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Transforming anti-doping education with web-based interactive programs and applications: A scoping review

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ABSTRACT

Background: Doping has become a global social, moral and institutional challenge that has serious consequences for athletes and the integrity of sports. Since educational tools are deemed not to be sufficiently effective in minimizing doping, the benefits of digital and web-based (desktop and/or mobile) interventions are being explored.
Objective: The present study undertakes a scoping review of research on web-based anti-doping interventions to provide an overview of peer-reviewed studies that have examined their effectiveness in raising awareness of doping among athletes and exercisers.
Design: Online databases were used to identify nine papers that examine a web-based anti-doping intervention. The review maps out the key PICO (population, intervention, comparator, outcome) characteristics of each web-based program and their effectiveness in reducing the risk for engaging in doping use.
Results: The scoping review reveals that only seven web-based anti-doping interventions have been tested worldwide and that four appear to have been successful. Three studies present a different view of web-based anti-doping interventions and indicate they may be partially effective.
Conclusions: The review suggests that newly emerging web-based anti-doping interventions have shown some success in improving knowledge and awareness of doping, reducing favourable attitudes towards doping, and reducing doping susceptibility. The review paves the way for future projects and encourages researchers to utilise cutting-edge technologies to ensure interventions are innovative, impactful and contemporaneous.

1. Introduction and rationale

It is well-documented that doping[1] has become a global social, moral and institutional challenge that poses a risk to the health and wellbeing of users, and that it destabilises the values on which sport has been built (Gleaves et al., 2021; Woolway et al., 2021; Nicholls et al., 2017). Commonly referred to as image and performance enhancement drugs (IPEDs), doping substances that are prohibited by the World Anti-Doping Agency (WADA) include, among others, anabolic androgenic steroids, human growth hormone, and stimulants (WADA, 2023). Doping is not confined to the realms of elite and competitive sport, as increasing evidence has shown that a substantial number of amateur athletes recreational exercisers also use doping substances, to improve their physical appearance and performance (Barkoukis et al., 2022a; Lazuras et al., 2017; Sagoe et al., 2014). For instance, Lazuras et al. (2017) showed that almost 1 out of 5 amateur exercisers and sportspeople aged between 16 and 25 from 5 European countries self-reported the use of doping substances.

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[1] Although the World Anti-Doping Code (Code) defines doping as the violation of one or more Anti-Doping Rule Violations (ADRVs), in this paper we refer to doping as the use or intentions to use prohibited performance enhancement drugs.

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1.1. The role of education in doping prevention

As the use of IPEDs remains uncontrolled, especially in recreational sport and exercise, there is growing recognition of the importance of clean sport education (Pöppel, 2021). Moving away from WADA's detect-and-punish approach, education is increasingly being used as a means of a) emphasising the role of social, contextual and individual risk factors for doping use and b) preventing the use of doping substances at different stages (Lazuras et al., 2021). Although addressing doping use at different stages has been highlighted as important, several studies indicate that education has the greatest impact when it starts early since attitudes to doping are formed at a young age (Backhouse, 2015). Hence, there have been numerous efforts to facilitate anti-doping education in schools as it is an efficient way of reaching many young people (Woolf, 2020). To harmonise approaches in clean sport education on a global scale, in January 2021 WADA published The International Standard for Education (ISE). The WADA ISE begins with the principle that first experiences with anti-doping should be through education before doping control (WADA, 2021). This principle follows the argument that informed decision-making can only take place if there is a sound basis of understanding that has been built early using targeted education processes (WADA, 2021).

Recent reviews on anti-doping education explore some of the positive impacts of doping prevention measures. For instance, Pöppel's (2021) consideration of 30 relevant studies shows that groups from age 10 upwards benefitted from anti-doping education as it enabled them to increase their physical and health literacy. It also found that education programs that actively engaged participants emerged as being more effective than traditional educational approaches, and that programs offering a benefit-orientation (in addition to initiating health promotion) gave participants greater perceived value. A separate review by Sipavičiūtė et al. (2020) shows that the most promising studies in anti-doping education are concentrated on the validity of athletes' belief system as they have been found to provoke critical thinking about using IPEDs. Another evaluation of the anti-doping education activities of 53 national anti-doping agencies (NADOs) by Gatterer et al. (2020) reveals they have played a major role in providing anti-doping education for competitive athletes.

1.2. Transforming anti-doping education

The efforts and achievements of existing anti-doping education notwithstanding, it has been argued by Woolf (2020) and Barkoukis et al. (2022b) that it remains in its infancy, and that more needs to be done to raise the quality and effectiveness of programs. As Barkoukis et al. (2022b) point out, with the exception of the SAFEYOU TOOL, there are no other anti-doping interventions that explicitly promote a positive approach to doping prevention. Elsewhere, Barkoukis (2015) has also argued that more needs to be done to incorporate information and communication technologies into doping prevention programs. Further arguments are made in the above-mentioned review papers on anti-doping education. For example, Pöppel (2021) points out that most programs only concentrate on competitive sport contexts. Sipavičiūtė et al. (2020) also argue that most focus on health education and providing information about doping. Additional problems that have been highlighted include programs not appearing to achieve long-term changes in their target groups (Pöppel, 2021), and programs failing to provide athletes with the necessary tools to deal with difficult situations (Gatterer et al., 2020).

