

Analyzing the association between dietary supplementation and doping tendency in athletes: A cross-sectional study of swimming

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Abstract:

Doping is one of the most important problems in modern sports, and there is growing global concern regarding the potential link between dietary supplementation and doping among athletes. There is an evident lack of studies that have examined this problem in swimming, particularly concerning different types of dietary supplements. The objective of this study was to identify the possible associations between the consumption of various dietary supplements and doping tendencies among high-level swimmers. The study sample consisted of 301 competitive swimmers from Slovenia, with an average age of 16.7 years and an average of 9.2 years of experience (148 females). The variables analyzed included gender, age, swimming experience, questions on specific types of dietary supplements used, personal opinions on the prevalence of doping in swimming (predictors), and individual attitudes toward doping (criterion). The associations between the predictors and criterion were established via logistic regression, and for this purpose, the criterion was dichotomized (negative doping tendency vs. neutral/positive doping tendency). Male gender (OR = 1.15, 95% CI: 1.03–1.27), belief that doping is present in swimming (OR = 1.14, 95% CI: 1.01–1.31), and consumption of recovery supplements (OR = 1.30, 95% CI: 1.03–1.64) were univariately associated with neutral/positive doping tendencies. When a multivariate design was applied to control for possible confounding effects, the consumption of recovery supplements was the only significant predictor of a neutral/positive doping tendency (OR = 1.30, 95% CI: 1.02–1.65). Our results support the hypothesis that the consumption of (legal) recovery supplements paves the way for doping due to factors such as psychological dependency, pressures to recover and perform, and an evolving acceptance of performance enhancement. Further studies in other sports are needed.

Keywords: nutritional supplements; performance enhancement; substances; gender; sport

Introduction

Doping continues to be one of the most important problems in modern sports because of the two reasons. First, doping is undoubtedly associated with serious negative health consequences, including cardiovascular issues (risk of heart attack and stroke, cardiac arrhythmia, and chronic cardiomyopathy), liver damage (hepatotoxicity and liver tumors), hormonal imbalances, and mental health issues (Bird et al., 2016). Second, doping undermines the fundamental principles of fair play in sports, creating an uneven playing field and compromising the integrity of athletic competition. In other words, doping provides an unfair advantage to those who use it, violates the rules and spirit of sport, taint results, and definitively damages the sport's reputation (Liposek et al., 2018). Therefore, the global fight against doping is highly prioritized in sports society. One approach involves identifying factors that might be associated with doping among athletes to control those factors found to be associated with a higher risk of doping behavior, while promoting those factors is associated with a lower risk of doping. Studies have therefore frequently evaluated sport-related, sociodemographic, psychological and other correlates of doping behavior and doping attitudes in sports (Liposek et al., 2018; Sekulic et al., 2017)

Dietary supplements play a significant role in supporting athletic performance. First, even with a well-planned diet, athletes may have deficiencies in certain vitamins or minerals due to increased needs or restrictive eating patterns. Supplements can help fill these gaps and support overall health and performance (Close et al., 2022). Second, certain supplements, such as creatine and caffeine, have been shown to improve strength, power, endurance, or mental focus, potentially giving athletes a competitive edge. Furthermore, supplements can aid in muscle recovery, reduce inflammation, and support immune function, helping athletes recover from training and reducing their risk of injuries. Finally, in some cases, supplements can be a convenient way to obtain nutrients that may be difficult to obtain through diet alone, especially when individuals travel or during intense training periods (Close et al., 2022; Forbes et al., 2024; Rodek et al., 2012). Not surprisingly, studies have reported a high prevalence of dietary supplementation in sports and evaluated factors associated with dietary supplementation in sports. In brief, dietary supplementation ranges between 60% and more than 90% of consumers, with a higher

prevalence in male athletes, athletes with advanced competitive status, contact sports, and sports with high energetic demands (Daher et al., 2022; Rodek et al., 2012; Sekulic et al., 2017; Valentina, 2022).

