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ORIGINAL ARTICLE

Doping prevalence and attitudes towards doping in Dutch elite sports

Lisanne Balk ✉ . *Mulier Institute. Utrecht, the Netherlands.*
Marit Dopheide. *Mulier Institute. Utrecht, the Netherlands.*
Maarten Cruyff. *Utrecht University. Utrecht, the Netherlands.*
Erik Duiven. *Doping Authority Netherlands. Capelle aan den IJssel, the Netherlands.*
Olivier de Hon. *Doping Authority Netherlands. Capelle aan den IJssel, the Netherlands.*

ABSTRACT

The use of performance enhancing substances among elite athletes is a well-known phenomenon, but data on prevalence are inconsistent. The aim of this study was to investigate (1) the prevalence of doping use in Dutch elite athletes and (2) the attitude of elite athletes with regard to the use of performance enhancing substances. A total of 272 elite athletes completed an online questionnaire about doping use using the randomised response method and about their attitude towards the use of performance enhancing substances. The estimated prevalence of the use of doping among Dutch elite athletes during the last 12 months was 12.5 percent (95% CI 3.0 to 24.7%). The prevalence for using non-prohibited medication (without medical necessity) during the last 12 months was 15.4% (95% CI 7.1 to 23.7%). One in four athletes (23%) accepts the use of medication on prescription without a medical necessity, in order to enhance their performance. Doping prevalence among Dutch elite athletes is estimated at 12.5%, with a confidence interval from 3 to 25%. Acceptance of other performance enhancing substances is relatively high demonstrating that educational and preventive programs are essential in the fight against doping and the protection of athletes.
Keywords: Physical activity psychology, Doping, Elite sports, Performance enhancement, Randomized response, Doping prevalence.

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✉ **Corresponding author.** *Mulier Institute. Utrecht, the Netherlands.*
E-mail: L.balk@mulierinstituut.nl
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INTRODUCTION

The use of performance enhancing substances among elite athletes is a well-known phenomenon. Performance enhancing substances are defined as substances that are not part of a typical dietary intake and are meant to improve the performance. There is a wide range of substances that may improve performance. This ranges from substances that are not prohibited in sport such as vitamins and common supplement ingredients, to substances prohibited in sport such as anabolic or stimulating agents, which are popularly defined as doping. The use of doping in elite sports not only affects the integrity of sports, but also poses a risk for the health of athletes. The seriousness of the adverse effects strongly depends on the substance and way of using, but ranges from relatively mild symptoms to fatality (Albano et al., 2021; Anderson et al., 2018; Gild et al., 2022; Salamin et al., 2018; Siebert and Rao, 2018; Smit et al., 2022).

Anti-doping agencies are committed to achieving a doping-free sport. In order to achieve this goal, they use different strategies, such as education, deterrence, detection and enforcement. However, the lack of data on doping prevalence makes it difficult to assess the effectiveness of their efforts (Gleaves et al., 2021). Due to the sensitivity of the subject, studies investigating doping use are complex. There are different approaches to investigate doping prevalence and De Hon et al. have investigated all pros and cons of these methods (Hon et al., 2015). They conclude that researchers should use harmonised definitions of the terms "*doping*" and "*elite sports*" and that using questionnaires using a randomised response approach is preferred over "*regular*" questionnaires. They also state that current worldwide doping prevalence lies probably between 14 and 39%, but that this finding needs further confirmation (Hon et al., 2015). Although the authors state that this estimate may differ considerably between subgroups, it is most likely closer to the truth than the 1-2% of the positive test results on prohibited substances. A more recent study on doping prevalence reported a prevalence of 43.6% (with a 95% confidence interval of 39.4–47.9%) among athletes at the International Association of Athletics Federations (IAAF) 2011 World Championships (Ulrich et al., 2018). An ever higher prevalence of 57.1% (95% CI of 52.4–61.8%) was observed among athletes at the 12th Quadrennial Pan-Arab Games. However, it is important to note that the data of these two studies were recently critically reviewed and re-analysed, resulting in lower estimates of 21.2% and 10.6% respectively (Petróczi et al., 2022).