In response to the problems that have been highlighted, and further concerns that the majority of anti-doping education programs only employ traditional learning approaches (Barkoukis et al., 2022b), it is thought that adapting educational resources and applications so they are more in line with changes occurring in the present 'Digital Age' might be more successful at discouraging athletes and exercisers from doping (Barkoukis et al., 2022b; Woolfe, 2020). New technologies and new norms of communication signal that human beings have entered a different stage of evolution, and this has caused a paradigm shift in education. At the very least, digital teaching seems to enhance motivation for education and keep people focused on learning materials (Martin et al., 2020), and can expand learning beyond the physical times and boundaries of the classroom (Haleem et al., 2022). Recognising the benefits of digitalisation, some projects have begun to shift their focus to the development of digital anti-doping interventions. Examples of existing digital tools include GAME, VIRAL and iPlayClean. To date, however, no attempt has been made to provide an overview of all existing digital based interventions.

The benefits of digital technology notwithstanding, existing anti-doping programs have, as it is noted above, tended to adopt traditional, lecture-style approaches that require learners to receive learning material and then adapt their beliefs and intentions accordingly (Barkoukis et al., 2022b). Of the 14 anti-doping programs analysed in a detailed systematic review by Bates et al. (2019), only 1 was delivered online. Consequently, there is a lack of understanding surrounding the impact digital resources might have on anti-doping education and the role it can play in changing mindsets, intentions and behaviours towards doping.

The first step in the design of a new anti-doping program that uses new technologies is a scoping review to gain a clear overview of peer-reviewed studies that have examined the effectiveness of existing digital programs that raise awareness of doping among athletes and exercisers andhave a positive impact on attitudes. Currently, there are no reviews that explore the effectiveness of digital, web-based anti-doping programs so this paper is the first of its kind.

1.3. Aim and objectives

The aim of the paper is to review existing web-based anti-doping education programs. To achieve the aim, a scoping review methodology was used. Scoping review methodologies are thought to be a relatively new addition to evidence synthesis methods but have recently gained increased attention, especially in health science research (Munn et al., 2018). Rather than synthesise findings, a scoping review was conducted to identify gaps in knowledge, set research agendas and provide a roadmap for a full systematic review (Munn et al., 2018).

2. Methods

2.1. Protocol

Our protocol was drafted using the Preferred Reporting Items for Scoping Reviews (PRISMA-ScR).

2.2. Eligibility criteria

Papers included in the review had to meet the following criteria. They needed to 1) examine a web-based (desktop and/or mobile) anti-doping program, 2) be peer-reviewed, and 3) written in English. Unpublished work, and presentation and abstract-only studies were excluded.

2.3. Information sources and search strategy

The review was undertaken in March 2021 and repeated in May 2023 using PubMed, PubReMiner, Scopus, EBSCO and Web of Science Core Collection databases. Search strategies were developed based on the singular and combined use of key terms. Key terms were identified using a specification of the thematic content of relevant studies, population information, intervention type, outcome descriptions and evaluation outcomes. The key search terms used are presented below in Table 1. To further the coverage of the search, the reference lists of all eligible articles were manually scanned for additional relevant papers.

Table 1
Key search terms.

Doping	Population	Intervention	Outcome	Evaluation
Image-enhancing	Recreational	Program	Improvement	Assess
Performance-enhancing	Amateur	Intervention	Increase	Measure
Banned	Elite	Treatment	Decrease	Compare
Illegal	Competitive	Prevention	Change	Evaluate
Illicit	Adolescent	Education	Transform	Examine
Prohibited	Young person	Activities	Stop	
Unsanctioned	Sportsperson	Resource	Combat	
Anti-doping	Coach	Initiative	Protect	
		Design	Challenge	
		Standard	Improve	
		e-Learning	Target	
		Digital	Prevent	
		Web-based		
		Strategy		

2.4. Selection process

A total of 301 articles were screened based only on their titles and abstracts (see Fig. 1). An additional manual search was conducted online to screen for web-based interventions with possible published findings. Following the initial screening process, 13 articles remained for full-text screening, and 6 websites. Four papers were excluded, along with the websites which featured programmes that were yet to be tested in a rigorous and scientific manner. In the end, 9 articles were deemed eligible for inclusion in the scoping review.

2.5. Data charting process

A data charting table was created by the first author (see Table 2). The table allowed for relevant data to be extracted from each study. The other authors later made further improvements to the table by including more detail.

