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Anti-doping Knowledge and Information Sources Among Indonesian Athletes: Strengthening Clean Sport

Pengetahuan dan Sumber Informasi Anti-Doping di Kalangan Atlet Indonesia: Penguatan Praktik Olahraga Bersih

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ABSTRACT

Background: Doping threatens sport and athlete health. Limited knowledge and insufficient access to anti-doping education increase the risk of intentional or unintentional violations. In Indonesia, very few studies have focused on athletes' understanding of anti-doping regulations and their educational experiences.

Objectives: This study aimed to identify the level of anti-doping knowledge and the sources of information that athletes received as a basis for strengthening clean sport practices.

Methods: This cross-sectional quantitative study enrolled 149 Indonesian athletes who answered an online standardized questionnaire previously tested for validity and reliability. The instrument encompassed knowledge and educational experiences related to anti-doping. To examine differences in knowledge scores across demographic characteristics, data were analyzed descriptively and by bivariate comparisons.

Results: Participants were predominantly 12–17 years old (58.4%), male (65.1%), and represented 18 sports disciplines. Only 36.9% had ever received anti-doping education, and most information was received from coaches. The mean knowledge score was 68.5 (SD=19.9), with 38% classified as having a good knowledge level. Age was the only demographic factor significantly associated with knowledge scores (p-value=0.039).

Conclusions: Indonesian athletes generally have moderate anti-doping knowledge, with notable disparities between age groups and weaknesses in specific areas of understanding. Most athletes reported receiving anti-doping information from coaches and the Indonesia Anti-Doping Organization. These findings highlight the need to develop more targeted and experience-based education strategies that actively involve key stakeholders to ensure consistent and standardized delivery of information.

INTRODUCTION

Sports are inherently competitive, motivating athletes to strive for victory. Appropriate training and adequate nutritional intake are among the factors that primarily influence athletic performance. However, when various efforts fail to yield the expected results, particularly when feeling self-doubt, fear of opponents, pressure to win, and emotional instability, athletes may be tempted to use doping substances¹. The 2021 World Anti-Doping Code (WADC) defines doping as a violation of one or more anti-doping rules². Doping practices not only jeopardize health but also represent an ethical violation that contradicts the vision of the World Anti-Doping

Agency (WADA) to promote fair play and unify anti-doping regulations³. Furthermore, violations of anti-doping regulations can tarnish a nation's reputation in the international arena, affect an athlete's career journey, and contravene Article 103, Paragraph (1) of Law No. 11 of 2022 on Sports⁴.

Globally, approximately 80% of anti-doping rule violations (ADRVs) are related to Article 2.1 of the WADC, which concerns the detection of a prohibited substance, its metabolites, or markers in an athlete's urine or blood sample³. Pelanggaran terkait poin tersebut salah satunya terjadi pada Olimpiade Tokyo 2020. Such violations were evident during the Tokyo 2020 Olympic Games, where an

athlete tested positive for two prohibited substances, namely, ostarine and S-23, which are selective androgen receptor modulators⁵. In the same event, an athlete who was found to have used human growth hormone was consequently suspended from entry⁶. Similar doping cases were also reported among Indonesian athletes, including the use of anabolic steroids during the SEA Games, diuretics during the National Sports Week (PON), and anabolic steroids among bodybuilding athletes in PON 2021⁴.

Dietary supplement intake is common among athletes across various sports disciplines, countries, and competition levels⁷. However, dietary supplements are among the major sources of unintentional doping risk. In several cases, athletes have tested positive for doping after inadvertently consuming contaminated foods or supplements containing substances listed in the WADA Prohibited List⁸. Therefore, athletes and their support personnel must have sufficient knowledge of the WADC to avoid doping violations. Awareness of sport-specific demands, the need for early intervention, and evidence-based support for athletes experiencing challenges, such as injuries or mental health issues, have contributed to the prevention of doping behavior⁹. A study conducted in East Java Province indicated that anti-doping education among athletes has not been fairly implemented and the National Sports Committee of Indonesia does not have concrete preventive efforts to address doping issues⁴. To our knowledge, no studies have explored athletes' knowledge of anti-doping regulations across various sports disciplines and competitive levels in Indonesia. Therefore, this study was conducted to describe the knowledge level among Indonesian athletes regarding anti-doping regulations and identify their experiences and sources of information related to anti-doping. Furthermore, the study is expected to provide a comprehensive overview of athletes' understanding of anti-doping regulations and identify key stakeholders or institutions involved in delivering anti-doping education.