Despite proven benefits, there are certain controversies related to dietary supplement use in sports. For example, many supplements lack robust scientific evidence to support their claims of performance enhancement or health benefits. Some supplements can cause side effects, such as gastrointestinal issues, sleep disturbances, or even more serious health problems, and can interact with medications (Ronis et al., 2018). Importantly, some supplements may be contaminated with banned substances or other harmful ingredients not listed on the label, posing a risk to athletes' health and careers (Mathews, 2018). In other words, athletes may unknowingly consume banned substances (e.g., doping substances) through contaminated supplements, leading to disqualification and damage to their reputation. As a result, studies have repeatedly reported possible connections between supplement use and doping in sports (Duiven et al., 2021; Martinez-Sanz et al., 2017).

The “contamination” of supplements with doping substances is frequently investigated, highlighting the “origins” of this problem, including (i) hidden contamination (e.g., prohibited doping substances are not specifically listed on the labels) and (ii) cross-contamination in manufacturing (e.g., some supplements may become contaminated by doping due to cross-production in factories that handle both legal dietary products and those containing banned substances) (Duiven et al., 2021; Torres et al., 2024). While those issues are not generated by athletes themselves, there are some situations in which dietary supplements are connected with doping because of the athletes themselves. First, there is no doubt that the use of dietary supplements in sports is often motivated by the desire to enhance performance legally. However, pressure to maintain a competitive edge may drive athletes toward illegal substances and doping. Additionally, for some athletes, dietary supplements can act as a gateway to doping because the perceived effectiveness of certain (legal) supplements might lead athletes to experiment with banned substances to further enhance their performance (Backhouse et al., 2013). Finally, the psychological reliance on supplements to achieve peak performance can blur the line between legitimate supplement use and doping (Hurst et al., 2023). Generally, athletes may become more willing to cross into doping if they believe that it will provide a further competitive edge.

Despite global anti-doping efforts, doping has emerged as one of the most important problems in sports today (Liposek et al., 2018; Sekulic et al., 2017). Scientific reports agree that dietary supplementation is highly prevalent in sports, while some studies have connected dietary supplementation with a positive doping tendency in athletes (Hurst et al., 2023). The problem of this study arises from the fact that the association between dietary supplementation was frequently theoretically and empirically connected to doping in sports (i.e., athletes who reported the use of dietary supplements were more prone to doping and/or were more likely to use doping than those who did not use dietary supplements), but in most of the studies, several methodological issues could be recognized. First, studies often include athletes involved in different sports, which could result in specific sport bias (i.e., both doping and dietary supplementation are known to be more prevalent in some sports). Second, most of the studies evaluated “general” consumption of dietary supplements, and studies in which the consumption of various dietary supplements was specifically investigated are lacking. Moreover, there is a logical concern that specific dietary supplements could be associated with doping, which is a definitive problem worth noting. Finally, and for the purpose of our research, the most important issue is the lack of research in which the association between dietary supplementation and doping was specifically investigated for swimming. Therefore, this study aimed to identify the possible associations that exist between the consumption of different dietary supplements and doping tendencies in high-level swimming. We hypothesized that the consumption of specific types of dietary supplements will be positively associated with doping tendency in swimmers.

Materials & methods

Participants: This study involved 301 competitive swimmers from Slovenia (average age 16.7 years, with 9.2 years of experience, 148 females). Ethical approval for the study was granted by both the national swimming federation and the Institutional Ethics Review Board of the Faculty of Sport, University of Ljubljana, Slovenia. Appropriate consent was obtained from all participants (or their parents/guardians for those under 18 years of age).

Study protocol: Swimmers were contacted by the National Swimming Federation and were informed about the importance of the study and the protocol. They were informed that participation was voluntary and that there would be no intention to connect the responses with specific individuals. The testing was planned and performed during the national swimming championship, and practically all swimmers agreed to participate (i.e., only those who did not compete due to illness, injury or eventual personal issues were not included in the research).

