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REVIEW ARTICLE

Doping in Sport: A Review of Elite Athletes' Attitudes, Beliefs, and Knowledge

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Abstract Doping in sport is a well-known phenomenon that has been studied mainly from a biomedical point of view, even though psychosocial approaches are also key factors in the fight against doping. This phenomenon has evolved greatly in recent years, and greater understanding of it is essential for developing efficient prevention programmes. In the psychosocial approach, attitudes are considered an index of doping behaviour, relating the use of banned substances to greater leniency towards doping. The aim of this review is to gather and critically analyse the most recent publications describing elite athletes' attitudes, beliefs and knowledge of doping in sport, to better understand the foundations provided by the previous work, and to help develop practical strategies to efficiently combat doping. For this purpose, we performed a literature search using combinations of the terms "doping", "sport", "elite athletes", "attitudes", "beliefs", "knowledge", "drugs", and "performance-enhancing substances" (PES). A total of 33 studies were subjected to comprehensive assessment using articles published between 2000 and 2011. All of the reports focused on elite athletes and described their attitudes, beliefs and knowledge of doping in sport. The initial reasons given for using banned substances included achievement of athletic success by improving performance, financial gain, improving recovery and prevention of nutritional deficiencies, as well as the idea that others use them, or the "false consensus effect". Although most athletes acknowledge that doping is cheating, unhealthy and risky because of sanctions, its effectiveness is also widely recognized. There is a general belief about the inefficacy of anti-doping programmes, and athletes criticise the way tests are carried out. Most athletes consider the severity of punishment is appropriate or not severe enough. There are some differences between sports, as team-based sports and sports requiring motor skills could be less influenced by doping practices than individual self-paced sports. However, anti-doping controls are less exhaustive in team sports. The use of banned substance also differs according to the demand of the specific sport. Coaches appear to be the main influence and source of information for athletes, whereas doctors and other specialists do not seem to act as principal advisors. Athletes are becoming increasingly familiar with anti-doping rules, but there is still a lack of knowledge that should be remedied using appropriate educational programmes. There is also a lack of information on dietary supplements and the side effects of PES. Therefore, information and prevention are necessary, and should cater to the athletes and associated stakeholders. This will allow us to establish and maintain correct attitudes towards doping. Psychosocial programmes must be carefully planned and developed, and should include middle- to long-term objectives (e.g. changing attitudes towards doping and the doping culture). Some institutions have developed or started prevention or educational programmes without the necessary resources, while the majority of the budget is spent on anti-doping testing. Controls are obviously needed, as well as more efficient educational strategies. Therefore, we encourage sporting institutions to invest in educational programmes aimed at discouraging the use of banned substances. Event organizers and sport federations should work together to

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adapt the rules of each competition to disincentivize dopers. Current research methods are weak, especially questionnaires. A combination of qualitative and quantitative measurements are recommended, using interviews, questionnaires and, ideally, biomedical tests. Studies should also examine possible geographical and cultural differences in attitudes towards doping.

1 Introduction

The use of performance-enhancing substances (PES) is not a new sporting phenomenon [1]. Since 2004, the World Anti-Doping Agency (WADA) has annually updated their Code and related documents that outline the official international anti-doping standards. Currently, two of the following three criteria must be met for a substance or method to be included on the prohibited list: (1) it enhances or has the potential to enhance performance; (2) it represents an actual or potential health risk to the athlete; and (3) it violates the spirit of sport described in the introduction to the code [2]. The aims of the World Anti-Doping Programme and the Code are to care for the athlete's fundamental right to participate in doping-free sport and thus promote health, fairness and equality for athletes worldwide, and to guarantee harmonized, coordinated and effective anti-doping programmes at the international and national level relating to the detection, deterrence and prevention of doping [3, 4].

Doping in sport has been a focus of medical, physiology and social science research in recent years. According to Gucciardi et al. [5], whereas medical and physiology researchers focus on improving methods (e.g. blood, urine and gene tests) for detecting the use of prohibited substances and to deter athletes from their use [6], social science researchers strive to better understand the psychosocial factors (e.g. attitudes, environment and beliefs) that may offer targets for educational programmes aimed at preventing this behaviour [7].

According to Petroczi and Aidman [8], in the absence of objective information on the use of performance-enhancing drugs (PED), attitudes are often used as a proxy for doping behaviour, assuming that those who use banned substances show greater leniency towards doping than those who stay clear of doping. Attitudes were also clear foci in behavioural models of doping [9–12] that were developed to identify possible risk factors for this behaviour. Consequently, researchers have identified the need to develop more sophisticated and bespoke interventions to support the athletes with attitudes that increase their likelihood of using banned substances, and the need to develop empirically tested models [7]. Based on these previous studies, it is reasonable to agree with the statement by the WADA that, in addition to medical, analytical and physiological investigation, anti-doping research should also include sociological, behavioural and ethical studies of athletes' attitudes and beliefs towards the use of banned substances in sport.

Unlike other areas [7], very few studies have focused on the attitudes, beliefs or knowledge of elite athletes towards PED [1]. One reason for this is that access to the population is not easy. In addition, athletes may be unwilling to discuss this topic with researchers, even if anonymity and confidentiality are guaranteed by the investigators [1]. Consequently, obtaining reliable information on doping behaviour is hindered by the fact that athletes are asked to admit to a behaviour that could jeopardize their sporting career [8].

While testing and research play a central and high-profile role in WADA's anti-doping strategy, their education programme is deemed central to fostering a lasting anti-doping culture in elite sports [13]. In the absence of more objective information on the use of PED among elite athletes, a greater understanding of the athletes' attitudes and their origins should allow us to develop more effective anti-doping educational programmes [1]. According to Vangrunderbeek and Tolleneer [14], if a physical education teacher's task is to educate children in a certain way, the school will be the primary source of education that children receive, apart from their upbringing by their parents. Therefore, a sports teacher or a coach that follows similar pedagogical principles must make it clear to athletes at an early age that doping is not an option.

Although the athletes' beliefs and values may influence whether or not an athlete will use banned substances in sport [8, 15], little is known about the elite athlete's attitudes. Therefore, the aim of this review is to gather and critically analyse recent publications (from 2000 to 2011) that described elite athletes' attitudes, beliefs and knowledge of doping in sport, to better understand the foundation provided by previous work and to help develop practical strategies to effectively combat doping in sport.

2 Methods

A systematic literature search was performed using a set of relevant criteria that were established a priori: (1) the study subjects consisted of "elite athletes"; and (2) the article reported on the attitudes, beliefs, and/or knowledge of doping in sport. For this study, we defined "elite athletes" as the best athletes in each sport at a national and/or international level, as suggested by Dunn et al. [16].

We searched PubMed, MEDLINE, Web of Knowledge, Scopus, and SPORTDiscus™ using a set of doping-related keywords to identify potentially relevant articles. Since

each database has unique indexing terms, bespoke search strategies were developed. The first search terms included combinations of "doping", "sport", "elite athletes", "attitudes", "beliefs", and "knowledge". To complete the search, and because of the nature of terms like "doping", in the scientific literature, we repeated the search by replacing "doping" with "performance-enhancing substance" and "drugs". In the first search that was carried out through to December 2011, we used the keyword "athletes" rather than "elite athletes" to later compare how many articles would be eliminated. The electronic search identified 99 potentially valid articles, after combining the articles retrieved from each database. When we added the term "elite athletes" to the search terms, the number of articles was reduced to 29, of which 20 met our established criteria.

We next performed a manual search of the references cited in the studies retrieved in the electronic search. This search retrieved 13 studies that met our criteria but were not identified in the original electronic search. Therefore, a total of 33 articles published between 2000 and 2011 were retrieved and evaluated. Although studies that focused on nutritional supplements were not the intended target of our review, those that met our criteria were reviewed and analysed. Articles that only reported the prevalence rates or that did not specifically refer to doping in sport were excluded. Only full papers published in peer-reviewed journals in English were included in this review (see Fig. 1).