Nevertheless, these data demonstrate relatively high estimates of doping prevalence in combination with a wide range of data. This does not only demonstrate the magnitude of the problem, but also that gathering data on this topic should be a priority. As Pielke described in a commentary paper: "*Sport will not begin to confront its doping problem until asking and answering, "how many?" becomes a priority"* (Pielke, 2018).

However, although the "*how many*" question is important, it is useful to combine this knowledge with data on athletes' attitudes towards the use of performance enhancing substances in general. Backhouse and colleagues demonstrated that doping use, but also attitudes and believes about doping were different between athletes who used performance enhancing supplements and athletes who did not. Doping was three and a half times more prevalent in supplement users compared to non-users and users had significantly more positive attitudes towards doping (Backhouse et al., 2013). They introduced the "*gateway hypothesis*", where athletes who use non-prohibited substances in order to increase their performance are a risk group for transition towards doping. Doping is associated with attitude towards doping. In order to develop efficient preventive strategies aiming to prevent doping in elite sports, knowledge of attitudes and believes about doping, in addition to data on prevalence, is relevant.

As for Dutch elite sports, reliable and current data on the use of and the attitude towards doping use is lacking. Therefore, in order to expand the knowledge on both prevalence measurements and potential risk behaviour related to doping use, we investigated (1) the prevalence of doping in Dutch elite athletes and (2) the attitude of elite athletes with regard to the use of performance enhancing substances.

MATERIALS AND METHODS

Participants

A total of 831 elite athletes, defined by having an official "*elite-status*" assigned by the Dutch Olympic committee (NOC*NSF), were invited by NOC*NSF to participate in the study. The elite status is generally assigned when athletes perform on top-8 level worldwide (at world championships of events of a similar level) or when they qualify for the Olympic or Paralympic games. The athletes received an email with an invitation to complete an online questionnaire. In order to achieve an optimal response rate, the email invitation was accompanied by a (digital) letter from the current minister of Medical care and Sports. In this letter she endorsed the importance of this study and the cooperation of the athletes. All athletes received one reminder per email. Data were collected between September 30th and November 12th 2020.

This study is not subject to the Medical Research Involving Human Subjects Act (WMO), therefore approval by an ethics committee was not required.

Measures

Questionnaire

The questionnaire contained questions about demographic factors (age, sex, type of sport), attitude with regard to the use of performance enhancing substances and four questions about their personal doping use during the past 12 months (anabolic agents, blood manipulation, stimulating agents and other prohibited substances/methods, as published by the World Anti-Doping Agency). Additionally, the athletes were asked about their use of non-prohibited medication in order to enhance their performance. For these five questions, the randomised response method was used.

Procedures

Randomised response method

The consequences for an elite athlete of admitting to doping can be immense. Consequently, studies investigating doping prevalence are often confounded by respondents giving dishonest and socially desirable answers. Using the randomised response (RR) method has shown to be effective in decreasing the level of this type of bias in questionnaires about sensitive topics (Lensvelt-Mulders et al., 2005). De Hon et al. performed a review on various methods for the assessment of doping prevalence. They conclude that the RR method (in combination with models of biological parameters) is the most accurate way of estimating the prevalence of doping in elite sports (Hon et al., 2015).

When using the RR method, researchers can guarantee respondents full anonymity as the researchers deliberately introduce a mathematical confounder. There are multiple variants of the RR method and in the current study the Kuk method was used (Kuk, 1990). Previous research among Dutch elite athletes showed that results obtained using the Kuk method were more reliable compared to the results from the forced response method (Duiven and de Hon, 2015). With the Kuk method, participants get questions that can be answered with either A or B. However, the meaning of both options (A = yes and B = no, or A = no and B = yes) is random and is defined by chance, which in this study was determined by the rolling of two dice by the participant. The chance distribution was as follows; when the sum of both dice was 2, 3, 4, 5, 6, 7, 8 or 9 then

A = yes and B = no (30/36). When the sum of both dice was 10, 11 or 12 then A = no and B = yes (6/36). As a results of this mathematical confounding, individual answered cannot be verified and prevalence estimations can only be made on a group level, using specific statistical analyses methods.