METHODS

Design and Sample

This quantitative descriptive study employed a cross-sectional approach. Ethical approval was obtained from the Ethics Committee of the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada (Approval no. KE-FK-1471-EC-2024) on September 20, 2024. A total of 149 athletes from 18 sports disciplines (i.e., weightlifting, athletics, basketball, badminton, rowing, wrestling, judo, karate, archery, sport climbing, pencak silat, swimming, gymnastics, football, taekwondo, boxing, volleyball, and wushu) were recruited from clubs, schools, and sports organizations across Indonesia. The participants consisted of 97 male and 52 female athletes. Purposive sampling was conducted based on predetermined inclusion and exclusion criteria. Athletes aged ≥ 14 years, actively training or competing within the last 6 months, willing to provide informed consent, and capable of understanding the Indonesian-language questionnaire were included. Conversely, athletes who did not complete the survey or declined participation after receiving an explanation of the study procedures

were excluded. The variables analyzed included athletes' knowledge of anti-doping regulations and their experience with anti-doping education, which were measured using a structured questionnaire.

Research Instruments

The questionnaire was adapted from the Play True Quiz 2024 developed by the WADA to assess athletes' knowledge of anti-doping regulations¹⁰. It was translated into Indonesian and back-translated to ensure semantic and conceptual equivalence. Content validity was assessed by experts from the Indonesia Anti-Doping Organization (IADO) to ensure that all relevant topics were covered, and items deemed unclear or inappropriate were refined.

A pilot test was conducted among 70 athletes from the National Talented Athlete Development Center in Jambi Province, who shared similar characteristics with the target population. Of the 20 items tested, 10 were deemed valid, showing significant correlations with the total knowledge score ($p\text{-value} \leq 0.05$), indicating that these items effectively quantified athletes' anti-doping knowledge. The reliability test of the valid items yielded a coefficient of 0.509, classified as moderate, indicating acceptable internal consistency¹¹. In general, the 10 retained items covered key domains of anti-doping knowledge, namely, testing and investigation procedures, athletes' strict liability and rights, consequences of doping, and ADRVs. In addition to knowledge, the questionnaire assessed athletes' experiences with anti-doping education, which included education history, sources of information, and entities that delivered educational content. Demographic data collected included age, sex, type of sport, history of doping testing, and use or intention to use prohibited performance-enhancing substances or methods.

Data Collection and Data Analysis

Data were collected through an online questionnaire distributed through Google Forms. Descriptive statistical analyses were conducted to present demographic variables as frequency distributions and percentages. Univariate analysis was conducted to describe the distribution of knowledge scores (mean, median, minimum, and maximum) and proportion of athletes who had received anti-doping education. Bivariate analyses were conducted to examine differences in knowledge scores across demographic characteristics using the Mann-Whitney test for variables with two categories (e.g., gender) and the Kruskal-Wallis test for variables with more than two categories (e.g., sports discipline). Furthermore, simple and multiple linear regression analyses were conducted to evaluate associations between respondent characteristics and knowledge scores. All analyses were conducted using IBM SPSS Statistics version 22 (IBM Corp., Armonk, NY, USA).

RESULTS AND DISCUSSIONS

The demographic characteristics of the study participants included age, sex, type of sport, history of doping testing, and history or intention of using prohibited performance-enhancing substances or methods. The study included a total of 149 athletes, with

the majority aged 12–17 years (58.4%), followed by those aged 18–22 years (32.2%). Only a small proportion of participants were over 23 years old (Table 1). This distribution reflects the significant involvement of young

athletes within the national sports development system in Indonesia^{12,13}. Early anti-doping education is crucial in influencing athletes' understanding and attitudes toward clean sport¹⁴.

Table 1. Characteristics of the study participants (n = 149)

Variable	n	%
Age (years)		
12–17	87	58.4
18–22	48	32.2
23–27	12	8.1
>28	2	1.3
Sex		
Male	97	65.1
Female	52	34.9
Sport discipline		
Weightlifting	8	5.4
Athletics	6	4.0
Basketball	1	0.7
Badminton	3	2.0
Rowing	10	6.7
Wrestling	9	6.0
Judo	17	11.4
Karate	3	2.0
Archery	6	4.0
Sport climbing	5	3.4
Pencak silat	11	7.4
Swimming	8	5.4
Gymnastics	4	2.7
Football	20	13.4
Taekwondo	19	12.8
Boxing	10	6.7
Volleyball	3	2.0
Wushu	6	4.0
Highest educational attainment		
Primary school	18	12.1
Junior high school or equivalent	55	36.9
Senior high school or equivalent	59	39.6
Diploma or bachelor's degree	17	11.4
Highest competition level		
District or city	27	18.1
Provincial	25	16.8
National	78	52.3
Asian or regional	15	10.1
World championship	4	2.7
History of doping testing		
Yes	16	10.7
No	133	89.3
Ever used or intended to use prohibited performance-enhancing substances or methods		
Yes	6	4.0
No	143	96.0