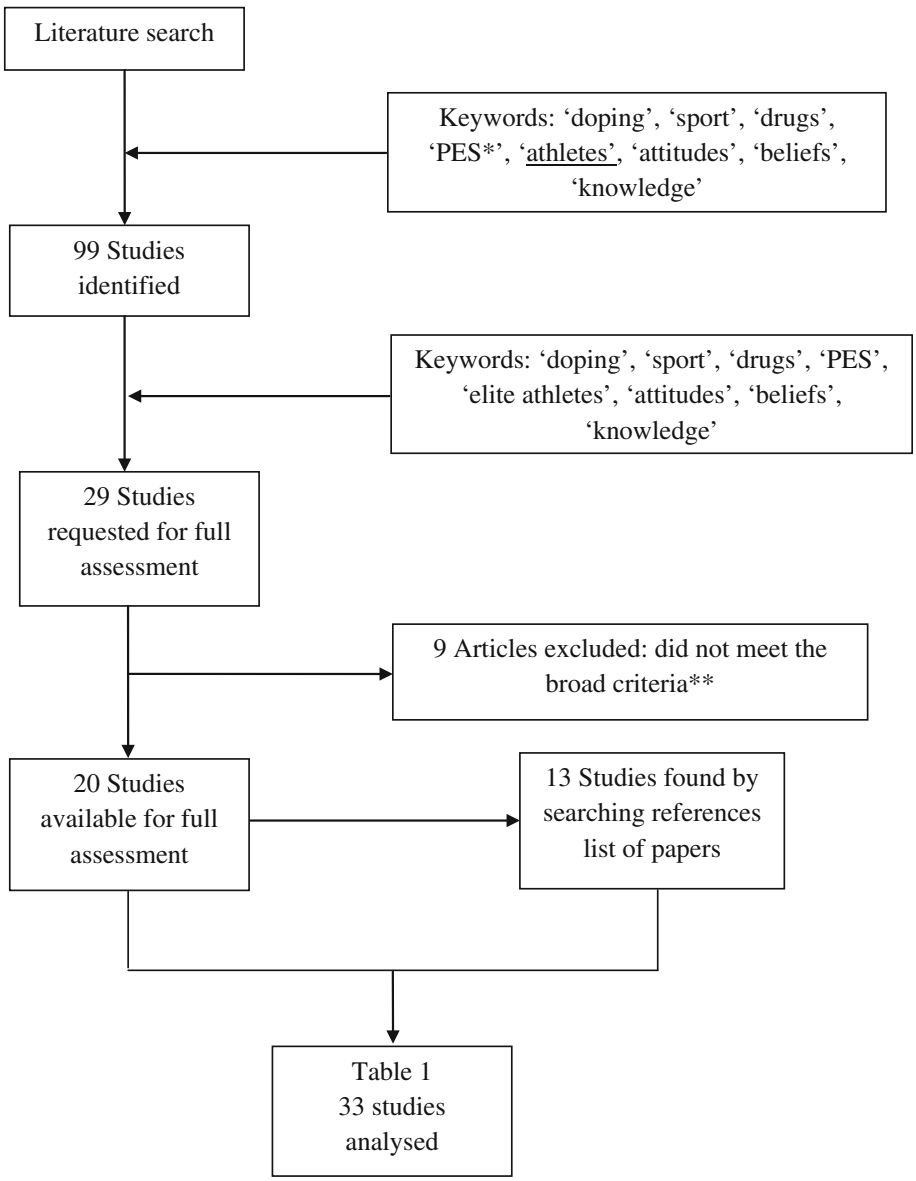

Fig. 1 Search procedure. Thirty-three studies accepted for analysis

3 Findings

3.1 Reasons for Use and Attitudes Towards Doping

To help introduce this section, we should consider that there are different approaches to explain doping behaviour. One is "realistic evaluation", which considers that outcomes (behaviours) are the sum of the mechanisms and the context [17]. This could consist of an influential approach to assess social promotion programmes, such as those promoting health. The MINDSPACE (Messenger, Incentives, Norms, Defaults, Salience, Priming, Affect, Commitment and Ego) framework [18] identified nine factors that could influence behaviours in mostly automatic, rather than deliberate, ways. This theory should be evaluated in the context of pro- or anti-doping decisions because these decisions seem to be more deliberate than automatic.

According to Lucidi et al. [11], the "theory of planned behaviour" [19] suggests that behaviours depend on the individual's plan of actions towards a specific behaviour (i.e. intentions), which is regulated by the individual's perceived behavioural control, subjective norms and attitudes. In this regard, Lucidi et al. [20] reported that "attitudes" were the strongest predictors for the intention to use doping substances.

3.1.1 Reasons for Use

Striegel et al. [21] described that the most frequently reported reasons for drug use were to achieve athletic success (86 %) and for financial gain (74 %). The responders ($n = 101$) also described that their motives included increasing self-confidence (30 %) and social recognition (24 %). Similar results were reported by Backhouse et al. [7] in their exhaustive review submitted to WADA in 2007. Pitsch et al. [22] reported that 5.1 % of the participants in their study were encouraged to engage in doping practices by their coaches and 6.5 % were encouraged by their family members and friends. However, in another study ($n = 40$), the athletes perceived no external pressure to encourage their use of PED, although the respondents did cite several reasons for their use, including to aid recovery from injury and the economic pressures of elite sport [1]. Although PES are not necessarily defined as PED (the latter are PES, but they are also substances specifically banned by WADA), we should take into account the reasons given by athletes for their use, particularly because of the close definitions of PES and PED, and the classification of some compounds, which could change each year (as with caffeine). From this context, Nieper [23] described, in a small study of 34 elite junior athletes, several different reasons for using PES as follows: to protect health (45 %), to enhance the immune system (40 %) and to improve performance (25 %). Similar results were observed in the study by Kim et al. [24], in which PES were reported to improve recovery ability (66 %) and muscle performance (22 %). Erdman et al. [25] stated that the three most popular reasons given for considering supplementation in a study of 582 athletes were to increase energy (54.3 %), to maintain health or prevent nutritional deficiency (53.8 %), and to improve exercise recovery (52.2 %). In other study, 15 % of the responders ($n = 403$) reported that supplement use is necessary to be successful in sport [26].

Meanwhile, all of the young elite cyclists ($n = 8$) interviewed by Lentillon-Kaestner and Carstairs [27] took nutritional supplements in the belief that they improved their performance. Hence, they were attracted to doping and admitted that they were open to using doping substances themselves if they considered it was essential to continue their cycling career, but only after they became professional. In another study of the same sample, Lentillon-Kaestner et al. [28] reported that the pressure exerted by team staff and doctors on the use of banned substances by cyclists has become less important and less direct after various doping scandals.

Dunn et al. [29] considered the so-called concept of the "false consensus effect", which has been discussed elsewhere [30, 31]. This term suggests that athletes with a history of illicit drug use overestimate the prevalence of drug use among other athletes. These results warrant much attention because the participants tended to report a higher prevalence of drug use among athletes in general compared with athletes in their own sport. Although overestimation of drug use was not common, it appeared to be influenced by the participants' history of drug use. In this context, Tangen and Breivik [32] showed that an individual's decision to take banned substances is influenced by the assumption that his or her competitors are also taking drugs [13]. Similarly, in the study by Uvacsek et al. [31], 14.6 % of 82 athletes acknowledged using banned substances and 31.7 % reported using recreational drugs. Moreover, those who admitted to using PED significantly overestimated the prevalence of doping in their sport (Mann–Whitney $U = 299.00$; $p = 0.098$) compared with those who abstained from doping. Therefore, it seems athletes who believe that others are taking PED are more likely to start using them as well, which could establish a vicious cycle that propagates the pro-doping culture. This is why people around athletes (i.e. physicians, coaches, family, and friends) must be very careful about the "false consensus effect" when talking about doping. It is important that these stakeholders stress the importance of avoiding doping and do not exaggerate the supposed use of PED or the assumption that those who achieve success are taking PED.