Analysis

The univariate prevalence estimates and standard errors for the five randomised response questions were obtained with the standard Kuk model (Kuk, 1990). The total prevalence of using any of the four prohibited doping substances was estimated using a randomized response log-linear model (van den Hout and van der Heijden, 2004). The reported total prevalence estimate is based on the mutual independence model, which in terms of the Akaike Information Criterion (AIC) performed best in comparison to the models including one or more interactions between the doping substances. The 95% confidence interval for the total prevalence estimate was obtained using the non-parametric bootstrap. As goodness-of-fit test for the log-linear models the G test is used; it has an asymptotic chi-squared distribution, and a non-significant test result indicates an adequate fit.

The comparison of projected prevalence were performed with the Mann Whitney U test. Categorical variables were analysed using the chi-square test. Analyses were performed using R (version 4.0.0) and IBM SPSS Statistic (version 27.0), with a significance level of 5%.

Pilot study

Although the RR method has shown to be effective in decreasing levels of bias in questionnaires on sensitive topics, a doping prevalence study among Dutch elite athletes from 2019 demonstrated that the method can be too complex for participants (Dopheide et al., 2020). Only when instructions are clear and feasible, participants will follow them which is absolutely essential for a reliable estimation on doping prevalence. In order to test whether the instructions for the RR method were clear and feasible, a pilot study was performed.

In this pilot study the RR method was tested in a group of former elite athletes, who's "*elite status*" ended in 2016 or 2017. These former athletes (n = 451) received a digital questionnaire including questions on demographic factors followed by 5 questions on doping use, using the RR method with rolling of the dice. The five questions with the RR method were about personal doping use with regard to anabolic agents, blood doping, stimulation agents, other prohibited substances/methods and non-prohibited medication, during their active career as an elite athlete. Subsequently, the former athletes were asked about the clarity of the instructions, feasibility of the method and the level of confidence they had in the anonymity of the method.

The level of response was relatively low (n = 46, 10%) but representative for the total population of former athletes. The majority (96%) reported that the instructions were clear enough and only 3% was not confident the method was completely anonymous. The log-linear analyses of the RR data with the mutual independence model demonstrated that no unexpected answering patters were observed and that the model fit the data (X^2 = 16.7, df = 11, p = .12). This suggests that participants most likely followed the instructions and answered the questions accordingly.

The questions about the clarity of the instructions yielded some useful suggestions, resulting in revisions of the instructions and answer categories.

RESULTS

Response profile

Of the 831 athletes who were invited, 272 (partly) completed the questionnaires, resulting in a response rate of 33%. Of the 272 participants, 249 completed the entire questionnaire. Data from incomplete questionnaires were included in the analyses, as there was no indication that these incompletions were caused by a specific confounder. Table 1 shows the response profile of the elite athletes. Female, younger and team athletes were slightly overrepresented compared to the target population.

Table 1. Response profile elite athletes.

	Target population (n = 831)	Response population (n = 272)
Sex (% male)	48	40
Age (%)		
<23 years	31	36
24-29 years	41	42
≥30 years	28	22
Discipline (%)		
Olympic	78	72
Paralympic	17	21
Non-Olympic	5	7
Type sport (%)		
(Semi)-individual	66	60
Team	34	40

Doping prevalence

A total of 249 elite athletes completed the four questions about the use of different types of doping during the past 12 months (anabolic agents, blood manipulation, stimulating agents and other prohibited substances/methods) using the RR method.