As shown in Table 1, male athletes (65.1%) outnumbered female athletes (34.9%). Participants represented 18 sports disciplines, with football (13.4%), taekwondo (12.8%), and judo (11.4%) being the most common. This variety provides a representative overview of cross-disciplinary perceptions and understanding of doping issues. The findings align with the results of studies conducted in Sri Lanka, which reported that athletes' levels of doping knowledge varied significantly across sports disciplines. Athletes participating in

gymnastics and weight training demonstrated higher knowledge scores than those in ball games and athletics^{15,16}.

In this study, most athletes had attained secondary education, including senior (39.6%) and junior (36.9%) high school, whereas only 11.4% had completed a diploma or bachelor's degree. This profile indicated that the majority of the participants were still within the school-age group, reflecting the typical demographic structure of the youth athlete development programs in

Indonesia¹⁷. Comparatively, a study conducted in Sri Lanka revealed that athletes with diploma or professional qualifications had the highest doping knowledge scores ($52.0\% \pm 18.3\%$), followed by bachelor's degree holders ($45.7\% \pm 19.0\%$), indicating the association of higher formal education with better understanding of doping-related issues¹⁶. In this study, 52.3% of the respondents had participated in national-level competitions, indicating a relatively high exposure to competitive sports. However, only 10.7% reported having undergone a doping test. This finding proposes that despite the considerable competitive level, the implementation of doping tests remains limited. According to WADA's 2022 report, the total number of global doping samples increased by 6.4%, from 241,430 samples in 2021 to 256,769 in 2022. Similarly, IADO data indicated an increase in the number of doping tests conducted in Indonesia by 7.2%, from 581 tests in 2022 to 623 in

2023¹⁸.

Table 1 shows that 4% of the athletes admitted to having used or intending to use doping. Although this proportion appears low, it is consistent with findings of a study on student-athletes in South Africa, which reported a rate of 3.9%¹⁹. Nevertheless, this figure should be interpreted cautiously because of the potential influence of social desirability bias, which may lead to underreporting of doping behavior^{20,21}. Additionally, 89.3% of the athletes stated that they had never undergone a doping test. The lack of systematic and routine biological verification through doping tests renders self-reported data unreliable as factual indicators of doping use^{2,18}. This observation is supported by the results of a previous study showing that the self-reported prevalence of doping was only 3.3%; however, it increased to 13.1% when respondents were asked whether they knew other athletes who used doping²¹.

Table 2. History of doping-related education

Variable	n	%
Ever received doping education/information (n=149)		
Yes	55	36.9
No	94	63.1
Source of doping information/education (n=42)		
Coach	23	41.8
Physician	3	5.5
Nutritionist	4	7.3
Other medical personnel	3	5.5
Indonesia Anti-Doping Organization	9	16.3
Others	13	23.6

Table 2 indicates that 36.9% of the athletes had previously obtained doping-related education or information. Among information sources, coaches were identified as the main source of information (41.8%), followed by the "others" category (23.6%), which included the internet and fellow athletes. However, only 16.3% cited IADO as a source of information, underscoring the need for anti-doping organizations and support personnel to take on a more active role in disseminating educational materials. These findings are consistent with the results of a study conducted among national junior athletics athletes in the United Kingdom²²,

which identified coaches as the primary source of doping-related information. Similar results were obtained in the analysis of athletes from various sports in Uganda, where fellow athletes (41.9%) and coaches (29.7%) were the main sources of information²¹. In contrast, a study of adolescent athletes in South Korea revealed that 63.9% received information from KADA, the national anti-doping agency, far higher than from coaches (16.5%) or medical staff (12.4%)¹⁵. Coaches and medical personnel remain the most trusted individuals among athletes regarding nutrition and doping issues^{21,23}.

