices because it indirectly encourages clandestine behavior: the use of less detectable but more dangerous substances or of masking agents; the emergence of an underground culture that is developing particularly on the Internet and that increasingly considers the black market as a source of supply for doping products;
- Sometimes, the sporting world manages to adapt, but the capacity to evolve and modify practices varies considerably, to the point of reinforcing inequalities in resources among competitors.

Thus, it appears that the entire chain of measures is called into question, from prevention to sanctions and the problematic adjustments that the system generates. What can be made of this analysis of the consequences?

Three types of positions can be identified. A normative stance, that is, one that contributes, more or less consciously and explicitly, to defending the validity of the fight against doping and the legitimacy of institutional approaches. A second position is based on criticism without proposing any real alternative. It is therefore regrettable that these texts do not describe the mediations of the suggested changes: how, for example, could an institution other than WADA be created when it is legitimized by a UN Convention? What political work and what process would be necessary for the authorities to abandon the principle of strict liability and for institutions to agree to promote a harm reduction policy when their watchword is to "eliminate doping"?[28] A final position is generally more prescriptive. Sometimes, these are not really "recommendations" but rather observations on the policies pursued. Work that highlights the sometimes problematic effects of these measures could therefore encourage regulatory bodies to modify or adapt them.

The question of the social utility of these critiques then arises. Normative texts undoubtedly serve anti-doping institutions, which find in these publications a means of reinforcing the normative system on which they are based. But is it appropriate to use academic literature, which generally attempts to maintain a form of axiological neutrality, to disseminate this "social order"? Critical and non-prescriptive contributions enrich knowledge in the social sciences and give a voice to actors who might otherwise remain unheard. Yet is the scientific arena not too confined to sustain critique and to nourish political work within the public sphere? Articles that, more or less directly, analyze anti-doping policies and their consequences potentially constitute a valuable resource for those responsible for regulating doping. But shouldn't we then facilitate dialogue between researchers and those involved in the fight against doping?

A truly ethical spirit of sport

The ethical dimension is a constant reference point for the fight against doping as developed by WADA. This strong reference, however, conceals considerable difficulties, both in terms of its definition and its application. It is based, particularly in the World Anti-Doping Code, on a notion of spirit of sport that is both difficult to define and considered a cardinal value. It is also based on a number of strong values, but these are enumerated in a heterogeneous list. Finally, these difficulties are also linked both to the nature of the ethical discourse itself and to its deployment in the context of competitive and high-level sport.

[28] https://www.unesco.org/en/sport-and-anti-doping/fund

Ethical discourse

Ethical discourse is fundamentally evaluative in nature and normative in scope, meaning that it aims to transform the actions of those who claim it. Ethical discourse constitutes a path parallel to two other forms of normative discourse, to which it cannot be reduced: professional ethics and legal discourse. The former concerns the rules and values that a profession or corporate body sets for itself, while the latter refers to the various branches of law, for example civil, penal, or criminal law. While an ethical wrongdoing may give rise to professional or legal sanctions (e.g., criminal or penal), its significance belongs to a different order of considerations: the correctness of the action in relation to criteria such as what is good, right, and just. These are assessed firstly on an individual and subjective manner, and then in relation to more collective and quasi-objective criteria. Whereas morality, for a human community, concerns the cultural codes and rules of conduct inherited from tradition or religion, ethics—strictly speaking—concerns a free and responsible human subject, that is, one capable of subjecting both the injunctions received from external sources and his or her own standards of judgment and action to the critical scrutiny. Morality, being collective, is based on the general (non-subjective) character of traditions and religious dogmas; ethics, as defined here, is based on the reflective choice of criteria (such as values) articulated in rational discourses aimed at demonstrating philosophical doctrines.

The aim of ethics, for a human being, is to strive to live in a dignified and just manner. In the details of its operation, ethical evaluation may take three different forms of reasoning, or may combine these three forms. These are: deontic or deontological reasoning (appealing to a sense of duty and to the rights of individual conscience), utilitarian reasoning (based on a calculation of the costs of an action and its benefits for existence), and finally, aretaic (also known as perfectionist) or axiological reasoning, that is, a form of evaluation grounded either in the pursuit of personal excellence or in reference to values regarded as superior.

High-level and competitive sport and doping

The conditions under which high-level and competitive sport are practiced are dominated by the systematic pursuit of performance: in the training of bodies and minds, in the material resources used, and in the way competitions are run. The logic of performance finds a natural framework for expression in the paradigm of innovation, which, at the global level, organizes the efforts of science and technology. In the contemporary context of high-level and competitive sport, doping appears more of a collective enterprise than a strictly individual one. The person who dopes is only the last link in a chain of complex interactions, within which various private interests (commercial and media) and public interests (national) are at play. Another difficulty that arises in this context is the tendency to adopt an approach to athletes' health based on a naturalistic or essentialist conception, whereas the pursuit of performance (the principle of competitive and high-level sport) leads to the athletes' bodies being viewed as something that is shaped, constructed, or even—although this idea may seem shocking—as a testing ground for experimentation. In any case, the entire chain of actors involved in this conception of sport contributes to such a representation.

The reality of the ethical approach to anti-doping

The demand for ethical behavior is directed by anti-doping authorities primarily at athletes, and secondarily at those in their close professional environment: coaches, agents, equipment manufacturers. Yet, given the two dimensions just described (performance and innovation), the ethical evaluation by athletes of their sporting practice, while possible in principle, proves in reality to be very difficult, if not impossible: its effects are severely limited by the imperative for performance and, more generally, by the competitive atmosphere in a context of

innovation. This gap between the strong assertions of the global governing body and their limited real-world effects leads to disappointment, as it creates the impression that the values asserted are difficult to apply. For some authors, athletes convicted of doping are subjected, in the name of ethical values that are explicitly and forcefully deployed by anti-doping actors, to media and public treatment that amounts to a form of social "lynching". Ethical arguments transform those who have been judged and punished by sporting sanctions into veritable scapegoats for a scourge which, although it manifests itself through the individual conduct of those who dope, is above all collective.

Despite the two previous dimensions (performance and innovation), certain behaviors in which ethical arguments can be found do exist in the world of sport, and manifest themselves in three ways:

- Alongside genuinely ethical utilitarianism, there exists a superficial, economically driven utilitarianism that is, therefore, unethical or even deeply contrary to the spirit of ethics. This concerns the typical approach of athletes (and their professional environment) in their pursuit of performance, as they seek to maximize the latter within the conditions of their sporting activity. This unethical utilitarianism does not discourage doping; on the contrary, it constitutes one of the recurring ways in which doping is justified by actors in the world of high-level and competitive sports;
- It happens that some athletes, across all disciplines, denounce the logic of doping in the name of freedom of conscience. Similar to whistleblowers in other fields, these individuals demonstrate deontic or deontological ethics. They tend to exclude themselves, and above all to be excluded, from their community of practice and from the world of high-level and competitive sport;
- Finally, the values of sport and the human excellence that its practice is said to foster are regularly evoked by athletes and their media hagiographers, but also—though for different reasons—by equipment manufacturers and other companies, as well as by coaches. An aretaic-axiological discourse therefore persists, and even has a certain effectiveness in terms of attractiveness.

Ethical value of the notion of the spirit of sport

The notion of the spirit of sport invoked by WADA is not only difficult to define, but also has a certain ethical value in and of itself, which could be exploited to develop a more effective discourse in the fight against doping. The task, then, is to examine more closely what it is about the spirit of sport that can promote the moral development of those who practice it. Indeed, by structuring the activities of athletes, it can be understood as a means of encouraging the virtuous development of talent. Interpreted in this way, sporting excellence contributes to human excellence in general. It follows that the value of the spirit of sport as a foundation for the fight against doping necessarily requires placing the notion of autonomy of judgment at the forefront, as well as the will to find ways of rebuilding the ethical discourse on anti-doping around this notion. It is necessary to counter the tendency toward paternalism and a surveillance mentality that sometimes dominates the anti-doping ethos. Doing so would help avoid both the stigmatization and victimization of athletes who dope or are accused of doping. This can be achieved by prioritizing new ways to promote athlete autonomy, such as extending responsibility for doping to the entire chain of actors involved in competitive and high-level sport, questioning the industrialist logics that governs the latter, explaining the dilemma that exists in sport between surpassing oneself and human enhancement, and creating moral communities based on the athletes' accounts (repentant dopers and others) of their own experiences.

