

# Evidence of use and users of image- and performance-enhancing drugs in sports in Switzerland: a scoping literature review and implications for Swiss drug policy

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## Summary

**BACKGROUND:** “Image- and performance-enhancing drugs” are widely used in sports worldwide to improve body image and performance goals. In view of the growing research interest and use of these substances, and the paucity of data on the situation in Switzerland, we conducted a scoping literature review on evidence of the use and users of these substances in Switzerland.

**METHODS:** A scoping review was conducted following the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) statement. We searched PubMed/Medline, Embase and Google Scholar for articles published before August 2022. Primary outcomes were evidence of the use and users of image- and performance enhancing drugs in Switzerland. We used a narrative synthesis approach for data analysis.

**RESULTS:** Overall, 18 studies were reviewed, which in total comprised 11,401 survey participants, 140 interviews and 1368 toxicologically analysed substances. Articles were mostly peer-reviewed (83%) and mostly included evidence from professional athletes (43%). The mean publication year was 2011. In most articles both outcomes (78%) were evaluated simultaneously. We demonstrate that image- and performance-enhancing drugs appear to be prevalent among athletes and non-athletes in Switzerland. A wide variety of substances exist, and the type of substances used varied by age, motivation, sex and sports discipline. The main motivations for using these substances were, among others, image- and performance enhancement. The main route of acquisition of these substances was the Internet. Furthermore, we demonstrated that substantial proportions of these substances, as well as supplements, may be counterfeit. Information on image- and performance-enhancing drug use was acquired from different sources.

**CONCLUSIONS:** Although evidence of image- and performance-enhancing drug use and its users in Switzerland is scarce and there are major gaps, we demonstrate that

these substances are also prevalent among athletes and non-athletes in Switzerland. Furthermore, high proportions of substances acquired from unregulated drug markets are counterfeit, which puts users in a situation of unpredictable risk when consuming them. Overall, the use of these substances may pose a substantial risk to individual and public health in this possibly growing and often insufficiently informed and medically neglected user community in Switzerland. There is a great need for future research, as well as prevention, harm-reduction and treatment programmes for this hard-to-reach user community. Doping policies in Switzerland should be critically reviewed as simple medical care and evidence-based treatment for non-athlete image- and performance-enhancing drug users is excessively criminalized under the current legislature, leaving possibly over 200,000 image- and performance-enhancing drug users in Switzerland with inadequate medical care.

## Background

Body culture has significantly changed over the past decades towards lean and muscular body types, resulting in often unnatural, extreme physiques [1–4]. “Image- and performance-enhancing drugs” (IPEDs) are widely used as a convenient way to rapidly achieve personal image and sports-performance goals, not only by professional bodybuilders and professional athletes, but increasingly by recreational athletes for aesthetic purposes [5]. Image- and performance-enhancing drugs, in the context of sports, or “doping”, are performance-enhancing substances banned by the World Anti-Doping Agency (WADA), as per the prohibited list [6]. IPEDs comprise different groups of substances, with anabolic androgenic steroids being the most frequently used [1]. The use of supraphysiological doses of testosterone and its synthetic derivatives, especially when combined with strength training, leads to increased fat-free muscle mass (lean muscle mass), hypertrophic changes in muscle volume and increased strength; these effects have been described and recognised in the literature for decades [7–10]. Many different IPEDs exist

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and considering their rising popularity in recent years, the problematic use of these substances now poses a serious risk to individual and public health. The use of anabolic androgenic steroids can lead to many well-established and alarming side effects on various organ systems and functions: the cardiovascular system; the metabolic system; the skin; male-specific or female-specific hormonal changes; the reproductive system, potentially causing subfertility; possible nephrotoxicity, hepatotoxicity, neurotoxicity and mental health problems [1, 7, 11, 12]. Furthermore, a large proportion of anabolic androgenic steroid users develop a substance dependence [7, 17]. Although the use of anabolic androgenic steroids spread throughout the US bodybuilding world and among Olympic athletes from the late 1940s onwards, it was only from the 1980s, when anabolic androgenic steroids started to spread among the general US population, that it became a worldwide substance use problem [2]. In the 21<sup>st</sup> century, other substances have also received increasing recognition, such as growth hormones, insulin and stimulants (e.g. clenbuterol) to name a few, but anabolic androgenic steroids still form the largest category of IPEDs used [2, 15].

Today, the use of anabolic androgenic steroids and other IPEDs has become widespread throughout the world and represents one of the newest of the world’s major substance use disorders [2]. There is a large and increasing number of individuals who may be exposed to these substances [1]. Unfortunately, international research often does not include research data from Switzerland. For example, in their systematic review of over 180 articles in 2014, Sagoe and colleagues [18] estimated that the global lifetime prevalence of anabolic androgenic steroid use was as high as 3.3% in the general population, but not a single article originated from Switzerland. Research interest in this user population is growing worldwide [2]. International research has revealed that the majority of IPED users are no longer athletes but non-competitive bodybuilders or recreational gym users [1, 10, 19]. The global lifetime prevalence of IPED users in recreational sportspeople and recreational athletes is estimated to be significantly higher than in the general population, with estimates of 18.4% and 13.4%, respectively [18]. Furthermore, the popularity of these substances is reported to have increased significantly over the last decade outside Switzerland [1].

Regarding the growing research interest and use of IPEDs worldwide, we decided to conduct a scoping literature review on evidence of the use of these substances and substance users in Switzerland. We also further elaborate on the implications of our findings for Swiss drug policy.

**Methods**

**Reporting guidelines**

This scoping review was conducted following the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) statement [20].

**Identification and selection of relevant studies**

For this scoping literature review, we searched PubMed/Medline, Embase and Google Scholar for peer-reviewed

studies and grey literature published before 6 August 2022. The primary objective was to further describe evidence of (1) IPED use, and (2) IPED users in Switzerland.

We used the following search strategy with Boolean operators: “(Doping) AND (Switzerland)”, “(AAS) AND (Switzerland)”, “(Anabolic steroids) AND (Switzerland)”, “(Image- and performance-enhancing drug) AND (Switzerland)”, “(Performance-enhancing drug) AND (Switzerland)”, “(Doping) AND (Swiss)”. For Google Scholar the search term “Doping Switzerland” was used. The search terms were translated and used in comparable expressions in German, Italian and French, which are the national languages of Switzerland. In addition, relevant article references were manually tracked in order to identify sources in obscure locations – the so-called snowball method [21]. Each study was screened by title, abstract, and full-text based on predefined eligibility criteria (table 1).

Two reviewers (MK/RM) performed the database search and extracted articles separately. Both reviewers removed duplicate records and screened each study by title and abstract. Full texts of eligible studies were screened and reviewed by both reviewers (MK/RM) for data extraction. Disagreements in study eligibility were resolved by consensus between all reviewers (MK/RM/PB).

**Data extraction**

Once the articles were selected, the following data were recorded in an extraction table: author, year of publication, geographical area of Switzerland, study design, study period (if applicable), peer-review status, study objective, sample size, study population with sports classification, outcome and outcome measure, evidence of IPED use or users, key findings. Three team members (MK/RM/PB) reviewed all data to ensure accuracy before analysis. Disagreements in data extraction were resolved by consensus between the three reviewers (MK/RM/PB).

**Study quality appraisal and data synthesis**

No formal study quality assessment was done for this literature review as it is not a prerequisite for scoping reviews. We used a narrative synthesis approach for data analysis. Outcome measures were not pre-specified, but continuous-

**Table 1:**  
Inclusion and exclusion criteria.

Inclusion criteria
Peer-reviewed original article; full text available
Non-peer-reviewed original article; full text available (grey literature)
Conducted in Switzerland
None for study period
Article in English, German, French or Italian
None for study design
None for study population or sex
Article that presents evidence on use or users of IPEDs
Exclusion criteria
Abstract-only article (e.g. conference proceedings), editorial, correspondence, thesis, book
Non-original article, e.g. review article
Article without full text available
Article that does not discuss direct or indirect evidence on use or users of IPEDs. Examples of excluded articles: those discussing attitudes towards IPEDs; policy papers

ly added throughout data extraction to ensure that all relevant outcomes were captured. Data was summarised by outcome table and text.

**Classification of prohibited substances and people participating in sports**

For the classification of prohibited substances, articles commonly referred to the world anti-doping agency (WADA) prohibited list, which can be viewed in table 2 (updated version as of 01 January 2021) [6].

People participating in sports were classified into “athletes”, “recreational gym users” and “bodybuilders”. “Athlete” refers to “a person who competes in one or more sports that involve physical strength, speed or endurance”. Based on their level of participation, athletes were professionals or amateurs [22]. “Recreational gym user” refers to a person who uses the gym for leisure. “Bodybuilder” refers to a person who uses resistance training for building muscle via muscle hypertrophy. Bodybuilders are professionals if they participate in competitions and recreational if they do not.

**Results**

**Identification of potential studies**

Figure 1 shows the process used to identify and select studies. The predefined search strategy, involving three electronic databases, yielded 138 records (PubMed: 45, Embase: 49, Google Scholar: 36, reference search: 8). After removing 53 duplicates, we screened 85 records, first by title then by abstract. Of the 40 records we marked for retrieval, we retrieved 34 full-text articles; we could not obtain 2 records in full-text format and 4 were abstracts only and hence excluded. The full-text screening stage of 34 articles yielded 18 articles relevant to this scoping review. Additional articles were excluded after full-text assessment for the reasons mentioned in the flow chart.

