
| RESEARCH ARTICLE

Doping Knowledge and Educational Needs of Tanzanian Competitive Runners: Implications for Stakeholders

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| ABSTRACT

The primary strategy to counter doping among athletes and their entourages is to enhance their knowledge and education, as outlined in the World Anti-Doping Agency (WADA) Code. However, limited research exists on doping in Tanzania, making this study a novel effort to explore athletes' knowledge and educational needs. The purpose of this study was to assess the knowledge and educational needs regarding doping among competitive running athletes in Tanzania. It was hypothesized that knowledge of doping would vary based on the athletes' age, gender and experience. The study employed cross-sectional analytical design. A census sampling technique was used to select 117 competitive running athletes (73 males, 62.4% and 44 females, 37.6%) from twelve running camps in Arusha and Dar es Salaam regions of Tanzania. Data was collected through self-administered questionnaires. Results revealed that the athletes in Tanzania self-reported an average doping knowledge score of (35.9 ± 10.46) , with the threshold for average doping knowledge set at 32.5. Athletes in the middle age category (26-35 years) exhibited the highest doping knowledge (42.81 ± 13.07) , while those in the older age group (36-45 years) had the lowest doping knowledge (29.33 ± 3.79) . Males demonstrated greater doping knowledge (39.38 ± 11.49) compared to females (35.18 ± 8.76) . Athletes with over 8 years of running experience showed higher knowledge of doping (38.00 ± 12.43) than those with few years of experience (0.5-3 years), who displayed lower knowledge (34.13 ± 9.33) . The findings indicated that athletes' doping knowledge was not influenced by age, gender or experience. Educational needs identified among athletes included; knowledge on prohibited substances and methods (41.9%), doping agents' adverse effects (29.1%), testing procedures (15.4%), and the risks of doping associated with nutritional supplements (12%). Running athletes in Tanzania exhibit insufficient doping knowledge, which increases the risk of inadvertent doping violations and jeopardizes both their careers and their well-being. Therefore, it is crucial to develop and enhance doping education programmes in Tanzania.

| KEYWORDS

Educational needs, Knowledge, Performance enhancing substance, Running.

| ARTICLE INFORMATION

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1. Introduction

Doping refers to any infringement of the eleven anti-doping rules outlined in Articles 2.1 to 2.11 of the World Anti-Doping Code (WADC, 2021). Anti-doping rule violations—including the use of prohibited substances and methods—remain a persistent global challenge in competitive sports (Backhouse et al., 2013; Nolte et al., 2014; WADA, 2021). Such violations undermine sportsmanship, breach the principles of fair play, and damage the integrity and reputation of athletes (Balk et al., 2023; Elbe & Pitsch, 2018). The stakes are particularly high in countries where athletic success is closely tied to national pride and personal financial gain. This often creates intense pressure, pushing athletes to seek unfair advantages, sometimes at the cost of their health and ethical standards (Haut et al., 2019).

Multiple factors contribute to the use of doping in sports, including lack of knowledge (Odeh et al., 2022; Ozkan et al., 2020), the desire to excel (Kaoche et al., 2020), and external pressures from coaches, peers, sponsors, and family members (Tahiraj & Hakaj, 2021). Research has also pointed to personal perceptions and motivation to perform as key drivers of doping behavior (Carreathers, 2020). Beyond the ethical concerns, doping presents serious health risks, such as cardiovascular complications, seizures, depression, aggression, addiction, and even death (Berger et al., 2024; Lungu & Nastas, 2021).

In Tanzania, Kilyinga (2018) reported that doping programs and testing initiatives remain poorly implemented, particularly outside of football. The Tanzania Football Federation (TFF) has occasionally provided doping education (Mwananchi, 2021), but similar efforts have yet to be documented in athletics or among runners. Notably, some Tanzanian athletes have been implicated in doping scandals (The Citizen, 2021), which have been attributed to inadvertent use due to limited knowledge and lack of qualified doping officers or proper laboratory access. These cases highlight the absence of structured education and support systems for Tanzanian athletes, making them particularly vulnerable to unintentional doping violations. This underscores the need to identify educational gaps and assess the level of doping knowledge among Tanzanian athletes. Accordingly, this study aimed to assess the knowledge and educational needs of running athletes in Tanzania. The findings are expected to provide valuable insights into the current state of doping knowledge and education among athletes, ultimately encouraging the Tanzanian government to develop and implement effective anti-doping education programmes.