2.6. Data items

The paper maps out the key PICO (population, intervention, comparator, outcome) characteristics of published web-based programs against doping use in sport and identifies which web-based programs are effective in reducing the risk for engaging in doping use. Following Woolf's (2020) critical observation that the designs of educational programs – even when they have met current recommendations for program design – provide unfavourable results when tested, four additional areas for consideration were included in the analysis: 1) unpack evidence about the usability, acceptability and engagement of existing programs; 2) explore evidence of implementation/adoption following an intervention period; c) better understand program costs; and d) identify the extent to which clear theoretical frameworks were utilised.

Although the additional areas for consideration are not common PICO elements, they were included in the present review to understand more completely the characteristics of published web-based programs against doping use. As Butler et al. (2017) explain, PICO frameworks can be extended or adapted by including further background details that may be appropriate for developing broader search strategies, elaborating research questions, and giving context to future research. This may be done when reviewers find the standard tool, which was originally developed as a model for structuring clinical questions, insufficient for meeting the desired scope of the review. Such adaptations are especially useful when bodies of literature are found to be limited or too diverse (Butler et al., 2017).

Attention was directed to the usability, acceptability and engagement of existing web-based programs to gain a better understanding of the kinds of characteristics that are favoured by target populations. Consideration of evidence of continued implementation following the intervention period was included to better understand the longevity and lasting impact of web-based programs. Program costs were taken into account to consider the feasibility of the wider rollout of web-based interventions. The justification for the inclusion of the final element was to examine the extent to which interventions are informed by relevant theories and whether these theories are relevant to behaviour change or other approaches.

2.7. Synthesis of results

The studies were analysed using an extended PICO framework. The key PICO characteristics are presented in a data charting table. A synthesis of the results is provided in narrative format.

3. Results

3.1. Selection of sources of evidence

3.2. Characteristics of web-based anti-doping education programs

ADVICE is a mobile application that can be downloaded in seven different languages on iOS devices from Google Play and iTunes. The application is evidence-based (*see* Nicholls et al., 2020a) and contains a variety of modules which are titled: 'Fair Play', 'Substances', 'Nutritional Supplements', 'Rules', and 'Leadership'. Each module encourages intended users (grassroots coaches) to make autonomous decisions. The modules provide clear information about each topic and encourage users to think about their own values and principles. Each module closes with a reflective task. The application's target variables were value-based and awareness-raising. The application is mapped against WADA's International Standard for Education (ISE) and therefore contains topics that WADA recommends in education interventions programs.

ALPHA is described as a pragmatic and interactive e-learning system available online for athletes. The program which is mobile friendly is part of WADA's Anti-Doping e-Learning Platform (ADEL). The latest version of ALPHA (ALPHA 2.0) is broken down into 8 lessons that each take approximately 10-minutes to complete. The lessons cover a range of topics: 'Doping Control', 'Whereabouts', 'Therapeutic Use Exemptions', 'Results Management Processes', 'Medical Reasons Not to Dope', 'Ethical Reasons Not to Dope', and practical support on how to stay clean and resist the pressure to dope. The extent to which the program is theory informed and evidence-based is not clear, but the program has been tested by two teams of researchers (*see* Deng et al., 2022; Murofushi et al., 2018).

The ET program was an online ethical decision-making training program that was developed as part of the project 'Being a Fair Sportsman'. Focusing on personality characteristics such as attitudes and values, and contextual factors that can influence behaviour, the program was designed to examine how people make ethical decisions. The ethical training was directed at young elite athletes and involved six online sessions. Each session featured three fictional text-based dilemmas which varied in difficulty and involved different tasks. The program was theory and evidence driven (*see* Elbe and Brand, 2016).

GAME is an online decision-making program that involves users in realistic scenarios designed by psychologists, anti-doping education experts, e-learning experts and game developers. Focusing on improving personal skills and self-regulation, each scenario involves a discussion that allows users to make decisions in order to gain feedback, awards and an overall score. The extent to which the program is theory informed and evidence-based is not clear (*see* Ziagkas et al., 2020). iPlayClean is an online desktop program designed to educate young high-level athletes and their parents and coaches about doping attitudes and susceptibility. The program is divided into two sections and each includes thought-provoking information, videos and questions. The program for parents and coaches includes three modules and links to

