

ORIGINAL SCIENTIFIC PAPER

Evaluating an Anti-Doping Education Program for Athlete Support Personnel: Knowledge Gains Without Behavioral Shift

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Abstract

Legal anti-doping knowledge is a critical component of global anti-doping efforts, yet few studies have examined the impact of targeted interventions on legal aspects of anti-doping policy among athlete support personnel (ASP). This study aimed to evaluate (i) the effects of a structured educational intervention on legal anti-doping knowledge among ASP, and (ii) whether changes in knowledge are associated with changes in doping tendency. A total of 183 ASPs (64 females; 45.11±8.90 years of age), including 101 medical staff and 82 coaches supporting senior-level athletes, were randomly assigned to either an intervention group (n=99) or a control group (n=84). The intervention group completed a 10-lesson program on anti-doping legislation. Variables included sociodemographic data, sport-related factors, doping tendency, and legal anti-doping knowledge. A two-way repeated measures ANOVA was conducted with Measurement (pre- to post-intervention), Group (Intervention vs. Control), and their interaction analyzed separately for medical staff and coaches. Significant improvements in legal anti-doping knowledge were found in both medical staff (Group × Measurement: $F=12.11$, $p<0.05$; Measurement: $F=21.05$, $p<0.01$) and coaches ($F=37.70$, $p<0.01$; $F=20.03$, $p<0.001$) in the intervention group, while no significant changes were observed in the control group. However, increased knowledge did not translate into changes in doping tendency. These findings emphasize the value of targeted education in enhancing legal anti-doping competencies among ASPs, though further strategies may be needed to influence attitudes and behaviors.

Keywords: sports medicine, intervention studies, anti-doping legislation, doping in sports

Introduction

Doping remains one of the most pervasive threats to the integrity of competitive sports, undermining both the fairness of competition and the health of athletes (Mottram, 2022; Versic, Uljevic, & Pelivan, 2022). Despite decades of regulation, testing, and punitive measures, the use of performance-enhancing substances continues across various levels of sport, from amateur leagues to elite international competitions. While much attention is given to the individual athlete's responsibility, research increasingly highlights the influence of the athlete's support network—particularly coaches and medical personnel—in shaping

attitudes toward doping (Tahiraj, Zenic, Musa, Zeljko, & Rodek, 2024). These figures often act as gatekeepers to both legitimate medical treatment and unethical performance enhancement practices. Studies have shown that athletes are more likely to engage in doping when they perceive implicit approval or pressure from their coaches or when medical professionals fail to communicate anti-doping norms effectively (Patterson, Backhouse, & Duffy, 2016). Moreover, a lack of legal and ethical literacy among these professionals can contribute to unintentional violations or rationalization of doping behavior.

The dynamic interplay between professional authority and



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athlete vulnerability makes the education of coaches and medical personnel a critical intervention point in anti-doping efforts (Patterson et al., 2016). These professionals occupy positions of trust and often serve as the primary source of guidance for athletes regarding training, recovery, and medical treatment (Mandic, Peric, Krzelj, Stankovic, & Zenic, 2013; Sekulic et al., 2016). When their knowledge is outdated or their ethical stance is ambiguous, athletes may be unintentionally steered toward doping practices—either through misinformation, negligence, or tacit encouragement. Therefore, anti-doping education targeted at these groups should not be seen solely as a legal or procedural requirement but rather as a vital component of athlete protection. By fostering ethical awareness, legal literacy, and a commitment to clean sport values, such education helps reinforce a supportive environment that discourages doping from the outset. Ultimately, empowering coaches and medical professionals with both knowledge and moral clarity to uphold anti-doping principles is essential in building a sustainable culture of clean sport.

Anti-doping regulations are governed by a complex legal framework that includes international conventions, national legislation, and the World Anti-Doping Code (Chester & Wojek, 2022; WADA, 2009; Vedder, 2022). This legal architecture defines not only prohibited substances and methods but also the rights and responsibilities of athletes and their support personnel. Coaches and medical professionals are explicitly recognized under the Code as athlete support personnel (ASP), making them subject to sanctions—including suspensions and bans—for involvement in antidoping rule violations (Viret, 2015). Without a solid understanding of these legal obligations, support staff may inadvertently contribute to violations or fail to protect the procedural rights of athletes under investigation. Thus, comprehensive legal literacy is not optional but essential for coaches and medical doctors to navigate their roles responsibly and uphold both athlete health and the integrity of sports.