3.1.2 Attitudes Towards Doping

According to earlier studies [1, 7], the general lack of scientific literature describing elite athletes' attitudes towards doping could be due to the difficulty in convincing athletes to discuss this topic with researchers.

Peretti-Watel et al. [33] conducted a cross-sectional study of elite student athletes ($n = 458$) in France. Almost all responders (90 %) reported that doping was dishonest, unhealthy and/or risky because of sanctions. In another study, 74.0 % of the athletes stated that the use of banned substances is dangerous or very dangerous to health [15]. De Hon et al. [34] assessed the attitudes of Dutch elite athletes ($n = 433$) towards various anti-doping matters. In that study, 91 % of the respondents reported that they would feel guilty if they used banned substances themselves. Similar results were reported by Bloodworth and McNamee [1], who interviewed 40 English elite young athletes organized into 12 focus groups. Their respondents, generally, viewed doping as "unnatural" and considered the shame associated with doping was a significant deterrent. Mottram et al. [35] reported that the majority of responders ($n = 507$) were of the opinion that stimulants enhance performance, pose a risk to health and their use is against the ethical spirit of sport.

In a cross-sectional study of 458 elite student athletes in France, three groups of subjects were identified according to their attitudes towards doping, health and performance: (1) those who considered doping as both dangerous and useless (Cluster 1; $n = 242$; 52.8 %), (2) those who viewed doping as dangerous but helped improve performance (Cluster 2; $n = 103$; 22.5 %); and (3) those who regarded doping as a dangerous but an essential adjunct to sporting and nonsporting achievement (Cluster 3; $n = 113$; 24.7 %) [33]. In a complementary study, Bloodworth et al. [26] conducted a survey of 403 talented athletes on their attitudes towards doping. In response to the question "How much do you agree or disagree with the following statement: You have to take supplements to be successful in sport", 45.4 % of young athletes disagreed and 33.0 % strongly disagreed. The responders, in general, also expressed a strong belief that no substance should be allowed for performance-enhancing purposes.

Alaranta et al. [15] assessed the self-reported attitudes of 446 Finnish elite athletes and 90 % believed that banned substances had performance-enhancing effects. In addition, 7.3 % of the athletes reported that they would use PES if their use was allowed (9.2 % men vs. 7.3 % women; $p = 0.05$). Notably, 96.9 % of the athletes considered that it is possible to reach the highest international level in sport without using banned substances or methods. Dascombe and Karunaratna [36] reported similar results, as 87 % (63/72) of athletes in their study had used nutritional supplements, while 63 % (45/72) recognized that their use could violate doping regulations.

Breivik et al. [37] compared the attitudes of Norwegian elite athletes ($n = 234$) with those of the general public ($n = 428$) and reported that elite athletes were more reluctant to use PES. Although the use of non-banned nutritional supplements was considered acceptable by more than 65 % of both groups (athletes and general population), both groups rejected the use of erythropoietin, anabolic steroids and amphetamines. In this context, Connor and Mazanov [38] considered that elite athletes constitute a discrete group with a set of norms, values and beliefs that are quite different from those of the wider population. This could be directly related to the different motivations, objectives, necessities, pressures, knowledge and other external influences placed on elite athletes, which could result in different behaviours. Therefore, comparisons between general populations and elite athletes, or even between athletes in different types of sports, should be made with caution.

Lentillon-Kaestner and Carstairs [27] interviewed eight Swiss elite young cyclists who reported that doping was acceptable at the professional level in cycling but not at the amateur level. Another study [39] stated that among Polish athletes ($n = 830$) who showed moderately positive attitudes, their attitudes towards anti-doping controls were much stronger than they were towards sanctions (multivariate analysis of variance [MANOVA]: Wilk's $\lambda = 0.74$, $F_{(3,782)} = 89.34$; $p < 0.001$), Furthermore, females were significantly less permissive than males (MANOVA: Wilk's $\lambda = 0.96$, $F_{(4,780)} = 8.55$; $p < 0.001$).

Bloodworth et al. [26] reported that the use of any substance to improve concentration was the most acceptable, while gene manipulation was the least acceptable in a survey of 403 athletes. In their study, 10 % responded that they would take a "magic" drug. Meanwhile, 72.6 % reported that at least some other athletes would take the drug if it had no harmful effects, while more than 40 % reported that some athletes would take the drug, even if it shortened the lifespan. Similar results were obtained in the study by Bloodworth and McNamee [1], in which a minority of athletes would consider using a banned hypothetical PES if it guaranteed success and was undetectable. Similarly, 5 % of English footballers ($n = 706$) reported that they would take banned PES if it could guarantee them selection for the national team in the next World Cup [40].

Barkoukis et al. [41] studied the motivational, achievement goals and sportspersonship profiles of 1,075 elite athletes in terms of their doping behaviour. A cluster analysis revealed three important segments with respect to self-determination (intrinsically motivated, extrinsically motivated and amotivated athletes). Amotivated athletes ($n = 129$) had significantly higher scores for past use of

prohibited substances and intentions for future use compared with intrinsically motivated ($n = 449$) and extrinsically motivated athletes ($n = 457$). On the other hand, no significant difference ($p > 0.05$) in the past use of banned substances and intentions for future use was found between athletes with high- and low-levels of sportspersonship. Peretti-Watel et al. [42] also used cluster analysis to summarize the attitudes towards doping among 996 elite student athletes ($F_{(2,1016)} = 0.221$; $p > 0.05$; $F_{(2,1014)} = 1.27$; $p > 0.05$). It was stated that 52.8 % of participants were prone to agree with a variety of statements dealing with sport- or non-sport-related benefits of banned PES.

Lazuras et al. [43] examined the predictors of doping intentions in Greek elite athletes because they expected that their attitudes, social norms (descriptive and injunctive) and behavioural control beliefs (reflecting both internal and external control processes) would significantly predict doping intentions. Pearson's correlation coefficients revealed that social desirability was negatively but significantly correlated with doping intentions ($r = -0.16$; $p < 0.001$) and situational temptation ($r = -0.27$; $p < 0.001$), which suggests that past and current doping behaviour strongly predicts doping intentions. According to these authors, behavioural control and attitudinal beliefs can be changed to reduce the future risk of doping. Therefore, according to Peretti-Watel et al. [33], other factors associated with a positive attitude towards doping include (1) a low personal and parental academic achievement; and (2) extensive involvement in sports, as assessed by the number of hours per week spent engaging in sporting activities.

On the other hand, a study of 830 Polish elite athletes showed an association between goal orientations and attitudes towards doping [39]. Using multiple regression analyses, it was shown that ego or achievement orientation was significantly negatively associated (i.e. more permissive) whereas task orientation was significantly positively associated to (less permissive) to attitudes towards doping.

Based on these studies, it could be argued that athletes are aware of the fact that the use of PED constitutes cheating, and that the athletes generally show anti-doping attitudes. However, it seems that there is a significant difference between what some athletes say and what they really think, which is a major limitation of these surveys.

3.1.3 Attitudes Towards Doping Controls

Dunn et al. [16] stated that 75.9 % (738/974) of Australian elite athletes considered testing an effective deterrent to drug use. In addition, 59 % (575) of the athletes agreed/strongly agreed that there should be separate punishments for being caught using an illicit drug and being caught using a banned PES in their sport.