Recommendations

An analysis of the literature, nourished by the collective reflection of the expert group, led to a number of recommendations. The first, termed "structural" recommendations, are intended to propose an organizational framework and key principles to facilitate the implementation of the accompanying recommendations for action and research.

Structural recommendations

In France, the fight against doping mobilizes actors with different statuses, competencies, and objectives: the Ministry of Sports and the Regional Academic Delegations for Youth, Engagement and Sports (DRAJES), the French Anti-Doping Agency (AFLD), the French National Olympic and Sports Committee (CNOSF), national sports federations, and the Doping Prevention Medical Units (AMPD). Other actors, outside the sports sphere, are also considered legitimate participants in the fight against doping: the Ministry of Justice, the Ministry of the Interior, Oclaesp,[29] the Ministry of Health, health agencies (ANSM, Anses),[30] and the Ministries of National Education, and of Higher Education and Research. The multiplicity of actors raises issues around the coordination of public action and the conditions for participation of these different actors.

At the international level, anti-doping policy is led by the World Anti-Doping Agency (WADA), which is responsible for developing, harmonizing, and coordinating anti-doping rules and policies for all athletes participating in competitions, in all sports and in all countries. The International Convention against Doping in Sport (UNESCO Convention) provides the legal framework enabling signatory states to comply with the provisions of the WADA World Anti-Doping Code. This commitment requires each State to address the issue of transposing the Code into domestic law and of developing a national anti-doping policy that is consistent and compatible with its institutions and laws. In France, the AFLD, an independent public authority, and the Ministry of Sports are responsible for implementing the anti-doping rules imposed by international bodies; however, the French State has the possibility of supplementing this framework and of articulating it with national policies in areas such as health, education, the fight against drugs, etc. This is fundamental, particularly with regard to the health-related issues facing athletes who participate in lower-level competitions and non-competitive athletes who are not (or only minimally) covered by the current anti-doping system, which focuses primarily on high-level or professional competitive athletes.

In France, political responses have taken the form of national plans aimed at distributing responsibilities among the various actors involved in the fight against doping, but institutional reports are critical of their implementation. In 2015, a report by the Court of Auditors noted a lack of coordination between the various actors and called for "improved interministerial coordination in the prevention of doping by setting joint objectives between the ministries concerned". The third pillar of the "National Plan for the Prevention of Doping and Doping Behavior in Physical and Sports Activities 2020-2024", laid out by the Ministry of Sports,

[29] Central Office for the Fight against Environmental and Public Health Violations.

[30] National Agency for Medicines and Health Products Safety (ANSM), under the supervision of the Ministry of Health, and the National Agency for Food, Environmental and Occupational Health and Safety (Anses), under the supervision of the Ministries of Health, the Environment, Agriculture, and Labor.

likewise noted insufficient coordination among those actors involved in prevention and aimed to strengthen it.

In 2021, a letter by the Court of Auditors, followed by the Prime Minister's response,[31] asked the AFLD to refocus its anti-doping testing and education mission on high-level athletes.

Thus, as a complement to the missions of the AFLD, whose scope of action is determined by WADA, there is a need to improve the coordination of the missions of all other actors, in order to ensure that all athletes are taken into account, particularly with regard to health issues (prevention of risks and harms, etc.).

Consequently, **the expert group recommends**:

- Entrusting the steering of national anti-doping and prevention policy to an interministerial mission coordinating all actions by the relevant ministries (ministries responsible for sports, health, national education, higher education and research, justice, the interior, etc.) and working in cooperation with the AFLD.

  The group of experts, like the Court of Auditors, considers the interministerial dimension to be a fundamental element that should enable effective coordination between the different actors and ensure the various sporting, health, educational, and societal issues are taken into consideration.

The evaluation of anti-doping policy or of plans for the prevention of doping and doping practices comes up against the difficulty of constructing reliable indicators. Analysis of the literature highlights the limited relevance of attempting to determine a single parameter that captures all aspects of doping. Most of the published data come from heterogeneous sources, including anti-doping controls, surveys, biological passports, etc. Finally, the international literature reports very little French data, most of which is outdated. The expert group stresses that it is crucial not to confuse the prevalence of doping with the frequency of violations of the World Anti-Doping Code reported by anti-doping organizations, and to take into account the heterogeneity of the populations concerned (categories of athletes, competitors or non-competitors, types of sport).

The expert group recommends:

- Not focusing on a single estimate of the prevalence of doping, as this cannot be summarized by a single approach and a single value;
- Using several "indicators" that differ according to the measurement methods used, the population, the period studied, or the substances considered (whether within the scope defined by WADA or not).

Data from the scientific literature show that doping can involve very heterogeneous populations of athletes that differ in terms of their sporting practice: age, nationality, discipline, and level of practice, ranging from recreational sport to high-level competition. The sociological literature highlights the problems arising from the transposition of the anti-doping rules of the World Anti-Doping Code to amateur sport. Indeed, anti-doping rules are primarily aimed at ensuring fairness in sporting events for high-level athletes, whereas for amateur athletes, the fight against doping should instead be aimed at protecting health, which may require attention to substances not included in the WADA Prohibited List.

- **The expert group wishes to emphasize** the need to avoid transposing anti-doping measures and prevention strategies developed for high-level athletes to amateur athletes without engaging in reflection with the various actors, and to rely on evaluated

[31] https://www.ccomptes.fr/sites/default/files/2021-06/20210616-refere-S2021-0723-lutte-contre-dopage-JO-paralympiques-France-2024-rep-PM.pdf [Document in french]

data to design doping prevention policies and actions. For example, as is already the case in other countries, reflection on public policies should be conducted to a greater extent in collaboration with professionals in the gym industry and the commercial sports sector.

Recommendations for action

Measuring and monitoring of doping substance use and doping practices

Generate data to estimate the scale of the phenomenon in the general population

Data on the prevalence of this phenomenon in the French general population, based on self-administered questionnaires are scarce. No epidemiological survey, such as the various editions of the Health Barometer conducted by *Santé publique France*, has clearly addressed this issue, even though questions on physical and sporting activity were introduced as early as the 2000s. Among young people, the first edition of the ESCAPAD[32] survey in 2000, conducted by the OFDT,[33] included a question relating to doping. Subsequently, only the 2016 edition of the ESPAD[34] survey introduced specific questions on doping.

The expert group recommends:

- Promoting surveillance by conducting ongoing, biennial surveys in the general population to monitor the use of substances that are on the WADA Prohibited List (e.g., anabolic steroids) as well as of substances of interest not prohibited under the World Anti-Doping Code (dietary supplements, antalgics/analgesics and anti-inflammatory drugs, etc.). These should preferably be integrated into an existing instrument, such as the Health Barometer, in which case it would be interesting to oversample young adults between the ages of 18 and 24;
- Prioritizing studies on high school and middle school students, for whom there exists long-standing, robust, and recognized surveys (EnCLASS,[35] which merges the HBSC[36] and ESPAD surveys), as adolescence is a period particularly conducive to substance experimentation in a context of profound physiological and psychological changes and intense socialization. Particular attention must be paid to young people (between 11 and 20 years) involved in competitive sports, both within and outside the school setting;
- Complementing school-based surveys with studies conducted among athletes in the various sports federations. Indeed, the sampling methods used in school-based surveys result in the selection of a few thousand students, with an extremely low probability of selecting competitive athletes. Mobilizing the different sports federations or training centers (Creps,[37] Insep,[38] etc.) would make it possible to target a population difficult to reach through school surveys, particularly those between the ages of 18 and 24.

[32] Survey on Health and Drug Use on National Defence and Citizenship Day.

[33] French Monitoring Center for Drugs and Drug Addiction.

[34] European School Survey Project on Alcohol and Other Drugs.

[35] National Adolescent Health and Substance Use Survey in Middle and High Schools.

[36] Health Behaviour in School-aged Children.

[37] Centre for Sports Resources, Expertise and Performance.

[38] National Institute of Sport, Expertise, and Performance.