As a result, the study group represents all competitive swimmers in the country. The testing was performed in groups of at least five swimmers, and the first author of the study was available for any possible questions and help. The participants were informed that they could skip some questions and/or leave the full questionnaire unanswered. When the questionnaire was finished, it was placed in a closed box, which was open when all the participants were tested.

Variables: Variables were collected via previously validated questionnaires, and in this study, they included sociodemographic variables, doping factors, and questions regarding dietary supplementation (Sekulic et al., 2016; Sekulic et al., 2017). Sociodemographic variables included age (in years), gender (male vs. female), and experience swimming (in years). Doping factors included questions on personal opinions about the presence of doping in swimming (answers included: No, I do not think that doping is used in swimming—used but rarely—doping is common in swimming sports) and self-declared doping attitudes (I will never use doping—I do not know—I could consider doping usage if there is no health hazard—I could consider doping usage). For the purpose of later statistical analyses, doping attitudes were binarized and recorded as “Negative DT” (first answer) and “Neutral/Positive DT” (remaining answers).

Dietary supplementation practices were asked by one general question (e.g., “Do you use dietary supplements?”), and possible responses were as follows: Yes, regularly - From time to time - No, I don’t use it) and separate responses regarding the consumption of vitamins and minerals, carbohydrates, proteins, isotonic/electrolytes, recovery supplements, energy bars, and other supplements. For all supplements, four-point scales were offered (No - Sporadically - Often - Regularly).

Statistics: After the normality of distributions was checked via the Kolmogorov–Smirnov test, descriptive statistics included calculations of means and standard deviations (for age and experience in swimming) and counts and percentages (for remaining variables). The associations between the study variables and doping attitudes were performed by (i) calculating differences in the study variables between groups on the basis of doping attitudes (negative vs. neutral/positive doping attitudes) and (ii) performing logistic regressions for binarized criteria—doping attitudes. Differences between groups were calculated via the t-test, Chi-square test, and Mann–Whitney (MW) test (depending on the type of study variable). Univariate logistic regressions were first calculated, observing each study variable as a predictor of doping attitudes (criterion). In the second phase, all the predictors found to be significantly associated with the criterion were included in the multivariate regression model to control for possible confounding effects. Statistica 13.5 (Tibco Inc. Palo Alto, CA, USA) was used for all analyses, and the p value was set at 95% ($p < 0.05$).

Results

No significant difference in age (t test = 0.5, $p = 0.44$) or experience in swimming (t test = 0.67, $p = 0.50$) was found between groups formed on the basis of doping tendency (Table 1).

Table 1. Descriptive statistics and differences between groups (t test) based on doping tendency with respect to age and experience in swimming

	Negative DT (n = 217)		Neutral/positive DT (n = 84)		t test	
	Mean	Std.Dev.	Mean	Std.Dev.	t value	p
Age (years)	15.85	2.37	15.61	2.72	0.76	0.45
Experience (years)	14.34	81.67	8.27	3.62	0.68	0.50

A significant difference in gender was found between groups in terms of doping tendency, with more males in the group of swimmers who reported a neutral/positive doping tendency (Chi square = 9.99, $p < 0.001$). Additionally, the groups differed in their opinions about the presence of doping in swimming (MW = 3.01, $p < 0.001$). Specifically, swimmers who reported being neutral (a positive doping tendency) were likely to believe that doping occurred in swimming (Table 2).

Table 2. Descriptive statistics and differences (MW – Mann–Whitney test; Chi-square test) between groups on the basis of doping tendency in general variables

	Negative DT		Neutral/positive DT		MW	Chi-square	p
	F	%	F	%			
Gender						9.99	0.001
Females	119	54.84	29	34.52			
Males	98	45.16	55	65.48			
Doping in swimming					3.01		0.001
No, I don’t think doping occurs in swimming	85	39.17	13	15.47			
Yes, but rarely	67	30.88	39	46.43			
Yes, frequently	65	29.95	32	38.10			
Dietary supplementation					1.4		0.15
No	28	12.90	19	22.62			
Yes, but not regularly (use it from time to time)	108	49.77	37	44.05			
Yes, regularly	81	37.33	28	33.33			

The consumption of protein supplements, as well as the consumption of recovery supplements, was greater in the group of swimmers with neutral/positive doping tendencies (MW = 1.99, $p = 0.04$, and MW = 2.46, $p < 0.01$, for protein and recovery supplements, respectively) (Table 3).