On the other hand, Chester et al. [44] reported that this anti-doping system is only reaching elite athletes, not those who have the potential to become elite. According to Striegel et al. [21], who surveyed 74 sports athletes, measures should be taken, such as improved doping controls, to eradicate doping in sport. Overall, 79 % of the respondents did not regard current dope testing to be sufficient. A similar conclusion was reached by Alaranta et al. [15].

These findings raise doubt about the ability of the current dope testing programme to detect banned substances because the relatively high level of recreational drug use is not reflected in the number of positive tests, which means that many football players could avoid potential detection [31]. Additionally, official statistics on drug tests could considerably underestimate (8-fold lower) the real prevalence of doping among elite athletes [45]. Therefore, many authors have different opinions regarding the current anti-doping programmes, most consider them to be quite ineffective.

Other studies [46, 47] have highlighted another problem with respect to dope testing, namely false-positive results. Berry [47], in a commentary published in *Nature*, stated that "Floyd Landis, a disqualified cyclist after winning the 2006 *Tour de France* for doping, had an 8 % probability of being innocent". Berry also recommended that this situation must be remedied because cheaters evade detection and innocents are falsely accused. One example is the seven-time *Tour de France* winner Lance Armstrong, who never tested positive during his career, was not free of suspicion, and years later was investigated, found guilty and, consequently, sanctioned. The sensitivity and specificity of a test should also be determined with a high level of accuracy before any conclusion on doping can be reached [47]. This was the case for the *Tour de France* winner Alberto Contador, who tested positive for clenbuterol (concentration, 0.00000000005 g/ml) using a highly sensitive test that had never been used before. In his case, it took more than 1 year of deliberations before his title was eventually stripped.

On the other hand, Waddington et al. [40] highlighted the limited number of controls in English elite-level football and commented that a system which allows many players to say that they do not expect to be tested in the next year is not an efficient system. They reported that one-third of English professional footballers had not been tested within the preceding 2 years and 60 % considered that they were unlikely to be tested in the next year. Surprisingly, only one in eight players ($n = 706$) had undergone blood tests at their club. In this regard, Alaranta et al. [15] concluded in their study, which compared attitudes towards doping according to the type of sport, that "controlling doping only by tests is not sufficient".

Anti-doping researchers are continually searching for new tools to catch cheaters. Indeed, several new

instruments have been introduced, such as the "biological passport"; however, these instruments are still subject to criticism [48]. Additionally, some elite athletes, who are enrolled in a system run by WADA called Anti-Doping Administration & Management System (ADAMS) [2], are required to be available for testing without advance notice throughout the year and must inform the corresponding authorities where they are at each moment. If an athlete provides incorrect information or cannot be found when a test is intended to take place, he or she could be given a warning. According to current anti-doping regulations [2, 4], three such warnings within 18 months may be regarded as a violation of the doping regulations and may lead to exclusion from sport for between 3 months and 2 years. According to Hanstad and Loland [49], however, the location reporting system is controversial because it does not respect ideas of justice or the athletes' autonomy and right to self-determination. De Hon et al. [34], who studied 433 Dutch elite athletes, also consider the ADAMS and location reporting system to be the most controversial anti-doping rule. Overall, 61 % of the athletes in that study had experience of reporting their location, but 33 % regularly experienced problems with fulfilling the ADAMS requirements. However, the testing procedure itself was slightly less controversial, as more than half of the athletes supported the principle of out-of-competition testing.

There is a lack of studies comparing attitudes among different sports, particularly the attitudes of athletes to doping controls. To our knowledge, no studies have compared the impact of geographical or cultural influences on these attitudes, for example how doping controls are perceived by European versus African elite athletes, or whether religion and/or economic status can affect these perceptions. These factors should be taken into account in further research.

3.1.4 Attitudes Towards Punishment

According to Waddington et al. [40], 59 % of 706 football players considered the level of punishment for the use of banned drugs was correct, 25 % felt it was not severe enough, and 3 % suggested that the punishment was too severe. Similar results were reported in the study by Striegel et al. [21], where 74 % ($n = 74$) of the athletes supported governmental interventions in anti-doping efforts through the establishment of anti-doping laws. In the study by Pitsch et al. [22], 16.7 % of the responders ($n = 448$) admitted knowing of cases where athletes had tested positive for doping but were not sanctioned. Consequently, the punishment system was considered to be too weak.

Based on these findings, we suggest that the involved institutions (i.e. WADA, International Olympic Committee, national anti-doping agencies and national/international sport federations) develop a testing protocol directed at athletes under suspicion of doping, taking into account their competitive calendar and doping-sensitive moments during the season, rather than conducting randomized tests or conducting tests only during competitions.

On the other hand, D'Angelo and Tamburrini [50] considered that the doping debate has traditionally been dominated by stakeholders who desire to see doping forbidden (i.e. the prohibitionist view) and those who want to see it acceptable (i.e. the ban abolitionist view). These authors proposed a third position, starting from the assertion that dope use is a symptom of the paradigm of highly competitive elite sports, in the same way addictions reflect the current social paradigms in the wider society.

Future studies should attempt to discriminate between the views and opinions of elite athletes involved in different sports (e.g. football vs. cycling) on testing and punishments. As described above, these studies should also take into account possible geographical/cultural differences.

3.2 Doping and Different Types of Sport

The status of doping in different sports has been examined in several studies. For example, Waddington et al. [40] reported that English professional footballers undergo drug tests less often than many other elite athletes, with only about 33 % undergoing tests each year. The authors also reported that 77 % of elite track and field athletes considered that they were certainly or were likely to be tested out of competition each year, compared with just 40 % of footballers, with 2 % and 38 % certainly or likely to be tested, respectively.

In the study by Peretti-Watel et al. [42], 52.8 % of participants were prone to agree with a variety of statements focusing on the benefits of doping in a sample of 996 young elite athletes. This behaviour was linked to motives to participate in sports, and it was more prevalent among friends, older responders, those practicing an individual sport (e.g. athletics or cycling) without frequent contact with other athletes and those registered in a training centre dependent on a professional club.

Alaranta et al. [15] conducted a study of 446 Finnish elite athletes, of which 30 % knew another athlete who used banned drugs. Notably, 42.5 % were stress power and speed athletes, and 37.0 % were endurance athletes. On the other hand, just 17.8 % of athletes involved in motor skill-demanding activities knew another athlete who used banned drugs. In addition, 15 % of the athletes reported that they had been offered banned substances, including 21 % of the speed and power athletes, 14 % of team sport athletes and athletes in motor skill-demanding events, and 10 % of the endurance athletes. In another study, Alaranta

et al. [51] noted that the type of sport had a significant impact on medication use. Among speed and power athletes, 18.6 % had used prescribed non-steroidal anti-inflammatory drugs (NSAIDs) and 4.4 % had used oral antibiotics during the past 7 days, whereas endurance athletes more frequently reported the use of anti-asthmatic and anti-allergic drugs.

Lazuras et al. [43], took into account the type of sport in their analysis of the use of PES in a cohort of 750 Greek elite athletes. They found that the use of banned drugs was significantly more common ($p < 0.005$) in individual sports (14.4 %) than in team sports (7.4 %). On the other hand, Mottram et al. [35], in a study of 507 elite athletes who represented ten Olympic sports, found that athletes involved in athletics, cycling and weightlifting were more likely to know and understand doping rules than athletes in other sports.

Lentillon-Kaestner et al. [28] highlighted the statements made by young cyclists who reported a distinction between two generations of cyclists: cyclists within the new generation, and those in the older generation who started their cycling career before the "Festina scandal" in 1998 in which different cycling teams participating in the *Tour de France* were involved in the use of banned substances. According to the cyclists in that study, doping use has declined among professional cyclists. The study also highlighted that most current cyclists decide not to use banned substances. In the past, the cyclists that chose not to take banned PES were marginalized. The cyclists surveyed acknowledged that doping organizations appear to have become more individualized. Hence, the authors concluded that, although the use of banned substances is becoming less widespread, the substances used are similar to those used in institutionalized "doping" programmes among cycling teams in the 1990s.