Implement innovative methodologies

Several studies have shown the usefulness of measuring the levels of various agents (drugs, medications, infectious agents, etc.) in wastewater samples collected in a given limited geographical area, in order to indirectly quantify exposure to the agent in question at the population level. This approach, known as "wastewater epidemiology", can be used, for example, to study trends in the use of specific substances over time and in different locations, including sporting events. Offering the advantage of protecting the anonymity of exposed subjects, it can provide indirect epidemiological insight on sports doping and enable the phenomenon to be tracked over time with the objective of health monitoring.

The expert group recommends:

- Implementing, on an experimental basis, a study based on wastewater epidemiology addressing the phenomenon of sports doping, following the model of the Obépine network.[39] This could be carried out in gyms or at the sites of major sporting events in France, particularly those aimed at amateur athletes (marathons, grand raids, etc.).

Improve the organization of data collection and health surveillance

Responsibility for monitoring the health consequences of doping substance use is fragmented among various French health authorities and agencies. The ANSM, which is responsible for the safety of health products, coordinates health vigilance activities: pharmacovigilance, with a particular focus on medicines that could be misused for doping purposes (anabolic steroids, erythropoietin, opioid analgesics, anti-inflammatories, etc.), but also addictovigilance, which broadens the scope of surveillance to addictive substances (medicinal and non-medicinal, with the exception of alcohol and tobacco); Anses oversees the national nutrivigilance system for dietary supplements, as well as the toxicovigilance system (coordinating the activities of poison control centers), that aims to detect adverse effects related to exposure to natural or synthetic products available on the market or present in the environment, and that fall outside the scope of other national vigilance systems; MILDECA[40] spearheads and coordinates government action in the fight against drugs and addictive behaviors, etc. There is a need for coordination between these different entities with regard to the health consequences of doping. In fact, no recent French data on the adverse effects of anabolic steroids were identified, even though these products fall into the category of drugs diverted from their intended use, are substances with addictive potential, and may also contaminate dietary supplements.

The expert group recommends:

- Establishing coordination between the various health authorities involved (Anses, ANSM, etc.) to improve or expand health surveillance related to doping substances;
- Alerting these health surveillance agencies to the need to collect incidents and cases related to doping and asking them to create a doping "checkbox" on forms to improve data collection, reporting, and use.

[39] Obépine (Epidemiological Observatory in Wastewater) is a French epidemiological observatory created as part of an integrated plan to combat coronavirus disease 2019 (COVID-19) to promote the use of wastewater as a quantitative indicator of the different phases of an epidemic caused by a bacterium or virus.

[40] Interministerial Mission for Combating Drugs and Addictive Behaviors, under the authority of the Prime Minister.

The reporting of this information relies on spontaneous notification by health professionals and patients. In the case of the health consequences of doping, under-reporting appears to be widespread, given the lack of available data.

The expert group recommends:

- Raising awareness specifically among health professionals (pharmacists, physical therapists, general practitioners, sports physicians, psychiatrists, cardiologists, hepatologists, etc.), and in particular those bound by the Sports Code, of the importance of reporting cases of pathologies suspected to be linked to the use of doping substances or of dietary supplements of questionable safety to the French health surveillance network;
- Facilitating reporting by adding a specific notice on the government portal for reporting adverse health events.[41] This approach requires promoting this reporting option;
- Relying primarily on the addictovigilance network to set up operational surveillance, as the addictive risk of anabolic steroids is now a well-established health risk;
- Strengthening the education of health professionals (initial education—including the *Sanitary Service for Health* Students—and continuing education) on doping and doping practices, on the substances involved, and on their adverse effects, in order to facilitate reporting.

Distributing responsibilities for doping among all actors

Assigning greater responsibility to sports organizations and public authorities

Despite changes to the World Anti-Doping Code, strict liability means that the responsibility for doping lies with athletes. Yet, some authors describe the competitive environment as "dopogenic" because sports organizations, clubs, and federations can put athletes at risk by demanding performance without providing adequate support. Moreover, the issue of doping and its prevention is often presented as a priority, when in fact the resources allocated by sports organizations to prevention are often derisory. In fact, sports organizations do not necessarily take their social responsibilities seriously, and they should examine the vulnerability factors they can influence (working conditions, resources, support, overloaded competition schedules, dual career pathways, etc.).

Consequently, **the expert group recommends**:

- Placing greater emphasis on collective responsibility, beyond that of athletes alone. Doping in high-level and competitive sport appears to be more of a collective enterprise than an individual one. It is imperative to assign clearer responsibility for doping in sport to those who hold authority over athletes and control the production of performance;
- Requiring sports organizations, clubs, and federations provide conditions for the production of performance that encourage athletes to comply with anti-doping rules by improving the quality of mechanisms for providing information (information channels, content, targets, intermediaries, etc.) and athlete support, with particular attention to emerging federations;
- Requiring sports organizations to invest a minimum and meaningful portion of their budget in anti-doping, and that a significant portion of this budget be allocated to education and prevention;

[41] https://signalement.social-sante.gouv.fr/

- Encouraging public bodies that support sports organizations to affirm more clearly their requirements that these organizations commit to safeguarding athletes by offering them quality support. For example, by defending the idea that federations or leagues that are not signatories to the Code should not be allowed to organize events in France;
- Ensuring that each signatory State to the Council of Europe's Anti-Doping Convention (ETS No. 135) (1989) adopts internal rules allowing for the exclusion of organizations that tolerate or promote doping. Through concertation between European states, economic leverage can be exerted on organizers of competitions to limit access to the European market to those committed to the fight against doping (so as to exclude, for example, the *Enhanced Games* from the European territory).

Better regulation of access to doping substances

Studies suggest that the implementation of a restrictive measure targeting, for example, the dispensing of anabolic steroids by pharmacies is likely to limit doping practices. This is consistent with data available for other products, such as alcohol, showing that access restrictions limit the consumption of these products. However, the availability of doping products *via* the internet (online pharmacies, specialized websites, commercial platforms, social media) may limit the effectiveness of such restrictions.

The accessibility of the market for doping products on e-commerce platforms or social media, which also promote the contribution of products (e.g., stimulants, synthetic peptide hormones, etc.) to consumers' well-being, can only raise concerns about the potential public health effects of this form of trivialization of such products. It is striking that the regulatory requirements governing the market for these highly popular platforms are so limited.

The expert group recommends:

- At a minimum, maintaining the restrictions on access to potential doping substances available through the pharmaceutical distribution system (physical and online pharmacies);
- Calling on public authorities to take measures to regulate access to doping products on publicly accessible websites and to limit the legitimization and trivialization of these products through this form of distribution;
- Improving controls on the composition of dietary supplements (contamination by doping substances, product sources, etc.) by developing labels that go as far as testing product composition—and that are not solely declarative such as the Afnor standard (NF EN 17444)—in cooperation with sports organizations, and notably fitness clubs and the sports retail sector, which play a significant role in the distribution of these products;
- Conducting random testing campaigns on dietary supplements by independent bodies (e.g., Anses);
- Coordinating actions involving the Ministries of Justice and the Interior, as well as the Ministry of Health and customs authorities, to collect data on the market and share this information on a regular, ongoing basis at the national level;
- Conducting investigations into the growth of a parallel market to better understand the distribution channels.

Reinventing the dialogue on doping

Reconsidering the ethical dimension and avoiding moralizing approaches

The reference to ethics appears supported and constant in the fight against doping. However, due to the misuse of the notion of ethics, its effectiveness is limited given the context of competitive and high-level sport, that is favorable to performance at all costs. This raises a dilemma for the expert group regarding ethics in the fight against doping: either abandon it or redefine it. The proposals outlined below are aimed at nourishing the second alternative.

The World Anti-Doping Code emphasizes the importance of ethics in the fight against doping. However, the ethical dimension is possible only if the individuals concerned are in a position to exercise a genuine ethical capacity. This is referred to in the literature as "moral autonomy", meaning the ability of each individual to freely formulate value judgments about their own actions, independent of social constraints and pressures.

The discourse on doping, which sometimes resembles a moral crusade presenting doping as an inexcusable moral failing, does not facilitate the expression of critical views or even simple questioning about doping and, as a result, does not adequately prepare young athletes for the dilemmas associated with doping and the social pressures they may face. However, given that a part of doping is intentional, it is important that athletes and their entourage are able to discuss these issues, expressing both their commitments and their doubts.