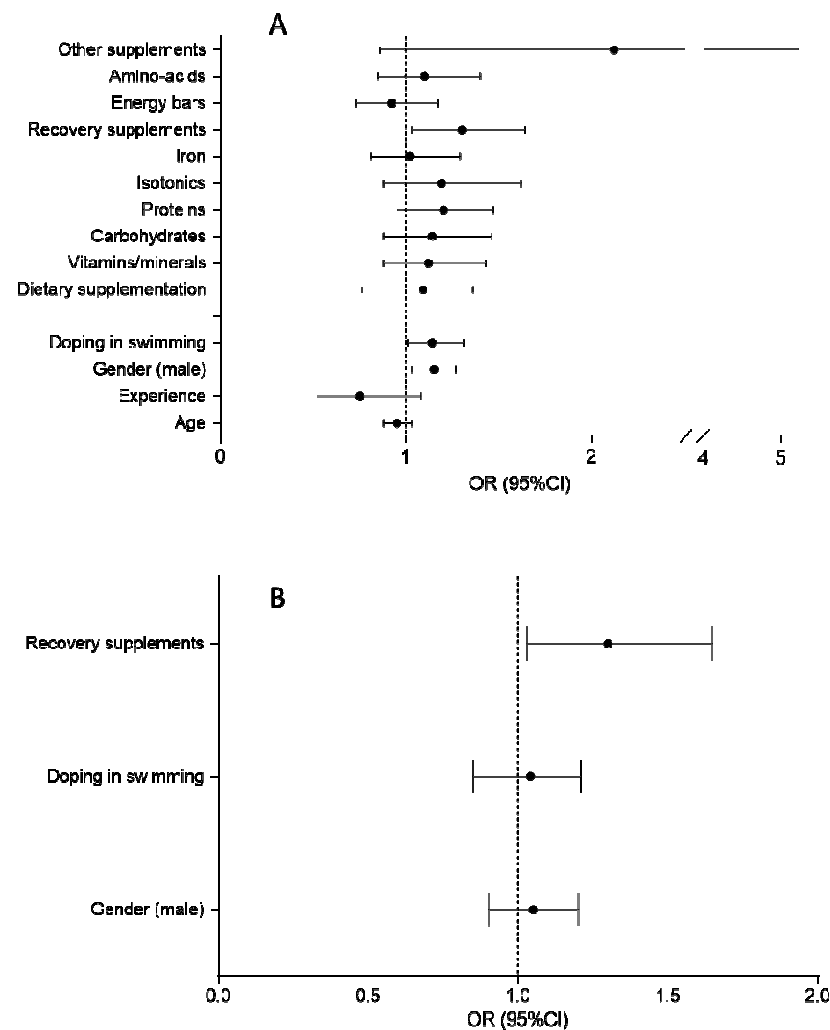
Table 3. Descriptive statistics and differences (MW–Mann–Whitney test) between groups on the basis of doping tendency in variables related to specific dietary supplements