2. Literature Review

2.1 Doping Knowledge among athletes

Knowledge about doping has been recognized as both a protective factor — helping to prevent inadvertent doping — and a risk factor when it is lacking (Ntoumanis et al., 2014). A lack of knowledge about doping among athletes is a widespread issue globally. For instance, a study conducted in Turkey revealed poor knowledge of prohibited substances among athletes, with only 41.1% and 43.1% correctly identifying caffeine and protein powder, respectively, as prohibited substances (Ozkan et al., 2020). Similarly, a study by Nasr et al. (2023) on doping knowledge among adolescent athletes in Oman (n=502) found that 67.7% of participants were unaware of any type of doping substances, and a third acknowledged having low knowledge overall. In the UK, Allen et al. (2019) noted limited awareness of Therapeutic Use Exemption (TUE) among athletes, while Henning and Dimeo (2018) reported that British athletes often lacked knowledge of essential anti-doping rules.

Research in Kenya by Mse et al. (2021) found that only 48.3% of athletes were familiar with the World Anti-Doping (WADA) Code. Studies by Rotich et al. (2023a; 2023b) among medical practitioners and pharmacists in Kenya found average doping knowledge levels but significant gaps regarding specific prohibited substances and WADA regulations. In South Africa, a study revealed that 73% of football athletes (n=343) lacked knowledge of anti-doping policies, 84% were unfamiliar with WADA's annually updated prohibited list, and 75% had insufficient knowledge about dietary supplements or beverages (Nyawose et al., 2022). Some athletes even believed that doping, if used wisely, does not adversely affect health. This indicates a significant gap in athletes' knowledge, particularly regarding the consequences of doping and testing procedures. Similarly, Mijuza, (2022) conducted a study in Tanzania and found that athletes sometimes engage in doping practices due to poor understanding of the associated legal implications. These findings highlight systemic gaps in anti-doping education programs and suggest that while awareness might exist, detailed and accurate knowledge is often missing.

Studies have shown that knowledge about doping varies based on age, gender and experience (Perera et al., 2023; Zhang et al., 2021). For example, Perera et al. (2023) reported higher knowledge scores among athletes older than 35 years compared to those under 35 years in Sri Lanka. Similarly, Zhang et al. (2021) found that older athletes demonstrated greater knowledge of Therapeutic Use Exemption (TUE) compared to their younger counterparts. The lower level of doping knowledge among athletes can be attributed to their limited experience in high-level competitions and a lack of exposure, which restricts their access to doping-related information.

Gender differences in doping knowledge have also been observed. While Puchades and Molina (2020) found that male athletes were more prone to doping and had higher awareness levels, Perera et al. (2023) reported no significant differences by gender on doping knowledge. This inconsistency may reflect differences in access to doping education or cultural perceptions around sports participation. Experience plays a role as well—more experienced athletes tend to show greater doping knowledge due to increased exposure to seminars, testing procedures, and competition guidelines (Kaoche et al., 2020). Therefore, it was essential to consider demographic factors to ensure comprehensive information is gathered across all levels in this study.

2.2 Educational Needs Regarding Doping

While anti-doping testing is critical, education is increasingly recognized as the most effective long-term solution to doping in sport. According to WADA (2021), a comprehensive and athlete-centered education framework should include awareness of doping consequences, testing procedures, supplement risks, TUEs, and rules related to the WADA Prohibited List. The

International Standard for Education (ISE, 2021) emphasizes that an athlete's first encounter with anti-doping should occur through education rather than sanction.

Morente-Sanchez and Zabala (2014) stressed the need for improved anti-doping education and prevention programs. Similarly, Kawaguchi-Suzuki et al. (2021) found a strong demand for doping-related education in Tokyo, particularly concerning banned substances and TUEs. These studies underline the necessity of targeted educational initiatives tailored to the needs of specific sports and regions. However, the scope of educational needs has often been investigated more among coaches or mixed groups, rather than focusing solely on athletes.