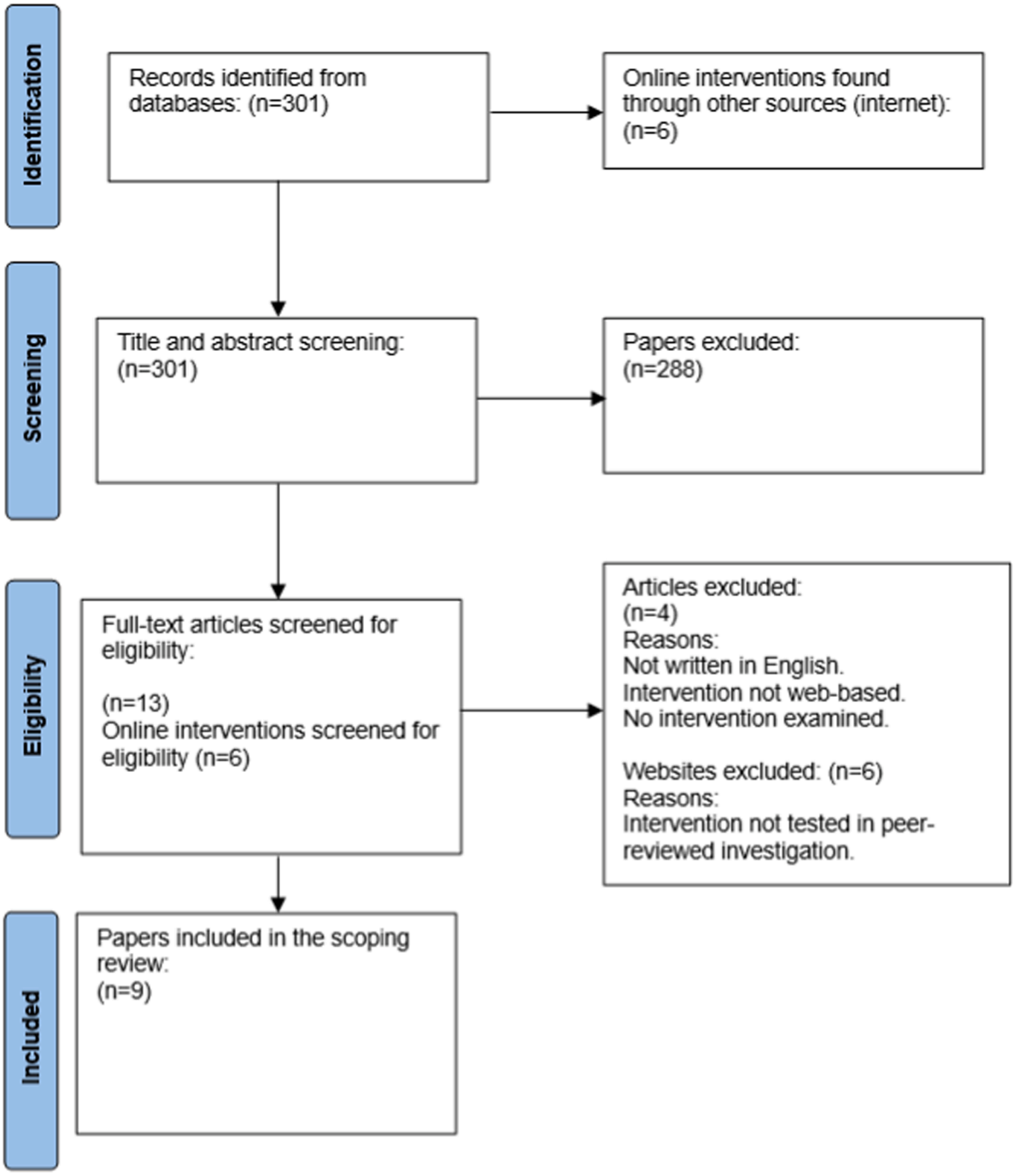


Fig. 1. Search results.

additional resources. The program for athletes contains 10 modules covering a wide variety of topics: introduction to doping, goals, motivations, doping myths, playing fair, resisting temptations, making the right decisions, drug testing, nutritional supplements, and coping strategies. iPlayClean is both theory informed and evidence-based (*see* Nicholls et al., 2020b).

The values-based intervention is an online program designed to encourage cognitive, emotional and group dynamic process, and to create awareness and reflection of personal values and attitudes. The intervention involves six sessions with interactive whiteboards, animated videos with opportunities to make decisions, Zoom breakout rooms, and role-play activities. The sessions cover a wide range of topics: introduction to doping; anticipated guilt; empathy; moral disengagement; and collective moral norms. The intervention is both theory informed and evidence-based (*see* Manges et al., 2022).

The VIRAL application utilises the immersive capabilities of virtual reality (VR) technology. The program is designed to immerse athletes in four realistic, interactive scenarios simulating situations that might be encountered in a fitness or sports environment. The scenarios cover a wide range of topics (performance plateaus, influences of peers and social media etc.) and aim to stimulate critical thinking, enhance emotional intelligence and sharpen decision-making skills. The extent to which the program is theory-informed and evidence-based is not clear (*see* Pouliou et al., 2023).

Table 2
Data Charting Table.