	Negative DT		Neutral/positive DT		MW	p
	Count	Percent	Count	Percent		
Vitamins/minerals					1.6	0.1
No	122	56.22	31	36.90		
Yes, from time to time	75	34.56	47	55.95		
Yes, regularly	20	9.22	6	7.14		
Carbohydrates					1.72	0.08
No	139	64.06	41	48.81		
Yes, from time to time	60	27.65	38	45.24		
Yes, regularly	18	8.29	5	5.95		
Proteins					1.99	0.04
No	126	58.06	34	40.48		
Yes, from time to time	59	27.19	42	50.00		
Yes, regularly	32	14.75	8	9.52		
Isotonics/electrolytes					0.79	0.42
No	134	61.75	49	58.33		
Yes, from time to time	78	35.94	30	35.71		
Yes, regularly	5	2.30	5	5.95		
Iron					0.61	0.54
No	149	68.66	52	61.90		
Yes, from time to time	40	18.43	27	32.14		
Yes, regularly	28	12.90	5	5.95		
Recovery supplements					2.46	0.01
No	173	79.72	55	65.48		
Yes, from time to time	24	11.06	19	22.62		
Yes, regularly	20	9.22	10	11.90		
Energy bars					0.61	0.53
No	65	29.95	28	33.33		
Yes, from time to time	120	55.30	42	50.00		
Yes, regularly	32	14.75	14	16.67		
Amino-acids					1.29	0.19
No	171	78.80	59	70.24		
Yes, from time to time	28	12.90	16	19.05		
Yes, regularly	18	8.29	9	10.71		
Other					1.23	0.21
No	214	98.62	81	96.43		
Yes, from time to time	2	0.92	2	2.38		
Yes, regularly	1	0.46	1	1.19		

Univariate and multivariate associations between the study variables and doping tendency are presented in Figure 1. A greater likelihood of a neutral/positive doping tendency was found for males (OR = 1.15, 95% CI: 1.03-1.27), those who were convinced that doping was present in swimming (OR = 1.14, 95% CI: 1.01-1.31), and swimmers who consumed recovery supplements (OR = 1.30, 95% CI: 1.03-1.64) (Figure 1A).

When three significant univariate predictors were included in the multivariate analysis (Figure 1B), the consumption of recovery supplements was the only significant predictor of a neutral/positive doping tendency (OR = 1.30, 95% CI: 1.02–1.65).

Fig 1. Univariate (Figure 1A) and multivariate (Figure 1B) logistic regression for doping tendency (with neutral/positive doping tendency as the reference value)



Discussion

There are several important results of this study. First, when observed univariately, male gender, belief that doping is present in swimming, and greater consumption of recovery supplements are associated with a greater neutral/positive doping tendency. However, when observed multivariately, the consumption of recovery supplements was the only significant predictor of doping tendency in the studied swimmers.

Gender and doping

Doping remains one of the most important problems in modern sports (Burnett, 2023). While health-related issues related to doping consumption are relatively well known, there is no doubt that doping behavior is against fair-play and corrupts the main essence of the sport itself (Alexandrescu & Mihailescu, 2021). Therefore, studies addressing factors associated with doping behavior in sports are recognized as crucial pillars in global anti-doping efforts. The greater likelihood of a positive doping tendency among male swimmers than among female swimmers is generally consistent with the findings of previous studies, which in most cases confirmed a greater positive doping tendency in male athletes than in female athletes (Alaranta et al., 2006; Mazzeo et al., 2019).

In one of the early studies dealing with this topic, authors from Finland reported that male athletes have more positive attitudes toward doping than female athletes do, which is consistent with a more recent Italian study (Alaranta et al., 2006; Mazzeo et al., 2019). While such differences could be attributed to differences in sports (e.g., men tend to be involved in sports where doping is generally more prevalent, which could also result in differences in doping factors), it is interesting that similar results are reported in studies where genders were compared within the same sport (Sekulic et al., 2016).

Regardless of the type of sport, this difference between genders can be attributed to several factors. The first is definitively sociocultural pressure. Specifically, men in sports may face greater pressure to achieve success and maintain a muscular physique, leading them to turn to performance-enhancing drugs (Overbye et al.,

2013). Second, men may be more susceptible to the effects of certain performance-enhancing drugs due to hormonal differences, which can orient men to doping more than women (Singhammer, 2012). Finally, men are generally more likely to engage in risk-taking behaviors, which may include the use of doping (banned substances) as well (Sekulic et al., 2016).

Opinion on doping in swimming and doping tendency

The personal belief that doping is present in swimming is significantly associated with a greater positive doping tendency. Specifically, swimmers who are convinced that doping exists in their sport are more likely to have positive attitudes toward their usage of doping. This finding is not novel, and studies have already reported similar tendencies in various sports and in different countries (Sekulic et al., 2016; Sekulic et al., 2017). Therefore, irrespective of the type of sport and sociocultural context, the background of the relationship is likely very similar.