2.3 Identified Gaps

Despite general awareness of doping among athletes, research shows that many lack a thorough understanding of the specific rules and regulations necessary to avoid violations. This knowledge gap is especially concerning in regions with limited access to anti-doping education and testing, where unintentional rule-breaking is more likely. In East Africa, research on this issue is limited, and in Tanzania, it is nearly absent—particularly among competitive runners. Existing studies often rely heavily on cross-sectional data, which restricts insight into how athletes' knowledge develops over time or in response to repeated educational efforts. While factors such as age, experience, education, and gender influence levels of understanding, inconsistent findings suggest that broader contextual elements may also play a role. This underscores the urgent need for sport-specific and context-sensitive studies in Tanzania to inform effective anti-doping education. Such efforts are essential not only for ensuring compliance with international standards but also for safeguarding the health, careers, and integrity of athletes in competitive sports.

3. Methodology

3.1 Research Design

The study was conducted between October and December 2023. This study employed a cross-sectional analytical design. It targeted 117 competitive running athletes from two purposively selected regions—Dar es Salaam and Arusha—which are known for having a high concentration of competitive runners in Tanzania. This design was ideal for assessing the doping knowledge and educational needs of Tanzanian running athletes at a specific point in time (Schmidt & Brown, 2021). The choice of this design was driven by its practicality for data collection without manipulating the independent or dependent variables, as well as its ability to provide a clear snapshot of the current traits and trends within the population.

3.2 Study participants

A census sampling technique was employed to gather data from 117 competitive running athletes across 12 deliberately chosen training camps in the Dar es Salaam and Arusha regions. Among the selected athletes, 73 (62.4%) were male, while 44 (37.6%) were female. When looking at age demographics, 14 athletes (12%) were younger than 15 years, 73 (62.4%) fell within the 16 to 25 age range, 27 (23.1%) were between 26 and 35, and 3 (2.6%) were aged between 36 and 45 years. In terms of running experience, 54 athletes (46.2%) reported having between 0.5 to 3 years of experience, 43 (36.8%) had between 4 to 7 years, and 20 athletes (17.1%) had 8 or more years of running experience. Looking into educational qualifications, 29 athletes (24.8%) had primary education, 67 (57.3%) had secondary education, 12 (10.3%) held a certificate, 3 (2.6%) had a diploma, and 6 (5.1%) had attained a university-level education.

3.3 Recruitment of participants

A letter of invitation to participate in the study was sent to the camp managers through Athletics Tanzania. The managers were asked to share the information with athletes in their training camps. Following this, arrangements were made to meet with the athletes and provide further details about the study's objectives. The aim and objectives of the study were explained to the athletes. Participation in the study was entirely voluntary, and participants were informed that they could withdraw at any time without any negative consequences or pressure. Once participants gave their consent to participate, a meeting was scheduled. During this meeting, the researcher and research assistant provided the survey questionnaire after the participants signed the consent form. A total of 117 out of 120 targeted competitive running athletes from the two regions agreed to participate and completed the questionnaire.

3.4 Inclusion and Exclusion criteria

The study included both female and male athletes who had been in the camp for at least six months prior to data collection and were based in the Dar es Salaam and Arusha regions. Runners who had been in the camps for less than six months prior to the data collection were excluded from the study due to their limited experience in competitions.

3.5 Data Collection Instruments

The study employed a modified self-reported questionnaire consisting of the three sections. Section A collected demographic information from the respondents, including age, gender, experience, level of education, and level of competition attained. Sections B and C were based on the WADA athletes' online resources (WADA, 2020). Section B of the questionnaire included 22 items assessing knowledge on prohibited substances and methods, nutritional supplements, testing and testing procedures. In this section, items were rated on a scale with the following options: 1- No (No knowledge), 2- Not sure (Partial Knowledge), and 3- Yes (High knowledge). An average score of 1 indicated a very low level of knowledge, while a score of 3 indicated a very high level of knowledge for each item. The maximum cumulative score for doping knowledge among competitive athletes was 65. A score of 32.5 or below indicated average to low doping knowledge, while a score above 32.5 indicated high doping knowledge. Section C focused on educational needs related to doping, where athletes were asked to identify the type of doping education they needed from a list of five topics provided. The topic with the highest frequency indicated the area in which athletes expressed the greatest need for education.