It could be argued that the differences between sports could be related to the independence of sport federations in most competitions, which only seems to be reduced in the Olympic Games. It is also possible that the number and quality of controls in each sport differ substantially (e.g. cycling vs. football). Therefore, because doping is a general issue, we suggest that all sport federations follow the same anti-doping protocols to avoid unfair situations among sports.

3.3 Sources of Information

In terms of advice on supplement use, the studies have revealed different but interesting data. Waddington et al. [40] suggested that English professional footballers took advice from the club's physiotherapist (28 %), 21 % from a fitness trainer, 21 % from another sports scientist (e.g., nutritionist), while the club's doctor was their last option (15 %). Surprisingly, 18 % acknowledged that they used supplements without taking advice from anyone. Nieper [23], in a survey of 34 British junior team athletes, noted that coaches provided the greatest influence (65 %), followed by sports dieticians (30 %) and doctors (25 %). Nieper also emphasized that, even though most athletes (72 %) had access to a sports dietician, they often underutilized this resource. In contrast, Somerville et al. [52] reported that the doctor was the first option for 62 % (46/74) of athletes in their study.

Other studies showed different sources of information. Erdman et al. [25], in a sample of 582 high-performance athletes, showed that the most common sources of information on the use of PES were family/friends (52.7 %), team mates (44.3 %), and coaches (40.7 %). Similar results were obtained in a study of Korean Olympic athletes [24], where the most common sources of information were parents (36 %) and coaches (35 %). In the study by Peters et al. [53], 25 % of elite athletes ($n = 1{,}757$) stated that their coach was the first contact for doping issues. Additionally, only 24.6 % of the athletes actively tried to obtain information, with the Internet being the most used source (42.1 %). In this context, Thomas et al. [54] reported that improving accessibility to reliable information via the Internet could be an effective way to help educate athletes on the effects of doping. Accordingly, we suggest that it is important to educate the people surrounding athletes, as they are often the most influential. People who induce and/or support the use of banned substances by athletes should also be punished. Nevertheless, if we educate athletes, they can search for appropriate sources of information and also evaluate its quality.

3.4 Measurement Instruments

A recent comprehensive review [55] reported that the current research methods used to examine attitudes towards doping in sport are weak. For most of the measurement tools, the scale development process was not reported at all, or not in sufficient detail. Furthermore, the scales were not subjected to psychometric testing, which seriously undermines the validity and reliability of any inference made based on the resulting scores [8]. Consequently, the bespoke measures, such as anonymous self-reported questionnaires that were developed and used for a single research project, could have limited scientific reliability.

Taking into account the few validated measurement tools [5, 25, 31, 39] used to assess attitudes towards doping in sport, the study by Petroczi and Aidman [8] must be emphasized because they developed a specific psychometric instrument, the Performance Enhancement Attitude Scale (PEAS). According to these authors, when the test scores are interpreted as one's attitude, and when

inferences are made for a specific population, it is essential to demonstrate reliability and validity of the scale. Methodologically, repeated use of a scale is encouraged because it provides researchers with empirical evidence for the test's validity and reliability. The PEAS has since been used in other studies, including the study by Uvacsek et al. [31]. In that study, as was expected, of 82 Hungarian competitive athletes assessed, those who confessed to drug use (12 %) scored significantly higher on the PEAS compared with those who reported no use of banned drugs. However, as this validated measurement instrument is completed as a self-report questionnaire, it has some limitations. Chester et al. [44] suggested that data collected using self-report questionnaires should be interpreted with caution because the answers may be intentionally false as the respondents may not wish to reveal that they or their team mates use drugs, even if anonymity and confidentiality are guaranteed by the investigators.

Several authors have considered the use of other instruments or have combined different measurement tools in their studies. For example, interviews, which are considered to be more reliable, were conducted in relatively few studies [22, 27, 28, 45, 53, 56]. Bloodworth and McNamee [1] conducted interviews of focus groups, whose discussions were recorded and transcribed in their qualitative study. Meanwhile, Thomas et al. [54] collected data using quantitative surveys and qualitative interviews with key experts who came into contact with elite athletes. Pitsch et al. [22] considered that interviews can provide more reliable information for questions related to illegal practices. In this context, Striegel et al. [45] sought to estimate the prevalence of doping abuse by surveying 1,394 athletes with an anonymous standardized questionnaire (SQ) and interviewed 480 of them using a randomized response technique (RRT). According to the RRT data, 6.8 % of the athletes confessed to having used banned drugs, whereas the results of the SQ revealed only 0.20 %, 4-fold fewer, had used banned drugs ($p < 0.001$). Although interviews seem to show greater reliability than questionnaires, very few studies have used this technique because access to elite athletes is very difficult [1]. Therefore, discussions between athletes and researchers on such a delicate matter may not be valid.

Another measurement tool that could be used to evaluate attitudes towards doping is Discursive Psychology (DP). However, of all the studies identified in our search, only one used this theoretical and methodological framework [57]. That study explored how one high-profile athlete, the Australian cricketer Shane Warne, accounted for his drug-taking behaviour when talking to the media. The authors argued that, to better understand drug use in sport, researchers need to understand how athletes talk about drugs. However, the use of media interactions as a source of data are not common in sport psychology, possibly because this information could be biased as the users of PED are likely to lie to the media to protect themselves from the possible economic and sociologic consequences associated with admitting to PED use.

A combination of both qualitative and quantitative measurements, ideally including less-invasive biomedical tests (e.g. based on hair and/or salivary samples), should be used to objectively determine attitudes towards doping in sport and to assess the efficacy of intervention programmes by understanding what is working and why. Therefore, we suggest that validated and comparable tools should be used in such research.

3.5 Knowledge About Doping and Its Side Effects

According to Petróczi and Aidman [8], increased knowledge of the risk factors and a better understanding of the causes of doping behaviour are among the priorities of WADA [58]. In this context, Erdman et al. [25] reported that 76.7 % of 582 responders said that they were aware of anti-doping regulations and 89.5 % believed they were following the regulations for anti-doping. However, only 63.2 % of the participants reported having access to anti-doping information. Moreover, Maughan et al. [59] reported that supplements are often used without full understanding or evaluation of the potential benefits and risks associated with their use, and without consultation with sports nutrition professionals. Additionally, Dascombe et al. [36] reported that among athletes who used supplements (63/72), many did not know their supplement's active ingredient (61.9 %, 39/63), possible side effects (57.1 %, 36/63) or the mechanism of action (54.0 %, 34/63). Furthermore, 57.0 % (36/63) admitted that they wanted additional information and only 52.4 % (33/63) knew the recommended supplement dosages. In a study of 706 English professional footballers, Waddington et al. [40] found that 68 % were aware of UK sport guidelines on banned drug use, but the remaining 32 % were not. Backhouse et al. [7], in their report on drug use in sport submitted to WADA in 2007, found similar results, supporting the fact that athletes should be more aware of doping-related information.

To test athletes' understanding of doping in sport, Mottram et al. [35] conducted a questionnaire survey of 507 athletes from four English-speaking nations (Australia, Canada, the UK and the US) in which they were to answer four questions related to their knowledge of punishments for doping and the status of certain substances on the prohibited list. Overall, 50.5 % knew the penalty incurred following a doping violation involving a banned stimulant. The terms "Monitoring Programme" and "Specified Substance List" were known by 43.3 % and 67.5 % of responders, respectively. The status of substances on the

Prohibited List was correctly identified by just 35.1 % of the subjects. Interestingly, younger athletes (aged ≤20 years) were generally less knowledgeable than older athletes, although the difference was not statistically significant ($p = 0.367$).