The expert group recommends:

- Making a clear break with current practice to facilitate dialogue and discussion about doping, thereby enabling young athletes to develop their own reflection and a response to the dilemmas they face between performance enhancement, doping, and social pressures;
- Instituting mechanisms, in a systematic manner, that promote the exercise of autonomous judgment, the only relevant principle for validating a genuinely ethical approach to anti-doping. For example, by organizing meetings and discussions between athletes so they can speak openly, drawing inspiration for example from innovative prevention programs that use the notion of dilemmas;
- Avoiding that values appear difficult to apply by providing better ethics training to athletes, as well as their entourage and sports event organizers, and by highlighting examples of sporting success achieved in an ethical manner;
- Equipping the ethical dimension by making it collective and public through the creation of commissions of high-level and professional athletes, selected at random from their communities of practice.[42] These committees would be invited to: *i*) express their views on ethically sensitive issues relevant to the fight against doping; *ii*) ensure their members receive mandatory training by ethics specialists; and *iii*) regularly issue widely publicized public opinions. This would allow athletes to be explicitly recognized as stakeholders in a fight against doping that is based on ethics, thus enabling them to act as its authentic guarantors. The aim is to empower athletes by increasing their involvement in anti-doping policies and by establishing organizational practices that consider them as invested partners in an effective fight against doping.

[42] These commissions would be different in nature from the "*Comité national pour renforcer l'éthique et la vie démocratique dans le sport*" (National Committee for Strengthening Ethics and Democratic Life in Sport) which has a broader mission but is an initiative to be encouraged and improved with the integration of philosophers and ethicists.

Self-narratives (*stories*) are omnipresent in sport. In elite sport, these narrated stories unfold in packed stadiums and are broadcast simultaneously to huge television audiences. Because they feature controversial goals, dramatic comebacks, and clever instances of cheating, they can foster moral reflection.[43] These narratives, told by "fallen and reformed" stars, can thus be powerful drivers of change.

Consequently, **the expert group recommends**:

- Establishing a system for engaging "reformed" athletes, to introduce an ethical approach and enrich knowledge through the morally instructive example of those who have fallen into doping.

Considering the harm caused by doping in all its dimensions

The issue of the harmful effects of doping has often been addressed in a restrictive manner. Health is one of the key arguments in the fight against doping. However, epidemiological data is lacking and the available literature does not provide clear indications that doping threatens the health of professional and high-level athletes under the current regulations, which probably tends to limit the doses of doping substances. And while a principle of precaution must continue to prevail in this area, an excessive focus on the issue of health may lead to neglecting other potential harms. These include the consequences of doping for non-doped athletes or teams who are deprived of their sporting titles, and sometimes their income, or the negative effects of doping on the reputation of sports organizations and their competitions, with potential negative economic impacts on sponsorship or media rights. Yet, sports organizations mainly treat doping as an individual choice and a moral issue that does not directly concern them. For these reasons, **the expert group recommends**:

- Educating athlete support staff (coaches, physical trainers, etc.) on the diversity of harms associated with doping in professional and high-level sport, so that prevention and education efforts directed at athletes are not reduced solely to issues of morality or health;
- Educating sports managers and senior staff on the negative economic consequences of doping for the attractiveness of their sport. The challenge is to convince them that the fight against doping concerns them directly, that it represents an investment with multiple effects, and not merely a burden intended to protect the health of athletes;
- Ensuring that the education and information provided to athletes raises their awareness of: *i)* the diversity of harms caused to non-doped athletes: exclusion from employment in sport, deprivation of titles, downgrading in rankings, loss of income, damage to reputation, loss of confidence; and *(ii)* the harms experienced by doped athletes, in particular the devastating effects on their sporting career, reputation, and mental health.

Also informing athlete support staff and family on the risks of unintentional doping

The World Anti-Doping Code is complex, the identification of traces of substances and metabolites is more effective, the dietary supplement market is growing, and the risks of consuming adulterated supplements are significant. As a result, this increases the risks of unintentional doping, which is reported to account for between 10 and 40% of doping cases, depending on the study. There are therefore gaps in the information given to athletes; clarification and guidance are needed. While athletes are concerned by the information and education, it is primarily their support staff and family members who must be targeted.

[43] Passage adapted from: Sandvik MR. Sport, stories, and morality: a Rortyan approach to doping ethics. Journal of the Philosophy of Sport 2019; 46: 383-400.

Indeed, as "advisors" or "prescribers" of training, nutrition, or medical care, it is particularly important to educate coaching staff on these issues, which are too often neglected.

The expert group recommends:

- Systematically include the issue of the risks of unintentional doping in the education of managers, coaches, physicians, and physical and mental trainers, both in initial training and in continuing education;
- Asking support staff to systematically inform and educate high-level athletes and their families about the risks of unintentional doping.

Developing coordinated doping prevention efforts to protect the health of athletes

The following recommendations are intended to be articulated with those related to the structuring of entities responsible for prevention and the implementation of a risk and harm reduction (HR) approach.[44]

The scientific literature on doping prevention is dominated by academic studies conducted in high schools in the United States and Europe on populations of young athletes pursuing sporting programs. Very few studies have focused on amateur athletes, whether competitive or not, athletes who train in gyms, or those in older age groups.

In this collective expert report, only studies implementing a program that incorporates a prospective evaluation (experimental or quasi-experimental) were considered. The recommendations are based on this literature, and reports or studies based on the WADA International Standard for Education were not included, as none, to our knowledge, has undergone prospective evaluation, making it impossible to estimate their effects.

The results of ecological experiments suggest that coercion, through the implementation of control and sanction measures, limits doping practices. However, such measures can lead to adverse secondary effects, since only some of those who violate the rule are detected and sanctioned, and non-doped athletes must endure the constraints and psychological consequences of testing. The acceptability of control and sanction measures depends on their positive effects, such as promoting doping-free sport, provided that these effects are real and communicated to the public, which is not the case with doping prevention in general.

The expert group therefore recommends:

- Maintaining control and sanction measures primarily for high-level athletes or young people pursuing a career in sport;
- Better supporting these athletes to limit negative psychological effects (feelings of threat, anxiety) and improve adherence by communicating more positively on control and sanction measures in a non-moralizing manner by promoting doping-free sport.

Studies targeting young athletes suggest that "educational" approaches are more effective than purely "informative" approaches in raising awareness of the health, social, ethical, and moral risks of doping, strengthening their ability to refuse substances (doping or otherwise), and promoting healthy behaviors. The recent development of interventions based on empathy and moral norms seems to be a promising avenue for creating "value conflicts" among young athletes who will face doping dilemmas at different points in their careers. Few of these have used process evaluations to measure their acceptability, the actual level of engagement, and

[44] Harm Reduction (HR) consists of recognizing the reality of doping substance use, despite their prohibition and toxicity, and offering users information and services to limit their harmful consequences. This approach aims to preserve their health and, *ultimately*, to promote abstinence.

the degree to which the interventions are adopted by the actors involved (athletes, teachers, parents, coaches).

The expert group recommends:

- Developing one or more sustainable and repeated anti-doping education programs, adapted to the French context and primarily aimed at youth in sport development pathways in relevant settings (schools, sports centers, Creps, etc.), and that include an outcome evaluation (*did the intervention achieve the intended effects?*) complemented by a process evaluation (*did the intervention proceed as planned?)*;
- Incorporating knowledge from the literature on the psychosocial determinants of doping when developing programs that can be implemented in the field: individual psychological, situational, and socio-contextual factors, and situations and periods that are particularly critical in the emergence of doping;
- Bringing together doping prevention and health promotion in anti-doping education programs. These programs should offer multidimensional content that takes into account both risk factors and protective factors to help athletes develop psychosocial skills for coping with situations of vulnerability they may encounter during their careers.

Prevention is often founded on values-based education, the long-term effect of which is highly uncertain, and it primarily targets athletes. However, the history of doping shows time and again the decisive role played by their support staff and entourage, who must also be a priority target. Their role, primarily that of coaches or parents, is a determinant of attitudes and intentions towards doping (and even behaviors) and is fundamental in anti-doping education and interventions. This impact can be facilitative or preventive in nature.

The expert group recommends:

- Involving and integrating the athlete's support staff and entourage (technical and medical staff, parents, peers, etc.) in the implementation of these programs;
- Educating and developing the skills of these actors so they can identify situations of vulnerability, accompany and support athletes facing such situations.