**Study characteristics**

All study characteristics can be viewed in detail in table 3. The peer-reviewed literature on IPED use and users has not increased considerably in the last few years. Among the included articles, a minority (17%) were published within the 5-year period (2018–2022) preceding the present re-

view and less than half (39%) within the preceding 10-year period (2013–2022). The mean year of publication of the studies included was 2011. Most of the studies included were peer-reviewed (83%). Among the included articles, a cumulative total of 11,401 participants were surveyed and 140 people were interviewed. Importantly, among the interviewees, eight of the professional cyclists were interviewed in three different articles. Among the toxicological articles included, 1368 substances overall were chemically analysed.

Among the different study designs included, the most frequent (50%) was survey. Other designs were semi-structured interview (22%), non-clinical in vitro toxicological analysis (17%), observational study (6%) and mixed study design (6%).

With regard to different types of athletes, 43% of the obtained data was derived from studies with professional athletes, 36% from studies with amateur athletes. In 21% (n = 3), the data was mixed; this data included articles that did not focus on athletes, such as surveys of the general population, comparison between sporty and non-sporty adolescents and IPED importers [23–25].

With regard to articles that conducted interviews and surveys, most originated from the French-speaking part of Switzerland (57%), whereas 7% originated from the German-speaking part. The origin was not clear in four studies, and one study was conducted in both French- and German-speaking parts of Switzerland [23, 25–28].

Among the 18 included studies, only 11 different first authors conducted the research. Three of these studies were based on interviews with professional cyclists and their environment, with eight cyclists repeatedly interviewed in all three studies.

**Data extraction**

The full extraction form can be viewed in table S1 in the appendix. Regarding the primary outcomes, most (78%) of the included articles focused on both outcomes. Table 4 shows outcome measures that were extracted from available literature per primary outcome.

**Table 2:** Classification of prohibited substances coded according to the World Anti-Doping Agency prohibited list (updated version as of 01 January 2021) [6].

WADA Class	Compound class	Examples of compounds
S0	Non-approved substances	Specified substances, e.g. drugs under preclinical or clinical development or discontinued, designer drugs, substances approved only for veterinary use
S1	Anabolic agents	E.g. anabolic androgenic steroids, other anabolic agents such as clenbuterol and selective androgen receptor modulators
S2	Peptide hormones, growth factors, related substances and mimetics	E.g. erythropoietin and agents affecting erythropoiesis, chorionic gonadotropin, luteinising hormone and growth hormone, growth factors and growth factor modulators
S3	Beta-2 agonists	E.g. fenoterol, salbutamol and salmeterol
S4	Hormone and metabolic modulators	E.g. aromatase inhibitors, antioestrogenic substances, agents preventing activin receptor IIB activation (such as myostatin inhibitors), metabolic modulators (such as insulins)
S5	Diuretics and masking agents	E.g. desmopressin and acetazolamide
S6	Stimulants	E.g. ephedrine, cocaine, methylenedioxymethamphetamine (MDMA / “ecstasy”)
S7	Narcotics	E.g. diamorphine (heroin), fentanyl, oxycodone
S8	Cannabinoids	E.g. in cannabis (hashish, marijuana), natural and synthetic tetrahydrocannabinols (THCs)
S9	Glucocorticoids	E.g. cortisone, prednisolone

## Data synthesis

### Image- and performance-enhancing drug users

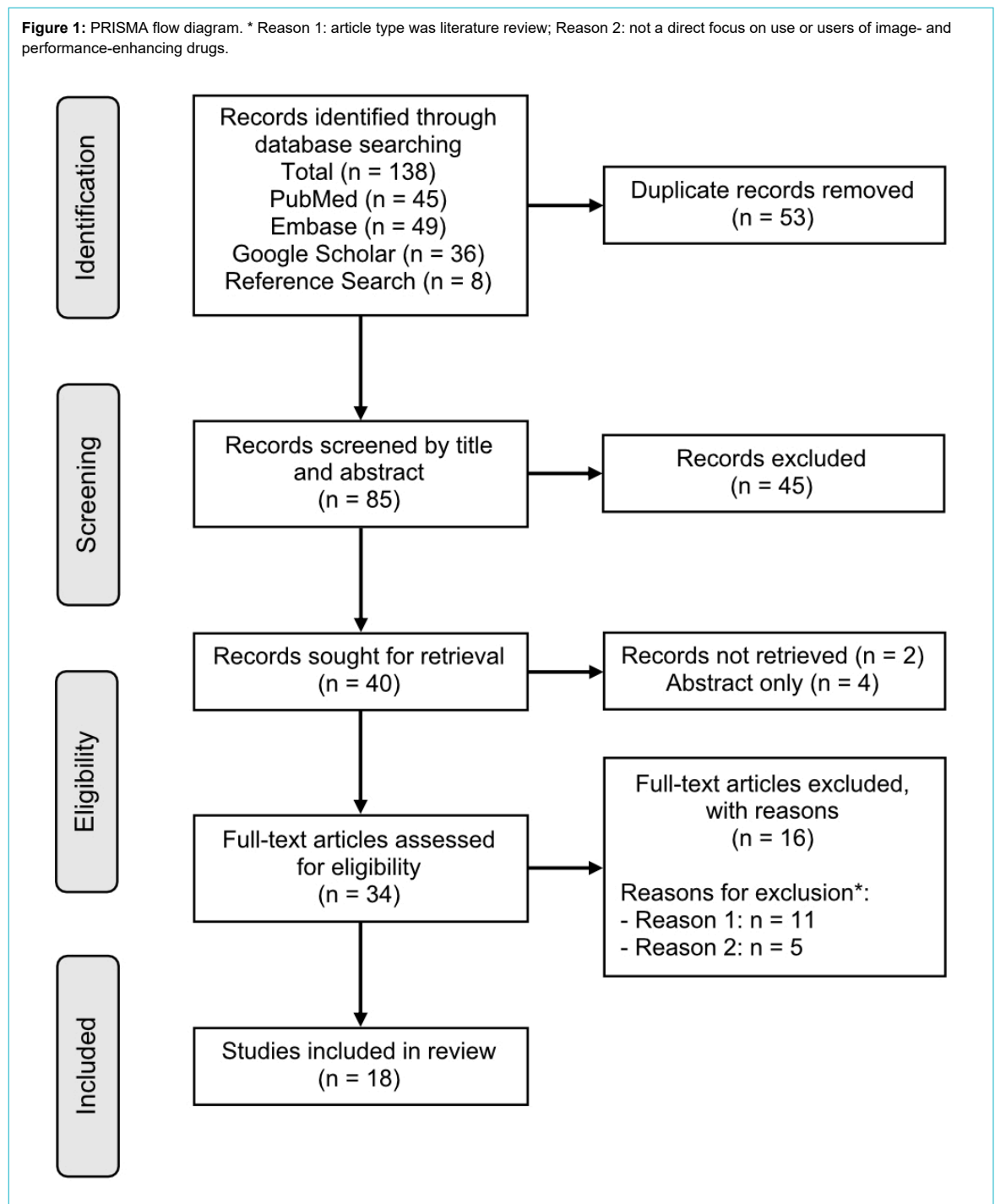
#### Epidemiology

Some authors have analysed the prevalence of IPED use in sports in Switzerland. The prevalence of IPED use among amateur athletes and sporty active adolescents was estimated to be between 2% and 3.7%, according to survey data [24, 29, 30]. These estimates come with some caveats. Different questionnaires used different types of question: open-ended questions, closed-ended questions or lists of substances. Furthermore, definitions of performance-enhancing drugs varied, not always being consistent with the World Anti-Doping Agency (WADA) anti-doping list

(table 2); thus the prevalence of performance-enhancing drug use among athletes could range from 1.3% to 39.2% according to survey data [29, 30]. Nocelli and colleagues additionally concluded that the prevalence of performance-enhancing drug use in sports is perceived to be high among the Swiss population in general [23]. Importantly, the surveys demonstrated the non-trivial proportion of non-users (8.6%) and of adolescents (7.4%) who intended to use performance-enhancing drugs in the future [24, 29].

Lentillon and colleagues further investigated the frequency of performance-enhancing drug use among users and demonstrated that the majority of users (60.9%) only used them sometimes, while a minority used them regularly (25.9%) or even daily (13.2%) [29]. Furthermore, Bélanger

**Figure 1:** PRISMA flow diagram. \* Reason 1: article type was literature review; Reason 2: not a direct focus on use or users of image- and performance-enhancing drugs.



and colleagues demonstrated that the percentage of sporty and non-sporty adolescents who reported knowing peers using performance-enhancing drugs was as high as 14% and 9%, respectively [24].

Use of IPEDs is not confined to athletes; the general population in Switzerland also seems highly affected [25]. Although survey data on recreational bodybuilders and gym users in Switzerland was not found in the literature search, the analysis of importers of IPED packages seized by Swiss border authorities gives more insight on the whole spectrum of IPED users in Switzerland. Only 1% of a total of 696 importers of IPEDs in 2013/2014 were athletes subject to anti-doping regulations of the Antidoping Switzerland (ADCH) Foundation, and hence liable to disciplinary action [31]. In the vast majority of cases, users did not belong to any active sports organisation and were partaking in recreational bodybuilding or staying fit [31].