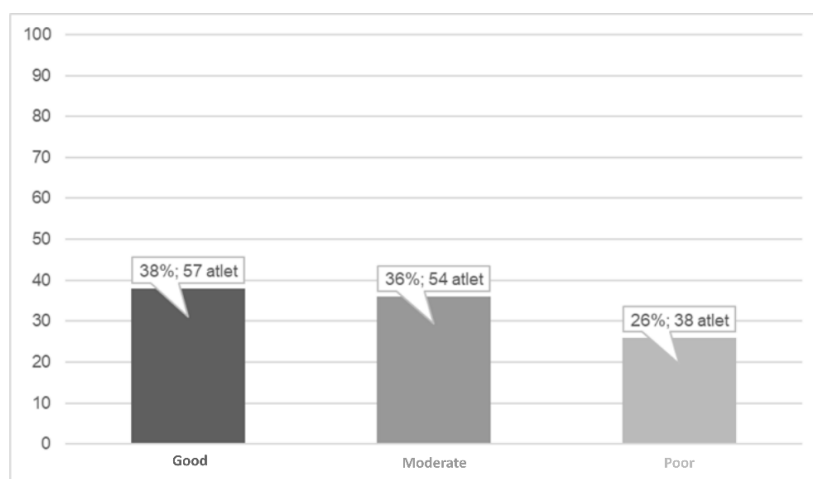


Figure 1. Distribution of athletes' knowledge scores

In this study, the mean anti-doping knowledge score among athletes ($n = 149$) was 68.52, with a median of 70.00. The data showed a wide distribution, with standard deviation, minimum score, and maximum score of 19.95, 20.00, and 100.00, respectively. Figure 1 presents the distribution of anti-doping knowledge scores among the 149 athletes. Scores were derived from responses to 10 items assessing understanding of anti-doping regulations, each ranging from 1 to 10. The graph illustrates that 38%, 36%, and 26% of the athletes demonstrated good (scored $>75\%$), moderate (scored $60\%–75\%$), and poor (scored $<60\%$) knowledge, respectively. This variation reflects opposing levels of understanding of anti-doping regulations among athletes. These findings are consistent with the results of a study conducted in Sri Lanka, which reported that national-level athletes exhibited inadequate doping knowledge¹⁶. Similar results have been observed among athletes in Uganda (mean knowledge score, 37.7%), Poland (45.2%), and Kenya (46.4%), all within the low category^{21,24}. However, other studies have reported contrasting results, with 76.7% of elite athletes in Canada reporting a good understanding of anti-doping

regulations²⁵ and 68% of professional football players in the United Kingdom demonstrating awareness of prohibited substance guidelines²⁶. In these countries, anti-doping education programs are often formally integrated into athlete training systems or educational curricula, often through collaborations between sports federations and academic institutions^{15,21}. At the national level, a study of athletes participating in the 20th National Sports Week (PON XX) in Papua revealed that 55%, 32.5%, and 12.5% of athletes had low, moderate, and high knowledge levels, respectively¹.

Subsequently, a comparative analysis of anti-doping knowledge scores was conducted based on participant characteristics, including age, sex, type of sport, educational attainment, competition level, and experience with doping education. This analysis aimed to evaluate whether demographic and educational factors influence athletes' understanding of anti-doping issues. Normality testing using the Kolmogorov–Smirnov test indicated a non-normal distribution of knowledge scores ($p\text{-value} < 0.05$); therefore, nonparametric Mann–Whitney and Kruskal–Wallis tests were applied for the bivariate analysis (Table 3).

Table 3. Comparison of knowledge scores based on participant characteristics

Variable	N	Median (min–max)	p-value
Age (years)			
12–17	87	70.0 (20.0–100.0)	0.039 ^a
18–22	48	70.0 (40.0–100.0)	
23–27	12	75.0 (40.0–100.0)	
>28	2	60.0 (50.0–70.0)	
Gender			
Male	97	70.0 (20.0–100.0)	0.306 ^b
Female	52	70.0 (20.0–100.0)	
Sport Discipline			
Weightlifting	8	80.0 (40.0–100.0)	0.474 ^a
Athletics	6	80.0 (40.0–100.0)	
Basketball	1	60.0 (60.0–60.0)	
Badminton	3	70.0 (60.0–80.0)	
Rowing	10	70.0 (40.0–100.0)	
Wrestling	9	80.0 (40.0–100.0)	
Judo	17	60.0 (30.0–100.0)	
Karate	3	90.0 (90.0–90.0)	
Archery	6	75.0 (50.0–100.0)	
Sport climbing	5	90.0 (60.0–100.0)	
Pencak silat	11	70.0 (40.0–90.0)	
Swimming	8	75.0 (60.0–100.0)	
Gymnastics	4	65.0 (60.0–80.0)	
Football	20	65.0 (20.0–100.0)	
Taekwondo	19	50.0 (20.0–100.0)	
Boxing	10	75.0 (40.0–100.0)	
Volleyball	3	70.0 (50.0–90.0)	
Wushu	6	55.0 (40.0–90.0)	
Highest educational attainment			
Primary school	18	60.0 (20.0–100.0)	0.176 ^a
Junior high school or equivalent	55	70.0 (20.0–100.0)	
Senior high school or equivalent	59	70.0 (20.0–100.0)	
Diploma or bachelor's degree	17	70.0 (40.0–100.0)	
Highest competition level			
District or city	27	70.0 (30.0–100.0)	0.081 ^a
Provincial	25	60.0 (40.0–90.0)	
National	78	70.0 (20.0–100.0)	
Asian or regional	15	70.0 (20.0–100.0)	