Despite the recognized importance of legal literacy among athlete support personnel (ASPs), there is a notable gap in the literature concerning targeted educational interventions. To the best of our knowledge, no study to date has systematically examined the effects of anti-doping education programs specifically focused on legal aspects for coaches and medical professionals. Most existing research emphasizes general anti-doping knowledge or ethical attitudes, often overlooking the legal dimension as a distinct and measurable outcome (Faros & Shehu, 2024; Weber, Patterson, & Blank, 2022). This lack of empirical evidence limits our understanding of how legal education might influence ASP behavior, decision-making, or compliance with anti-doping rules. Addressing this gap is essential for designing more effective, evidence-based education strategies tailored to the real responsibilities that ASPs face under the World Anti-Doping Code.

In response to the identified gap in both practice and research, the present study aims to develop and evaluate the effects of a specifically designed legal anti-doping education-program (LADEP) targeted at ASPs, namely, coaches and medical doctors. The intervention focuses on enhancing the knowledge of key legal concepts within the World Anti-Doping Code, including liability, sanctions, procedural rights, and obligations specific to ASPs. Initially, we hypothesized that (i) applying LADEP will increase the knowledge of participants in the field of legal issues of anti-doping policy and that (ii) increased knowledge of legal anti-doping rules will be associated with a lower positive doping tendency in ASPs.

Methods

Participants

The participants in this study were athlete support team members (ASTs; $N=183$; 64 females; $M\text{ age}=45.11\pm8.90$ years). Of these, 101 were members of medical staff (including medical doctors and physiotherapists), and 82 were coaches. All participants were actively involved in coaching or supporting senior-level athletes competing in top-tier competitions (see Table 1 for detailed participant characteristics). The participants were invited to take part in the study by the National Olympic Committee. Prior to participation, they were informed about the study's purpose, potential benefits, and associated risks. They provided informed consent and were assured that their participation was voluntary, that their responses would remain anonymous and that they could withdraw from the study at any time without providing a reason. The inclusion criteria were as follows: (1) a minimum of one year of involvement in sport as an AST; (2) support of athletes competing at least at the highest national level (e.g., national championships); (3) meeting the formal qualifications required by their national sport federation to work as a coach or medical staff; and (4) citizenship in Croatia. The participants were randomly allocated to either the intervention group ($n=99$; 45 coaches) or the control group ($n=84$; 37 coaches). Although 201 participants were initially enrolled, 18 withdrew (mostly from the intervention group), resulting in a final sample of 183 participants. This study fulfilled all ethical requirements and received prior approval from the Ethical Committee of the Faculty of Kinesiology, University of Zagreb (approval date: May 6, 2025; reference: 30/2025).

Variables and testing

The variables included sociodemographic factors, sport factors, doping factors, and legal anti-doping knowledge. Sociodemographic variables consisted of sex (male, female, other), and age (in years). Sports factors asked participants about their experience in sport (<5 years, 6–10 years, >10 years), highest level of sport achievement/success as an ASP (national-level competition, national-level medal, European and/or World Championship participation/medal, Olympic Games participation/medal). The participants were asked four questions about their self-opinion about personal anti-doping knowledge (poor, average, good), their participation in anti-doping testing as an ASP (never, 1–2 times, 3–5 times, >5 times), their personal opinion about the main problem of doping (doping is mainly health hazard, doping is against fair play, I do not see doping as a problem at all), and their likelihood of suggesting doping to athletes (No way!, I do not know (not sure), I could consider suggesting doping if there is no health hazard, I could consider it). For the purpose of later analyses, the responses to the last question (likelihood of suggesting doping to athletes) were grouped into “Negative doping tendency” (first response) and “Neutral/positive doping tendency” (remaining responses).