Author(s)	Study Aim(s)	Sample/Target Population	Intervention/Program	Methodology	Outcome	Usability and Engagement	Implementation	Program Costs	Theory and Evidence Base
Nicholls et al. (2020a).	To assess the effectiveness of the **ADVICE** mobile application on enhancing coaches' knowledge of doping and reducing favourable attitudes towards doping.	200 grassroots coaches over the age of 18 (had to coach 14-21 year-olds). Coaches selected using a computer-based randomisation procedure.	ADVICE mobile application that involves users' making autonomous decisions.	A two-arm randomised control trial (1:1 ratio) using an adapted 30-item questionnaire.	The ADVICE application is likely to increase doping knowledge and awareness in coaches and reduce favourable attitudes towards doping.	Highly usable, accessible, and engaging.	Longevity of intervention not known.	Not disclosed.	Intervention not grounded in a valid theoretical framework.
Deng et al. (2022).	Assess the effectiveness of the **ALPHA** seminar for Chinese college athletes and non-athletes.	32 young adults (another 32 were recruited for no-treatment purposes). All participants were recruited using a convenience sample. None of the participants had taken the ALPHA intervention before.	ALPHA intervention that represents a holistic, values-based approach and offers a pragmatic and positive alternative to the traditional approach to preventing doping.	A quasi-experimental design was used (between-group variable: competitive level; within-group variable: time). The ALPHA test, performance enhancement attitude scale, doping likelihood scale, and brief implicit association test (BIAT) were used.	Findings suggest that APLHA is partially effective among Chinese college athletes and non-athletes.	No comment on usability and engagement.	Intervention received an update shortly after testing.	Not disclosed.	Intervention not grounded in a valid theoretical framework.
Murofushi et al. (2018).	Support the development of Japanese athletes (using **ALPHA**) by clarifying university athletes' doping control experience.	514 men and 629 females, all of whom were athletes, were recruited across several universities.	A general survey and The ALPHA test via the e-learning system produced by WADA were used.	Simple survey design.	Findings revealed that doping control experience was not related to anti-doping knowledge and that anti-doping education was associated with anti-doping knowledge.	No comment on usability and engagement.	Longevity of intervention not recorded.	Not disclosed.	Intervention not grounded in a valid theoretical framework.
Elbe and Brand (2016); Melzer, Elbe and Brand (2010).	To identify whether a training programme (**ET**) can change young athletes' doping attitudes.	The study drew on a random sample of 69 young elite athletes in Germany. At least half were involved in team sports and others came from athletics, racquet sports, martial arts and swimming.	Ethical Training (ET) focusing on attitudes towards doping and how people make ethical decisions.	A quasi-experimental design. The evaluation was performed in a pre and post measure design using a comparison group.	The intervention indicated that stereotypical answering behaviour was changed as athletes became more aware that doping is not a simple issue.	Highly usable, accessible, and engaging.	Does not appear to have been used widely since testing.	Not disclosed.	Intervention follows a framework for ethical decision making but it is not grounded in a valid theoretical framework.
Ziagkas et al. (2020).	To present the development and objectives of a serious game (i.e. **GAME**) against doping and to evaluate GAME's usability, ease and users' enjoyment.	The study included 21 Information and Technology students at the Aristotle University of Thessaloniki.	Engagement with realistic scenarios that aim to improve personal skills and self-regulation.	Simply survey design.	Findings revealed that the serious game was found to be informative, useful, user friendly and enjoyable to play.	Informative, user friendly and enjoyable to play.	The intervention does not appear to be publicly accessible.	Not disclosed.	Intervention not grounded in a valid theoretical framework but does utilise innovative learning pedagogies.
Nicholls et al. (2020b).	To assess the effects of the **iPlayClean** education programme on attitudes towards doping and doping susceptibility among talented young athletes. A secondary aim was to assess whether different modes of intervention delivery affect the effectiveness of	A total of 1081 high-level young athletes aged 14-18 participated in the study. All participants had to be on a talent pathway or with a professional club.	The iPlayClean programme is an online module-based intervention that contains a variety of modules.	The methodology implemented was cluster randomised using a computer-based randomisation procedure. A control group was used to compare findings.	All modes of the iPlayClean programme reduced favourable attitudes towards doping. The programme also had a positive impact on reducing doping susceptibility.	Highly usable, accessible, and engaging.	Longevity of intervention not known.	Not disclosed.	Intervention is theory and evidence-informed. Further detail is not provided.

(*continued on next page*)

Table 2 (*continued*)