3.6 Validity and Reliability of the research instrument

To ensure the face and content validity of the questionnaire, a pilot study was conducted with 12 competitive athletes in the Manyara region of Tanzania, known for producing outstanding athletes, some of whom have competed in international athletic competitions. Feedback from the pre testing led to adjustments in the survey, including shortening the length, clarifying ambiguous items, and removing irrelevant items. The questionnaire was also evaluated by expert supervisors in doping research to ensure they effectively met the intended objectives. A test-retest reliability check was conducted with a two-week interval, yielding a high reliability index of 0.86, indicating sufficient reliability ($p < .001$) for sections B and C of the instrument.

3.7 Research Ethics

The survey adhered to the guidelines of the Kenyatta University Ethical Review Board (KUEB) under research protocol number PKU/2759/11884. Research approval was granted by the Kenyatta University Graduate School, and the National Commission for Science, Technology, and Innovation (NACOSTI) issued the research permit. As the study took place in Tanzania, the researcher also sought permission from the Ministry of Sport through Athletics Tanzania (AT), which authorized the engagement with the runners. The study's objectives and background were thoroughly explained to the respondents, and informed consent was obtained before data collection. All data was collected and analyzed anonymously to ensure confidentiality.

3.8 Data Analysis

Data was recorded, coded and analyzed using IBM Statistical Package for Social Sciences (SPSS) version 27. Descriptive statistics, including frequencies, percentages, means and standard deviations, were used to summarize demographic information and analyze doping knowledge and educational needs. The Shapiro-Wilk test was applied to test for normality ($p < 0.05$). Since the data were not normally distributed, the Kruskal Wallis test was used to determine if there were significant differences between doping knowledge related to demographic factors (age and experience) among athletes. The Mann-Whitney test was employed to examine significant differences based on gender. The hypothesis were tested at 0.05 level of significance.

4. Results

4.1 Running athletes doping knowledge

Running athletes were asked about their knowledge on general doping concepts, WADA regulations, and anti-doping rule violations. Their responses are presented in Table 1.

Table 1: Knowledge of Doping, WADA, and Anti-doping rules among Running Athletes (n=117)

General concepts	No		Not sure		Yes		Mean	Std
	f	%	f	%	f	%		
Doping	38	32.5	57	48.7	22	18.8	1.86	0.71
WADA	80	68.4	19	16.2	18	15.4	1.47	0.75
Anti-doping rules in sport	69	59.0	24	20.5	24	20.5	1.62	0.81

The results in Table 1 indicate that most of athletes, 57 (48.7%), were unsure of the concept of doping, 38 (32.5%) did not know the concept of doping, and a few athletes, 22 (18.8%) were familiar with the concept of doping. When asked about their knowledge of WADA, the majority, 80 (68.6%), had no knowledge of WADA, while only a few athletes, 18 (15.4%), were familiar with the organization. Regarding their awareness of anti-doping rule violations, in sport, most athletes, 69 (59.0%), were unaware of the rules, while only 24 (20.5%) knew them. These results provide evidence that the majority of the running athletes in Tanzania have insufficient knowledge about doping concepts, WADA, and anti-doping rule violations.

The athletes were also asked to assess their knowledge of prohibited substances and methods, and their responses are presented in Table 2.

Table2: Knowledge of Prohibited Substances and Methods among Running Athletes (n=117)

	Mean	Std
Knowledge on Prohibited Substances		
Cannabinoids	1.68	0.84
Narcotics	1.67	0.79
Glucocorticoids	1.60	0.75
Stimulants	1.56	0.75
Caffeine	1.54	0.77
Knowledge on prohibited methods		
Manipulation of blood and blood components	1.57	0.80
Gene and cell doping.	1.57	0.78
Chemical and physical manipulation	1.48	0.66

As shown in Table 2, running athletes demonstrated low knowledge of several prohibited substances, including caffeine (1.54 ± 0.77), stimulants (1.56 ± 0.76), glucocorticoids (1.60 ± 0.76), narcotics (1.67 ± 0.79) and cannabinoids (1.68 ± 0.85). Furthermore, the athletes exhibited low knowledge of prohibited methods in sport, such as blood manipulation and blood components (1.57 ± 0.80), gene and cell doping (1.57 ± 0.78), and chemical and physical manipulation (1.48 ± 0.67). The running athletes were also asked to assess their knowledge of nutritional supplements, and their responses are presented in Table 3.