Weber and colleagues identified common traits of Swiss IPED importers and users [25]. Typical IPED importers are well-educated, employed, non-competing males in their

20s to 40s. Furthermore, sex differences exist with the overwhelming majority (82%) of the importers investigated being male and the minority (15%) female [31]. This data was confirmed by Lentillon and colleagues who showed that males had a higher prevalence of IPED use [30]. Furthermore, a higher frequency of training was also associated with a higher level of IPED misuse [23, 28, 30].

*Motivation for using IPEDs*

The most frequently cited reasons for IPED use were performance enhancement and muscle building [25, 27, 28, 32]. Among IPED importers, it could be shown that the motivation to use these substances differed according to age and sex [25]. While men aimed to increase their muscle mass and improve athletic performance, women focused on weight loss [25]. For both men and women, however, appearance seemed to play an important role in IPED use, with men and women importing IPEDs for image reasons [25]. While the vast majority of young people under the age of 20 aimed to improve their athletic performance, the aim of those over the age of 50 was for medical, health

**Table 3:** Characteristics of n = 18 published studies presenting data on image- and performance-enhancing drug users and use in Switzerland.

Characteristic		Proportion of articles
Year of publication (mean)		1998 to 2022 (2011)
	Published within last 5 years	3 (17%)
	Published within last 10 years	7 (39%)
Peer-reviewed	Yes	15 (83%)
	No	3 (17%)
Sample information (total included n, range)	Survey participants	11,401 (147 to 2500)
	Interview participants	140 (8 to 70)
	Chemically analysed samples	1368 (75 to 1190)
Study design	Non-clinical in vitro toxicological analysis	3 (17%)
	Observational	1 (6%)
	Semi-structured interviews	4 (22%)
	Survey	9 (50%)
	Mixed	1 (6%)
N° (of total n = 14) of included studies involving:	Professional athletes	6 (43%)
	Amateur athletes	5 (36%)
	Mixed	3 (21%)
N° (of total n = 14) of articles originating from different areas of Switzerland	French-speaking area	8 (57%)
	German-speaking area	1 (7%)
	Italian-speaking area	0 (0%)
	Mixed	5 (36%)
Articles involving as outcome	Use of IPEDs	4 (22%)
	Users of IPEDs	0 (0%)
	Both	14 (78%)

IPEDs: image- and performance-enhancing drugs

**Table 4:** Outcome measures.

Outcome	Outcome measure	N° of articles measuring the outcome
Users of IPEDs	Epidemiology	6
	Motivators of IPED use	8
	Affected sports disciplines	5
	Knowledge about IPED use	8
	Use of performance-enhancing drugs among athletes	5
	Perception of IPEDs	3
Use of IPEDs	Diversity of substances used	13
	Chemical quality of substances	3
	Access to banned substances	7
	Information on IPED use	7

IPEDs: image- and performance-enhancing drugs

or other reasons [25]. Other motivators were: to prevent injuries; pain relief; regeneration; the feeling of strength; and overall wellbeing [28, 33]. It was demonstrated that bodybuilders started using IPEDs through contact with more experienced peers [33]. Among professional cyclists, reasons for the use of performance-enhancing drugs varied, but they were primarily for short-term performance improvements, e.g. to win a race, to achieve personal goals or to overcome insecurities especially in the absence of adequate support [32, 34, 35]. Living in a city was another risk factor for the use of IPEDs among adolescents [24]. In professional sports, the main risk factor for the use of performance-enhancing drugs was the pressure exerted on the athlete by the family, team members and staff or managers [34].

#### *Affected sports disciplines*

According to survey data and interviews with coaches, the general population and bodybuilders, it was demonstrated that IPED use appears to be common among power sports, i.e. bodybuilding and fitness in general, but also among endurance sports [25]. Among bodybuilders, the use of IPEDs appears to be particularly common and widespread [23, 33]. Among professional sports, disciplines that were perceived to have high proportions of performance-enhancing drug use included swimming, track and field, cycling and Nordic walking [23, 26]. Comparable results were also found in a survey of young Swiss amateur athletes, which showed that IPEDs are most used in outdoor sports and team sports, with sports such as martial arts (e.g. judo), ice hockey and cycling being the most frequently mentioned [30].

#### *Knowledge about IPEDs*

There appears to be a lack of knowledge about the type of IPEDs used, the import of IPEDs into Switzerland and their side effects. It was demonstrated that the vast majority of amateur athletes lacked knowledge about performance-enhancing drugs that appear on the WADA anti-doping list; therefore on some occasions athletes did not have the intention of using performance-enhancing drugs or were not aware of even taking banned substances [29, 30]. Regarding the import of IPEDs, only a minority of importers was aware that the import of these substances into Switzerland was prohibited and that they were at risk of legal action [25]. Regarding the awareness of side effects, a higher proportion of bodybuilders were aware of the side effects and dangers of IPEDs than professional athletes, e.g. professional cyclists, who either hardly recognised or trivialised side effects and potential harm to health [32–34]. The use of performance-enhancing drugs under medical supervision was perceived as health protection by interviewees [36]. Regarding supplements, survey data also confirmed a lack of knowledge among adolescent professional athletes and amateur athletes, as supplements were often taken inappropriately and consumers did not know whether the substances contained in the supplements were on the WADA anti-doping list [27, 28].

#### *Image- and performance-enhancing drug use among professional athletes*

A number of interviews with professional cyclists further explored the role of performance-enhancing drug use in professional sports and revealed that interest in using them

still persists, as the majority of interviewees were tempted by performance-enhancing drugs [32, 34, 36]. In the past, it was demonstrated that at the professional level there was extensive pressure to start using performance-enhancing drugs, which manifested as, for example, exclusion from the team, bullying or being forced to end one's career [32, 36]. Furthermore, the use of performance-enhancing drugs under medical supervision was common practice at international professional level [36]. As a result of several performance-enhancing drug scandals, however, the use of performance-enhancing drugs in professional cycling has changed [32]. Nowadays, performance-enhancing drug use in professional cycling is less common and more individual [32]. Associated health risks are also considered more dangerous since these substances must be obtained from the Internet and are less easily available from doctors [32]. This has led to some rejection among athletes, as the clandestine market over the Internet does not guarantee good-quality substances and there is a risk of possible anti-doping checks [32]. Following several performance-enhancing drug scandals, the external pressure on professional cyclists has decreased and it is possible nowadays to avoid the use of performance-enhancing drugs, according to interviewees [32]. However, the interest of professional cyclists in performance-enhancing drug use can also be seen indirectly nowadays, as six of the eight respondents intentionally chose a sports doctor who supports performance-enhancing drug use rather than a doctor who is against their use, a finding that is also evident from interviews with professional cyclists conducted by Brissonneau and colleagues [32, 35].

Mettler and colleagues demonstrated in a recent user survey that supplement use was widespread among adolescent professional athletes of various sports disciplines, with only 3% of all respondents not taking any supplements [27]. Substantial proportions (30%) of the substances were intentionally used to enhance performance, in addition to the main motivators of improving regeneration (40%) and supporting health (39%) [27]. Overall, a small proportion (2.8%) of all respondents was willing or somewhat willing to use illegal IPEDs if no-one would ever find out [27]. Importantly, this group also uses supplements more often to improve performance than those who would never use banned IPEDs [27].

#### *Perception about IPED use*

Surveys among the general population conducted in 1995 already suggested that there was a problem of performance-enhancing drug use in sport, as performance-enhancing drug use in professional sports was considered a serious problem by most of the Swiss general population; in contrast, in amateur sports, performance-enhancing drug use was assumed to be a less severe problem [23]. Up until today, large proportions of athletes and trainers have stated that they perceived performance-enhancing drug use to be a serious problem in their sport, according to survey data [23]. However, among professional cyclists, performance-enhancing drug use was not only perceived as a problem in sport, but much more as a social phenomenon, as nowadays performance-enhancing drugs are used in many areas of life and have been trivialised [34].

## Image- and performance-enhancing drug use

### *Diversity of used substances*

Some authors assessed the variety of different substances that are used by the Swiss population. Among 1190 IPEDs seized at the Swiss border in 2013/2014, by far the most common substance group seized was anabolic agents, most frequently anabolic androgenic steroids (75%), with testosterone and its esters (27.3%; 213/779) among many other synthetic derivatives [37]. Other substance groups that were commonly seized were peptide hormones or growth factors and mimetics, e.g. human chorionic gonadotropin (hCG), human growth hormone (hGH), insulin-like growth factor 1 (IGF-1), and antioestrogens, e.g. aromatase inhibitors, or other metabolic modulators, e.g. clomiphene, tamoxifen, anastrozole [37].

