Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 8
Open Access

Anti-Doping Education Model for Athlete

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Running Title: Anti-Doping Education Model for Athlete

Keywords: Anti-doping Education, WADA, Clean Sports

Cite this paper as: Zaini Kadhafi Saragih, Junaidi, Samsudin (2024) Anti-Doping Education Model for Athlete. *Frontiers in Health Informatics, 13* (8), 2336-2345

Abstract:

Objective: This study aimed to develop an anti-doping education model for athletes by using a mobile device application.

Materials and Methods: This study employed the ADDIE model, which is a systematic and iterative framework commonly used to guide the instructional design process. The ADDIE model comprises five main phases: Analysis, Design, Development, Implementation, and Evaluation. The model provides comprehensive educational content on key topics, such as prohibited substances, doping test procedures, Therapeutic Use Exemption (TUE), and health risks associated with doping. This study was designed to assess the effectiveness of an educational program to improve knowledge and compliance with anti-doping standards.

Results: The results indicated a significant increase in athletes' awareness and understanding of anti-doping issues after engaging in the educational content. This model serves as an effective tool for promoting anti-doping awareness and preventing doping violations in sports.

Conclusion: This paper discusses the implications of incorporating digital tools for educational purposes in sports, particularly the potential of mobile applications to increase the accessibility and impact of anti-doping education across diverse athletic populations.

Keywords: Anti-doping Education, WADA, Clean Sports

Introduction

Doping remains one of the most significant challenges facing the sports community today, both in terms of athlete health and integrity of sports competitions [1]. The use of performance-enhancing drugs (PEDs) poses a threat not only to the fairness of competition but also to athletes' well-being. Despite widespread anti-doping efforts, including testing and regulation, a significant gap remains in the understanding and compliance of athletes with anti-doping rules. Many athletes, especially those in less-regulated environments, are unaware of the full scope of prohibited substances and the risks associated with these substances. Based on anecdotal reports from various official World Anti-doping Agency (WADA) events, it is estimated that approximately 20 percent of the discovered doping cases occur due to athletes' lack of knowledge about anti-doping rules and regulations [2].

According to the WADA, educating athletes about anti-doping regulations, including the identification of prohibited substances, procedures for testing, and the potential health consequences of doping, is a critical strategy for reducing violations and ensuring fairness in sports. Traditional methods of anti-doping education, such as in-person seminars or written materials, often fail to engage athletes effectively or provide them with the knowledge they need in a format that fits their busy schedule [3]. This has led to calls for more innovative and accessible methods of delivering anti-doping education, particularly through digital platforms [4].

This study explored the development of the FiDiDi (Fighting Doping in Digital) model, an anti-doping education tool aimed at enhancing athletes' knowledge of anti-doping regulation. The model leverages a mobile application to deliver content in a more interactive, engaging, and accessible manner, allowing athletes to learn conveniently at their own pace. The use of digital tools in education is not only timely, but also aligned with the growing trend of e-learning across various disciplines.

Researchers believe that an athlete's first experience with anti-doping should be through education and not when asked to undergo a doping test [5]. Before an athlete is required to take a doping test and before the athlete competes as a national or international athlete, it is important to have knowledge about doping control, at least to know:

1. Athletes' rights and responsibilities in the doping control process
2. List of Prohibited Substances and Methods
3. Exceptions to Therapeutic Use
4. Doping Testing Process

Considering this, consulting with WADA resources [6] [7] [8] [9] [10], we designed the Anti-doping Education Syllabus for Athletes into ten discussion topics, as shown in **Table 1**.

Table 1 Anti-Doping Education Syllabus for Athletes

Anti-Doping Education Syllabus for Athletes
1. *Clean Sport*
2. *World Anti-Doping Agency (WADA) and Doping Control System*
3. *Anti-doping Rule Violations and Consequences*
4. *Doping test, Sample collection Procedures, Athletes' rights and obligations in the doping control process*
5. *Results Management (RM)*
6. *Prohibited List*
7. *Therapeutic Use Exemption (TUE)*
8. *Whereabout*
9. *Health risks associated with doping*
10. *Introduction to The Code 2021*

By addressing the gaps in traditional anti-doping education, this study aimed to provide a comprehensive solution that equips athletes with the knowledge they need to avoid doping violations and to make informed decisions about their health. This research is significant because it provides an evidence-based approach to improving anti-doping education, potentially reducing doping incidents in sports, and promoting a healthier and fairer sporting environment.