Table 3: Knowledge of Nutritional Supplements among Running Athletes (n=117)

Knowledge on Nutritional supplements	No		Not sure		Yes	
	f	%	f	%	f	%
Are you familiar with nutritional supplements?	49	41.9	30	25.6	38	32.5
Are you aware of the doping risks associated with nutritional supplements?	63	55.6	31	26.5	23	18.7
A nutritional supplement containing a prohibited substance should always have a label clearly indicating this.	69	59.0	30	25.6	18	15.4
I may be held liable if I can test positive after consuming or using what I believe to be a safe supplement.	47	40.2	25	21.4	45	38.5

As shown in Table 3, 49 (41.9%) of athletes indicated no knowledge of nutritional supplements, while 38 (32.5%) reported some knowledge. About 63 (55.6%) of athletes were unaware of the risks associated with nutritional supplements, whereas only a few athletes, 23 (18.7%), were aware of these risks. When asked whether they knew that a nutritional supplement containing a prohibited substance should be labeled accordingly, the majority, 69 (56.4%), were unaware, while a few athletes, 18 (15.4%), knew about this requirement. When asked whether they knew if they could be held liable after testing positive for consuming or applying what they believed to be a safe supplement, 47 (40.2%) did not know, while 45 (38.5%) were aware of the potential liability. Overall, the findings indicated that running athletes in Tanzania had low knowledge of nutritional supplements and the associated risks. In addition, the study aimed to assess knowledge of doping testing and testing procedures among the running athletes, and the results are presented in Table 4.

Table 4: Running athletes' knowledge on doping testing and testing procedures (n=117)

Knowledge on Testing and Procedures	No		Not sure		Yes	
	F	%	f	%	f	%
Are you familiar with Therapeutic Use Exemption (TUE)?	85	72.	18	15.4	14	12.0
Have you ever undergone a drug test, either during or outside the competition?	90	79.9	12	10.3	15	12.8
Are you familiar with Drug testing procedures?	79	67.5	22	18.8	16	13.7
A Doping Control Officer of the same sex as the athlete should be present during the sample collection.	61	51.1	35	29.9	21	17.9
Are you aware of the procedures to follow after receiving a positive test result from the laboratory?	71	60.7	19	16.2	27	23.1

The results in Table 4 indicate that 85 (72.6%) of the running athletes lacked knowledge of Therapeutic Use Exemption (TUE), and 90 (79.9%) of athletes had never undergone a drug test. Additionally, 79 (67.5%) of athletes reported a lack of knowledge about testing procedures, and 61 (51.1%) did not know whether a doping control officer of the same sex as the athlete should be present during sample collection. Moreover, 71 (60.7%) of the athletes were unaware of the procedures to follow after receiving a positive test report from the laboratory.

The study also aimed to determine whether anti-doping knowledge among running athletes varied based on demographic factors such as age, gender and experiences. The cumulative knowledge score was calculated, with a maximum score of 65 and a mean of (35.94 ± 10.46) . A score of 32.5 or below indicated average to low doping knowledge, while a score above 32.5 indicated high doping knowledge. The findings revealed that running athletes in the age group younger than 15 years had a mean knowledge score of (35.64 ± 6.13) , athletes aged 16-25 years had a mean score of (36.71 ± 10.06) , those aged between 26-35 years had a mean score of (42.81 ± 13.07) , and athletes aged 36-45 years had a mean score of (29.33 ± 3.79) . Therefore, athletes in the 26-35 age group demonstrated the highest anti-doping knowledge.