The type of substances used varied by age, motivation, sex and sports discipline. Among young adolescents, the most commonly used illegal substances were analgesics (11.3%), alcohol (5.1%) and cannabis (3.4%) according to survey data [24]. There is a higher prevalence of IPED use among users of recreational drugs, e.g. cannabis, than in non-users (2.3% vs 0.1%); in the same survey, approximately 32% of all cannabis users also used IPEDs with the aim of improving athletic performance [24]. Other substances mentioned in that user survey were human growth hormone and cocaine use among the sporty adolescents, as well as erythropoietin (EPO) and anabolic androgenic steroids among the non-sporty adolescents [24]. Furthermore, substances such as methylphenidate (neurodoping) and corticosteroids were identified [24]. The products most frequently used by adolescents to improve performance included caffeinated products such as energy drinks, sports drinks or other supplements [24].

Regarding the motivation of IPED importers, this depended on the prospective use of the different substances. In order to improve athletic performance, supplements were mainly used, whereas for increasing muscle mass, anabolic androgenic steroids and supplements were preferred [25]. Regarding sex, it was demonstrated that for men, anabolic androgenic steroids and supplements were the most popular, while women preferred human chorionic gonadotropin, testosterone and clenbuterol [25, 31].

Regarding the different sports disciplines, Weber and colleagues demonstrated that athletes imported significantly more anabolic androgenic steroids than non-athletes [25]. According to user survey data, the most commonly used performance-enhancing drugs in recreational athletes were alcohol, marijuana and drugs for asthma [29, 30]. Less frequently, other substances were also listed such as anabolic androgenic steroids, amphetamines, beta-blockers or beta-2 agonists, cocaine, corticosteroids, diuretics, ecstasy, ephedrine, erythropoietin, growth hormone, heroin, local anaesthetics, morphine, methylphenidate [28–30].

Interviews among professional cyclists demonstrated that all interviewees ( $n = 8$ ) were taking nutritional supplements [34]. Corticosteroids were the substances most frequently misused, due to anti-doping regulations with a Therapeutic Use Exemption, and often formed the entry point for IPED abuse among cyclists [34, 35]. The use of other banned substances was widespread in professional cycling, e.g. erythropoietin, human growth hormone and

blood transfusions, which are more expensive but also more difficult to obtain and apply and therefore only used at professional level [32, 34, 36]. Regarding methods of using IPEDs, injected substances appear not to be used in amateur cycling but are more common among professional cyclists [34, 35].

### *Chemical quality of substances from unregulated online markets*

In order to further determine the proportions of fake IPEDs among the compounds seized at the Swiss border, chemical analyses of these substances were carried out. It was demonstrated that the majority, over 80%, of all analysed products either did not contain the labelled substance or the substance was not present at the anticipated concentration [37]. The authors demonstrated that these fake products might contain no active ingredient, or contain it but in an amount other than that labelled; contain a wrong active ingredient; or contain none, all or more active ingredients than those labelled [37]. Interestingly, the proportion of fake substances varied by substance group, e.g. anabolic androgenic steroids were most commonly fake whereas antioestrogens, i.e. aromatase inhibitors, were of original quality throughout [37].

Additionally, the problem of fake products obtained via unregulated channels was not confined to pharmaceutical compounds but affected supplements too. Kamber and colleagues as well as Baume and colleagues demonstrated that major proportions of supplements might be mislabelled or adulterated, most frequently with testosterone and its derivatives, whereby their intake would even result in a positive doping test [38, 39].

### *Access to banned substances*

It was demonstrated that by far the most frequent access route to substances was via the Internet or the black market, but other suppliers were also used, such as friends, other athletes, physicians, pharmacies, gyms, and coaches or trainers [23–25].

Regarding imported black-market products seized at the Swiss border, Weber and colleagues demonstrated that shipments originated from many manufacturers, ranging from well-known pharmaceutical companies to underground laboratories, and that these were sent to Switzerland mostly from Asian countries or China, mostly via south-east European countries [31]. Importantly, the vast majority of these seized shipments were sent with the final destination being Switzerland [31]. In particular, the biggest proportion was sent to the canton of Zurich [31]. Other frequent destinations in Switzerland were Geneva, Lausanne, Bern, Basel and St. Gallen [31]. The imported IPEDs were mostly for personal use and on some occasions consumers ordered more than once [25, 31]. Importantly, the import of these substances appears to be a multimillion CHF business. The 960 packages seized had an estimated value of 1,114,311 CHF, and these seized packages represent only a fraction of all packages that are actually imported; the exact number of imports remains unknown [31].

### *Information on IPED use*

Among IPED importers, the Internet appears to be the channel most frequently used to obtain information about the quality of substances [25]. In professional sports, infor-

mation about performance-enhancing drugs is commonly obtained from Antidoping Switzerland (ADCH), trainers and staff, experienced peers, federations and clubs, doctors, articles or books about performance-enhancing drug scandals, as well as via the Internet [26, 32, 34–36]. Moreover, adolescent professional athletes mostly obtained information about supplements from those who recommended the substances, but also from the Internet and supplement suppliers, so the information they received is considered low-quality [27]. According to survey data, professional athletes commonly felt sufficiently informed about performance-enhancing drugs, but their coaches wished to be better informed [26].

## Discussion

Our scoping literature review included 18 articles from the published literature that provided evidence on use and users of IPEDs in Switzerland. A diversity of study designs and a variety of sports areas were assessed. Results were derived from a total of 11,401 survey participants and 140 interviewees, as well as toxicological results of 1368 chemically analysed substances.

We have demonstrated that there is a lack of studies and a lack of diversity within the different research groups that are conducting research on IPED use and users in Switzerland. Less than half of the studies were conducted within the past ten years and only eleven different first authors of these 18 articles were responsible for the articles included. Furthermore, the geographical scope was limited as most studies originated from the French-speaking area of Switzerland, but the diversity of sports fields was also disproportionate, as most studies were conducted among professional athletes. We have demonstrated that most imported substances seized at the Swiss border were from non-athletes [25], which is in line with the literature outside of Switzerland [1, 7, 10, 19, 40–43]. It is of great importance that more research will be done on this possibly growing user population in Switzerland, and particularly among recreational gym users and bodybuilders, as they represent most users.

Few authors have provided data on IPED users. Due to a lack of reporting, precise prevalence and demographic data about these users are scarce and, due to methodological challenges, this data must be interpreted with caution. Use of these substances among professional and amateur athletes appears to be prevalent. Prevalence of performance-enhancing drug use among amateur athletes was estimated to be between 2% and 3.7% according to survey data in Switzerland, although the prevalence of performance-enhancing drug use among athletes ranged from 1.3% to 39.2% [24, 29, 30]. It has been demonstrated that many more intend to use IPEDs in the future or knew someone who was also using IPEDs. This is in line with a systematic review that estimated a global lifetime prevalence of anabolic androgenic steroids users in athletes of up to 13.4% in 2014 [18]. In this scoping review, we did not find any evidence for prevalence among non-athletes. The analysis of IPED importers supports the hypothesis that most users are non-athletes as it was demonstrated that only 1% of Swiss IPED importers via online sources were athletes, whereas the rest were non-athletes [31]. Some common traits of these importers or users were identified: importers

were well-educated, employed, non-competing males in their 20s to 40s [25]. This is in line with epidemiological data from IPED users from other countries outside Switzerland [1, 7]. The most common reasons for use were image enhancement, i.e. muscle growth, although athletes were motivated by the performance-enhancing effect. Other motivators exist depending on age, sports field, sex and other sociodemographic factors. Furthermore, the type of substances used could also vary by age, motivation, sex and sports discipline. More epidemiological data on this user population is of great importance to further understand this threat to individual and public health in Switzerland.

We have demonstrated that substantial proportions of IPEDs found on the black market and seized at the Swiss border are fake and of a substandard drug purity that leaves users in Switzerland with unpredictable risks [37]. Fake products were a problem affecting almost all imported substances, although differences exist between substance groups. These findings are in line with data from outside Switzerland [14]. These fake products can lead to unexpected adverse events in addition to the already well-established side effects of IPEDs, as well as additional unexpected drug-drug interactions as this user population is inclined to polydrug use [1, 40, 44]. These substances commonly originated from many different manufacturers and were sent to Switzerland from Asian countries, mostly via south-east European countries. Users in Switzerland need to be protected from these fraudulent substances. There is nothing that would suggest that the use and import of these substances will decline in the foreseeable future as we also provide further evidence that the amount of seized or confiscated compounds increased over the observation period in Switzerland, and that the illegal import of these substances is also estimated to be a multimillion CHF business [37].

Besides fake IPEDs from the black market, we have also demonstrated that sports supplements from online markets may be adulterated and possibly contain testosterone and synthetic derivatives [38, 39]. Supplements are very widely used by non-athletes, athletes and bodybuilders [24, 25, 27, 33, 34, 38, 39]. This is particularly concerning as these users do not intend to use anabolic androgenic steroids and may possibly suffer from unexpected effects, as well as adverse events and unexpected positive doping tests from unintentional intake of these substances. These products are widely unregulated, do not go through any drug approval process and thus lack the necessary quality control. It is of importance that prevention strategies incorporate the use of these non-regulated supplements.