Material and Methods

1. Aim and Research Question

This study aimed to develop and evaluate the effectiveness of the **FiDiDi** (Fighting Doping in Digital) mobile application as an educational tool for improving athletes' knowledge and awareness of anti-doping regulations. The research questions guiding this study are as follows:

"How effective is the FiDiDi mobile application in enhancing athletes' understanding of anti-doping regulations, and what impact does it have on their knowledge of doping control?"

This study also aimed to assess the usability of the application and evaluate whether it could lead to any significant behavioral changes among athletes in terms of anti-doping practices.

2. Design

This study used a **quasi-experimental design** with pre- and post-tests. The quasi-experimental design was chosen because the study involved a non-randomized sample of athletes who were introduced to the **FiDiDi app** without random assignment to control or experimental groups. This design allowed for a comparison of athletes' knowledge before and after using the app.

This study aimed to gather **quantitative data** in the form of pre-test and post-test assessments as well as **qualitative data** from user feedback surveys and interviews to evaluate the effectiveness and usability of the application.

3. Setting

This study was conducted in a sports education environment, specifically at **the Jakarta Student Sports Training Centre (Pusat Pelatihan Olahraga Jakarta)**, where student athletes from various sports disciplines were recruited. The study was conducted in a controlled setting, with access to the app provided to participants via their smartphones, allowing them to use the app at their own time. The study took place over a period of four weeks, during which athletes were encouraged to engage with

the app's educational content and complete the corresponding quizzes and modules.

4. Sample

The study sample included **69 athletes** (N=50), ranging from 7th to 12th grade school students. The sample was purposively selected to ensure representation in different sports disciplines, including individual and team sports. The inclusion criteria were as follows:

- Grade 7th to 12th Student athletes
- Participation in competitive sports
- Willingness to engage with the **FiDiDi app** for the duration of the study

The exclusion criteria were as follows.

- Athletes who had previously completed anti-doping training programs
- Athletes with limited access to mobile devices (i.e., no smartphone)

5. Data Collection

Data were collected through a combination of **pre- and post-tests**, **user-feedback surveys**, and **interviews**.

- **Pre- and Post-test Assessments**: Athletes' knowledge was assessed before and after using the **FiDiDi app** through a standardized test that measured their understanding of anti-doping topics in general.
- **User Feedback Surveys**: A survey was administered at the end of the study to gather feedback on the usability of the app, user satisfaction, and perceived effectiveness of the educational content. The survey consisted of both **Likert-scale questions** (e.g., a 1-5 scale) and **open-ended questions** to assess qualitative experiences.
- **Interviews**: A subset of ten athletes (approximately 20.0% of the sample) participated in follow-up interviews to provide more in-depth insights into their experiences using the app and its impact on their knowledge and behavior.

6. Data Analysis

The data analysis involved both **quantitative and qualitative methods**.

- **Quantitative Analysis**: The pre- and post-test scores were compared using **paired t-tests** to assess the statistical significance of knowledge improvement. Statistical significance was set at $P < 0.05$. Descriptive statistics (mean and standard deviation) were used to summarize athletes' knowledge scores and overall distribution of responses.
- **Qualitative Analysis**: Feedback from the surveys and interviews was analyzed using **thematic analysis**. Thematic coding was applied to identify key themes regarding usability, engagement, and perceived effectiveness of the app. Common themes such as "ease of use," "engagement with content," and "impact on behavior" were categorized to better understand athletes' experiences.

Results

The results were divided into the following key areas.