However, the Kruskal -Wallis test did not yield a statistically significant difference in the cumulative knowledge scores among the age groups ($H(3) = 6.63, p = 0.09$). Therefore, the null hypothesis stating that there would be no statistical difference between age and the level of doping knowledge among athletes was not rejected. This suggests that age may not be a significant factor influencing doping knowledge in running athletes. Furthermore, the post-hoc test (Bonferroni) revealed no significant differences between the age categories.

Experience, in terms of the duration of participation in running, was also assessed to determine if it affect running athletes' doping knowledge. The findings indicate that running athletes with 0.5-3 years of experience had a doping knowledge score of (34.15 ± 9.33) , those with 4-7 years of experience had a score of (37.23 ± 10.71) , and athletes with over 8 years of experience had a higher doping knowledge score of (38.00 ± 12.43) compared to the other two experience categories. In assessing the significant difference of running experience on doping knowledge, the Kruskal-Wallis test revealed no statistically significant difference between athletes' doping knowledge and years of experience ($H(2) = 2.25, p = 0.33$). Therefore, the null hypothesis stating that there would be no significant difference between years of experience and doping knowledge among athletes was not rejected. This implies that experience did not impact the athletes' doping knowledge. Furthermore, the post-hoc test (Bonferroni) revealed no significant differences between the experience categories.

Differences in doping knowledge based on gender were assessed and results indicated that males had higher knowledge (39.38 ± 11.49) compared to their female counterparts (35.18 ± 8.76) . A Mann-Whitney U test was performed and found no statistically significant difference in cumulative knowledge scores between males and females regarding doping ($U(N \text{ males} = 73, N \text{ females} = 44) = 1290.500, z = -1.777, p = 0.076$). Therefore, the null hypothesis, which states that there would be no significant difference between gender and doping knowledge among athletes, was not rejected. Thus, gender did not affect athletes' doping knowledge.

The study further focused on the educational needs of running athletes, highlighting specific areas where athletes felt they required more information. The areas identified with a high demand for education included, education on prohibited substances and methods (41.9%), the adverse effects of doping agents (29.1%), testing procedures (15.4%), and the risks associated with nutritional supplements and natural products (12.0%). The area with the least identified educational need was Therapeutic Use Exemption, which was at 1.7%.

5. Discussion

This study examined running athletes' knowledge of doping, including prohibited substances and methods, nutritional supplements, testing, and related issues. It also explored whether doping knowledge among athletes would vary based on age, gender or experience. Further, it assessed athletes' educational needs. The findings aimed to inform the Tanzanian government and the Tanzania Olympic Committee (TOC) in creating effective anti-doping education programmes. The results revealed that only 18.8% of athletes were familiar with the concept of doping, indicating insufficient campaigns, seminars, or forums to enhance awareness. This finding aligns with similar studies in Uganda, where 80% of athletes could not define the term doping (Muwonge et al., 2015), but contrasts with results from Ethiopia, where 53.3% of athletes understood the term 'doping' (Mohammed et al., 2022).

Similarly, only 15.4% of athletes were aware of WADA, with a significant 68.4% of the athletes being unaware of the organization. This suggests that athletes have limited exposure to international events and a failure of WADA's educational programmes to effectively communicate the concept and role of WADA to member organizations and athletes, including those in Tanzania

(Petroczi & Biley, 2020). Comparable knowledge gaps were reported among athletes in Spain, where 95% lacked knowledge of WADA (Morente-Sanchez et al., 2019). The lack of awareness regarding doping and WADA places athletes at risk of unintentional rule violations, which can lead to penalties, disqualifications, or long-term career damage.

The findings revealed that only 20.5% of athletes were aware of anti-doping rule violations. A similar finding was observed in Cyprus, where only 33.5% of athletes understood those violations (Tsivitanidou et al., 2023). Low awareness may be attributed to the complexity and frequent updates to anti-doping rules each year. However, failure to comprehend these anti-doping rules can lead athletes to unintentionally commit doping violations, although ignorance of the law does not absolve one from responsibility. The findings indicated that knowledge of prohibited substances was limited, which is consistent with findings from Sri Lanka, Saudi Arabia, Cyprus, and Kenya, where gaps were linked to inadequate training and a lack of interest in staying updated with WADA information (Alghobain et al., 2016; Chebet, 2014; Perera et al., 2023). In contrast, athletes in Malawi and Ghana demonstrated higher knowledge due to strong educational initiatives and regulatory frameworks (Brown et al., 2013; Kaoche et al., 2020). Awareness of prohibited methods was also low among athletes in the current study, raising concerns about fair play and athletes' health. This finding aligns with research in Australia, where over 50% of athletes lacked knowledge on prohibited methods (Orr et al., 2018). The low knowledge of prohibited substances and methods highlights the urgent need for more comprehensive anti-doping education programmes that go beyond traditional substances and include complex procedures like genetic manipulation, cell, and blood doping.