Table 2 shows that the estimated prevalence of the use of anabolic agents in Dutch elite athletes during the past 12 months was 2.1 percent, with a 95% CI of 0.0 to 9.3 percent. For the use of blood manipulation, the estimated prevalence was 0.3 percent, with a 95% CI of 0.0 to 7.3 percent. The use of stimulating agents demonstrated an estimated prevalence of 2.7 percent, with an 95% CI of 0.0 to 10.0 percent, whereas the estimated prevalence of other prohibited substances/methods (such as glucocorticoids, bèta-2-agonists, diuretics or other prohibited hormones) was clearly higher with 8.1 percent (95% CI of 0.4 to 15.9%).

Table 2. Estimated prevalence of different types of doping and total prevalence among Dutch elite athletes (n = 249).

Type	Prevalence (%)	95% CI	*p*-value
Anabolic agents	2.1	0.0 – 9.3	.565
Blood manipulation	0.3	0.0 – 7.3	.933
Stimulating agents	2.7	0.0 – 10.0	.463
Other prohibited substances/methods	8.1	0.4 – 15.9	.040
Total prevalence*	12.5	3.0 – 24.7	

*Note. CI: confidence interval. *Total prevalence is lower than the sum of the different types, because athletes reported combinations of more than one type of doping.*

For the estimation of the total prevalence of doping use, data on the four types of doping was combined and the possibility of using combinations of different types of doping was taken into account. This resulted in an estimated overall prevalence of 12.5 percent, with a 95% CI of 3.0 to 24.7 percent (Table 2). The large confidence interval is a result of the RR method, combined with the relatively small number of respondents. The goodness-of-fit test shows the model fits the data ($X^2 = 8.25$, df = 11, $p = .69$).

Non-prohibited substances

Athletes were asked whether they had used any type of medication which was not on the WADA Prohibited List, in order to enhance their performance, during the past 12 months. In the questionnaire it was specified that using the medication was not medically necessary for the athlete. The prevalence among Dutch elite athletes for using non-prohibited medication during the last 12 months is 15.4% (95% CI 7.1% to 23.7%, $p < .001$).

Intention to dope and projected doping prevalence

Intention to dope

Athletes were asked (without the RR method) if they ever had the intention to dope. A total of 3% of athletes (n = 8) reported having intentions to dope.

Two of these athletes reported that their intentions were to use doping in recreational setting, instead of doping in order to enhance their performance. One athlete explains why he considered doping:

> *"When you see the major advantages that your competitors have because they dope and you don't, it makes you think and consider doing it yourself. Then, if you reach the top, you are "set for life"." (elite athlete in non-Olympic discipline*)

Doping prevalence projection

All elite athletes were asked about what percentage of athletes they think doped during the last 12 months. This was asked for the situation within the field of their own sport in the Netherlands and internationally. This projected prevalence should not be interpreted as a measure for doping prevalence (due to egocentric bias),[1] but merely as an indication of the subjective difference from the athletes' perspective, between the national and international tour.

Dutch elite athletes estimate the use of doping within the field of their own sport in the Netherlands at 3.9% (95% CI 2.9 to 5.0), whereas the estimation of doping use in international events is significantly higher at 11.0% (95% CI 9.4 to 12.7, $p < .001$ for difference). Athletes active in a (semi-) individual sport had lower estimations for the prevalence on national level (3.1%) compared to athletes participating in team sports (5.5%, $p = .023$). No difference between team and (semi-) individual athletes was observed for the estimated prevalence on international level.

Attitudes towards using performing enhancing substances

Regarding other substances (such as supplements and medication) which may be performance enhancing, but are not listed as prohibited, the attitudes of athletes towards using these substances were investigated.