Author(s)	Study Aim(s)	Sample/Target Population	Intervention/Program	Methodology	Outcome	Usability and Engagement	Implementation	Program Costs	Theory and Evidence Base
	the iPlayClean programme.								
Manges et al. (2022)	To develop a **values-based intervention** program (alongside an information-based intervention) based on theory and empirical evidence; implement the intervention program in young elite athletes along with an information-based program; and, evaluate its effectiveness.	A sample of 321 competitive athletes, aged between 13 and 19, from 30 teams, classes or training groups was recruited.	The interventions were online programs, each consisting of six 45-minute-long sessions.	The study was carried out as a cluster randomized controlled trial (RCT). A three-arm parallel-group trial with two measurements was implemented.	Analysis revealed that the values-based intervention was able to decrease athletes' moral disengagement and increase their anticipated guilt. Athletes' also reported higher empathy from post to follow-up. No effects for the information-based intervention emerged.	No comment on usability and engagement.	Longevity of intervention not recorded.	Not disclosed.	Intervention based on theory and empirical evidence, and underpinned by previous intervention studies. Further detail is not provided.
Pouliou et al. (2023).	Offer insights into the practical realisation of VR application (**VIRAL**) as an educational approach and provide a thorough assessment of its technical components and user experience.	A group of 10 participants with varying levels of familiarity with virtual reality technology.	VIRAL utilises the immersive capabilities of VR technology to create realistic, interactive scenarios that athletes may encounter within the fitness and sports environment.	Post-interaction interviews and surveys.	Overall, the VIRAL application scored 7.4 out of 10 for its technical aspects and characteristics. Overall, the VIRAL application scored 7.4 out of 10 for its technical aspects and characteristics.	Highly usable, accessible, and engaging.	Longevity of intervention not known.	Not disclosed.	Intervention not grounded in a valid theoretical framework.

3.3. Key PICO characteristics

3.4. Synthesis of results

Study 1: ADVICE

The study by Nicholls et al. (2020a) involved testing a mobile application that includes modules on fair play, substances, nutritional supplements, and rules and leadership. The study targeted 200 grassroots coaches aged 18 or over who all worked with 14-21 year olds. A two-arm randomised control trial, with a control group receiving no anti-doping education and an experimental group receiving the ADVICE application, was conducted. Findings indicate that the mobile application is a successful tool for increasing knowledge of doping and that it reduced favourable attitudes towards doping.

Studies 2/3: ALPHA

Drawing on a convenience sample, a study by Deng et al. (2022) involved 64 participants (32 elite athletes with at least 5-years competition experience and 32 non-athletes). The study involved testing the Zh-hans version of WADA's untested but validated e-learning education system which offers a pragmatic and interactive approach that is different to video-based online webinars. A quasi-experimental design was used and participants were divided into control and experimental groups. During the baseline measurement, participants were asked to complete a series of scales measuring knowledge of, attitude towards, and likelihood of doping. They also completed the BIAT. Findings indicate that the online program is partially effective and that participants reflected enhanced cognitive control after using the resource to suppress negative doping attitudes.

A study by Murofushi et al. (2018) drew on a sample of 514 males and 629 females. All participants were athletes recruited across several Japanese universities. The study involved using WADA's ALPHA e-learning system (Japanese version) to measure anti-doping knowledge. A simple single stage survey design was used to gather data and questionnaires were distributed during classes of participating universities. Findings of the study indicate that forparticipants with/without doping test experience there was no significant difference in knowledge after using the e-learning system. However, it was also found that for individuals with/without anti-doping education there was significant difference in knowledge after using the same e-learning system.

Study 4: Ethical Training (ET)

Elbe and Brand's (2016) study drew on a sample of 69 young elite athletes aged between 13 and 17. Elite athlete status was given to athletes who engaged in a minimum of two training sessions per week and who were regularly involved in competitions. Following an analytical framework for ethical decision-making, the study involved testing a training program that required participants to contend with ethically problematic scenarios which varied in difficulty. A quasi-experimental approach was adopted and participants were randomly placed into control and experimental groups. The study reveals that the program made athletes more aware that doping is a complex issue but that there were concerns the educational tool might inadvertently encourage users to experiment with doping substances since it allowed them to question right and wrong behaviour.

Study 5: GAME

In Ziagkas et al.'s (2020) study 21 Information and Technology students were recruited. Each participant was required to use the program for four hours. A questionnaire with 68 items was used to measure knowledge about doping, usability and enjoyment. The study reveals that the program was found to be informative, useful, user friendly and enjoyable to play.

Study 6: iPlayClean

A study by Nicholls et al. (2020b) recruited 1081 high-level adolescent athletes aged between 14 and 18. To be eligible for the project, participants had to be on a talent pathway with an NGB or a professional club. The study tested an online module-based resource (only available on desktop) that is theory and evidence-based and targeted at high-level adolescent athletes, parents and coaches. A cluster randomised trial was conducted and participants were randomly placed into control and experimental groups. The study reveals that it is possible to reduce doping susceptibility and favourable attitudes towards doping for at least 8 weeks using the program and that results can be sustained.

Study 7: Values-Based Education

A study by Manges et al. (2022) recruited 321 young elite athletes aged between 13 and 19. To be eligible for the project athletes had to perform in a team or individual sport on a competitive level. An online values-based anti-doping intervention was tested and compared against an information-based intervention and control group. A cluster randomized controlled trial was carried out and participants were randomly assigned to one of three possible groups. The study found that the values-based intervention was able to decrease athletes' moral disengagement and increase anticipated guilt for a short time, while the information-based intervention had no effect. Athletes in the values-based intervention reported higher empathy from post to follow-up.