The findings showed that only 32.5% of athletes were familiar with nutritional supplements, and 55.6% were unaware of associated doping risks. Similar gaps were reported in other studies conducted in Saudi Arabia (Aljaloud et al., 2020), South Africa (Nyawose et al., 2022), Sri Lanka (Rashani et al., 2021), and Lebanon (Sadek et al., 2022). In contrast, Malaysian athletes demonstrated higher knowledge due to educational workshops (Balaravi et al., 2017). These findings imply that athletes are at risk because nutritional supplements, while often marketed as safe and beneficial, can sometimes be contaminated with banned substances. This contamination may lead to inadvertent doping violations, potentially damaging their careers and reputations (Zapata-Linares & Gervasini, 2024).

The majority of athletes (59.0%) were unaware of proper labeling practices of nutritional supplements, leaving them vulnerable to unintentional doping (Murofushi, 2020). Moreover, the finding that 40.2% of athletes were unaware of the strict liability principle highlights their risk of unintentional doping violations, which could endanger their careers and reputations, as ignorance is not a valid defense in doping cases. To mitigate the doping risks associated with nutritional supplements, athletes should focus on regular exercise and maintaining a balanced diet rather than relying on supplement. Regarding testing, 72.6% of athletes lacked knowledge about Therapeutic Use Exemptions (TUE), with similar gaps reported globally (Dressler, 2022; Henning & Dimeo, 2018; Muwonge et al., 2015; Williams et al., 2020). This suggests that athletes may not fully understand their rights or the procedures for using prescribed medications containing prohibited substances. This knowledge gap could lead to unintentional anti-doping rule violations or missed opportunities to seek legitimate exemptions.

Additionally, 79.9% of athletes had never undergone drug testing, suggesting limited facilities or exclusion from Registered Testing Pools (RTP). Engelberg et al. (2019) noted that this gap is often linked to coaches failing to discuss doping issues with athletes. Similar findings were observed in India, where one-third of athletes had never been tested due to their lack of awareness of potential culpability (Krishnan et al., 2022). Moreover, most athletes (67.5%) were unfamiliar with testing protocols, and 51.1% were unaware of the need for same-sex doping control officers, raising ethical concerns (Stoffers et al., 2023). Comparable findings were also reported among Kenyan long-distance runners, where athletes showed low awareness of the need for same-sex doping control officers during sample collection (Ogama et al., 2019).

Finally, the fact that 60.7% of athletes did not know the steps following a positive test underscores a lack of transparency in how doping cases are handled. This could lead to mistrust in the system or panic among athletes when confronted with such situations. It may also result in unfair penalties, even for athletes who have valid defenses. Similar gaps were observed in Kenya, where only 35.5% of long-distance runners understood these procedures (Chebet, 2014).

Running athletes aged between 26 and 35 years demonstrated the highest doping knowledge (42.81 ± 13.07) compared to other age groups. However, the lack of significant differences based on the athletes' age and doping knowledge ($p > 0.05$) indicates that age alone is not a determinant of doping knowledge. This finding highlights the need to explore other factors, such as education, training environments, or access to resources that may contribute to the observed differences in doping knowledge across age groups. This study contrasts with several others that found a significant association between age and doping knowledge (Corluka et al., 2011; Kaoche et al., 2020; Perera et al., 2023; Singhammer, 2012).