Variable	N	Median (min–max)	p-value
World championship	4	90.0 (90.0–100.0)	
Ever received doping education/information			
Yes	55	70.0 (20.0–100.0)	0.123 ^b
No	94	70.0 (20.0–100.0)	

*p-value<0.05 = significant; a = Kruskal–Wallis test; b = Mann–Whitney test

As shown in Table 3, only age was significantly associated with anti-doping knowledge scores (p-value = 0.039). Kelompok usia 23–27 tahun mencatatkan skor median tertinggi (75,0), sedangkan kelompok usia >28 tahun memperoleh skor median terendah (60,0). The group aged 23–27 years recorded the highest median score (75.0), whereas the group aged >28 years showed the lowest (60.0). This finding indicates that athletes in early adulthood tend to have higher levels of anti-doping knowledge, possibly due to greater engagement in formal training, higher-level competitions, and broader exposure to relevant education and information. Conversely, the lower scores observed among athletes aged >28 years may reflect reduced involvement in structured development programs or limited access to updated information. However, this interpretation should be made cautiously because this age group included only two respondents. A study reported that athletes aged ≥35 years demonstrated the highest levels of doping knowledge, likely attributable to accumulated experience and increased exposure over time¹⁶. Similarly, studies among young Austrian athletes indicated that maturity contributed positively to doping awareness²⁷.

Analysis of sex differences showed no significant variation in anti-doping knowledge scores (p-value = 0.306), with identical median values between male and female athletes (70.0). These results indicate that sex does not significantly affect doping knowledge. In the Sri Lankan sporting context, the absence of sex differences was attributed to equal exposure to competitive environments among male and female athletes¹⁶. Comparable findings were reported among junior athletes in Austria, where sex did not significantly affect knowledge levels²⁷. However, studies conducted in Kenya have yielded contrasting results, indicating that male athletes tended to score higher than their female counterparts^{24,28}.

Comparisons across types of sports also revealed

no significant differences (p-value = 0.474), although median scores varied widely from 50.0 to 90.0. As regards educational attainment, no significant differences were observed (p-value = 0.176); however, median scores tended to increase with increasing educational level. This indicates that general literacy gained through formal education may contribute to understanding complex issues, such as doping. Nevertheless, general literacy alone appears insufficient to produce a significant effect without targeted and specific anti-doping education. Supporting evidence presents that athletes with higher educational backgrounds tend to exhibit better doping-related knowledge than those with only secondary-level education¹⁶. Similar findings from Kenya emphasized the importance of incorporating doping education at the school level, as young athletes are likely to progress to elite status in the future²⁴.

No significant differences were noted across competition levels (p-value = 0.081). However, athletes who had participated in world championships yielded the highest median scores (90.0), possibly reflecting greater access to anti-doping education at the international level. Given the small number of respondents in this category (n = 4), this result should not be generalized. Olympic-level athletes have held less permissive attitudes toward doping compared with regional-level competitors¹⁶. This is supported by the results of a study indicating that the transition to professional-level competition is recognized as a period of vulnerability to doping practices²⁹.

Simple regression analysis (Table 4) indicated that athletes aged 18–22 years achieved significantly higher knowledge scores than other age groups. Athletes with only elementary education and those who reported using or intending to use doping substances gained lower knowledge scores, whereas those who had participated in world championships exhibited significantly higher knowledge levels.