The legal anti-doping knowledge was tested by adapting a previously validated athlete-focused questionnaire. The version of the measurement tool used included 10 true/false items covering rights, obligations, and antidoping procedures, with a “not sure” option. Given that the original tool was developed without input from medical professionals, two medical doctors affiliated with national anti-doping agencies reviewed and revised the content to suit the target population. Athlete-specific items were modified to reflect the responsibilities of sport staff. The used version of the questionnaire consisted of 10 items, with total

range of scores from 0–10 (Stankovic, Sinkovic, Sekulic, Jelcic, & Rodek, 2022).

The testing was performed via the SurveyMonkey digital platform (SurveyMonkey Inc., San Mateo, CA, USA), and all questionnaires used in this study were validated in the local language, with details available elsewhere (Kondric, Sekulic, Uljevic, Gabrilo, & Zvan, 2013; Stankovic et al., 2022; Zenic, Peric, Zubcevic, Ostojic, & Ostojic, 2010).

Intervention and study design

The LADEP intervention consisted of 10 structured lessons, each designed to improve participants' legal knowledge related to anti-doping. The content targeted two core domains: (i) obligations and rights under anti-doping regulations and (ii) legal procedures involved in anti-doping testing. Instruction was delivered by a multidisciplinary team of experts, including certified anti-doping officers, legal professionals specializing in sports law, and experienced sport coaches. This diverse team ensured a

well-rounded perspective, bridging theoretical frameworks with practical, sport-specific insights. The sessions emphasized real-world applicability over abstract legal theory. The lessons included interactive discussions, real-life case studies, and examples drawn from the instructors' personal professional experiences. The participants were encouraged to actively engage with the content, ask questions, and reflect on complex or ambiguous scenarios encountered in actual anti-doping practices. The curriculum was informed by findings from previous studies that assessed antidoping legal knowledge and identified common areas of weakness among sport professionals. As a result, the program was strategically designed to address these gaps. Special focus was placed on presenting real-world challenges and procedural nuances in doping control—ranging from notification and sample collection to managing athlete rights during testing and appeal processes. Authors of the study are at disposal for details of the intervention and educational materials. The study design is presented in Figure 1.

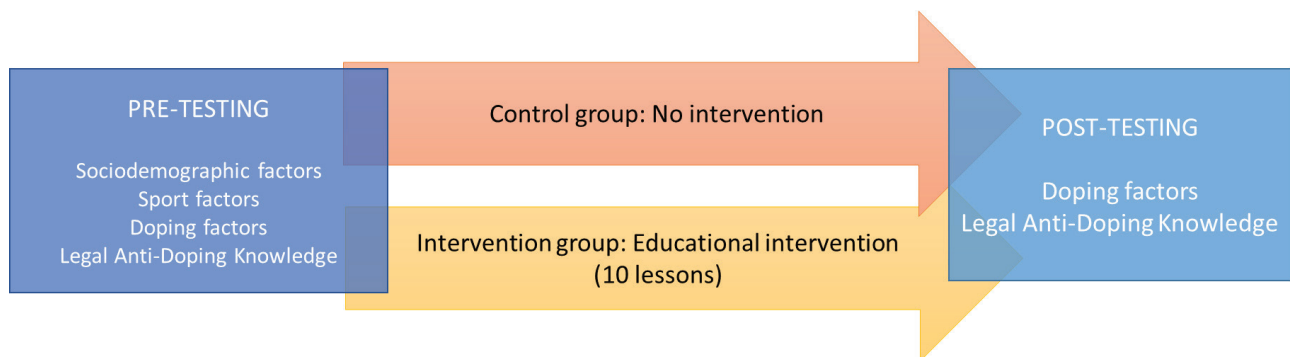


FIGURE 1. Study protocol

Statistics

The Kolmogorov–Smirnov test was used to assess the normality of data distributions. Accordingly, means and standard deviations were reported as descriptive statistics for normally distributed variables, while frequencies and percentages were reported for ordinal and interval variables.

Group differences in non-parametric variables were examined using the Chi-square test. This procedure also enabled the identification of potential associations between doping tendencies and legal anti-doping knowledge (see Results for further details).