## Implications for Swiss drug policy

Image- and performance-enhancing drug use has become widespread throughout the world and represents one of the newest of the world's major substance abuse disorders [2]. According to international data, there appears to be a large and increasing number of individuals who encounter these substances [18, 45]. With this scoping literature review, we have presented some evidence that the use of these substances is also prevalent in Switzerland, although we have not presented any conclusive evidence on prevalence, side effects or long-term implications of use in Switzerland. We



have demonstrated that the quality and quantity of research relevant to Switzerland is limited and further research with robust methodologies is needed, particularly as IPED use is becoming an aesthetic tool across the general population. At this point, we can only surmise that use of these substances and motivations for use by Swiss users will follow international trends. In neighbouring Germany, the Epidemiological Survey of Substance Abuse (ESA) estimated the 12-month prevalence of anabolic use in the general population to be 0.7% in 2018, which has increased over the observation period [46]. In a systematic review and meta-analysis by Sagoe and colleagues, the global lifetime prevalence of anabolic androgenic steroids use in the general population was estimated to be 3.3%, which would suggest that over 200,000 people have used anabolic androgenic steroids in Switzerland [18].

Clinicians should become aware of the considerable individual and public health threat that anabolic androgenic steroids and other IPEDs pose in Switzerland and worldwide, given the significant negative long-term health effects of IPED use. Importantly, anabolic androgenic steroid dependence among substance users is common and is described in 25–40% of anabolic androgenic steroid users according to literature [1, 7, 19, 47]. Other relevant risks regarding addiction medicine that should be mentioned are the concurrent use of other psychotropic substances that appears to be common, as well as the risk of infection by blood-borne viruses from injection practices and sexual behaviours [48, 49]. Swiss drug policy aims to reduce drug use and its negative consequences for users and society [50]. The revised Narcotics Act (NarcA) of 2008 implemented a four-pillar drug policy into law, comprising prevention, harm reduction, therapy and repression. Unfortunately, IPED use as substance use disorder is currently a widely neglected area in the field of medicine; prevention and harm-reduction strategies, as well as medical programmes barely exist in Switzerland and should be further explored and evaluated for this user population.

### Prevention and harm reduction

Prevention strategies often do not reach this hard-to-reach user population. According to survey data in Switzerland, most anabolic androgenic steroid users demonstrate inadequate knowledge about the harmful effects of these substances, the WADA anti-doping list and the law surrounding import, as demonstrated in this review [24–26, 28–30, 32, 34]. Tailored prevention strategies are needed to accurately inform this hard-to-reach user community.

Harm reduction addresses people who use IPEDs, those who cannot or do not want to discontinue their use, to reduce risks wherever possible. Different, established harm-reduction strategies that are already implemented for different areas of addiction medicine in Switzerland should be further explored and could be implemented to reduce risks of IPED use. Such strategies could entail the controlled use and availability of these substances through healthcare providers, such as the medical prescription of opioids (opioid agonist therapy), needle and syringe programmes (NSP) and promotion of safer-use practices [51]. The authors would like to highlight the findings of Weber and colleagues, who demonstrated the high levels of counterfeiting and mismatches between listed and contained ingre-

dients in IPED samples shipped through Switzerland and seized by Swiss border authorities [37]. International data demonstrates that this trend is similar across various countries and settings [14]. Many who use IPEDs such as anabolic androgenic steroids for non-medical purposes report coming into contact with counterfeit substances and experiencing harm as a result [52]. Furthermore, some IPED users try taking steps to limit coming into contact with counterfeit products, though recognise that many of these methods have limitations (e.g. appearance of packaging or content) [52]. The implementation of drug safety checking services with accompanying counselling could provide IPED users with an opportunity for more informed decision-making when taking these substances. This harm-reduction strategy has already been successfully implemented for other illicit drugs in Switzerland and worldwide [53]. People using this service submit samples for chemical analysis and receive feedback on the composition of their samples prior to use [54]. Drug-checking services in Switzerland have existed since the 1990s and they are central elements in the Swiss drug policy that aims to reduce drug use and its negative consequences for users and society. Evidence on the positive impact of drug-testing services on substance user behaviour and individual health has been described in the literature [55–58]. To our knowledge, there is currently no published evidence on drug-checking services for IPEDs. Existing drug-checking guidelines should be reviewed to further explore the potential role in engaging people who use IPEDs within their services, given significant health effects of its use.

### Medical therapy / repression

For IPED users who develop side effects and dependency, there are some guidelines in the literature on treatment recommendations [10, 16, 47, 59]. A few so-called “steroid clinics”, specialised clinics for IPED users, have already been successfully implemented and established in the recent past in a few countries [60]. Previous positive experiences in the field of addiction medicine with patient groups that are difficult to reach, such as recreational substance users, give hope that with adapted treatment concepts, stable contacts can also be established with this user population and that these patients can be persuaded to accept further offers of help [61, 62]. Despite the global rise of IPED use, only a minority of IPED users seek support from medical professionals in case of questions or adverse events [63]. In practice, the medical approach includes the principles of harm reduction and adheres to medical guidelines regarding optimal treatment for a patient. For the treatment of IPED users, these guidelines often suggest the prescription of a few substances prohibited under anti-doping regulations in order to treat adverse events. In Switzerland, by virtue of the Sports Promotion Act, healthcare professionals could be held criminally liable for providing care or prescribing treatment with these substances, leaving non-athlete IPED users in Switzerland untreated when it comes to medical problems [64]. Principles of medical care that apply to patients consuming other illegal substances in unregulated drug markets, such as heroin and other opioids, do not apply to IPED users, not even for non-competing, recreational gym users. Under current legislation, the Sports Promotion Act, providing care to non-athlete IPED

users may lead to imprisonment of the treating doctor. Unfortunately, as demonstrated, regulations and legislation surrounding these substances currently still represent the biggest hurdle in providing prevention and medical care to IPED users and in reducing the related public health burden. There are substantial efforts to conduct doping tests among athletes and efforts to stop their use in competing athletes. Importantly, these efforts only affect a minority of users as most individuals using these substances appear to be non-athletes. The current anti-doping legislation does not seem to be preventing the number of non-athlete IPED users from growing, but it is actively hindering adequate medical care for these individuals and contradicts Switzerland's established drug policy for other illegal substances.

**Limitations**

This research has some limitations. The evidence base for this research area is very limited due to the paucity of Swiss studies and there are many variables in this study that may lead to bias of the studies included and the conclusions drawn. The use of self-reporting, possibly poor interviewing techniques, inclusion of outdated studies, use of grey literature, use of multiple data sources and possible misclassification of doping substances in the respective studies may have led to inaccurately measured study variables and thus influenced the results and conclusions of this review, as well as led to over- or underestimation of prevalence data (information bias). More studies with robust methodologies undergoing peer-review are needed. Furthermore, the use of interviews and self-reports may have led to interviewer bias, as well as response bias, particularly as the consumption of doping substances is illegal (social desirability bias) and may have led to inaccurate responses among interviewees and thus impacted the data synthesis of this review. Lastly, interviews of professional athletes consisted almost entirely of cyclists (selection bias), and we demonstrated a misrepresentation of user populations (most perspectives were from athletes, the minority of IPED users), a misrepresentation of regions in Switzerland (most articles derived from the French-speaking area), small sample sizes and involvement of the same interviewees across different articles (sampling bias). This may have led to a one-sided perspective and influenced the generalisability of results and conclusions of this review. Future studies should involve a greater variety of IPED users, including non-athletes, as well as represent all areas of Switzerland.

**Conclusions**

In this scoping literature review on IPED use and users among Swiss sportspeople, we have demonstrated that the use of these substances is prevalent among athletes, recreational bodybuilders and gym users. Many different substances are used in that context. The major method of obtaining information about these substances and obtaining the substances themselves appears to be the Internet. We have demonstrated that substantial proportions of these substances may be fake and as such they put the user at unpredictable risk when consuming them. The individual and public health impact of IPEDs among this growing, often insufficiently informed, and hard-to-reach user community in Switzerland may be substantial. There is considerable

need and opportunity for future prevention, harm reduction and treatment programmes for this growing and hard-to-reach user community. The use of anabolic androgenic steroids and other IPEDs affect tens of millions of individuals worldwide and their use belongs to the newest of the world's major substance use disorders. Image- and performance-enhancing drug use as substance use disorder is currently a widely neglected area in medicine in Switzerland and worldwide. Current Swiss doping policies should be critically reviewed, as simple medical care and evidence-based treatment for non-athlete IPED users is excessively criminalised under current legislation, leaving possibly over 200,000 IPED users in Switzerland with inadequate medical care. Furthermore, the policies do not appear to prevent the number of non-athlete IPED users from growing, but actively hinder adequate medical care for these individuals, contradicting the established Swiss drug policy for other illegal substances.

**Potential competing interests**

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest was disclosed.