Table 4. Simple linear regression analysis of athletes' anti-doping knowledge scores

Variable	B	95% CI	p-value
Age (years)			
18–22	8.940	2.161–69.491	0.010*
23–27	6.137	–5.727 to 18.002	0.308
>28	–8.639	–36.760 to 19.481	0.545
Sex			
Female	–3.640	–10.412 to 3.132	0.290
Sport Discipline			
Weightlifting	5.523	–8.823 to 19.869	0.448
Athletics	3.275	–13.198 to 19.748	0.695
Basketball	–8.581	–48.240 to 31.078	0.670
Badminton	1.507	–21.559 to 24.573	0.897
Rowing	0.511	–12.438 to 13.459	0.938
Wrestling	6.302	–7.260 to 19.863	0.360
Judo	–2.981	–13.161 to 7.198	0.564
Karate	21.918	–0.871 to 44.707	0.059

Variable	B	95% CI	p-value
Archery	6.748	−9.696 to 23.193	0.419
Sport climbing	13.944	−3.903 to 31.792	0.125
Pencak silat	−4.295	−16.666 to 8.076	0.494
Swimming	9.486	−4.805 to 23.777	0.192
Gymnastics	−1.052	−21.097 to 18.993	0.918
Football	−5.225	−14.691 to 4.241	0.277
Boxing	5.871	−7.043 to 18.784	0.370
Volleyball	1.507	−21.559 to 24.573	0.897
Wushu	−10.618	−27.008 to 5.773	0.202
Highest educational attainment			
Primary school	−10.327	−20.125 to 0.528	0.039*
Junior high school or equivalent	0.035	−6.679 to 6.749	0.992
Diploma or bachelor's degree	4.987	−5.172 to 15.145	0.334
Highest level of competition			
Provincial	−5.435	−14.061 to 3.190	0.215
National	−0.130	−6.617 to 6.357	0.968
Asian or regional	−0.582	−11.350 to 10.186	0.915
World championship	24.638	4.998–44.277	0.014*
History of Doping Test	−3.247	−13.699 to 7.205	0.540
History of Doping Use or Intention to Use	−21.037	−37.158 to 4.917	0.011*

*p-value<0.05 = significant; B = Coefficient; CI, confidence interval

The multiple linear regression analysis (Table 5) revealed that the overall model was significant in explaining the variation in anti-doping knowledge scores ($F = 1,650$; $p\text{-value} = 0.031$). The adjusted R^2 value of 0.116 indicated that approximately 11.6% of the variance in knowledge scores could be explained by the combination of variables included in the model. Being 18–22 years old remained a significant predictor of higher

knowledge scores. This may be attributed to a more advanced cognitive and social developmental stage in this age group when compared with younger adolescents, as well as greater opportunities to access information through formal education, broader competition experience, and exposure to social media. Athletes' age may influence their level of understanding regarding performance-enhancing substances^{16,30}.

Table 5. Multiple linear regression analysis of athletes' doping knowledge scores

Variable	B	95% CI	p-value
(Constant)	63.433	49.003–77.863	<0.001
Age (years)			
18–22	10.313	1.292–19.333	0.025*
23–27	11.076	−6.173 to 28.326	0.206
>28	3.008	−28.779 to 34.794	0.852
Sex			
Female	−6.142	−13.786 to 1.502	0.114
Sport discipline			
Weightlifting	19.473	2.838–36.109	0.022*
Athletics	2.860	−16.400 to 22.121	0.769
Basketball	−3.433	−43.265 to 36.109	0.865
Badminton	4.748	−19.473 to 28.968	0.699
Rowing	11.935	−3.994 to 27.864	0.141
Wrestling	13.120	−3.142 to 29.382	0.113
Judo	3.046	−10.568 to 16.661	0.658
Karate	31.862	6.873 to 56.851	0.013*
Archery	15.895	−2.141 to 33.930	0.084
Sport climbing	5.913	−15.278 to 27.103	0.582
Pencak silat	0.610	−13.877 to 15.097	0.934
Swimming	19.333	3.264–35.403	0.019*
Gymnastics	12.068	−8.994 to 33.131	0.259
Football	−1.865	−16.651 to 12.921	0.803
Boxing	11.748	−3.844 to 27.340	0.138
Volleyball	8.617	−16.708 to 33.942	0.502
Wushu	−1.274	−19.065 to 16.518	0.887
Highest educational attainment			
Primary school	−5.720	−19.458 to 8.017	0.411
Junior high school or equivalent	3.066	−6.244 to 12.376	0.516
Diploma or bachelor's degree	−1.888	−16.560 to 12.784	0.799