Intervention effects were analyzed using factorial analysis of variance for repeated measures (ANOVA). The within-subject factor was Measurement (pre- vs. post-intervention), and the

between-subject factor was Group (Intervention vs. Control). The interaction effect (Measurement $\times$ Group) was also evaluated. When appropriate, Scheffé post-hoc tests were conducted.

All statistical analyses were performed using Statistica, version 14.5 (TIBCO Inc., Palo Alto, CA, USA), with a significance level set at $p < 0.05$.

Results

Table 1 presents the distribution of study variables across groups. Notably, the majority of participants perceived doping primarily as a health hazard. Self-reported neutral or positive attitudes toward doping were negligible, although coaches exhibited a slightly higher tendency toward doping behavior compared to medical staff.

Table 1. Descriptive statistics for the study variables (data are presented as F(%) values)

	Medical staff		Coaches	
	Control (n = 54)	Intervention (n = 47)	Control (n = 45)	Intervention (n = 37)
Gender				
Male	35 (65)	29 (61)	32 (71)	28 (75)
Female	19 (35)	18 (39)	18 (39)	9 (25)
Other	-	-	-	-
Experience in sport (as an athlete support personnel)				
< 5 years	13 (24)	14 (29)	23 (50)	14 (39)
6–10 years	24 (44)	15 (31)	10 (23)	15 (41)

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Table 1. Descriptive statistics for the study variables (data are presented as F(%) values)

	Medical staff		Coaches	
	Control (n = 54)	Intervention (n = 47)	Control (n = 45)	Intervention (n = 37)
> 10 years	17 (32)	19 (40)	12 (27)	7 (20)
Sport success (as an athlete support personnel)				
National level competition	22 (41)	16 (33)	13 (29)	13 (36)
National level medal	24 (44)	24 (51)	18 (41)	9 (23)
European and/or World Championship (participation and/or medal)	4 (7)	2 (4)	10 (22)	14 (39)
Olympic Games (participation and/or medal)	4 (8)	6 (12)	4 (8)	1 (2)
Self-opinion about personal doping knowledge				
Poor	6 (11)	10 (21)	23 (51)	15 (41)
Average	33 (61)	26 (55)	19 (43)	19 (51)
Good	15 (28)	11 (24)	3 (6)	3 (8)
Anti-doping testing (as an athlete support personnel)				
Never	1 (2)	1 (2)	2 (5)	2 (6)
1-2 times	24 (44)	16 (35)	30 (66)	19 (51)
3-5 times	18 (34)	21 (45)	9 (21)	14 (39)
> 5 times	11 (20)	8 (18)	4 (8)	1 (4)
The main problem of doping in sport				
Doping is mainly a health hazard	49 (91)	42 (90)	40 (88)	33 (89)
Doping is mainly against fair-play	5 (9)	5 (10)	3 (7)	1 (4)
I don't see doping as a problem at all	0 (0)	0 (0)	2 (5)	3 (7)
Likelihood of suggesting doping to athletes				
Absolutely not!	54 (100)	46 (98)	41 (90)	33 (89)
Don't know (not sure)	0 (0)	1 (2)	3 (6)	3 (7)
I'd consider it if there will be no health hazard	0 (0)	0 (0)	1 (2)	1 (4)
I'd consider it	0 (0)	0 (0)	1 (2)	0 (0)

Table 2 provides descriptive statistics for Legal Anti-Doping knowledge across groups and time points, while Figure 2 displays the repeated-measures ANOVA results sep-

arately for medical staff (Figure 2A) and coaches (Figure 2B). Among medical staff, a significant Group $\times$ Measurement interaction was found ($F=12.11$, $p<0.05$), along with a sig-