The large majority of the Dutch elite athletes (94%) considers the use of vitamins and minerals in order to enhance the performance, acceptable (Figure 1). The use of supplements such as caffeine, creatine, beta-alanine and sodium bicarbonate is also seen as acceptable by the majority of athletes (86%). Besides vitamins and other supplements, some athletes use non-prohibited medication to enhance their performance. This medication can be divided in medication for which no prescription is needed (over-the-counter medication, such as paracetamol of ibuprofen) and medication for which a prescription by a medical professional is needed. Medication without prescription is seen as acceptable by 74% of athletes. The extent to which the use of non-prohibited medication for which a prescription is needed is accepted, depends on the medical necessity. When an athlete has a medical condition for which he or she needs to take prescribed medication (in order to enhance their performance), this use is accepted by 87% of athletes. Younger (aged <23) athletes are more likely to consider the use of medication with a medical condition acceptable compared to older (aged >35) athletes (82% and 42% respectively, not in figure). The use of medication without medical necessity was considered unacceptable by 57% of athletes. Nevertheless, almost one in four athletes (23%, Figure 1) believes using prescribed medication (no doping) solely for the use of enhancing performance, is (completely) acceptable. Finally, doping is considered somewhat or completely unacceptable by almost all athletes (99%). It should be noted however, that this was a "*regular*" question, without the use of the RR method.

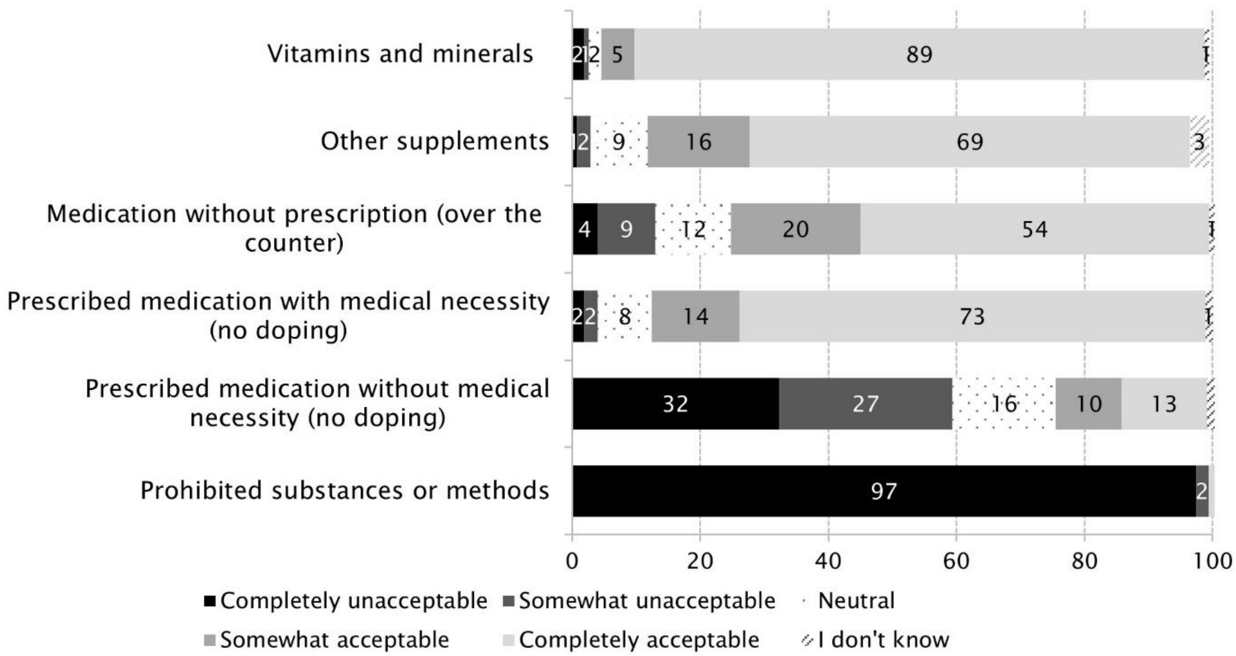

Figure 1. Level of acceptance of using substances by elite athletes in order to enhancing their performance (n = 272).