Despite the growth of research on doping over the last three decades, prevention programs remain focused on young athlete populations, and data is lacking on how to reduce the use of doping substances outside of professional or high-level sports. The problems of substance use outside of school and in sports environments among adult populations (amateur sports, gyms) should be addressed through intervention studies tailored to these target populations.

The expert group recommends:

- Raising awareness among all adolescents/young adults about the risks of doping by incorporating this topic into existing substance use prevention programs (alcohol, drugs, etc.) in schools (high schools, vocational training centers, etc.);
- Training educational staff and those responsible for prevention in schools (health services, school doctors and nurses, associations, etc.) on the specificities of doping, and prospectively evaluate the effect of the actions taken on the use of doping substances in addition to other targeted substances.
- Developing and evaluating prevention efforts outside the education system, particularly in gyms (weight training, wellness centers, fitness clubs, etc.), which are very likely to account for most of the doping-related public health issues among.

Improving the care of athletes who use doping substances by combining support mechanisms with a harm reduction approach

The use of doping substances, particularly anabolic steroids, is a health problem, especially among amateur athletes. Indeed, the studies attest to the use of anabolic steroids among gym users, often at high doses and in combination with other image and performance enhancing drugs, and without any medical supervision. Doping substances have pleiotropic effects that can sometimes be irreversible. It should also be noted that certain risks are increased in women, particularly those who use anabolic steroids. Finally, the reluctance to seek care among those who use or have used doping substances clearly contributes to the amplification of health risks.

The expert group recommends:

- Strengthening specific healthcare support for this population of doping substance users; inform them about the health risks they face;
- Developing comprehensive, multidisciplinary care that can integrate somatic, psychological, psychiatric, and/or addiction-related approaches;
- Training health professionals, particularly those in contact with athletes, to provide non-judgmental care and to understand the harmful effects of doping, in order to improve their competencies and the relationship of trust between caregivers and athletes who use doping substances;
- Developing guidelines for the management of steroid use—during active use, steroid cycles, and withdrawal—in order to limit adverse effects and the risk of relapse.

Individual approaches to doping prevention are virtually absent from studies on the subject. A harm reduction approach is rarely considered for doping prevention in France, revealing that this issue is perceived and discussed as distinct from other forms of substance use. There is also a lack of medical and psychological care for the consequences of doping (targeted prevention), due to a lack of both systematic studies on the subject and guidelines. Several avenues, inspired by the field of addiction, could help to improve our understanding of the phenomenon and protect the health of amateur athletes (e.g., gym users) who dope.

The expert group recommends:

- Experimenting and evaluating a new HR mechanism targeting primarily amateur athletes. This service would aim to answer questions about doping substances and direct athletes to appropriate care services; it could refer users to the network of professionals providing these services for drug use through the online platform *drogues-info-service*[45] (listening support, advice, referral, discussions/forum), by training these professionals in the specificities of doping substances and doping in sport.
- Using this new service to collect data (substance use, health effects) on amateur athletes, who are not subject to anti-doping controls, through access to low-threshold care (without abstinence requirements);
- Providing a safe and empathetic care environment, using existing territorial resources and benefiting from the multidisciplinary expertise of health professionals involved in the treatment of substance misuse, such as sports physicians and addiction specialists;
- Ensure the overall steering of AMPDs by placing them under a single authority, which could be the Ministry of Health or, if the first structural recommendation is adopted, an

[45] Drogues info service is a service that reports to *Santé publique France*, a public administrative institution under the supervision of the Ministry of Health.

interministerial mission, and by providing them with sufficient resources to fulfill their mission to safeguard the health of all athletes. In this way, they could fully position themselves as structures providing guidance and support for the implementation of doping prevention measures.

Support measures for high-level athletes sanctioned for doping are very rare, and this is also the case for athletes or other sports figures who may report cases of doping. Indeed, exclusion from sport and the stigma associated with a doping sanction can be very difficult to endure, especially in cases of unintentional doping. Moreover, by reporting a case of doping, these individuals enter into conflicts of legitimacy and face tension between their closeness to an athlete or team and their desire to report breaches of integrity. Even if anti-doping or sports organization officials have other priorities, it is because of their social responsibilities—and from a harm reduction perspective—that appropriate support mechanisms need to be implemented.

The expert group recommends:

- Systematically ensuring regular follow-up of athletes sanctioned for doping, coordinated by a multidisciplinary support structure, including a medical assessment and, in particular, psychological care;
- Better protecting those who report doping cases by creating conditions favorable for speaking out, and that target all those involved in sport, not just athletes.

Revitalizing public policies on anti-doping

One of the criticisms levelled at the fight against doping in the international literature is that it leads athletes to act clandestinely, increasing the risks because it remains intrinsically linked to a moral approach; the WADA International Standard for Education is grounded in a "values-based" approach to education. Proposing a harm reduction approach in this context, where the anti-doping system is harmonized globally, is therefore extremely difficult. However, there remain possibilities for action, particularly in the area of prevention and also in the development and evolution of anti-doping regulations.

The expert group recommends:

- Creating a prevention policy to complement the International Standard for Education imposed by WADA for competitive athletes and extend it to all other athletes. It is important to integrate the diverse forms of harm (physical, mental, and social), and particularly health, at the heart of prevention;
- Involving athletes in France in the deliberative process of anti-doping rulemaking, and finding ways to broaden consultation to include, at a minimum, the sporting community when considering future regulatory developments. This could take the form of a participatory democracy approach, incorporating an "action research" methodology combining legal awareness and education that questions the construction and legitimacy of the rules. Issues such as consent, out-of-competition testing, the use of data, etc. could be addressed;
- Conveying the need for debate at the international level. France must equip itself with the means to exert greater influence in international bodies to shape the direction and evolution of anti-doping policies.

Part of the literature reporting the failures of the fight against doping proposes deregulating doping or reducing risks through a less orthodox view of doping and medically supervised use of certain substances. Although stimulating, these proposals should be treated with caution. Deregulation, even partial, would likely shift the problems rather than resolve them.

The development of a model inspired by private leagues makes the fight against doping very difficult due to the lack of harmonization of rules. Deregulation creates significant inequalities between athletes depending on their country of residence and makes the fight against doping very difficult, as sanctions do not prevent athletes from participating in competitions in a rival league or in other countries.

- **The expert group considers that** deregulating sport according to a liberal model would weaken the fight against doping, for example, as proposed by the organizers of the Enhanced Games. However, **the expert group recommends** undertaking work aimed at improving clarity and transparency in the fight against doping, for example, by reflecting on the complexity of the Code and the uncertainty created by a list of prohibited substances that continues to expand over time. This amounts, therefore, to creating new conditions for sincerity in the positions taken and truthfulness throughout the system.

Research recommendations

General recommendations

Due to its dominant position in the anti-doping ecosystem, WADA exerts a significant influence on the direction and funding of research in this field. This raises questions about the degree of autonomy of this area of research. The impact of WADA's influential position has not been scientifically evaluated. Moreover, the bibliography compiled for this collective expert review reveals an "unbalanced" body of literature, with some areas insufficiently explored (doping among amateur athletes, in gyms, doping among women, parasports, e-sports) and others overrepresented (doping detection methods).

The expert group recommends:

- Promoting a diversity of approaches by encouraging researchers from outside the field to contribute to doping and anti-doping research;
- Encouraging bodies other than WADA to fund research on doping and its prevention.

Research on anti-doping policies: historical lessons and future perspectives

Certain academic disciplines are underrepresented in doping research. Although many authors refer to "policies," political science is ultimately among them. Moreover, in France, research on the history of doping and anti-doping is almost non-existent. Yet, much could be learned from these approaches, for example, by examining debates over the status of a historical text or law and that place anti-doping measures in the context of events more or less directly related to politics.

To examine doping from different angles, gain critical distance, and address this gap in "institutional memory", **the expert group recommends**:

- Developing research on the history and policies of doping and anti-doping;
- Facilitating access to archives and resources for academic purposes.

There is a lack of knowledge about the local realities of anti-doping, which vary by sport, culture, and region (e.g., interregional collaborations in France). This can potentially create substantial gaps between anti-doping policy prescriptions and their actual implementation.

The expert group recommends:

- Systematically expanding comparative research on the realities of anti-doping.

There is a need to better understand how the sports community judges doping, as well as the anti-doping measures in place (e.g., place of athletic support staff, appropriation of measures, relationship with the law).