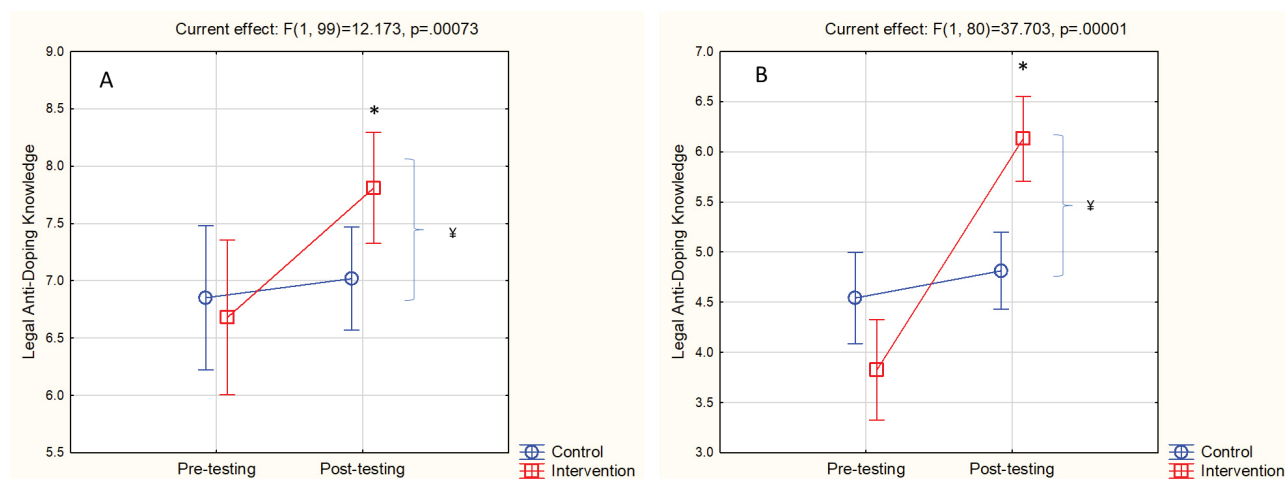


FIGURE 2. Results of the 2-way ANOVA for repeated measurements in legal anti-doping knowledge for medical staff (A) and coaches (B) with significant post-hoc differences among groups (*) and between groups (#)

nificant main effect for Measurement ($F=21.05$, $p<0.01$), indicating that the Intervention group demonstrated greater improvement in knowledge than the Control group (see Table 2). Similarly, among coaches, the ANOVA revealed a

significant main effect for Measurement ($F=20.03$, $p<0.001$) and a significant Group $\times$ Measurement interaction ($F=37.70$, $p<0.01$), with knowledge gains observed only in the Intervention group.

Table 2. Descriptive statistics for legal anti-doping knowledge before and after testing across study groups

	Pre-testing				Post-testing			
	Control		Experimental		Control		Experimental	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Coaches	4.54	1.62	3.83	1.41	4.81	1.32	6.13	1.25
Medical staff	6.85	2.22	6.68	2.33	7.02	2.01	7.80	1.15

Table 3 shows descriptive statistics for doping tendency across groups and measurement points. For medical staff, a Chi-square test could not be performed due to zero frequencies in the neutral/positive doping tendency category. Nevertheless, no change in doping tendency was observed from pre- to

post-measurement. Among coaches, no significant differences were found between the Intervention and Control groups either at pre-test (Chi-square =0.01, $p>0.05$) or post-test (Chi-square =0.01, $p>0.05$). These results suggest that the intervention had no measurable impact on doping attitudes.

Table 3. Distribution of the doping tendency across study groups and measurements

	Pre-testing				Post-testing			
	Control		Intervention		Control		Intervention	
	F	%	F	%	F	%	F	%
Medical staff - doping tendency								
Negative tendency	54	100	46	98	54	100	46	98
Neutral/Positive tendency	0	0	1	2	0	0	1	2
Coaches - doping tendency								
Negative tendency	41	90	33	89	42	91	46	98
Neutral/Positive tendency	5	10	4	11	4	9	1	2

Discussion

With respect to the study aims, we can highlight the two most important results, which are discussed in the following text. First, the applied educational program (LADEP) resulted in increased knowledge of legal anti-doping issues among both coaches and medical personnel. Second, increased knowledge of legal anti-doping issues did not doping tendencies among coaches or medical personnel. Therefore, our first study hypothesis can be accepted, and the second study hypothesis should be rejected.