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# Appendix

Table S1 Extraction form.					
Author, Year, Geographical area of Switzerland, Reference	Study design/ Study period/ Peer-reviewed	Objective	Sample size/ Study population (sports classification)	Outcome and outcome measure	Evidence of IPED use and its user / Key findings
Weber C. et al., 2016, mixed, (25)	Survey/ 2013 - 2014/ Yes	Evaluate user profiles and reasons for importing World Anti-Doping Agency prohibited substances	N = 147 Swiss doping product importers (mixed)	<p><i>IPED users:</i> epidemiology, motivators of IPED use, affected sports disciplines, knowledge about IPED use/ <i>IPED use:</i> diversity of used substances, access to banned substances, information on IPED use</p>	<i>User profile:</i> not competing physically active athletes, predominantly male, born in Switzerland, well-educated, aged 20 to 40 years, employed
					<i>Doping use:</i> not limited to regulated sport, present in general population
					<i>Sport disciplines:</i> bodybuilding, fitness, endurance sport
					<i>Gender:</i> 81% (119/147) men, 18% (26/147) women; men more bodybuilding than women
					<i>Motivation:</i> men to increase muscle size, improve athletic performance (i.e., anabolic androgenic steroid, supplements); women to lose weight (i.e., human chorionic gonadotropin and clenbuterol)
					<i>Image-enhancement:</i> import of products for beauty reasons by 44% (52/119) of men, 35% (9/26) of women
					<i>Substances:</i> supplements to improve athletic performance; anabolic androgenic steroid, peptides, and other compounds for beauty reasons; medicines for medical reasons; anabolic androgenic steroid and supplements to increase muscle mass
					<i>Use of imported products:</i> 85% for self-use, 88% no resell of the products
<i>Knowledge on prohibition of doping import:</i> 29% aware, 35% unsure					

					<p><i>Suppliers:</i> internet (52%), friends (13%), doctors (5%), fitness centers (1%), coaches (1%)</p> <p><i>Information on product quality:</i> 52% of importers through internet</p> <p><i>Products imported significant more by athletes than non-athletes:</i> anabolic androgenic steroid, <math>t(121) = 2.743</math>, <math>p &lt; 0.008</math>, 95% CI [0.185, 1.146]</p> <p><i>Positive correlation:</i> between import of anabolic androgenic steroid and bodybuilding, <math>r(99) = 0.470</math>, <math>p &lt; 0.001</math>; between supplements and bodybuilding, <math>r(92) = 0.435</math>, <math>p &lt; 0.001</math></p> <p><i>Motivation according to age:</i> &lt;20 years: 85% for athletic performance-enhancement; &gt;50 years: about 30% medical reasons, 30% beauty reasons, 30% another reason</p>
Kamber M. et al., 2000, German, (65)	Survey/ 1996/ Yes	Investigate frequency of medication use and influence of physical activity on medication use	N = 718, of which n = 418 competitors of "Frauenfelder Waffelauf" and n = 300 postal workers as control (amateur athletes)	<i>IPED use:</i> diversity of used substances	<p><i>Medication use at "Frauenfelder Waffelauf":</i> 1.8% during, 3.4% 24h after, 4.2% two days after, 4.6% 24h before</p> <p><i>Motivation:</i> 7.1% (45/628) medication intake against sport complaints in past 30 days</p> <p><i>Substances before the event:</i> 20 drugs reported among the 4.6% (18/388) of runners, including analgesics (n = 8), asthma medication (n = 2), rheumatism (NSAR) patches (n = 2)</p> <p><i>Activity:</i> better self-reported health assessment and fewer medication use among sportive active than non-active; medication use in 33.0% (70/212) of runners vs. 50.0% (43/86) among inactive postal workers</p>

Lentillon-Kaestner V. et al., 2011, French, (29)	Survey/ 2008/ Yes	Test influence of type of question and definition of doping on doping prevalence and evaluate most used banned substances among amateur athletes	N = 1810 amateur athletes (amateur athletes)	<i>IPED users:</i> epidemiology, knowledge about IPED use/ <i>IPED use:</i> diversity of used substances	<i>Doping prevalence:</i> between 1.3 and 39.2% depending on type of question
					<i>Future doping:</i> 8.6% of non-users consider future doping
					<i>Most used banned substances:</i> alcohol (27%), marijuana (about 10%), drugs for asthma (4-10%), others as diuretics, ephedrine, amphetamines, corticosteroids, ecstasy, Ritalin, cocaine
					<i>Knowledge about prohibited substances:</i> majority unaware; often no intention to dope
					<i>WADA list:</i> only 2% (37/1810) took banned substances from WADA list
					<i>Frequency of doping:</i> 39.1% (133/340 users) regular, 60.9% (207/340 users) occasional use
					<i>Intention to start doping:</i> erythropoietin and anabolic androgenic steroid always used with the intention to dope
Nocelli L. et al., 1998, German & French, (23)	Survey/ 1995/ Yes	Assess public awareness of performance-enhancing drug use in sport	N = 1201 respondents (mixed)	<i>IPED users:</i> affected sports disciplines, perception about IPEDs/ <i>IPED use:</i> access to banned substances	<i>Perception of doping problem:</i> seen by 84% of population as a "very serious problem" or "somewhat serious problem" in elite sport, by 44% in recreational sport; seen as bigger problem in elite sports than recreational sports
					<i>Estimation of doping in different sports disciplines:</i> track and field (79%), cycling (27%); 35% of respondents believe that >60% of bodybuilders use doping
					<i>Sources of doping:</i> black market (91.5%), athletes and trainers (79.8%), fitness centers (74.2%), medical doctors (63.9%), pharmacies (42.0%); 16.0% thought that health food shops provide doping products
					<i>High estimated doping use:</i> among respondents younger than 35 years ( $p < 0.01$ ), persons participating in daily sport ( $p < 0.01$ )

Lentillon-Kaestner V. et al., 2010, French, (34)	Semi-structured interviews/ Yes	Identify and understand use of doping substances by young elite cyclists	N = 8 cyclists (professional athletes)	<p><i>IPED users:</i> motivators of IPED use, knowledge about IPED use, PED use among professional athletes/ <i>IPED use:</i> diversity of used substances, access to banned substances, information on IPED use</p>	<p><i>PEDs:</i> 8/8 cyclists took nutritional supplements; doping widespread at professional level, also exists at amateur level; only 1/8 cyclist not tempted to use doping</p>
					<p><i>Motivation:</i> doping after losing a race or failing to achieve a goal, win a race, sign a contract, be better and stronger than others; not just a sport issue but perceived as a social phenomenon</p>
					<p><i>Source of information:</i> articles on doping scandals, books, internet, experienced cyclists</p>
					<p><i>Methods:</i> injection use only at professional level; injected products by one cyclist in transition to professional level, two professional cyclists</p>
					<p><i>Substances:</i> mostly corticosteroids; erythropoietin and blood transfusions expensive, hard to obtain and use</p>
					<p><i>Attitude towards doping at amateur level:</i> must show potential without doping; majority very interested and knowledgeable</p>
					<p><i>Attitude towards doping at professional level:</i> open to doping substances; pressure to start doping</p>
					<p><i>Prevention:</i> stable family life, clean social network; having something else besides cycling</p>
					<p><i>Risk factors:</i> pressure from family, teammates and staff, managers</p>
					<p><i>Transmission of doping:</i> through more experienced or former cyclists to young cyclists</p>
<p><i>Health risks:</i> only few perceived; considered riskier for health to take nothing</p>					



Lentillon-Kaestner V., 2014, French, (36)	Semi-structured interviews/ 2007/ Yes	Understand doping norms in Swiss national and international elite cycling	N = 16 interviews, of which n = 8 young cyclists, n = 2 coaches, n = 3 physicians, n = 2 team managers and n = 1 journalist (professional athletes)	<i>IPED users</i> : PED use among professional athletes/ <i>IPED use</i> : diversity of used substances, information on IPED use	<i>Role of doping</i> : deviant at national elite level, not at international level; prove performance without doping before moving to international elite level
					<i>Doping under medical supervision</i> : accepted at international elite level; perceived as health protection
					<i>Information on doping</i> : through neo-professional and professional cyclists
					<i>WADA list</i> : cortisone not considered as doping substance in cycling; widespread use of cortisone, 7/8 cyclists misuses therapeutic use exemptions for cortisone; no other substances mentioned
					<i>Social pressure</i> : harassed and excluded at professional level if refusing doping, some forced to stop career
					<i>Role of physicians</i> : easy access to substances; give therapeutic use exemptions; achieving athletes goals through doping under medical supervision

Lentillon-Kaestner V. et al., 2012, French, (32)	Semi-structured interviews/ Apr. - Oct. 2007/ Yes	Examine how health risks influence elite-level cyclists' decisions to use banned substances	N = 16 interviews, of which n = 6 young cyclists, n = 2 neo-professional cyclists and n = 8 former professional cyclists (professional athletes)	<p><i>IPED users:</i> motivators of IPED use, knowledge about IPED use, performance-enhancing drug use among professional athletes/ <i>IPED use:</i> diversity of used substances, access to banned substances, information on IPED use</p>	<i>Use of banned substances:</i> widespread in elite-level cycling
					<i>Doping today:</i> less widespread; more individualized since doping scandals instead of doping under medical supervision
					<i>Risks of individual organized doping:</i> greater health risks due to reduced medical supervision; clandestine market over internet, bad substance quality, fear of anti-doping control if bought over internet
					<i>Motivation to dope:</i> young cyclists focused on short-term performance-enhancing benefits (e.g., improving performance, achieve excellence, combating fatigue, winning races)
					<i>Refusal of doping:</i> today possible, previously excluded from peloton and team
					<i>Substances:</i> mostly corticosteroids; at professional level erythropoietin, growth hormone, blood transfusions
					<i>Health risks:</i> intake of banned substances despite perceived health hazards; trivialization of side effects and health risks; young cyclists not concerned about long-term health consequences
					<i>Reasons not to use doping:</i> ethical grounds, protect media image, fear of abusing compromising health, costs
					<i>Transmission of doping:</i> from former experienced generation to new generation of cyclists
					<i>Physicians:</i> chosen by athletes depending on attitude towards doping; 6/8 cyclists chose doctors with a positive reputation for doping
<i>Influence of doping scandals:</i> decreasing pressure of team staff and doctors to take banned substances					