Peters et al. [53] stated that 66.4 % of 1,757 competitive athletes surveyed wanted more detailed information on doping. Similar results were obtained by Nieper [23] where 25 % of 34 track and field elite athletes surveyed believed they had average knowledge of dietary supplements, while 75 % felt that they needed more information. De Hon et al. [34] surveyed 433 Dutch elite athletes and observed that their knowledge of the Prohibited List and doping regulations was good (7.1–8.8 on a scale of 0–10). They concluded that athletes would support better international coordination, more educational opportunities and more anti-doping instructions for their technical personnel. In, another study [52], 90 % of responders ($n = 74$) had received a doping educational update in the last 6 months, and clearly agreed (with a score of 6.0, on a scale from 1 = strongly disagree, to 7 = strongly agree) with the statement "I have received the information; I need to avoid getting into trouble with the doping laws". However, more than half of the responders agreed with the statements "I should receive reminders more often" and "authorities should do more to educate sportspeople".

Focusing on the side effects of PES based on the studies reviewed here, we can conclude that elite athletes' knowledge of doping and its consequences can be improved. For example, in the study of Erdman et al. [25], 83.5 % of 582 high-performance athletes were ignorant of the possible side effects associated with each supplement or failed to document the known side effects. Also, Dascombe et al. [36] concluded that, of athletes using supplements (63/72), only 57.1 % (36/63) knew the possible side effects. In relation to illicit drug use in sport, a short negative impact on mental functioning, including altered perception, concentration, judgement and decision making, was reported by two-thirds of a sample of 974 Australian elite athletes [60]. Lentillon-Kaestner et al. [28] interviewed eight elite cyclists whose statements let authors reach the conclusion that "most of the time, the cyclists trivialised the side effects of banned substances. Many cyclists said that it was worse for their health if they took nothing than to use these substances. They considered high-level sport as very dangerous for their health and to preserve good health it was necessary to be treated". On the other hand, many studies have evaluated the use of dietary supplements, and an important side effect associated with their use could be the risk of a positive doping test result [58]. Indeed, Dascombe et al. [36] stated that 47/72 Australian elite athletes considered "positive doping results" as a potential risk of supplement use.

Although athletes seem to be more aware about doping in general, we think that it is important that sport federations or organizers are made aware of the fact that everything needs to be standardized and, in some cases, this could require adaption of the competition to preserve the athletes' health. For example, this could entail shortening the length of some stages in cycling events, providing a longer rest between stages and emphasizing, when possible, the importance of technical/tactical aspects of the sport rather than the physical aspects. In fact, it seems that cycling is slowly changing in relation to changes in doping policy and performance, as the speed of major cycling races has slowed following recent anti-doping efforts [61].

3.6 Prevention and Education

"Controlling doping only by tests is not sufficient; a profound change in the attitudes, which should be monitored repeatedly, is needed" [15]. This statement synthesized the current situation in relation to doping in sport according to most of the studies reviewed. Since Backhouse et al. [7] submitted their report on the doping situation to WADA, it seems that, although the biomedical and legal perspectives have been developed and reinforced, this has not been the case in terms of education and prevention. The practical applications from that report in 2007 are still up to date and need to be supported economically by institutions. Since drug testing alone can fail, as was suggested in the case of Lance Armstrong, we believe that education is the only way to truly minimize the doping culture and reduce the cases of doping in the middle to long term.

According to Peters et al. [53] and Lentillon-Kaestner et al. [28], preventive measures are needed to establish and fortify attitudes towards doping at an early stage of an athlete's career. Elite athletes are members of a group that includes family, coaches, support staff and other athletes, and these relationships may encourage or minimize the behaviour towards the use of banned substances [62]. For instance, changing favourable attitudes towards doping into unfavourable ones, and teaching athletes how to resist pressure to engage in doping under risk-conducive circumstances, may help to reduce the intentions to engage in doping, even among athletes with a history of drug use [43]. Therefore, courses allowing for doping-related discussions and informative Internet platforms would be particularly welcome for athletes and coaches [45]. Besides, Sas-Nowosielski and Swiatkowska [39] highlighted that, with the increase in task orientation compared with ego orientation, the attitudes towards doping have become more favourable. They concluded that creating a motivational climate which promotes task orientation may aid anti-doping efforts. Striegel et al. [21] reported that the most frequently suggested methods of improving athletes'

knowledge were to increase awareness using website platforms and provide regular updated lists of acceptable medicines and supplements. Mottram et al. [35] reported that elite athletes required targeted education strategies that would enable them to make informed decisions on the potential properties of medications for therapeutic or performance-enhancing purposes. According to them, delivery of this information is also incumbent on national federations and the support personnel, including team doctors. Indeed, Kim et al. [24] reported that 79 % of Korean Olympians received regular education on anti-doping regulations from Olympic-sponsored education classes (64 %) and coaches (15 %). Striegel et al. [21] reported that 92 % of 74 elite athletes surveyed received a doping education update within the last 6 months, and most believed that the update was relevant. In addition, the educational requirements of team doctors in relation to doping laws need to be assessed [52]. These authors considered that the use of Internet-based resources capable of delivering up-to-date information on banned substances should be promoted. Indeed, the Spanish Cycling Federation has been conducting an intervention project called "Preventing to Win" since 2009, with the aim of educating the cyclists and coaches of the future [63].

Knowledge on doping issues should be maintained, but more personal ways to accommodate for specific individual questions during educational meetings should be considered [34]. In this way, Erdman et al. [25] proposed that individual consultations on dietary supplement use may be a more appropriate educational strategy for older competitors, whereas presentations given by credible sports medicine and sports science professionals may be better suited for younger athletes. Gender differences regarding the types of supplements selected should also be considered within these educational strategies. These authors, similar to Nieper [23], believe that the athletes' advisors, including their family, friends and coaches, would also benefit from education on dietary supplements, particularly in relation to anti-doping laws and associated risks of supplement use. Indeed, many authors have proposed that the immediate and long-term adverse effects of the use of medications should be taken into account in prevention programmes [15, 64].

Several studies have evaluated the efficiency of current anti-doping education programmes. Peters et al. [53] reported that the current development of information has not been sufficient. Most of the preventive messages concerning the use of banned substances in sport are ineffective for three major reasons (1) the content of the message (2) the athletes receiving the information; and (3) the person giving out the information [28]. In this context, these authors explained that informing athletes of the side effects and possible health risks does not necessarily reduce the use of medications or change attitudes. The authors have stated that the messages must be surprising, intense and cause a heightened emotional reaction.

Peretti-Watel et al. [42] suggested that information and preventive actions targeting young athletes should not focus on the anticipated negative effects of doping, because this population already seems to be well aware of the deleterious consequences of doping. Thomas et al. [54] emphasized that many sporting organizations in Australia conduct drug information seminars for their athletes, but it is unclear whether these programmes provide athletes with pertinent drug information in formats that are conducive to information retention. Callaway [48] stated in the journal *Nature*, that "this is an endless whirl" describing his pessimistic view on the phenomenon of doping in sport. On the other hand, a more positive view was recently given by Zabala and Atkinson [65], who suggested that the principles to be followed should build on the so-called "athlete 2.0". This concept supports the idea of sport based on ethics and science as a collaborative challenge for all the stakeholders, which should also provide optimal education to the athletes.

We encourage institutions (e.g. WADA, national anti-doping agencies, national/international sport federations, regional governments in sport, and other national/regional sport foundations or sports institutes) to invest more money by balancing the costs of control and prevention programmes. Sometimes, institutions develop and start prevention or educational programmes without suitable financial investment. Better controls are clearly needed, as are more effective educational programmes that do not necessarily involve greater financial investments.