An improvement in the knowledge of the legal issues of anti-doping policy as a result of the applied LADEP was generally expected. There are several important reasons for such results. First, at the beginning of the study, participants demonstrated relatively low levels of knowledge regarding antidoping legal regulations (please see average results at the study baseline). This was particularly evident among coaches, many of whom lacked familiarity with core legal principles such as strict liability, the scope of athlete support personnel responsibilities, or procedural rights during disciplinary proceedings. Although disappointing, the poor knowledge of coaches is consistent with previous literature indicating that doping literacy is often overlooked in both coaching certification programs and continuing medical education (Patterson et al., 2016). Additionally, studies dealing with general anti-doping knowledge in athletes and coaches have frequently reported similar levels of knowledge in athletes and coaches,

although athletes regularly report coaches as the most important figures in their anti-doping knowledge (Mandic et al., 2013; Sajber, Rodek, Escalante, Olujić, & Sekulić, 2013). The gap in baseline understanding is additional concern given that ASPs can be sanctioned under the World Anti-Doping Code even in cases of indirect or unintentional involvement in rule violations.

Despite the poor initial knowledge of legal issues, which almost certainly contributed to improvements in knowledge as a result of the LADEP intervention, the organization and overall concept of applied education cannot be ignored as contributing factors. Specifically, the design of the educational intervention was based on prior research and needs assessments highlighting specific areas of legal misunderstanding in sports (Stankovic et al., 2022). In brief, the authors previously evaluated the psychometric properties of the applied measurement tool, which allowed us to identify critical issues in antidoping legal knowledge. Therefore, the LADEP curriculum was tailored to address commonly misunderstood elements such as procedures, roles in doping investigations, and legal consequences of complicity or failure to report. This focused approach ensured that the content was not only relevant but also immediately applicable to participants' professional responsibilities. In other words, rather than offering broad or theoretical overviews, the LADEP prioritized real-world scenarios and case studies to contextualize legal obligations in day-to-day support roles. This targeted strategy appears to

have been key to achieving measurable improvements in legal knowledge following the intervention.

Another significant factor contributing to the effectiveness of the intervention was the involvement of trained anti-doping educators with both legal and sport-specific expertise. These professionals were able to translate complex regulatory language into accessible, context-specific guidance tailored to the realities of coaching and medical practice. Their ability to facilitate discussion, answer practical questions, and relate legal frameworks to actual cases helped bridge the gap between theory and application. This type of expert-led instruction is a well-documented feature of effective education across various disciplines, especially in professional training environments where learners must apply abstract concepts in high-stakes real-world contexts, also known as Kolb's model of experiential learning (Kolb, 2014).

Most specifically, Kolb's model of experiential learning is an educational theory developed by David A. Kolb in 1984 (Kolb, 2014). It is based on the idea that learning is a process whereby knowledge is created through the transformation of experience. This model emphasizes that effective learning occurs through a cyclical process involving concrete experience, reflective observation, abstract conceptualization, and active experimentation. The approach was found to be particularly relevant in professional education, where learners benefit from engaging directly with realistic scenarios and applying knowledge in context. Therefore, the use of real-life doping cases and interactive discussions in our intervention almost certainly assured a deeper understanding and retention of legal principles. From the perspective of legal anti-doping learning, the presence of skilled educators—the officials of the national anti-doping agency—played a central role in participant engagement and comprehension, resulting in measurable gains in legal knowledge. Moreover, their credibility and ability to build trust fostered a psychologically safe learning environment, allowing participants to openly discuss uncertainties and misconceptions about anti-doping laws.