Kamber M. et al., 2001, (38)	Non-clinical in-vitro toxicological analysis/ Yes	Determine if products on product labels contained anabolic androgenic steroid or stimulants not listed, or poorly described	N = 75 nutritional supplements bought through internet, of which n = 69 from US and n = 6 from Switzerland	IPEd use: chemical quality of substances	<i>Products with different substances than indicated on the labels:</i> In 41% (7/17) prohormones, corresponds to 9% (7/75) of all analyzed supplements
					<i>Products with ephedrine and caffeine:</i> 2 products without clear declaration on label; ephedrine concentration in 1 product high enough for a positive doping test when consuming one capsule
					<i>Testosterone:</i> not indicated on label but detected in several products
					<i>Development:</i> increase in use of supplements by athletes, some take daily more than 20 different products

Weber C. et al., 2017 (37)	Non-clinical in-vitro toxicological analysis/ 1. Jan. 2013 – 31. Dec. 2014/ Yes	Investigate pharmaceutical quality of doping products seized at the Swiss border	N = 1190 doping products	IPED use: diversity of used substances, chemical quality of substances	<i>Labeling of products:</i> 75% (889/1190 products) anabolic agents, 12% (146/1190) peptide hormones or growth factors and mimetics, 9% (113/1190) antiestrogens, aromatase inhibitors or other metabolic modulators; 3.5% (42/1190) either mixtures of compounds or of unknown classification
					<i>Pharmaceutical quality:</i> unsatisfactory, substandard pharmaceutical quality; nonapproved substances detected; <20% of products contained claimed substance in respective amount
					<i>Monosubstance products:</i> 27% (278/1038) of labeled compounds not detected (9% no active substance, 18% substituted by another doping substance); 73% (760/1038) detected, thereof 53% (552/760) accurately labeled, 20% (208/760) with ≥1 additional prohibited substance
					<i>Most common anabolic agents (monosubstances):</i> 27.3% (213/779) testosterone and its esters, 10.7% (83/779) methandienone, 9.0% (70/779) stanozolol, 8.5% (66/779) nandrolone esters, 7.2% (56/779) trenbolone esters, 6.3% (49/779) clenbuterol, 5.0% (39/779) boldenone esters, 4.6% (36/779) oxandrolone, 3.6% (28/779) DHEA, 3.5% (27/779) methenolone esters, 14.4% (112/779) “other steroids”
					<i>Most common peptide hormones, growth-factor related substances and mimetics (monosubstances):</i> 39.0% (57/146) human chorionic gonadotropin, 35.0% (51/146) human growth hormone, 6.8% (10/146) insuline-like growth factor 1
					<i>Most common hormones and metabolic modulators (monosubstances):</i> 42.5% (48/113) clomifene, 37.2% (42/113) tamoxifen, 10.6% (12/113) anastrozole
					<i>Concentration of all monosubstance products:</i> 32.0% (243/760) within anticipated concentration, 60.3% (458/760) under-concentrated (<50%), 6.1% (46/760) over-concentrated (>200%)
					<i>Only substance accurately labelled within anticipated concentration:</i> aromatase inhibiting drug (anastrozole, 12/760)
					<i>Formulations:</i> oral formulations more often within anticipated concentration than parental formulations

Weber C. et al., 2015, (31)	Observational study/ 1. Jan. 2013 – 31. Dec. 2014/ Yes	Evaluation of content, destination and source of postal items seized by Swiss customs authorities at Swiss border	N = 960 postal items	<p><i>IPED users:</i> epidemiology/  <i>IPED use:</i> diversity of used substances, access to banned substances</p>	<p><i>Amount in 960 postal items:</i> 1825 doping products; average of 1.9 doping products per seized item</p>
					<p><i>Manufacture:</i> 229 different manufacturers, well-known pharmaceutical companies, or underground laboratories; 12% (115/960) of items from China, 23% (221/960) from other Asian countries</p>
					<p><i>Shipping:</i> mostly through south-eastern Europe countries; 26.9% (258/960) Slovakia; 18.1% (174/960) Greece; 9.2% (88/960) China; 7.9% (76/960) USA</p>
					<p><i>Customers:</i> 849 different individuals, 82% (696/849) located in Switzerland; 10% (86/849) imported more than once</p>
					<p><i>Athletes subject to ADCH anti-doping rule jurisdiction:</i> 1% (7/696) of importers, sport sanctioning initiated on these; other importers no active link to organized sport (fitness and bodybuilding excluded)</p>
					<p><i>Gender:</i> 82% (696/849) of importers male, 15% (127/849) female, 3% (25/849) unknown gender</p>
					<p><i>Destination:</i> 82.5% (792/960) Switzerland (top import destinations in Swiss cities: Zurich (n = 81, 10%), Geneva (n = 18, 2%), Lausanne (n = 17, 2%), Bern (n = 14, 1%), Basel (n = 12, 1%) and St. Gallen (n = 10, 1%)), 17.5% (168/960) transit parcels to third country</p>
					<p><i>Substances:</i> 74% (1351/1825) anabolic androgenic steroid, mostly testosterone esters; 12% (219/ 1825) peptide hormones, growth factors, related substances, and mimetics; 10% (186/1825) hormone and metabolic modulators</p>
					<p><i>Products of women:</i> 16.7% (41/245) human chorionic gonadotropin, 16.3% (40/246) testosterone, 7.7% (19/246) clenbuterol</p>
					<p><i>Products of men:</i> 27.1% (406/1500) testosterone, 7.2% (108/1500) nandrolone, 6.8% (102/1500) methandienone</p>
<p><i>Estimated sales value:</i> 1'114'311 CHF; amount of seized doping substances doubled within a two-year period (n = 1096 vs. n = 506); much higher assumption of actual amount of imported doping products into Switzerland than number of seized items, but exact number not known</p>					

Bélanger R. et al., 2010, French, (24)	Survey/ 23. Feb. 2009 – 3. Jan. 2010/ No	Determine prevalence of psychoactive substances and performance-enhancing drugs between youth practicing sports and those not practicing sports and investigate characteristics of sports practicing youth who use psychoactive and/or doping substances with those who do not	N = 1247 young people aged 16-20 years (mixed)	IPED users: epidemiology, motivators of IPED use, knowledge about IPED use/ IPED use: diversity of used substances	Doping peers: 14% (125/894) of sportive adolescents, 9% (32/353) of non-sportive adolescents
					Use of PEDs: 73.1% (654/894) of sportive adolescents; mostly caffeinated products (esp. energy drinks), sports drinks, nutritional supplements (esp. vitamin supplements)
					Active use of substances either legal under certain circumstances or illegal: 5.1% alcohol, 11.3% analgetic drugs
					Banned substance most reported to enhance sports performance: 3.4% cannabis
					Use of products considered doping substances: in sportive adolescents: 3.7% current use, 2.1% previous use (1 growth hormone, 3 cocaine); in non-sportive adolescents: 1 currently using erythropoietin, 1 previous use of anabolic androgenic steroid
					Doping in future: 7.4% (66/894) among all sportive adolescents consider doping in future
					Offer of doping substances: 2.6% (23/894) of sportive adolescents; mainly through close friends
					Risk factors for use of cannabis and doping substances: living in urban area (AOR = 5.17)
					Protective factors: competitive sportive context (AOR = 0.37), being a student (AOR = 0.19)
					Impacts of cannabis consumption on doping: active doping in 32.4% of recreational cannabis users; cannabis users with higher use of other doping substances than non-cannabis users (2.3% vs. 0.1%; p<0.001)
Open-ended question on doping: 0.2% (2/894) of sportive adolescents ever used doping substances, of which none on WADA list (1 asthma inhalant potentially considered as doping product); 3.0% (27/894) not sure about the used substance (4 products could not be identified, 1 steroid, 1 Ritalin, 1 alcohol, 1 cannabis, 1 Swiss product containing nicethamide); in total 2/3 of substances not recognized as doping by WADA list					

Gebert A. et al., 2019, mixed, (26)	Survey/ 2016-2017/ Yes	Investigate how Swiss athletes and coaches perceive doping problem and current anti-doping policy	N = 1628, of which n = 1040 Swiss squad coaches and n = 588 Swiss athletes (professional athletes)	IPED users: affected sports disciplines, perception about IPEDs/ IPED use: information on IPED use	Doping seen as a serious problem in their sport: 41.5% (244/588) of athletes, 31.5% (328/1040) of coaches; individual sports more vulnerable to doping than team sports
					Sports disciplines with perceived doping problem: swimming, track and field, cycling, Nordic skiing
					Problem of doping: contradicts principle of fair play thought by majority of athletes and coaches
					Source of information about doping: Antidoping Switzerland (64.3%), coaches and staff (55.5%), federation and club (52.5%), physician (48.2%); 96.5% (567/588) of athletes and 81.7% (850/1040) of coaches feel enough informed
Coquet R. et al., 2018, French, (33)	Observation and semi-directive interviews/ Yes	Investigate evolution of practitioners' relations with IPED use	N = 30 interviews and n = 100 participant observations (amateur athletes)	IPED users: motivators of IPED use, knowledge about IPED use/ IPED use: diversity of used substances, access to banned substances	Substance use: use of supplements common; use of IPEDs seen as frontier between ordinary weightlifters and professional bodybuilders; commonplace in bodybuilding, seems unavoidable
					Attitudes towards doping: little or no ethical condemnation in bodybuilding world; effect of doping on performance relativized
					Motivation: IPEDs used to reduce risk of injury; sense of well-being and power through doping
					Beginning: none of practitioners imagined becoming bodybuilder and using IPEDs; initiation into IPEDs possible through interactions with more experienced peers; must be integrated into bodybuilding community
					Health risks of doping: understood by bodybuilders, sense of being in control of risks; IPED users referring to medical knowledge to regulate their substance use and oversee their state of health