Deterrents for doping use

Athletes' deterrents to dope were investigated. Athletes were asked to what level they considered six potential motivations to not use doping as (un)important. The Dutch elite athletes report "*fair play*" as the most important deterrent to use doping (96%, see Figure 2). Health risks and the responsibility as a role model were also reported as important deterrents. Female athletes are more likely to consider their responsibility as a role model an important deterrent compared to male athletes (92% and 77% respectively, p = .01, not in figure). Fear of sanction or punishment was only considered important by 51% of athletes.

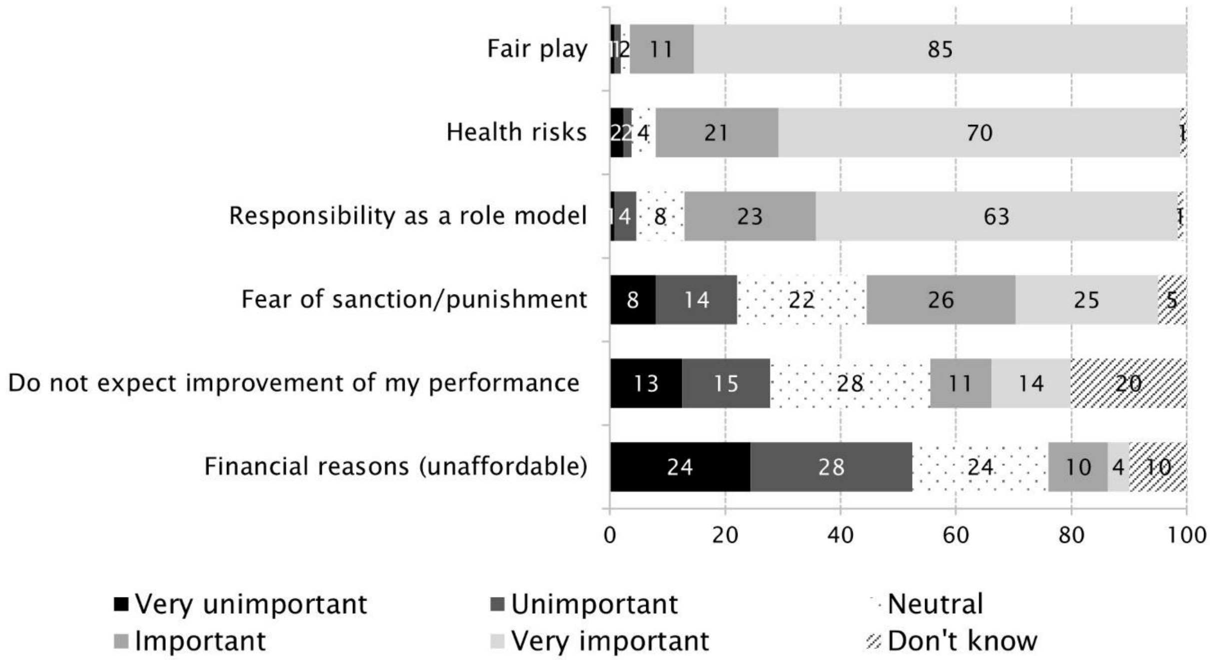

Figure 2. Importance of deterrents to use doping according to elite athletes (n = 263).

DISCUSSION

This study demonstrates that doping prevalence among Dutch elite athletes is estimated at 12.5%, with a confidence interval from 3 to 25%. This overall estimation includes the use of anabolic agents, blood manipulation, stimulating agents, other prohibited substances/methods and combinations of these. When looking at individual types of doping, the estimated prevalence was highest for "*other prohibited substances/methods*" (such as glucocorticoids, bèta-2-agonists, diuretics or hormones other than anabolic agents) with an estimated prevalence of 8.1 percent, followed by stimulating agents (2.7%), anabolic agents (2.1%) and blood manipulation (0.3%).