The expert group recommends:

- Developing research on judgements of doping and anti-doping regulations.

In the field of doping, there is a disconnect between the academic world, caught up in scientific activity, and anti-doping actors who are caught up in the contingencies of their work. However, the latter are paying special attention to what has happened in the past (keeping in mind what has been tried and, above all, the flaws revealed by past affairs); they are also attentive to what future opportunities have to offer, questioning the credibility of alerts and promises; finally, possessing political awareness—and like all those whose actions are subject to repeated interpretation—these actors are attentive to what is happening in the present, while working themselves on the modalities of transformation. How should we account for political debates as they unfold?

The expert group recommends:

- Creating a "space" to bring the two valences closer together. The idea is not to choose between antinomic interpretative systems, but rather of having the means to assess what each dispute changes within the environments in which individuals and groups operate.

Better understanding the scope of the phenomenon

Studies on the prevalence of doping and doping practices are characterized by a very high degree of methodological heterogeneity (definitions, products, reporting periods, populations, sports disciplines, etc.), complicating the interpretation of results and any attempt at comparison. This has also been highlighted by the WADA research group on doping prevalence.

For studies aiming to estimate the prevalence of doping or to conduct a systematic review of available data, **the expert group recommends**:

- Standardizing the collection of prevalence data by systematically specifying the substances concerned, the frequency and period of use (year, month, week), the athlete population studied (sex, age, sporting discipline, and level of practice, etc.);
- Using the methodological reference framework proposed by the EQUATOR network,[46] which is dedicated to promoting quality and transparency in research, when carrying out epidemiological studies on the prevalence of different forms of doping. Given the heterogeneity of the data, it is important to also consider high-quality studies using alternative approaches to quantify the phenomenon;
- Broadening reflection on methods for collecting prevalence data that complement general population surveys. At present, there is insufficient data in the French context, but the next ESPAD survey of high school students will take place in late spring 2026, and the results will be published in 2027. All of this should guide future research: place and role of specific samples, introduction of the randomized response method,

[46] https://www.equator-network.org/

articulation of quantitative and qualitative approaches, and generalization of mixed methods. This could be considered, for example, for anabolic steroid doping in gyms.

As with doping substances, studies on the prevalence of dietary supplement use among athletes are characterized by considerable methodological heterogeneity—definitions, types of supplements, reporting periods, populations, sports disciplines—complicating any attempt at synchronic or diachronic comparisons. A non-negligible proportion of these studies is limited to simple descriptions, even though the multiplicity of risk factors (gender, age, participation in sport, disciplines practiced, training intensity) requires, at a minimum, an "all other things being equal" analysis. Furthermore, the latest systematic review of the international literature on the prevalence of dietary supplement use among athletes, published in 2014, highlighted the poor methodological quality of the studies included (1969-2014).

The expert group recommends:

- Conducting studies in the general population, based on standardized data collection and representative samples, to produce high-quality baseline data;
- Conducting a systematic review of the international literature on the prevalence of dietary supplement use among athletes, taking into account data since 2014 and following the recommendations of the EQUATOR network.

Deepening understanding of determinants to improve doping prevention

While it is important to better understand the psychological processes involved in doping behavior among athletes, it is equally important to identify and understand the protective factors that can prevent the phenomenon. Furthermore, although there is strong consensus in the scientific literature on the preventive role—as well as the deleterious and incentivizing impact—of the entourage on doping behavior, it presents certain methodological limitations: biases related to self-reported measurement of attitudes, intentions, and doping behavior; overrepresentation of cross-sectional studies to the detriment of longitudinal or interventional studies; a focus on coaches, which provides little insight into other individuals in the athlete's circle (parents, peers, health professionals).

The expert group recommends:

- Including, within the same studies, measures of both implicit and explicit attitudes, as the literature on the role of implicit processes in sport doping is still fairly recent but particularly promising;
- Conducting longitudinal and interventional studies that make it possible to document, in particular, the causal role of the entourage in athlete's doping behaviors;
- Including a variety of actors in the athletes' entourage (coaches and technical staff, parents, peers, health professionals) in studies on the role of the entourage;
- Testing the replicability of results across varied samples (age, levels of practice, sports disciplines);
- Developing social psychology studies to consider factors that have not been fully explored through the various self-reported measures most commonly used in the scientific literature—factors that could explain doping behaviors (in light of the percentages of variance observed in studies based on sociocognitive theories and integrative models).

To our knowledge, few prevention programs have addressed the issue of body image in relation to the use of doping substances, and in particular steroid use. The Goodform program showed no changes attributable to the intervention over time, but this type of approach should

be further developed and tested in order to adapt anti-doping efforts to the problems encountered among adult populations who frequent weight-training facilities.

The expert group recommends:

- Promoting research on prevention programs that help adolescents and young adults develop a positive body image.

Some of the studies on media exposure and the influence of social media on doping or doping practices are highly descriptive and rarely provide an explanatory framework. The finding of a correlation between doping and a whole range of media exposure (TV shows about muscularity, magazines about bodybuilding and beauty, etc.) does not provide an explanation. Rather, it is likely that both types of activities reflect a shared preference, whose origins would need to be examined through a more precise analysis of lifestyles.

The expert group recommends:

- Promoting research on media exposure and the influence of social media in doping and doping practices;
- Better understanding the role of social media on body image, doping, and doping practices.

Better understanding the health and social harms

The results of recent studies converge in showing the harmful health effects of certain doping substances, which can be serious and permanent in some cases. The specific organs and tissues affected, and the potential reversibility of these effects vary depending on the substance used, as well as the dose and duration of use. However, due to a lack of methodologically rigorous studies, there remain gaps in our understanding of certain pathologies.

The expert group recommends:

- Studying the repercussions of anabolic steroid use among female athletes, recreational athletes, and particularly adolescents, whether used alone or in combination with recreational drugs, taking into account the interaction with sports practice;
- Studying the side effects and ergogenic effects of SARMs,[47] hormones or hormone derivatives (e.g., GH, IGF-1, EPO, GC),[48] and the mechanisms underlying these effects, taking into account the interaction with sports practice.

The harmful effects of anabolic-androgenic steroids in athletes remain very unclear because they are rarely used in isolation and, above all, because of the lack of studies conducted on large athletic populations. Given the unquestionable ethical limits of conducting prospective longitudinal studies in humans, **the expert group recommends**:

- Conducting further epidemiological and preclinical studies to elucidate the overall effects of supraphysiological doses of androgens, particularly on hemostasis and thrombosis.

Additional high-quality research appears essential to better clarify the cardiovascular risks associated with doping and, given the demonstrated individual susceptibility, to be able to identify high-risk groups.

[47] Selective androgen receptor modulators.

[48] GH: Human growth hormone; IGF-1: *Insulin-like Growth* Factor-1; EPO: Erythropoietin; GC: Glucocorticoids.

The expert group recommends:

- Conducting repeated cross-sectional studies comparing the characteristics of clinical assessments and standard complementary tests examinations (ECG, echocardiogram, stress test) in a blinded design for healthcare professionals, involving both doped and non-doped volunteer athletes over sufficiently long periods of sport practice to determine the long-term risk of cardiovascular morbidity and mortality;
- Conducting longitudinal studies on users and non-users confirmed by detection tests to analyze morbidity and mortality over time in competitive athletes and identify predictors of long-term risk, taking into account the type of sporting discipline (particularly whether it includes weight training), the duration and the period of practice;
- Investigating and proposing methods to at least mitigate the harms caused by anabolic steroids, especially in bodybuilding.

All available clinical data show a clear association between the use of anabolic steroids and the occurrence of cardiovascular events. In addition, the occurrence of a serious, potentially fatal cardiovascular event is unpredictable and could be linked to individual susceptibility, even long after anabolic steroid use. To assess the potential impact of doping, and in particular of anabolic steroid use, **the expert group recommends**:

- Exploiting the results of an ongoing national study[49] that aims to assess the impact of anabolic steroid use in cases of sudden death in young athletes (<35 years old) and of suspected death related to anabolic steroid use, through systematic autopsy with a broad toxicological analysis and genetic testing focused on cardiovascular disease according to a standardized protocol;
- Establishing, if justified by the study's findings, a database of these results like that of the DRAMES (Deaths related to drug and illegal substance abuse) registry, to enable systematic evaluation of substances potentially involved in these deaths.