Mettler S. et al., 2022, mixed, (27)	Survey/ 1 week in May 2018/ Yes	Determine prevalence of adolescent athletes' supplement use, motivating factors, sources of information	N = 430 adolescent elite athletes (professional athletes)	<p><i>IPED users:</i> motivators of IPED use, knowledge about IPED use, affected sports disciplines, performance-enhancing drug use among professional athletes/ <i>IPED use:</i> diversity of used substances, access to banned substances, information on IPED use</p>	<p><i>Supplement use:</i> widespread and large-scale; 84% regular use (<math>\geq 1</math> supplement weekly); 97% intake in past 4 weeks; only 3% never using any products; 43% of athletes consuming <math>\geq 7</math> different supplements, 1.1% <math>\geq 20</math>, maximum 25</p>
					<p><i>Sports disciplines:</i> 94.1% consumers in endurance sports, 84.2% in intermittent sports, 83.1% in power speed sports, 73.9% in other sports; in endurance sports mostly sport drinks and recovery products</p>
					<p><i>Quantity:</i> <math>\bar{x}</math>13.3 supplement servings/week; maximum 67 supplement servings/week; <math>\bar{x}</math>7.8 different supplement products</p>
					<p><i>Substances:</i> 40.7% of athletes multimineral products, 34.2% multivitamins, 34.2% Vitamin C, 32.8% Vitamin D, 31.6% caffeine</p>
					<p><i>Gender:</i> men significantly more Vitamin C/D, sports drinks, protein powder, recovery products; women iron supplements</p>
					<p><i>Motivation:</i> 40% recovery support, 39% health maintenance, 30% performance-enhancement</p>
					<p><i>Recommendation of supplements:</i> 36% family/friends, 27% physician, 25% coaches</p>
					<p><i>Information sources:</i> 56% people who recommended supplementation, 25% internet, 11% supplement suppliers; low level of information quality</p>
					<p><i>Knowhow:</i> indications of inappropriate supplement use (i.e., iron supplements or creatine 1x/week, large number of different supplements = no targeted supplement application)</p>
					<p><i>Supply sources:</i> 34% pharmacies, 31% supermarkets, 16% physicians, 15% parents</p>
<p><i>Attitude towards doping:</i> positive attitude towards doping associated with consumption of performance-enhancing supplements (<math>p = .017</math>); 1.4% would and other 1.4% would rather be willing using prohibited substances if nobody would find out</p>					



Baume N. et al., 2006, (39)	Non-clinical in-vitro toxicological analysis / end of 2002/ Yes	Analyze composition of supplements bought on the Internet regarding contaminations with major anabolic steroid parent compounds, stimulants, traces of testosterone, nandrolone and their precursors	N = 103 dietary supplements	IPED use: chemical quality of substances	<i>Anabolic steroid contamination:</i> very high amount of Metandienone in 3 products
					<i>Mislabeled supplements:</i> 18% (19/103); 1 creatine product, 3 mental enhancers, 14 prohormone products
					<i>Most frequent contaminant:</i> testosterone parent molecule
					<i>Consequences:</i> high Metandienone metabolite quantity, would cause a positive anti-doping test
Lentillon-Kaestner V. et al., 2009, French, (30)	Survey/ 2007-2009/ No	Understand drug taking practices related to all sports cultures	N = 1810 young French speaking Swiss aged 16 to 22 (amateur athletes)	IPED users: epidemiology, affected sports disciplines/ IPED use: diversity of used substances	<i>Definition of doping:</i> significant variation of prevalence rate depending on definition
					<i>Open-ended question:</i> PED prevalence of 2.7% (49/1810); 53% (26/49) of the products not on the WADA anti-doping list
					<i>List of doping products:</i> PED prevalence of 26.4% (478/1810); when purposes other than doping are removed: PED prevalence of 4.8% (87/1810), with 1.5% (27/1810) regular use
					<i>Gender:</i> boys more tempted by doping, more doping acquaintances, more positive opinion of doping, greater doping consumers (5.6% vs. 4% of women)
					<i>Level of training:</i> professional athletes more tempted by doping, more doping friends, higher doping consumers (8.1% vs. 4.8% in general education vs. 2.5% in higher education); competition level athletes' greater doping consumers than leisure athletes (5.2% vs. 4.2%) and having a more positive image of doping
					<i>Sports disciplines:</i> highest doping consumption in outdoor and team sports (judo, hockey, cycling)
					<i>Doping products:</i> asthma medicine (10.2%), marijuana (9.8%), local anesthetics (7.6%), beta blockers (2%), cocaine (1.5%), morphine (0.9%), diuretics (0.7%), corticosteroids (0.6%), amphetamines (0.5%), growth hormone (0.2%), anabolic steroids (0.1%), erythropoietin (0.1%), Heroin (0.1%)

Brissonneau C. et al., 2009, (35)	Semi-structured interviews/ 2007 - 2008/ No	Understand and compare effects of forms of socialization of young cyclists on their attitude towards doping	N = 70 interviews, of which n = 22 young cyclists becoming professionals, n = 22 former professional cyclists, n = 6 coaches, n = 5 doctors, n = 10 sports managers and n = 5 other interviewees (professional athletes)	<p><i>IPED users:</i> motivators of IPED use, PED use among professional athletes/ <i>IPED use:</i> information on IPED use</p>	<i>Cycling in Swiss Romandy:</i> little support from cities, cantons or confederation; autonomous training alone or in a group; cycling not very popular; obstacles in obtaining resources from sponsors
					<i>Choice of doctor:</i> some choose doctor who advocate pharmacological assistance (“doping doctor”); assumed to be less dangerous than consumption on one's own
					<i>Definition of doping:</i> different definitions; WADA definition important guide for all
					<i>Injection of substances:</i> only at professional level; rare in U23, more common amongst new professionals; too complex or costly
					<i>Doping:</i> very widespread among former cyclists; not extremely common amongst young; line between doping and non-doping becoming blurred during careers progress
					<i>Doping evolution:</i> collective doping practices in past; today significant lower doping level in peloton; winning a race without doping today possible
					<i>therapeutic use exemption:</i> main entry into doping; abuse of cortisone
					<i>Motivators:</i> professional insecurity, difficulty of races, absence of favourable support, curiosity, moving to professional level or at the end of a contract
					<i>Reasons not to dope:</i> health issues, risk to one's reputation if cheating becomes public, moral concerns, risk of no longer being able to practice one's profession
<i>Information:</i> regular exchange among cyclists, internet, gyms					

Stamm H. et al., 2011, mixed, (28)	Survey/ Oct. – Dec. 2007/ Yes	Determine how often supplements, medication and doping substances are consumed in recreational sport	N = 2500 recreational athletes (amateur athletes)	<i>IPED users:</i> epidemiology, motivators of IPED use, knowledge about IPED use, perception about IPEDs/ <i>IPED use:</i> diversity of used substances	<i>Supplement intake:</i> 18.5% (397/2144) without any intake, 22.2% (476/2144) ≤2x/week, 27.1% (581/2144) 1x/day, 32.1% (688/2144) ≥7x/week, 8.4% (180/2144) ≥14x/week; most commonly sports drinks, bars, magnesium, sports gels
					<i>Increased supplement intake:</i> high training frequency, competitions; consumers with foreign nationality, younger respondents
					<i>Knowledge:</i> 35.7% unaware if substances contained in supplements and 54.2% in medication were on doping list
					<i>Medication intake:</i> 13.5% (276/2043) regularly ≥1; only few to treat or prevent sports-related complaints; exceptions: 18.5% medication for muscle pain and respiratory tract; increased in women and older respondents; increased intake if no or few competitions are held
					<i>Doping misuse:</i> <5%; 9.7% (198/2043) already tried; increased in foreign nationality and younger respondents; increased misuse with increased frequency of training
					<i>Doping substances:</i> glucocorticoids, b2 agonists, anabolic steroids, growth hormone, erythropoietin, other
					<i>Motivation:</i> Doping for performance-enhancement (17.5%), pain relief (13.7%), regeneration (5.4%), muscle building (4.5%), other purposes (8.9%)
AOR: Adjusted Odds Ratio; CHF: Swiss Franc; CI: Confidence Interval; IPED: Image- and Performance-Enhancing Drug; PED: Performance-Enhancing Drug; USA: United States of America; WADA: World Anti-Doping Agency.					