The overall prevalence of 12.5% is below the estimated worldwide doping prevalence range reported by de Hon and colleagues (14-39%) (Hon et al., 2015) but falls within the range reported in a more recent overview of doping prevalence studies (3.2-57.1%) (Gleaves et al., 2021). In this review, studies were included using different methods for assessing doping prevalence. In total 9 studies were identified where prevalence was estimated using the RR method, but populations were different in terms of type of sport (elite athletes of all sports, or only athletes from one specific sport) or performance level (regional, national or international level). Boardly et al. investigated doping prevalence in high-level athletes from Australia (n = 261), the UK (n = 300), and the USA (n = 261) and reported an estimated prevalence of 13.9% (Boardley et al., 2019). However, the definition of "*high-level*" was unclear. Another study investigated seasonal doping use among Danish elite athletes (n = 771) using an online survey with RR method. They reported an estimated prevalence of 30.6% (95% confidence interval 22.6–35.7%). However, the authors stated that results may partially be biased by the high proportion of respondents who did not answer according to the RR method instructions (30.6%) (Elbe and Pitsch, 2018). Somewhat similar results were reported by Pitsch and colleagues in 2007 (Pitsch et al., 2007). In elite athletes performing on international level, they reported a range of 12.1 to 31.1% for doping use in the current season. Finally, Ulrich and colleagues investigated doping prevalence among elite athletes at two large athletics events, using RR method. They reported estimated prevalence of past-year doping use of 30% and 45% at two elite-level events in 2011 (Ulrich et al., 2018), but a recent re-analysis of these data resulted in somewhat lower estimations (Petróczi et al., 2022). It should be noted that comparison of these numbers is difficult for multiple reasons. First, in contrast to the studies by Boardly, Pitsch, Elbe and the current study, Ulrich and colleagues investigated athletes from a specific sport (athletics) whereas the other studies included elite athletes from a wide range of sports. Another important aspect which makes comparison difficult is the definition of "*elite sports*". Although in the present study this was clearly defined as having an official "*elite-status*" assigned by the national Olympic committee (indicative of performance on top-8 level worldwide or participating at the Olympic or Paralympic games), this was not clear for all studies. Including athletes performing on a lower level may yield different doping prevalence numbers, as these athletes receive less education, testing frequency is lower and the (perceived) gains of doping use may be different.

Besides the use of the typical types of doping the prevalence of the use of non-prohibited medication (without medical necessity) was studied using the RR method. This resulted in an estimated prevalence of 15.4% (95% CI 7.1% to 23.7%). The estimated prevalence of non-prohibited medication seems to be in the same range as doping. There seems to be a large difference between the two however, regarding the level of public acceptance. When asked directly (without the RR method), 99% of athletes stated that they consider doping somewhat or completely unacceptable. This number was significantly lower when athletes were asked to what extent the use of medication without medical necessity was considered acceptable. Almost one in four athletes (23%) considers using medication without medical necessity, solely for the use of enhancing performance, as (completely) acceptable. This finding suggest that use of improper medication seems to be more acceptable among athletes than doping. Prevalence are however in a similar range. This may be a result of the use of the RR method, suggesting that the use of the RR method further enhanced the feeling of complete anonymity for the respondents, resulting in more honest answers.

Besides doping and prescribed medication without medical necessity, there are other substances that can enhance athletic performance. These substances are not on the WADA Prohibited List and are sometimes considered a "*grey area*" regarding the level of acceptance. Among Dutch elite athletes, the majority has no problem with the use of vitamins and minerals (94%) or other food-related supplements such as caffeine supplements (86%). The use of over-the-counter medication (such as painkillers) in order to enhance performance, is also accepted by the majority of athletes (74%). Generally, Dutch athletes have a positive attitude towards these over-the-counter, non-prohibited performance enhancing substances.