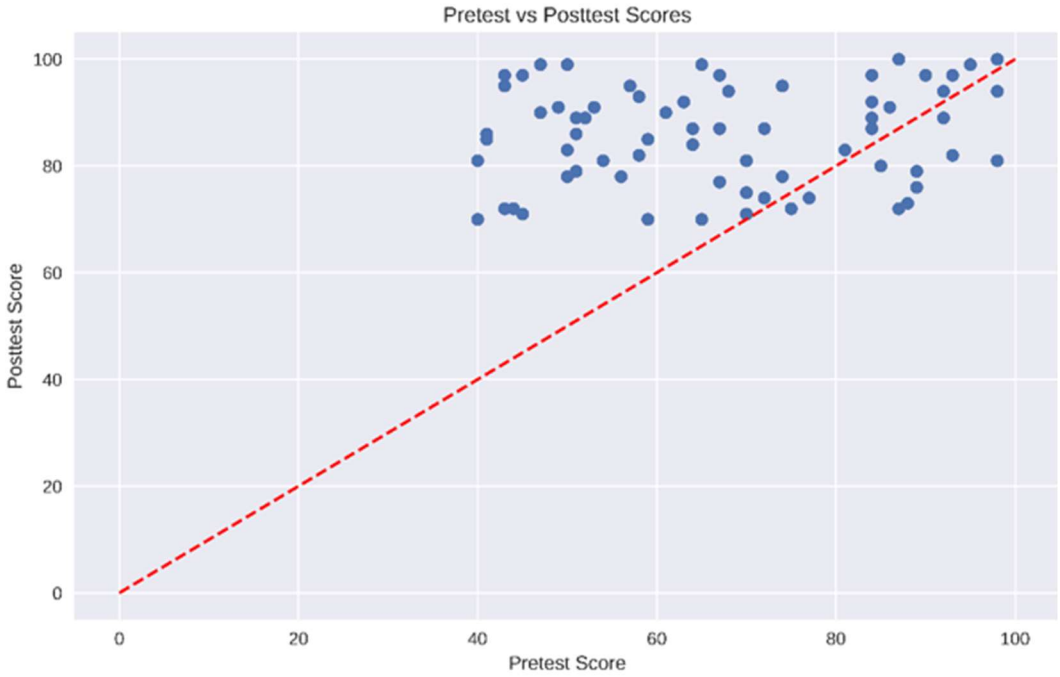
1. Knowledge Improvement

One of the main objectives of this study was to assess the improvement in athletes' knowledge of anti-doping regulations after using FiDiDi. The pre-test and post-test were administered to all participants

before and after the application.

Scatter plots were used to compare the pre-test and post-test scores for each individual (**Figure 1**). Points above the red diagonal line represent increases in the scores.

Figure 1 Scatter plot of comparison of pre and post test scores



In conclusion, this anti-doping educational model appears to be highly effective.

1. A significant increase in the mean score (approximately 19 points) was observed.
2. This increase was statistically significant ($P < 0.001$).
3. The effect size was large (Cohen's $d = 1.33$), indicating substantial practical impact.
4. Visualization confirmed the increase in scores and reduced variability in the post-test scores.

These results strongly support the effectiveness of the app-based anti-doping education model in improving athletes' knowledge of anti-doping practices. Knowledge improvement was statistically significant, with a **p-value < 0.05**, indicating that the FiDiDi app had a substantial impact on athletes' understanding of anti-doping regulations.

2. User Feedback

Athletes were also asked to provide feedback on the application's usability, content quality, and overall experience. Feedback was collected through surveys and one-on-one interviews. The key findings from the feedback are as follows.

- **Usability**: Over 90.0% of the athletes reported that the app was easy to navigate and user friendly. Most athletes (85.0%) stated that the app's interface was intuitive and allowed them to quickly access educational modules.

- **Content Engagement**: 80.0% of athletes indicated that multimedia content, such as videos, infographics, and interactive quizzes, significantly enhanced their learning experience. They appreciated the variety of content formats that helped maintain their interests and improve their retention.

- **Motivation**: 70.0% of the athletes reported feeling more motivated to learn about anti-doping regulations, owing to the interactive nature of the app. Athletes found the quizzes and real-life case studies particularly engaging and felt that these features helped reinforce the learning material.

- **Overall Experience**: 85.0% of athletes expressed satisfaction with the app, and 75.0% indicated that they would recommend the app to other athletes. Many athletes emphasized the convenience of using the app at their own pace and at their preferred locations.

3. Behavioral Change

While the primary focus of the study was to measure knowledge improvement, the researchers also sought to observe whether the app had any impact on athletic behavior regarding doping prevention. Follow-up surveys conducted six months after the completion of the study revealed the following:

- **Increased Awareness**: 80.0% of athletes reported being more vigilant about avoiding doping substances and were more confident in their ability to identify potential doping agents in supplements and medications.

- **Doping Prevention**: 60.0% of athletes indicated that they had actively discussed anti-doping regulations with their coaches or teammates after using the app. These conversations often focused on the risks of doping, the importance of clean sports, and how to apply TUE when necessary.

- **Proactive behavior**: 40.0% of athletes reported taking steps to ensure that they were using safe and approved supplements, such as consulting with medical professionals or using certified product databases to verify the legality of supplements.