Study 8: VIRAL

A study by Pouliou et al. (2023) recruited 10 participants with varying levels of familiarity with VR technology. Participants were required to engage with different aspects of the VR program to provide a holistic evaluation of its technical components and the overall user experience. Post-interaction interviews and surveys were used to gather data. It was found that the program scored 7.4 out of 10 for its technical aspects and characteristics.

3.5. Effectiveness of programs

The results from most of the studies indicate that web-based anti-doping education programs are effective in raising knowledge and awareness of doping and/or reducing doping susceptibility and favourable attitudes towards doping and/or decreasing moral disengagement and increasing empathy. While the findings of the studying involving a values-based intervention indicate the intervention can produce desired changes in some of the targeted outcomes, it had little effect on decreasing anticipated guilt in the long-term. The findings of the GAME study indicate that the program could be effective as it scored highly in the technical evaluation; however, Information and Technology students were used rather than athletes or sportspeople. The findings of both ALPHA investigations yielded mixed results as the online program was found to be partially effective. The findings of the ET study suggest the program might raise knowledge and understanding of doping before decisions to dope are made, but that there is an unintended risk it could encourage young people to experiment with doping substances.

3.6. Usability, acceptability and engagement of programs

Most of the studies report that users of web-based anti-doping education programs suggest they are highly usable, accessible and engaging, especially when compared with more traditional methods of delivery. It was suggested that the ET training could be incorporated into future anti-doping programs. The study testing a values-based intervention and an information-based intervention and both investigations testing the effectiveness of ALPHA do not comment on the usability, acceptability and engagement of the intervention.

3.7. Implementation

Little evidence has been gathered to understand the longevity of programs and whether they are used very widely from the period of their initial launch. One study reports that the programs they tested (ET) do

not appear to have been used widely since they were originally tested. WADA's ALPHA programappears to have the greatest longevity and since its launch the system has been updated several times, but both studies do not mention how widely it is used. In the 2022 study (Deng et al., 2022), it is implied that more could be done to improve the implementation of the resource as none of the participants involved in the study had used the e-learning system before.

3.8. Program costs

None of the studies included in the review report on program costs. However, most of the studies point out that the programs are a cost-effective way of delivering anti-doping education.

3.9. Theory/evidence base

Three of the studies included in the review mention that the programs being tested were theory and evidence-informed (*see* Manges et al., 2022; Nicholls et al., 2020b and Elbe & Brand, 2016). However, no further detail is included in the first and second paper to describe or explain the underpinning theory. The third investigation mentions that a framework for ethical decision making was followed but no additional information is provided. The remaining investigations do not comment on theory/evidence base.

4. Discussion

4.1. Summary of main findings

In recent years, increasing attention has been turned to anti-doping education and the need for the expansion of empirical evidence from the social and behavioural sciences (Barkoukis et al., 2022a). So far, there have been a number of efforts to develop and evaluate traditional resources and materials (seminar content, curriculum-based activities, information pamphlets etc.), many of which have been delivered in educational settings where the focus has centred around positively influencing behaviour by providing key messages about IPEDs (Bates et al., 2019). Recognising there is a need to adapt anti-doping education so it is more in tune with the 'Digital Age' and that new learning pedagogies must be state-of-the-art, the present scoping review set out to examine the current breadth of knowledge of web-based anti-doping programs. This was done by mapping out the key PICO characteristics of published web-based programs against doping use and identifying which programs are effective in reducing the risk for engaging in doping use.

The findings from this scoping review reveal, at the time of writing the paper, that only seven web-based anti-doping programs have been tested worldwide. Four of the programs appear to have been successful. The study involving ADVICE indicates that the program was successful at improving coaches' knowledge and awareness of doping and reducing favourable attitudes towards doping. Similar findings emerge in the study testing iPlayClean as it was found that the program succeeded at reducing favourable attitudes towards doping, and that it had a positive impact on reducing doping susceptibility. The study testing a values-based intervention indicates that moral disengagement was decreased from pre to post testing and maintained over time. For anticipated guilt the study found that the values-based intervention was effective at post-test but that the effect was not maintained in the long-term. For empathy, the study reported that the intervention had no immediate effect but in the follow-up athletes showed an increase in empathy. The study involving VIRAL points out that the potential of VR in anti-doping education is promising but that further research is needed to address technical, ethical and usability considerations. The study evaluating GAME indicates that the program could improve knowledge on doping in sport and the health-related issues of doping use but that the game needs to be tested with other audiences to evaluate its true effectiveness.

The remaining studies that examined ALPHA and ET present a different view of web-based programs. The two studies investigating ALPHA suggest the program is only partially effective as it did not alter the likelihood of doping scores in benefit or cost situations and it had no significant effect on athletes with/without doping test experience. Both studies make the important point that ALPHA, having been prepared solely by researchers of WADA's social science research programme, has not been sufficiently validated. They also suggest it lacks a strong theory and evidence base as several prominent predictors of doping behaviour are not included in the e-learning system. The study examining ET makes the surprising observation that the online program increased favourable attitudes towards doping as athletes became more aware doping is not a simple 'right' or 'wrong' issue. For some, this finding raises concerns about the potential effectiveness of web-based anti-doping programs (Nicholls et al., 2020b). It has been noted, however, that the scale used to measure the program is a poor fit and that this may have contributed to the increases in favourable attitudes towards doping (Nicholls et al., 2020b).