The use of prescribed medication and high level of acceptance of other supplements might be a risk factor for increasing levels of doping use. Backhouse and colleagues demonstrated that athletes who use nutritional supplements have a more positive attitude towards doping and a higher chance to dope. They state that athletes using legal substances to enhance performance may therefore form a risk group for transition towards doping (Backhouse et al., 2013). This potential risk in supplement users, together with the relatively high level of acceptance of supplements and medication among Dutch athletes, advocates proper education on this topic in both athletes and support personnel.

The potential effectiveness of (preventive) educational programs is further strengthened by the finding that the importance of fear of sanction or punishment as a deterrent for doping use, is relatively limited. Instead, athletes state that fair play, potential health risks and their responsibility as a role model are the most important deterrents to dope. This is in line with a previous study demonstrating that the decision to start doping is extremely complex and that athletes do not appraise current anti-doping strategies as highly effective (Kegelaers et al., 2018). Educational programs should therefore not only include anti-doping regulations but should also (or especially) include topics such as potential health risks, physical and psychological side effects or awareness about the effects they have as role models on others when they are caught doping. The latter should support athletes in making decisions based on their personal values and increase their sense of responsibility (values-based education).

Studies investigating doping prevalence always have the limitation of the unwillingness of athletes to participate and to disclose their doping use. This may lead to selection bias, as athletes who dope are less likely to participate in studies, but also to untruthful answering of the questions regarding doping. Many approaches to assess doping prevalence have been described, with various levels of quality and reliability (Gleaves et al., 2021). Although previous research has shown that a survey using the RR method is one of the more reliable methods, there are still limitations (Hon et al., 2015). Compared to traditional questionnaires, RR methods decrease the chance respondents give socially desirable answers. This results in higher prevalence estimates, which are closer to the truth (Lensvelt-Mulders et al., 2005). A major limitation of the approach, however, is the level of uncertainty in the estimated prevalence. This uncertainty is caused by the use of the chance mechanism and consequently the outcome is reported as a confidence interval, instead of a single percentage. Especially in small samples (which is common in many countries when studying populations of elite athletes) the results provide an indication of the doping use in the studied sample, but numbers are difficult to compare with other studies or when follow-up assessments are done. Moreover, the uncertainty limits the potential to use this method for the evaluation of preventive anti-doping programs. Studies focusing on other parameters, like athletes' attitude towards doping may be of higher value for this purpose.

The types of doping investigated in this study were anabolic agents, blood manipulation, stimulating agents and other prohibited substances/methods. One relatively new and fast developing method which was not specifically defined is gene doping. In gene doping, gene therapy products can be used to stimulate production of bodily substances such as erythropoietin or human growth hormone, in order to improve sports performance (Haisma and de Hon, 2006). Even though gene doping is listed on the WADA Prohibited List (category M3) and was therefore categorized in "*other prohibited substances/methods*" in our study, it may be of interest to investigate gene doping as a separate category in future studies. The search for new, accurate detection methods continues, (Baoutina et al., 2022; Cantelmo et al., 2020), but so far there have been no identified cases of gene doping in elite sports. Future prevalence research should clarify whether this is because gene doping is not used in elite sports, or because current detection methods are insufficient.

CONCLUSION

This study demonstrated that doping use is present among Dutch elite athletes. The prevalence during the last 12 months lies within a range of 3.0 to 24.7%, with a point estimate of 12.5%. The acceptance of other performance enhancing substances, including improper use of prescribed medication, is relatively high. In light of these findings, together with the result that fear of sanction or punishment was found to be a relatively unimportant deterrent for doping, educational and preventive programs are essential in the fight against doping and the protection of athletes.

AUTHOR CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: L. Balk, M. Dopheide, E. Duiven; data collection: L. Balk, M. Dopheide, E. Duiven; analysis and interpretation of results: L. Balk, M. Dopheide, M. Cruyff, E. Duiven, O. de Hon; draft manuscript preparation: L. Balk, O. de Hon. All authors reviewed the results and approved the final version of the manuscript.

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No potential conflict of interest was reported by the authors.

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