Contrary to our initial expectations, the increase in participants' legal knowledge regarding anti-doping regulations did not correspond with a measurable decrease in their positive tendency toward doping. There are several possible reasons for such results, which will be discussed in the following text. First, we must highlight that although it disagrees with our initial expectations (e.g. 2nd hypothesis), the lack of correlation between improved legal anti-doping knowledge and doping tendencies in ASPs actually aligns with previous findings indicating that knowledge alone is often insufficient to alter behavior or attitudes, especially in complex ethical domains such as doping. Doping tendency is influenced by a constellation of factors, such as sport-specific culture, the perceived prevalence of doping, gender, the level of competition, and individual moral disengagement. Most of these factors of influence are not directly addressed by legal education alone (Barkoukis, Lazuras, Tsorbatzoudis, & Rodafinos, 2013; Morente-Sánchez & Zabala, 2013). In this context, it is plausible that while participants became more legally informed, their broader value systems and perceptions remained unchanged, limiting the impact on behavior-related outcomes. Therefore, although their knowledge improved, it did not translate to their (more) negative doping tendency. This is probably augmented by the fact explained in the following

text as a second possible reason for the lack of correlation between legal knowledge and doping tendency.

Second explanation for the lack of a significant effect lies in the initial distribution of attitudes toward doping. At the study baseline, more than 90% of the participants declared a clear negative stance toward doping, reflecting a “ceiling effect” that naturally truncated the variance in the dependent variable (Austin & Brunner, 2003; Ho & Yu, 2015). Statistically speaking, the “ceiling effect” occurs when a measurement tool cannot detect higher (or lower) scores beyond a certain point because participants are already scoring near the top (or bottom) limit. This results in a compressed range of data at the upper (or lower) end, reducing variability and potentially masking pre- to post-measurement differences. In other words, when the majority of scores cluster at one end of the scale, detecting any further changes becomes statistically difficult. In our study, this actually means that even if knowledge improvements occurred, the already low endorsement of doping meant that there was little room for further reduction, leading to an artificial impression of no change.

Although the distribution of results in our case was highly skewed, it may reflect not only genuine attitudes but also strong social desirability bias. Social desirability is a well-documented phenomenon in doping research. Studies have shown that athletes and ASPs often underreport favorable attitudes toward doping to conform to social and professional expectations (Gucciardi, Jalleh, & Donovan, 2010; Petróczy, Aidman, & Nepusz, 2008). Given the legal and moral stigma surrounding doping, participants may have felt pressured to present themselves as firmly anti-doping, especially in an educational context. This tendency likely inflated baseline anti-doping attitudes, masking any real variability and making it difficult to detect meaningful postintervention changes in doping tendencies. As such, while the data suggest high initial rejection of doping, the extent to which these responses reflect the true beliefs of the participants remains uncertain.

This study has several limitations that should be considered. First, the educational intervention was relatively short-term, which may have limited its impact on deeper attitudes or behavior changes. Second, participants reported low doping tendencies at baseline, creating a ceiling effect that reduced the ability to detect correlations between legal knowledge and doping tendencies. Finally, the potential influence of social desirability bias cannot be ignored, as participants may have reported more socially acceptable anti-doping attitudes than their true beliefs. On the other hand, this study has several notable strengths. This is one of the first investigations to specifically examine the effects of antidoping legal education targeting ASPs. The intervention was delivered by qualified anti-doping authorities with both legal and sport-specific expertise, which added credibility and ensured accurate, context-relevant instruction. Additionally, the study involved a relatively large sample of coaches and medical professionals, enhancing the generalizability of the findings and providing a robust basis for evaluating knowledge change.

Conclusion

This study demonstrated that educational intervention effectively improved legal anti-doping knowledge among ASPs. This finding supports the first hypothesis and highlights initial gaps in legal understanding, especially among coaches. The program's tailored content, expert educators, and experiential

methods likely contributed to the positive outcomes.

In contrast, the second hypothesis was not confirmed since improved legal knowledge did not reduce the likelihood of doping among ASPs. This may be due to the complex, multifactorial nature of doping attitudes, which are influenced by personal, cultural, and situational factors. Moreover, ceiling effects and social desirability bias likely limit the ability to detect meaningful changes in doping attitudes.

Nonetheless, legal education remains an essential compo-

nent of antidoping efforts. These findings suggest that knowledge alone is insufficient to change the doping tendency of ASPs. Therefore, future programs should integrate legal education with ethical and psychological elements to better support long-term changes in anti-doping attitudes and doping behavior in ASPs.

The study findings highlight the importance of targeted educational programs in strengthening anti-doping competencies within professional sports environments.

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Conflicts of interest

The authors declare no conflict of interest.

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