4.2. Recommendations for research and practice

Sufficient evidence exists to form recommendations for future research and practice. The findings of the present review support the suggestion made by Barkoukis et al. (2022b) and Woolf (2020) that the evidence base assessing the effectiveness of web-based anti-doping programs in reducing the risk for engaging in doping use is currently insufficient. To date, limited attempts have been made to develop digital learning pedagogies situated within the context of newly emerging technologies that not only enable users to actively engage with learning content but also reduce risk factors by changing mindsets, intentions and behaviours towards doping use. A new area of focus is the gamification of education because it has been found to increase motivation, improve the effectiveness of teaching content and decrease user dropout rates (Nor, Sunar and Kapi, 2020), but more experimentation needs to take place.

In addition to improving and intensifying experimentation with newly emerging technologies, there is an urgent need to further evaluate the effectiveness of existing online interactive anti-doping programs and applications (Pouliou et al., 2023; Deng et al., 2022; Nicholls et al., 2020b). In this regard, one recommendation might be that national and international anti-doping organisations and National Governing Bodies (NGBs) serving sport could be used to disseminate programs more widely to better measure the strengths and limitations of initiatives. Programs and applications could also be tailored to specific cultural backgrounds to move away from approaches adhering to a 'one-size--fits-all' model.

Another recommendation drawn from the present review concerns the lasting impact of existing web-based programs. As each intervention was tested only once, longevity and lasting usefulness remains unknown. Therefore, to better support the development of existing programs and applications, researchers could continue to improve them by analysing not only what they can do for users but also what they might potentially do in the long-term. One area for improvement, for example, which is overlooked in most of the studies included in this review paper concerns human interaction (with educators or other learners) and community engagement. It has been reported that web-based interactive programs and applications are likely to facilitate long-term learning if they help athletes engage in collective learning experiences and regular conversations (Ruck and Moustakas, 2023; Moustakas and Kalina, 2022).

A final recommendation based on the review concerns the qualitative and quantitative orientation of existing studies. With only one investigation indicating that interviewing was a method of data collection, a preoccupation with quantitative measurement is evident across the studies that were reviewed. To better capture rich detail and the nuances of human behaviour, and also generate new ideas and hypotheses that

can be further tested using quantitative methods, more qualitative research is required.

4.3. Limitations

There are a number of limitations for the studies conducted to date. Firstly, as noted above, some of the scales and questionnaires used to assess attitudes towards doping have been critiqued for presenting a bad fit. Secondly, criticism extends to the fact some investigations were conducted without the use of valid theoretical frameworks. A third limitation is that several of the studies experienced high attrition rates between key stages of the data collection period; the high attrition rates indicate that without improved recruitment and retention strategies potential users who are difficult to reach initially may remain difficult to reach. A fourth limitation concerns the relatively short periods of time the effects of the programs were examined since they do not provide any indication of the anticipated longevity of the educational materials. A final limitation is that since some of the studies were conducted programs have undergone modification, improvement and relaunching which means new investigations are required to reassess their effectiveness.

Although this paper is useful as it is the first to map out the key PICO characteristics of published web-based programs against doping use in sport and identify which web-based programs are effective in reducing the risk for engaging in doping use, several limitations need to be acknowledged. First, the search was limited to articles written or translated in English which means it is possible relevant studies in other languages have been unintentionally overlooked. Second, as a scoping review was performed rather than a systematic analysis the findings might be deemed too broad. Third, a risk of bias assessment was not conducted. This is usually the case with scoping reviews, but it does mean the quality of evidence discussed could be reviewed at some stage in the future. Despite these limitations, the scoping review serves its purpose of providing a suitable foundation for furthering future research on web-based anti-doping education programs.

5. Conclusion

In conclusion, the review suggests that newly emerging web-based anti-doping programs have shown some success in improving knowledge and awareness of doping, reducing favourable attitudes towards doping, and reducing doping susceptibility. Although a number of problems and complications have been reported with the programs, the consolidated results from this review may contribute to the development of improved future initiatives and programs. The scoping review paves the way for future projects by encouraging them to utilise cutting-edge technologies in ways that ensure the delivery of programs will be innovative, impactful and contemporaneous.

CRediT authorship contribution statement

K.P. Bingham: Writing – original draft, Writing – review & editing. **L. Lazuras:** Supervision. **V. Barkoukis:** Writing – review & editing. **A.-M. Elbe:** Writing – review & editing. **L. Moustakas:** Writing – review & editing. **N. Ntoumanis:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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