3.7 Summary of the Analysed Studies

The main findings of the studies included in our review are summarized in Table 1. Based on the studies identified in our search, and as listed in Table 1, there are several aspects that we wish to emphasize. First, the researchers used the following tools: questionnaires (72.73 %, 24/33), interviews (12.12 %, 4/33), questionnaires and interviews (12.12 %, 4/33), and focus groups (3.03 %, 1/33).

Second, most of the studied were conducted in Europe (61.54 %, 24/39), followed by Oceania (20.51 %, 8/39), America (10.26 %, 4/39), Asia (5.13 %, 2/39) and Africa (2.56 %, 1/39). The study conducted by Mottram et al. [35], which included subjects from Australia, Canada, the UK, and the US, was included in each continent. Similarly, the study conducted by Corrigan et al. [64] at the Olympic Games was included in all of the relevant continents. Therefore, the denominator was 39 instead of 33.

The individual countries represented in our review were Australia (18.18 %, 6/33), the UK (18.18 %, 6/33),

Table 1 Sample characteristics, country of study, methodology and topics explored in studies included in the analysis[a]

	Study, year	Sample	Country	Methodology	Topics
1.	Chester et al. [44], 2003	$n = 401$ (199 Track and Field Athletes: 127 men, 72 women; 202 nonathletes: 74 men, 128 women	UK	Questionnaire	Attitudes towards doping controls Measurement instruments
2.	Waddington et al. [40], 2005	$n = 706/2,863$ footballers (response rate <25 %). 22 % premier league; 25 % first division; 26 % second division; 27 % third division	UK	Postal questionnaire	Attitudes towards doping Attitudes towards doping controls Attitudes towards punishments Doping in different types of sport Sources of information Knowledge of Wada's rules
3.	Peretti-Watel et al. [42], 2005	$n = 996/1,197$ French elite students athletes (response rate: 83 %). Age range: 16–24 years; 659 boys and 332 girls; team sports ($n = 357$), individual sport ($n = 639$)	France	Self-administered anonymous questionnaire	Doping in different types of sport Prevention of doping
4.	Alaranta et al. [15], 2006	$n = 446/494$ Finnish elite athletes (response rate: 90.3 %; mean ± SD age: 23.0 ± 4.5; 261 men, 185 women); speed and power ($n = 113$); endurance ($n = 108$); motor skills ($n = 73$); team sports ($n = 152$)	Finland	Structured questionnaire	Attitudes towards doping Attitudes towards doping controls Doping in different types of sport Prevention of doping
5.	Erdman et al. [25], 2007	$n = 582$ high-performance athletes (314 men, 268 women). Mean ± SD age: 19.96 ± 3.91. 27 different sports	Canada	Validated questionnaire	Reasons for use Sources of information Measurement instruments Knowledge of Wada's rules Side effects Prevention of doping
6.	Mottram et al. [35], 2008	$n = 507/557$ elite athletes from four English-speaking nations (electronic responses: 91 %) and 50/557 (9 % postal responses). Canoeing, cycling, gymnastics, hockey, rowing, swimming, triathlon, volleyball and weightlifting	Australia, UK, Canada, US	Electronic and postal questionnaires	Attitudes towards doping Doping in different types of sport Knowledge of Wada's rules
7.	Peters et al. [53], 2009	$n = 800/1,757$ athletes (response rate: 45.5 %) and 252/620 coaches (response rate: 40.7 %)	Germany	Questionnaire and interview	Sources of information Measurement instruments Knowledge of Wada's rules
8.	Hanstad et al. [49], 2009	$n = 236/292$ Norwegian elite athletes (response rate: 80.8 %)	Norway	Survey	Attitudes towards doping controls
9.	Dunn et al. [16], 2010	$n = 974/1,007$ Australian elite athletes (response rate: 80 %); mean age: 23.1; 75.6 % men; 24.4 % women. National Rugby League, Australian Rugby Union, athletics, diving, hockey, netball, softball, triathlon	Australia	(1) Quantitative surveys; (2) Qualitative interviews	Attitudes towards doping controls
10.	Bloodworth and McNamee [1], 2010	$n = 40$ (age = 19.6 years; 22 men, 18 women). 13 sports: swimming, football (soccer), rugby, wrestling, canoeing, rowing, gymnastics, and two from athletics, netball, modern pentathlon, diving, rugby league and cricket	UK	Focus group discussions	Reasons for use Attitudes towards doping Measurement instruments

Table 1 continued

	Study, year	Sample	Country	Methodology	Topics
11.	Bloodworth et al. [26], 2012	$n = 412/1,674$ (response rate: 24.7 %). 33 % men. The largest possible range of Olympic and professional sports	UK	Anonymized questionnaire (modified version of a questionnaire used by UK Sport in its 2005 drug-free sport survey)	Reasons for use Attitudes towards doping
12.	Dascombe et al. [36], 2010	$n = 72$ elite athletes (mean ± SD age: 21.9 ± 3.9 years; 36 men and 36 women). Kayaking ($n = 5$); swimming ($n = 4$); rowing ($n = 14$); athletics ($n = 13$); netball ($n = 7$); field hockey ($n = 21$), and water polo ($n = 8$)	Australia	Questionnaire detailing their daily usage and rationale	Knowledge of Wada's rules Side effects
13.	Lazuras et al. [43], 2010	$n = 750/2,000$ Greek elite athletes. Mean ± SD age: 25.0 ± 5.89 years; 63.9 % men. Team sports: football, handball, basketball, volleyball, ($n = 477$; 63.3 %); individual sports: athletics, swimming, shooting, Taekwondo, and rowing; ($n = 273$; 36.4 %)	Greece	Anonymous questionnaires	Attitudes towards doping Doping in different types of sport Prevention of doping
14.	Thomas et al. [60], 2010	$n = 974/1,007$ Australian elite athletes (response rate: 80 %); mean age: 23.1; 75.6 % men; 24.4 % women. National Rugby League, Australian Rugby Union, athletics, diving, hockey, netball, softball, triathlon	Australia	Self-administered survey	Side effects
15.	Lentillon-Kaestner et al. [28], 2011	$n = 16$ cyclists (8 young elite-level cyclists; 8 former professional cyclists)	Switzerland	Semi-structured interviews	Reasons for use Doping in different types of sport Measurement instruments Side effects Prevention of doping
16.	Barkoukis et al. [41], 2011	$n = 1,040$ valid responses of 1,075/2,000 (response rate: 53.7 %). Mean ± SD age: 22.9 ± 6.39 years. 62.9 % men. Nine Olympic sports represented in the study: football, basketball, volleyball, handball, athletics, swimming, archery, taekwondo and rowing	Greece	Questionnaire	Attitudes towards doping
17.	De Hon et al. [34], 2011	$n = 433$ (337/888 Olympics athletes; 38 % response rate; Olympics athletes and 95/453 professional football players: 21 %)	Holland	Anonymous, internet-based, 83-item questionnaire	Reasons for use Knowledge of Wada's rules Prevention of doping
18.	Gucciardi et al. [5], 2011	$n = 643/2,030$ (response rate: 33 %). Mean ± SD age: 23.75 ± 8.49 years. 285 men, 383 women. Sports represented: team sports (e.g. rowing, hockey, baseball, rugby) and individual sports (e.g. cycling, athletics, triathlon, judo)	Australia	Questionnaire	Measurement instruments
19.	Thomas et al. [54], 2011	$n = 974/1,007$ Australian elite athletes (response rate: 80 %); Mean age 23.1; 75.6 % men; 24.4 % women. National Rugby League, Australian Rugby Union, athletics, diving, hockey, netball, softball, triathlon	Australia	(1) Quantitative surveys; (2) Qualitative interviews	Sources of information Measurement instruments Prevention of doping