Variable	B	95% CI	p-value
Highest level of competition			
Provincial	-6.684	-17.786 to 4.419	0.236
National	-3.603	-13.576 to 6.370	0.476
Asian or regional	-6.867	-21.168 to 7.434	0.344
World championship	18.905	-5.096 to 42.906	0.121
History of doping test	1.174	-11.139 to 13.487	0.851
History of doping use or intention to use	-22.408	-41.397 to 3.418	0.021*

*p-value<0.05 = significant; B = coefficient; CI, confidence interval

Athletes competing in sports such as weightlifting, karate, and swimming exhibited significantly higher doping knowledge scores than those in other disciplines. This observation may be linked to their greater exposure to doping-related issues, as these sports are often subjected to strict monitoring by national and international anti-doping bodies. A study conducted in Sri Lanka also indicated that athletes in gymnastics and weight training exhibited higher doping knowledge scores than those in ball games and athletics¹⁶.

Conversely, athletes with a history or intention of using doping substances had significantly lower knowledge scores. This may reflect unawareness of the risks and consequences of doping or misconceptions about its perceived benefits. This finding aligns with theories suggesting that low knowledge can be a risk factor for doping behavior^{20,31}. Limited understanding of anti-doping regulations was found to correlate with a higher susceptibility to doping practices³². Other variables, such as formal education level, sex, and doping test experience, did not show significant associations in the multivariate model. Thus, anti-doping knowledge may be more strongly influenced by specific educational contexts, such as targeted training or workshops, rather than by general demographic characteristics. Several studies have also emphasized the importance of contextual and experiential education approaches^{32,33}. According to WADA International Standard for Education, the effectiveness of an educational program depends not only on its existence but also on the approach employed³⁴. Value-based education and active learning

methods, such as reflective discussions and case studies, are more effective in improving understanding and instilling clean sport principles than passive information delivery^{33,34}.

In this study, the anti-doping knowledge instrument consisted of 10 items covering four main subtopics: testing and investigation, athlete rights and responsibilities, consequences of doping, and ADRVs. In the testing and investigation section, questions included items 1 ("What does WADA stand for?") and 2 ("How many times can an athlete be tested for doping in a year?"). The athlete rights and responsibilities section comprised items 3 ("When athletes are sick, they may take any medication to recover"), 4 ("Athletes can refuse to undergo a doping test if they are too busy"), and 6 ("Injured athletes cannot be tested for doping"). The consequences of doping section included items 5 ("Athletes under 18 years old cannot be sanctioned for doping"), 7 ("If an athlete tests positive in their country, they can compete for another nation"), and 10 ("If an athlete is banned from their sport, they can compete in another discipline"). The ADRV section covered items 8 ("Can an athlete be found guilty of a ADRV if they consume a supplement contaminated with a prohibited substance?") and 9 ("Athletes may be sanctioned for working with coaches, doctors, or other support personnel currently serving a suspension for anti-doping rule violations"). An item-level analysis was conducted to identify specific areas of knowledge that require further improvement (Figure 2).