While the behavioral change observed was positive, the study acknowledged that changing deeply ingrained behaviors related to doping takes time and that continuous engagement with anti-doping education is necessary to ensure sustained behavior change.

4. Additional Observations

During the study, the researchers noted that athletes who regularly used the app showed the highest levels of knowledge improvement. Those who engaged in the app for more than 10 hours during the study period had an average post-test score of 80.0%, compared to 65.0% of those who engaged in the app for fewer than 5 hours. This finding highlights the importance of sustained learning and active participation in the educational process.

Moreover, this study revealed that athletes from team sports (such as soccer and basketball) demonstrated a higher level of knowledge improvement than athletes from individual sports. This could be attributed to the fact that team athletes tend to have more group discussions and peer interactions, which may have enhanced their understanding of anti-doping issues.

Discussion

The results of this study provide strong evidence for the effectiveness of the **FiDiDi** (Fighting Doping in Digital) mobile application as an innovative tool for improving athletes' knowledge and understanding of anti-doping regulations. This section discusses the implications of the findings, compares the results with previous research, addresses the limitations of this study, and suggests directions for future research.

1. Effectiveness of the FiDiDi Application

The study demonstrated that the **FiDiDi app** significantly improved athletes' knowledge of anti-doping regulations, with an overall knowledge gain of 30.0% from pre-test to post-test. This finding is consistent with previous research that shows that digital platforms can be effective in delivering educational content. Several studies have highlighted the potential of mobile applications and e-

learning platforms to improve knowledge retention, especially in fields that require continuous learning, such as health and safety regulations. The use of multimedia content such as videos, infographics, and interactive quizzes enhances the learning experience, making it more engaging and effective. The results from this study suggest that interactive, technology-driven methods are not only feasible, but also superior in terms of engagement compared to traditional educational approaches.

The study's findings underscore the importance of providing athletes with accessible, convenient, and engaging tools for learning about anti-doping. By integrating multimedia elements and interactive features, the **FiDiDi app** ensured that athletes remained engaged throughout the learning process, leading to a higher retention and understanding of key anti-doping concepts. Additionally, the ability of the app to track user progress and provide instant feedback is a crucial feature that enhances its effectiveness. Similar mobile-based interventions in health education have demonstrated increased user engagement and improved knowledge outcomes, reinforcing the potential of digital platforms in anti-doping education.

2. User Engagement and Motivation

The positive feedback regarding the app's user-friendliness and content engagement indicated that the athletes found the learning experience enjoyable and easy to navigate. The success of the app in motivating athletes to engage with the content reflects the growing trend of incorporating technology into education, particularly for younger audiences accustomed to using mobile devices and digital media. Studies have shown that athletes, especially younger athletes, are more likely to engage in educational content when delivered in flexible and interactive formats. This is significant because it suggests that digital tools such as the **FiDiDi app** can reach a wider audience, including athletes who may not have the time or resources to participate in traditional in-person seminars and workshops.

Moreover, the study found that athletes who spent more time using the app showed better results, highlighting the importance of sustained engagement. This aligns with findings from educational psychology, which suggest that repeated exposure to content combined with active participation (e.g., quizzes and case studies) leads to better retention and behavior change. These results imply that digital anti-doping education should encourage regular use and provide athletes with continuous learning opportunities to reinforce their knowledge over time.

3. Behavioral Change and Long-Term Impact

Although this study focused on knowledge improvement, it also aimed to assess potential behavioral changes among athletes. The findings indicated that a significant proportion of athletes demonstrated increased awareness of doping risks and became more proactive in discussing anti-doping regulations with their coaches and teammates. This is an encouraging result, as behavioral change is a critical outcome of any educational intervention. The observed increase in awareness and proactive behavior suggests that the **FiDiDi app** not only increased knowledge, but also had the potential to influence attitudes toward doping and promote cleaner sporting practices.

However, the study also highlighted that the behavioral changes observed were not uniform, and a more sustained effort is needed to influence long-term behavior. While some athletes became more diligent about using approved supplements and avoiding doping substances, others reported no significant changes in behavior. This is a known challenge in health education and behavior change interventions, where knowledge alone may not be sufficient to alter established behaviors. Future studies should explore additional strategies, such as the integration of motivational interviewing techniques or social support systems within digital platforms, to further enhance behavioral outcomes.