Evidence from various sources (case series, case reports, animal experiments) also converges to suggest a deleterious effect of anabolic steroids on renal function. However, at present, robust conclusions cannot be drawn due to the lack of methodologically rigorous studies.

The expert group recommends:

- Exploring this question through a cohort study with long-term follow-up or by integrating this research into an existing study.

It is important to note that the effects highlighted in this expert report are not limited to those affecting the physical or mental health of athletes who dope, but that there are also broader repercussions affecting their entourage and society.

The expert group recommends:

- Examining the social consequences and mental health impacts of doping sanctions, in cases involving French athletes, to identify measures to mitigate negative effects;
- Systematically examining the reception (perception, use, concerns, etc.) and consequences of anti-doping measures: their anxiety-inducing nature, delegation of the management of ADAMS,[50] use of athlete biological passport data for training purposes, but also the adaptation of sports organizations to the regulations;

[49] Results expected in 2027.

[50] The Anti-Doping Administration and Management System (ADAMS) is an online management tool that simplifies the day-to-day administration of anti-doping operations for partners and athletes. It brings together the following data: whereabouts

- Estimating the economic and social consequences of negative reputational impacts resulting from doping (e.g., study the reduced propensity of sponsors to invest in certain sports with tarnished reputations);
- Better understanding the perceptions of dietary supplements and medications by physicians and coaches and the challenges they face in relation to these substances;
- Identifying the factors and situations that put athletes at risk so that sports organizations can assume their social responsibilities and offer athletes conditions conducive to performance without doping;
- Better understanding the links between doping and different forms of abuse or mistreatment, particularly between the physical and psychological violence that athletes may suffer at the hands of coaches and parents.

Defining together what constitutes a truly ethical spirit of sport

Despite the difficulty of defining it, the notion of spirit of sport invoked by WADA has a certain ethical value that can be exploited to develop a more effective ethical discourse in the fight against doping: the spirit of sport can promote the moral development of athletes. By structuring the activities of athletes, it can be understood as a means of encouraging the virtuous development of talent and, when interpreted in this way, sporting excellence contributes to human excellence in general. The value of the spirit of sport as a foundation for the fight against doping therefore necessarily involves placing the notion of autonomy of judgement at the forefront, and a willingness to find ways of rebuilding the ethical discourse on anti-doping based on this concept.

The expert group recommends:

- Strengthening the ethical foundation of the fight against doping by deepening the work of defining the spirit of sport through collaboration between the humanities and social sciences (sociology, anthropology, social psychology, philosophy, law, history, and art history), as well as through the systematic contribution of retired or active high-level athletes;
- Conducting a multidisciplinary critique (life sciences and humanities and social sciences) of health and athletic form understood as natural; documenting the fact that, for a very long time, high-level and competitive sport, which is above all a social activity involving a variety of interests, has been a matter of various aids (medical and chemical, technological and organizational).
- Better defining and making explicit the "values" that define the ethics of sport, through more sustained dialogue between academic discourse on ethics and the accounts and testimonies of professional and amateur athletes; for example, loyalty, fairness, bodily autonomy, and the spiritual dimension of a healthy body.

information, Therapeutic Use Exemption (TUE) management, test planning and results management, and laboratory analytical results.

Annex 1: Inserm Collective Expert Reviews: principles and methods

The aim of Inserm Collective Expert Reviews[51] is to summarize scientific knowledge on topics in the health sector through a critical analysis of the international literature. They are conducted at the request of institutions (ministries, health agencies or insurance bodies, etc.) who want up-to-date research data relevant to their public policy decisions.

Since their inception in 1994, nearly 90 collective expert reviews have been conducted on numerous subjects. Inserm is responsible for the conditions under which the expert reviews are performed (selection of source documents, constitution of expert groups based on the qualifications and independence of its members, transparency of the process, etc.) in accordance with its Charter of Expertise, which sets out its ethical principles.[52]

The Collective Expert Reports Unit of Inserm, which is part of its Public Health Thematic Institute, manages the scientific and technical coordination of the expert reviews following a defined procedure consisting of six main stages.

Commission of the collective expert review

The first stage involves *i*) working with the commissioning body to ensure the request is clearly defined, *ii*) verifying that sufficient scientific literature exists on the topic in question, and *iii*) drawing up an agreement outlining the scope and principal topics of the expert review, as well as the project duration and budget. During this stage the commissioning body's request is translated into scientific questions that will be addressed by the experts.

Literature searching

A document base is assembled from articles identified through searches of international bibliographic databases, along with other documents identified from the gray literature (institutional reports, etc.) relevant to the scientific questions posed. This document base is provided to the experts, and updated during the expert review and is complemented by the experts according to their area of expertise.

Constitution of a multidisciplinary expert group

For each expert review, a group of 10 to 15 experts is formed whose composition is determined by the scientific fields required to analyze the literature and answer the questions asked, while also ensuring the complementarity of approaches and disciplines.

Experts are selected from across the French and international scientific community. The selection is based on scientific expertise as demonstrated by their publications in peer-reviewed journals and by peer recognition. The experts must be independent of the

[51] Brand name registered by Inserm.

[52] https://pro.inserm.fr/wp-content/uploads/2020/08/INSERM_DISC_CharteExpertise.pdf

commissioning body and of recognized lobbying groups. Prior to the start of the expert review, all the experts are required to complete and sign a declaration of interests that is kept on file by Inserm. The composition of the expert group is approved by the executive management of the Inserm Public Health Thematic Institute.

The experts' work lasts from 12 to 18 months depending on the amount of literature analyzed and the complexity of the topic.

Critical analysis of the literature by the experts

Over a series of expert group meetings, each member presents their critical analysis of the literature on a given topic, which is then discussed by the group. This analysis leads to the drafting of the various chapters of the expert report, that is constructed through collective discussion to ensure its coherence and articulation.

Individuals outside the group of experts may be invited to participate in these meetings to provide a complementary approach or viewpoint. Depending on the topic, meetings with civil society organizations may also be arranged by the Collective Expert Reports Unit in order to learn about their issues of concern and to identify other sources of data.

Summary and recommendations

A summary is produced that brings together the key points of the literature analysis and outlines the principal findings and overarching themes. Most collective expert reports include recommendations for action or research intended for decision-makers. These recommendations, formulated by the group of experts, are based on scientific arguments resulting from the analysis. The collective expert review procedure does not generally include an assessment of their feasibility and social acceptability. Such assessment may be subject to other types of expert review.

Publication of the collective expert report

After submission to the commissioning body, the collective expert report, consisting of the analysis, summary and recommendations, is published by Inserm. In agreement with the commissioning body, various communications strategies may be used, such as press releases, press conferences, or seminars open to various stakeholders including patient organizations, professionals, researchers, and institutions.

The expert reports are available from bookstores and can be accessed from the Inserm website.[53] The full collection is also available from iPubli,[54] which provides free access to Inserm publications.

[53] https://www.inserm.fr/information-en-sante/expertises-collectives

[54] http://www.ipubli.inserm.fr/handle/10608/1

Annex 2: Literature search strategy

Based on the specifications for the expert review and the corresponding scientific questions, a literature search was conducted to identify studies on doping in sports and to compile the document base provided to the experts for analysis. The corpus was updated through the end of December 2024. It consists of articles and documents published over the past 10 years (with the exception of certain older references), selected based on their relevance to answering the scientific questions. The corpus was enriched with literature identified by the experts according to their areas of expertise.

Main sources and bibliographic databases

The literature searches were carried out by querying various bibliographic databases: PubMed, Scopus, Web of Science, SocINDEX, HAL, LiSSa, PsycInfo, PsycArticles, ScienceDirect, and the EBSCO Psychology and Behavioral Sciences Collection. The gray literature sources consulted include the websites of sports bodies, institutions and agencies: WADA, AFLD, USADA, iNADO, FIFA, INSEP, CNOSF, UNESCO, Council of Europe, European Commission, MILDECA, OFDT, Court of Auditors, ARCOM. Searches were also conducted in specific journals including *Psychology of Sport and Exercise* and *Contemporary Drug Problems*, as well as on the Frontiers publisher portal. The database search covered the publication years 2015-2024.