The findings revealed that male athletes had slightly higher doping knowledge scores (39.38 ± 11.49) compared to females (35.18 ± 8.76). However, the absence of statistical significance ($p > 0.05$) suggests that this difference is not meaningful and could be due to chance. Thus, gender does not seem to influence doping knowledge, emphasizing the need for educational initiatives to address gaps among athletes, regardless of gender. This conclusion aligns with the findings of Perera et al. (2023), Chebet (2014) and Sepriani et al. (2021), who also found no significant differences in doping knowledge between genders.

Although knowledge levels may be comparable, male and female athletes might perceive the risks and consequences of doping differently. Previous research indicates that men and women often have distinct motivations for using performance-enhancing substances, and may differ in their perceptions of social pressure and associated risks (Christiansen et al., 2023; Tavares et al., 2020). For instance, Puchades and Molina (2020) found that while men exhibited higher doping knowledge than women, they were also more likely to use performance-enhancing drugs.

Running athletes with over 8 years of experience demonstrated higher doping knowledge scores (38.00 ± 12.43). However, the absence of statistical significance ($p > 0.05$) indicates that experience does not have a meaningful impact on doping knowledge. This suggests that an athlete's understanding of doping is not necessarily influenced by how the length of time they have been active in the sport. These findings emphasize the importance of implementing consistent anti-doping education programmes across all experience levels to ensure equal awareness among both novice and seasoned athletes. The findings are consistent with a study conducted in Croatia, which found that athletes' experience was linked to their knowledge of doping (Sajber et al., 2013). Similarly, a study in Sri Lanka observed no significant differences in knowledge scores based on training age ($p > 0.05$) (Perera et al., 2023). In contrary, Kaoche et al. (2020) identified a significant association between athletes' experience and their knowledge of doping.

The findings of this study highlight a significant need for education among athletes on topics such as WADA's list of prohibited substances and methods in sports, the adverse effects of doping agents, testing procedures, and the risks of doping associated with nutritional supplements and natural products. This demand for educational programmes may arise from the lack of tailored initiatives, such as specialized workshops, online resources, or seminars that address these specific topics in depth. Additionally, it may reflect insufficient collaboration with sports organizations, coaches, and healthcare professionals, who play a crucial role in effectively disseminating information and reinforcing anti-doping education.

The need for doping education is also evident in other studies, such as Hallward and Duncan (2018), which identified insufficient doping education among athletes and highlighted the educational needs on doping prevention. Furthermore, Gatterer et al., (2021) emphasized the necessity for multidimensional doping education, including awareness of prohibited substances and methods among athletes. Moreover, Berbecaru et al. (2024) pointed to the indicated anti-doping education focused on moral skills, which could help Romanian athletes resist the temptation to use banned substances in sports.

5.1 Strength and Limitations

This study on the doping knowledge and educational needs of the running athletes in Tanzania is a novel contribution to the field. These findings have significant implications for anti-doping stakeholder in the fight against doping in Tanzania. Additionally, the study highlights areas where further education and resources are necessary to enhance athletes' understanding of doping regulations and their consequences.

However, this study was limited by its cross-sectional design, which prevents the establishment of causal-effect relationships. However, the findings are still relevant to the Tanzania Olympic Committee (TOC) and can inform their efforts. Additionally, the self-reported nature of the survey may have introduced biases, such as social desirability or self-preservation, which could affect the accuracy of the responses.

6. Conclusion and Recommendations

Based on our findings, running athletes in Tanzania have insufficient knowledge of doping concepts, WADA, and anti-doping rule violations, prohibited substances and methods, nutritional supplements, as well as testing and testing procedures. The athletes' knowledge of doping is not significantly affected by age, gender, or running experience. The most requested topics for doping education among a large proportion of running athletes includes: prohibited substances and methods by WADA in sports, the adverse effects of doping agents, testing procedures, and the risks of doping associated with nutritional supplements and natural products.

This study advocates for the implementation of comprehensive anti-doping education programs in Tanzania, focusing on training athletes, coaches, and sports staff. It highlights the importance of providing accessible e-learning platforms and resources in local languages, tailored to the cultural context. The study also calls for the Ministry of Information, Culture, Arts and Sports to introduce anti-doping education in youth sports programs and establish athlete mentorship initiatives. Additionally, a nationwide survey of running athletes is recommended to provide more accurate reflection of the current state of doping knowledge among Tanzanian runners.

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