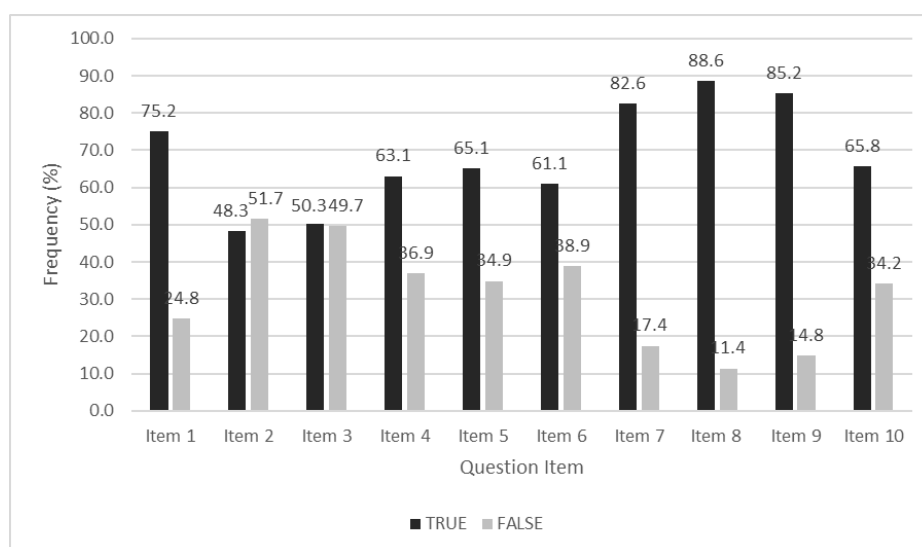


Figure 2. Distribution of responses by question item

Figure 2 illustrates the distribution of correct and incorrect responses across 10 items assessing knowledge of anti-doping regulations. Overall, athletes demonstrated a relatively good understanding of ADRVs, particularly in items 8 and 9, with correct response rates of 88.6% and 85.2%, respectively. These findings indicate that most athletes understood that consuming supplements contaminated with prohibited substances and engaging with personnel who have violated anti-doping rules can result in sanctions. This finding reflects a relatively high level of risk literacy, which is consistent with results of a previous study that highlight the importance of raising awareness about supplement contamination risks in anti-doping education programs³. Furthermore, doping susceptibility changes are indirectly associated with shifts in supplement use intentions, moderated by individual moral values³⁵. However, several items require special attention owing to their low proportion of correct responses. Item 2 ("How many times can an athlete be tested for doping in a year?") was answered correctly by only 48.3% of the respondents, and a similar pattern was observed in item 3 regarding medication use during illness (50.3% correct). This finding indicates that while understanding of legal aspects related to ADRVs is relatively adequate, knowledge of technical procedures and athletes' rights during testing remains limited. This finding aligns with the results of a previous study emphasizing the importance of a thorough understanding of testing procedures and athletes' obligations, particularly in relation to medications and application for a TUE³⁶. A study also found that the procedural anti-doping knowledge of Indonesian athletes was in the moderate range (59%), indicating the need to strengthen case-based educational approaches¹.

Items 5 ("Athletes under the age of 18 cannot be sanctioned for doping") and 6 ("Injured athletes cannot undergo doping tests") were correctly answered by 65.1% and 61.1% of the respondents, respectively. These figures indicate persistent misconceptions that age and physical condition may serve as exceptions to the testing process. WADA regulations clearly state that all athletes are subject to testing mechanisms and can be sanctioned if found to have violated anti-doping rules³⁷. Therefore, educational initiatives should emphasize both the normative aspects of regulations and the rationale, context, and implementation of these rules in various athletic situations.

Overall, these findings reinforce the argument that general and noncontextual anti-doping education approaches are insufficient to enhance comprehensive understanding of athletes. The concept of values-based education promoted by WADA must be operationalized through examples of best practices that are adapted to the cultural and socioeconomic characteristics of each country³³. Consequently, National Anti-Doping Organizations should implement multifaceted prevention programs that are contextually relevant. The integration of theoretical learning with practical application is a strategic approach to bridging the gap between normative and procedural knowledge³⁶. Future educational programs should consider athletes' age, learning styles, and sports disciplines. Such approaches

may improve educational effectiveness and foster a strong clean sport culture, particularly among young Indonesian athletes.

A previous study also suggested that educational programs that stimulate belief systems and promote critical thinking about doping were more effective than those focusing solely on health aspects³⁸. In addition, social environments and education quality influence athletes' readiness to support anti-doping policies. Interventions targeting policy legitimacy and sociocognitive factors have improved support for anti-doping policies among competitive athletes³⁹.

This study has some limitations. Data were collected online using standardized procedures, including instructions for completion, response duplication control, and data completeness checks, to ensure response quality and reliability. However, this online approach inherently carries potential variations in respondents' access levels and digital literacy, which must be considered when interpreting the results. Furthermore, the sample's representation was limited to specific athlete groups, which may restrict the generalizability of the results to the broader Indonesian athlete population. These limitations provide opportunities for future studies employing more comprehensive designs and broader coverage.

CONCLUSIONS

This study presents that the anti-doping knowledge level among Indonesian athletes is generally categorized as moderate, with significant differences noted across age groups and weaknesses identified in specific areas of understanding. These findings underscore the need for more targeted and experience-based anti-doping education programs through participatory methods, such as simulations and case discussions. Most athletes reported obtaining anti-doping information from coaches and the IADO, emphasizing the importance of strengthening the capacity of key stakeholders to ensure consistent and standardized delivery of education.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

MHSTP: conceptualization, methodology, supervision, data analysis, and drafting of the initial manuscript; RM: methodology and data curation; IN: participant coordination and data analysis; KMS: participant coordination and data analysis; VDYR: questionnaire development, instrument testing, data analysis, initial drafting, and manuscript review and

editing; ALA: administration, initial drafting, and manuscript review and editing; SHM: administration, initial drafting, and manuscript review and editing.

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