Main keywords used in searches and size of the document base

The document base currently comprises more than 3,800 documents[55]. The literature search was conducted using a combination of search terms related to the general topic of the expert review (doping/substances and sports) and terms related to the various subtopics or disciplinary approaches explored (epidemiology, determinants of doping, etc.). Depending on the database used, the search strategy was conducted either using keywords from the MeSH thesaurus or using text terms (Title, Abstract, Topic). Sequences in quotation marks indicate a sequence of words searched for in full, and the * symbol indicates keywords used with truncation. Below are the keywords used according to the themes.

Themes of the expert review

Doping

Analgesic*, Antidoping*, Anti-doping*, Anti-inflammat*, Boosting, Doped, Doping*, Drug*, Ergogenic*, Medication*, Painkiller*, Substance*, Supplement*, Supplementation, "Blood doping", "Brain doping", "Cell doping", "Cognitive-enhanc*", "Diet supplement*", "Dietary intake*", "Dietary supplement*", "Doping in Sports", "Food supplement*", "Gene doping", "Nutritional supplement*", "Performance enhanc*", "Performance-enhancing agent*",

[55] The literature was monitored until the publication of the expert report to identify any articles in the corpus that may have been retracted since they were collected.

"Performance-enhancing drug*", "Performance-enhancing medication*", "Performance-enhancing product*", "Performance-enhancing substance*", "Performance-Enhancing Substances", "Performance-enhancing supplement*", "Supplement use*"

Substances

Acetazolamide, Adderall, AICAR, Albumin, Alcohol, Amfetami*, Amiloride, Amphetamin*, AMPK, Anabolic*, Androgen*, Androst*, Argon, Betamethasone, BMPEA, Budesonide, Buprenorphine, Bupropion, Caffeine, Cannabi*, Cardarine, Cathin*, Clomifene, Clostebol, Cobalt, Cocaine, Codeine, Cortico*, Cortisone, Cyclofenil, Danabol, Danazol, DBOL, Deflazacort, Desmopressin, Dexamethasone, Dextran, Dianabol, Dimethylbutylamine, Diuretic*, Endurobol, Enobosarm, Ephedrine*, Epinephrine, EPO, Erythropoietin*, Ethanol, Fentanyl, Fluticasone, Formoterol, Fulvestrant, Furosemide, Glucocorticoid*, Glucocorticosteroid*, Glycerol, GSK-516, GW151, GW1516, GW501516, Heptaminol, Higenamine, HMB, hydrocortisone, "hydroxyethyl starch", Ibutamoren, Insulin*, IUPAC, Ligandrol, Lipotropin, Mannitol, Masking, Meldonium, Methadone, Methandrostenolone, Methylephedrine, Methylpredniso*, Mildronate, Mitragynine, Modafinil, Molidustat, Morphine, Nandrolone, Narcotic*, Nicotine, Nootropic*, Opioid*, Ostarine, Oxandrolone, Oxycodone, PPAR*, Predniso*, Pseudoephedrine, Raloxifene, Salbutamol, Salmeterol, SARM*, "Selective estrogen receptor modulators", Snuff, Snus, Spironolactone, Stanozolol, Stenbolone, Steroid*, Stimulant*, Strychnine, Tamoxifen, Telmisartan, Terbutaline, Testosterone*, Thiazide, THP, Tobacc*, Tolvaptan, Toremifene, Tramadol, Trenbolone, Triamcinolone, Triamterene, Trimetazidine, Tulobuterol, Vaptans, Vilanterol, VK5211, Xenon, "5-aminoimidazole-4-carboxamide ribonucleotide", "1-amino-2-phenylpropane", "5-aminoimidazole-4-carboxamide ribonucleotide", "Anti-Obesity Drug-9604", "AOD-9604", "Beta-2 agonist*", "Beta-Adrenergic*", "Beta-block*", "Growth factor*", "Growth Hormone", "L-163,191", "LGD-4033", "LUM-201", "MET-88", "Mildronats", "MK-0677", "MK-2866", "MK-677", "Smart drug*", "β-hydroxy β-methylbutyrate", "β-Hydroxy β-methylbutyric acid", "β-Me-PEA", "β-Methylphenethylamine"

Sport

Amateur*, Athlet*, Base-Ball*, Baseball*, Basketball*, Basket-Ball*, Biathlet*, Bi-Athlet*, Bicycling*, Bicyclist*, Bodybuild*, Body-Build*, Boxer*, Boxing, Cycling, Cyclist*, Danc*, Diver, Divers, Diving, Elite*, Esport*, E-Sport*, Fitness, Football*, Foot-Ball*, Games, Golf*, Gym*, Judo*, Leagu*, Marathon*, Olympi*, Paralympi*, "Physical Activit*", "Recreational* athlet*", Rugby*, Tennis*, Runner*, Running*, Sailing, Ski, Skier*, Skiing, Soccer*, Sport*, Swim*, Tri-Athlet*, Triathlet*, Weightlift*, Weight-Lift*

Sub-themes of the expert review

Epidemiology

Epidemiolog*, Estima*, Frequenc*, Incidence, Occurrence, Prevalence, Rate, Statistic*, Trend, "Risk assessment", Cohort, FAIR, HAARLEM, HBSC

Ethics and philosophy

Bioethic*, Clean*, Ethic*, Integrity, Legal, Moral, Philosoph*, "Spirit of sport"

Determinants

Attitud*, Behav*, Behavio*, Beliefs, Causalit*, Cause, Determinant*, Gateway, Incentive*, Intention, Methodolog*, Model*, Motiv*, Motivation, Opinion, Perception, Practice, Predict*, Psycho*, "Psychopathy", Scale, Self-esteem, Self-expansion, Temptation, Test*, "Abnormal psychology", "Anticipated guilt", "Anticipated regret", "Applied psychology", "Athletes psychology", "Athletic performance", "Clinical psychology", "Cognitive psychology", "Comparative psychology", "Consulting psychology", "Depth psychology", "Developmental psychology", "Doping intentions", "Experimental Psychology", "Health knowledge", "Individual psychology", Machiavellianism, "Moral disengagement", "Moral identity", "Moral traits", Narcissism, Perfectionism, "Physiological psychology", "Positive psychology", "Psycho associat*", "Psycho* factor", "Psychology of men", "Psychology of women", "Psychosocial Factor*", "Self-determination", "Self-efficacy", "Self-psychology", "Self-regulatory", "Sensation seeking", "Social factor*", "Sport drug control model", "Sport psychology", "Sports psychology", "Strive for perfection", "The life cycle model", "Theory of planned behavior"

Harms

Abus*, Adverse, Consequenc*, Damage*, Death*, Disorder*, Effect*, Harm*, Hazard, Misus*, Mortalit*, Patholog*, Pathophysiological, Physiopatholog*, Psychopatholog*, Risk*, Toxic*, "Biological response*", "Case Report*", "Physio-patholog*", "Psycho-patholog*", "Risk assessment", "Side effects"

Complementary refined searches

Fertilit*, Hormon*, Hypogonad*, Reproduction, Semen*, Sperm*, Testosterone, Testicle*, Uterus, Acne, Cancer, Cardio*, Heart, Infection, Injection, Kidney, Liver, Rhabdomyolysis, Violence, "Atrial Fibrillation", "Sexual trauma", "Viral Infection"

Death, Longevit*, Morbidit*, Mortalit*, Survival, "Health consequence*", "Life expectancy", "Live longer"

Antisocial, Socio*, Social

Gene doping

Epigenetic*, Genetic, "Gene* doping", Genomics

Market

"Black market", Market, Traffic*

Prevention

Alternative, Athena, Avoid*, Combat, Educati*, Fight*, Intervention, Preventi*, Reduc*, Tackling, "Adolescents training and learning to avoid steroid", "Anabolic steroid education program", "Anti-doping education", "Anti-doping policies", "Athletes targeting healthy exercise and nutrition alternatives", "Clean sport", "Doping prevention", "Drug education", "Drug prevention", "Education policies", "Education program", "Education programmes", "Guiding policies", "Indicated prevention", "Intervention programme", "Prevention programmes", "Selective prevention", "Universal prevention"

Policies

Authority, Campaign, Control*, Effectiveness, Efficacy, Government*, Integrity, Sport doping, Law, Policy, Politic*, Preventive, Prohibition, Proposal, Proposition, Regulation, Regulatory, Repressi*, Strateg*

Harm reduction

"Harm minimization", "Harm reduction"