Table 1 continued

	Study, year	Sample	Country	Methodology	Topics
20.	Dunn et al. [29], 2012	$n = 974/1,007$ Australian elite athletes (response rate: 80 %); Mean age 23.1; 75.6 % men; 24.4 % women. National Rugby League, Australian Rugby Union, athletics, diving, hockey, netball, softball, triathlon	Australia	Self-administered survey	Reasons for use
21.	Striegel et al. [21], 2002	$n = 101$ German competitive and professional Athletes. Mean age: 15–25 years. 60.4 % men, 39.6 % women 72.28 % individual sports, 10.89 % team sports and 16.83 % not specified	Germany	Standardized questionnaire	Reasons for use Attitudes towards doping controls Attitudes towards punishments Prevention of doping
22.	Corrigan et al. [64], 2003	$n = 2,758$ Olympic athletes in Sydney 2000	Not defined	Direct question: "what medications have you taken in the past 3 days?"	Prevention of doping
23.	Peretti-Watel et al. [33], 2004	$n = 458/616$ French elite student athletes Response rate (response rate: 74 %). Mean age: 18.3 years. 299 boys and 159 girls	France	Cross-sectional Questionnaire (127 items)	Attitudes towards doping
24.	Nieper [23], 2005	$n = 32/34$ British track and field athletes competing at the 2004 World Junior Championships. Mean age: 18.0 years. 20 men and 12 women	UK	Questionnaire	Reasons for use Sources of information Knowledge of Wada's rules Prevention of doping
25.	Somerville et al. [52], 2005	$n = 74/196$ Olympic level sportspeople (response rate: 38 %). Sports represented: athletics, cycling, rowing and sailing	UK	Mail questionnaire	Sources of information Knowledge of Wada's rules
26.	Huang et al. [56], 2006	$n = 257/271$ Canadian athletes participants at the Atlanta Olympics Games and 300/304 at the Sydney Olympics Games	Canada	Personal interview	Measurement instruments
27.	Alaranta et al. [51], 2006	$n = 446/494$ Finnish elite athletes (response rate: 90.3 %; mean ± SD age: 23.0 ± 4.5; 261 men, 185 women); speed and power ($n = 113$); endurance ($n = 108$); motor skills ($n = 73$); team sports ($n = 152$) and $n = 1,503/1,876$ (response rate 80.1 %; mean ± SD age: 23.4 ± 3.5; 765 men, 738 women (general population: control group)	Finland	Structured questionnaire	Measurement instruments
28.	Pitsch et al. [22], 2007	$n = 448/586$ German Olympic athletes (analysable data records rate). 66.1 % men, 28.3 % women. Sports represented: cycling, weightlifting, baseball, hockey, softball, track and field, basketball, swimming, sailing, team handball, other sports ($n \leq 5$)	Germany	Interview: RRT	Reasons for use Attitudes towards punishments Measurement instruments
29.	Sas-Nowosielski and Swiatkowska [39], 2008	$n = 830/1,000$ Polish athletes (from local to elite). Response rate: 83 %. Mean ± SD age: 20.02 ± 3.96; 567 men, 263 women. Variety of sports: individual and team sports, winter and summer sports, outdoor and indoor sports	Poland	Questionnaires	Attitudes towards doping Measurement instruments Prevention of doping

Table 1 continued

	Study, year	Sample	Country	Methodology	Topics
30.	Breivik et al. [37], 2009	$n = 234/290$ Norwegian elite athletes ([response rate: 80.8 %]. Age range: 16–51 years old. 151 men and 83 women) and $n = 428$ general population (age range: 18–35 years. 275 men and 153 women)	Norway	Mail and e-mail questionnaires	Attitudes towards doping
31.	Lentillon-Kaestner and Carstairs [28], 2010	$n =$ Eight Swiss elite young cyclists (mean age: 22.75 years; 100 % men)	Switzerland	Semi-structured interview	Reasons for use. Attitudes towards doping Measurement instruments
32.	Striegel et al. [45], 2010	$n = 978/1,126$ German elite athletes (response rate of questionnaires 86.9; age range 14–18 years; 611 men, 364 women; team sports = 302, individual sports = 658); n = 480/480 (100 % response rate of RRT interview; age range 15–18 years; 301 men, 179 women; team sport 155, individual sport 325)	Germany	Questionnaires and RRT interviews	Attitudes towards doping controls Measurement instruments
33.	Kim et al. [24], 2011	$n = 228$ Korean Olympic athletes. Men: $n = 128$ (56 %). Mean ± SD age: 25 ± 4 years. Women: $n = 100$ (44 %), age = 24 ± 5 years. 14 sport disciplines	Korea	Questionnaires	Reasons for use Sources of information Prevention of doping

[a] Includes articles identified by the first literature search (of several electronic databases) [articles 1–20], and by the second search (of the reference lists of articles identified by the first search) [articles 21–33]

RRT randomized response technique

Germany (12.12 %, 4/33), Canada (6.06 %, 2/33), France (6.06 %, 2/33), Finland (6.06 %, 2/33), Greece (6.06 %, 2/33), Norway (6.06 %, 2/33), Switzerland (6.06 %, 2/33), Holland (3.03 %, 1/33), Korea (3.03 %, 1/33), and Poland (3.03 %, 1/33). Two studies enrolled athletes from multiple countries, with athletes participating in the Olympic Games in one study [64] and athletes from Australia, Canada, the UK, and the US, in the other [35].

It is remarkable that there were no studies conducted in Africa or South America, or in countries like Spain. We encourage researchers to further expand our current knowledge to all geographical and cultural areas to fully understand the global situation in relation to drug use, and to allow better comparisons between countries.

4 Conclusions

It has been emphasized that athletes who use banned substances mainly do so to improve their performance, even though most athletes acknowledge that doping is dishonest, unhealthy and risky because of the impact of sanctions. The "false consensus effect" seems to play a key role in legitimizing the use of banned substances. Anti-doping programmes are generally considered to be ineffective and inefficient, and the way tests are performed is often criticized, particularly WADA's location reporting system. Athletes consider the severity of punishment to be appropriate or not severe enough, although there are some differences between sports. In this sense, the advisors and stakeholders who can influence athletes should also be educated and punished if they are found guilty of supporting doping. In this way, all interested parties would be aware of the magnitude of the problem.

The current generation of athletes are more familiar with anti-doping rules than earlier generations, but there is still a lack of knowledge that should be improved using well designed educational programmes. There is also a distinct lack of information around dietary supplements and the possible side effects of PES.

Future studies should compare the views and opinions of elite athletes' involved in different sports (e.g. football vs. cycling) on tests and punishments. The studies should also take into account the possible geographical and/or cultural differences (e.g. religion and economic status). Furthermore, as doping is a general issue, we think that all sport federations should adhere to the same anti-doping protocols to avoid unfair situations among sports.

The current research methods that focused on attitudes towards doping have some limitations, particularly

questionnaires, which frequently differ among studies, are seldom non-validated and are therefore incomparable. A combination of qualitative and quantitative measurements, using interviews, questionnaires and, ideally, less-invasive biomedical tests (e.g. based on hair or salivary samples) are recommended. There could be a significant difference between what athletes say and what they really think, a major limitation of data collection methods used to date.

To minimize the phenomenon of doping, information and prevention programmes, starting with athletes at a young age, and involving other stakeholders (e.g. the athletes' doctors, coaches or family), are necessary to establish and maintain correct attitudes and behaviours. It is also very important that the sport institutions at all levels (from WADA to regional governments) provide more resources to psychosocial projects in relation to the biomedical approach (i.e. anti-doping controls), which have been the main priority of anti-doping programmes currently in use. Also, event organizers and federations should check that sporting rules do not favour the possible advantages of using banned substances in competitions (i.e. by reducing the distance covered in competitions, allowing longer recovery between stages and encouraging, where possible, the importance of technical/tactical aspects rather than physical aspects). The programmes targeting athletes and those around them must be carefully planned and developed as a middle- to long-term objective and, ultimately, change attitudes towards doping and the doping culture.

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