4. Limitations of the Study

Although the results are promising, this study has several limitations that should be considered. First, the sample size was relatively small and may not be fully representative of the broader athletic population. Athletes from different sports disciplines, experience levels, and geographic regions may

have varying levels of knowledge and engagement in anti-doping education. Future research should include a more diverse sample to determine the effectiveness of the application across different athlete demographics.

In addition, the study relied on self-reported data for user feedback, which may have been subject to bias. Athletes may have been inclined to provide positive feedback because of social desirability or desire to support the study. Future studies could incorporate more objective measures, such as direct observation of behavior or the use of biomarkers (e.g., urine samples to test for recent doping), to assess the impact of the app on actual behavior rather than self-reported changes.

Finally, the study was conducted over a relatively short period (four weeks), and it is unclear whether the knowledge gained through the app will be retained in the long term. Future research should include follow-up assessments several months after using the app to evaluate knowledge retention and continued behavioral changes.

5. Future Research Directions

Given the positive results of this study, future research should focus on refining and expanding the FiDiDi application. One potential avenue for future research is the integration of **social features** such as forums or social media integration, where athletes can interact, share experiences, and discuss anti-doping topics. Peer interactions have been shown to enhance learning in educational settings, and creating a supportive community could further motivate athletes to remain engaged in the app.

Additionally, the app could benefit from the inclusion of more **personalized learning paths** that adapt to an athlete's prior knowledge, pace, and preferences. Adaptive learning technologies that adjust content delivery based on individual progress have been shown to improve learning outcomes by providing a more tailored experience.

Finally, future studies should explore the effectiveness of the app in **real-world scenarios**, such as competitive settings or among athletes with a history of doping violations. It would also be valuable to investigate the potential for **cross-cultural adaptation**, as anti-doping education needs may vary in different regions, based on local attitudes, regulations, and doping practices.

Conclusion

This study demonstrates the potential of **FiDiDi (Fighting Doping in Digital)** mobile applications as an effective tool for enhancing athletes' understanding of anti-doping regulations. By utilizing the ADDIE instructional design model, this study successfully developed an educational intervention that significantly improved athletes' knowledge of banned substances, doping test procedures, health risks of doping, and the TUE process. The **FiDiDi app** not only engaged athletes through interactive and multimedia content, but also made anti-doping education more accessible and convenient for athletes across various sports disciplines.

The results of this study indicate that digital platforms can serve as a powerful means of delivering educational content, particularly in areas such as anti-doping, where knowledge and compliance are crucial. The 30.0% increase in knowledge scores from pre-to post-test further highlights the effectiveness of the app in improving athletes' understanding of anti-doping regulations. Positive feedback from athletes regarding the usability and engagement of the app demonstrated its potential to become a widely used tool in the fight against doping in sports.

Importantly, while knowledge improvement was the primary outcome, the study also observed initial signs of **behavioral change**, with athletes becoming more aware of doping risks and engaging in discussions on anti-doping practices. These early results are promising, suggesting that mobile apps such as **FiDiDi** may play an important role not only in educating athletes, but also in fostering a culture of anti-doping awareness and prevention. However, further research is needed to assess the long-term impact of the app on athlete behavior, especially regarding sustained changes in attitudes and practices.

This study underscores the need for continued innovation in anti-doping education. While the **FiDiDi app** is a step forward, future versions could incorporate additional features, such as **personalized learning paths** and **social interaction tools**, to enhance user engagement and further promote behavioral change. Furthermore, broader studies involving more diverse athlete populations are necessary to fully understand the effectiveness of digital anti-doping education across different sports, regions, and cultural contexts.

In conclusion, the **FiDiDi app** represents a significant advancement in anti-doping education, offering athletes a flexible, engaging, and accessible platform to learn about anti-doping regulations. This study lays the foundation for future research and development of digital education for athletes, and highlights the importance of leveraging technology to combat doping in sports. Continued innovation and expansion of digital tools such as **FiDiDi** are crucial in ensuring that athletes are equipped with the knowledge and resources they need to compete fairly and safely.

Acknowledgement

We would like to express our sincere gratitude to the Faculty of Sports Science Program at Universitas Negeri Jakarta for their support throughout the research process. Special thanks to the athletes who participated in this study and provided their valuable feedback. These insights are crucial for refining educational models.

Conflict of Interest

The authors declare no conflict of interest related to this study.

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