The first factor that might explain this association is “normalization of doping” (Blank et al., 2016). Simply put, if an athlete believes that doping is widespread in their sport, they may be more likely to view it as necessary to remain competitive. This can lead to a “win-at-all-costs” mentality, where ethical concerns are overlooked. This perception can also reduce the stigma associated with doping, making it seem more acceptable or even an expected practice. Second, when athletes believe that doping occurs in sports, they may experience a form of moral disengagement, where they rationalize their own doping behavior by justifying it as a level playing field (Boardley & Kavussanu, 2011). This can also lead to a diffusion of responsibility, where athletes feel less personally accountable for their actions. Third, athletes often look to their peers and role models for guidance. If they observe others doping and achieving success, they may be more likely to adopt similar behaviors. This is particularly the case in environments where doping is tacitly accepted or even encouraged. Finally, the belief that others are doping can create intense pressure to keep up, leading athletes to consider doping as a way to increase their performance (Sekulic et al., 2014).

Dietary supplementation and doping tendency

As introduced, dietary supplementation has been repeatedly connected to doping in athletes, and explanations vary from biotechnical issues (i.e., dietary supplements can be contaminated by doping substances by cross-production of prohibited and nonprohibited substances in factories) to psychological explanations (i.e., dietary supplementation can act as a step toward doping because of its similarity with regard to performance enhancement) (Lauritzen, 2022). The results presented here clearly connected the consumption of recovery supplements with more positive attitudes toward doping, and this correlation was independent of other univariate predictors of doping tendency (e.g., male gender and opinions about the presence of doping in swimming). Notably, this is one of the rare studies where specific types of dietary supplementation were connected to doping attitudes, but some possible explanations for these findings are discussed in the following text.

First, there is no doubt that swimmers, particularly those at highly competitive levels, face immense pressure to perform at their best, recover quickly, and minimize the risk of injury. This pressure often pushes them toward enhanced recovery methods, including the recovery supplements. Even rigorous scientific studies have reported beneficial effects of some dietary supplements on recovery from intense training and/or injury (Bucci, 2022). However, when the results from legal supplements are insufficient, athletes might be more tempted to explore illegal options, including doping. This would be particularly possible for swimmers who are potentially frustrated with the perceived lack of efficacy of legal recovery supplements (i.e., legal recovery supplements may not always deliver the immediate or drastic results athletes desire). On the other hand, it is known that some substances which include doping are highly efficient and, in some cases, achieve dramatic results, particularly in regard to recovery from injury (Sjöqvist et al., 2008). It is understandable that such frustration may motivate athletes to explore illicit options to boost recovery, reduce fatigue, or enhance their athletic performance faster.

Second, the “gateway effect” of dietary supplementation is also possible (Backhouse et al., 2013). In other words, supplement use can “normalize” the idea of ingesting substances to enhance performance or recovery. This mindset might make an athlete more comfortable with the concept of doping. Once supplements are seen as part of the routine, the next step might feel like a natural progression, leading to doping. Given that recovery supplements are generally consumed by athletes who are exhausted, fatigued, and/or injured, the phenomena of “normalization” and the “gateway effect” are even more possible. Additionally, athletes often face significant psychological pressure, such as fear of losing or failure to meet expectations. This is even more likely to happen among athletes who already consume (legal) recovery supplements, since those athletes are definitively on the edge of their capacity. Indeed, the consumption of recovery supplements may reflect an athlete’s desire to maintain performance or avoid injury, creating a sense of dependency on external aids to maintain competitiveness. This dependency might transition into doping, which could explain our results on the correlation between the consumption of recovery supplements and the doping tendency.

Limitations and strengths

This study was cross-sectional; therefore, the results cannot be interpreted with regard to cause–effect relationships. Naturally, some relationships can be intuitively interpreted (i.e., male gender is certainly “the cause” and not “the effect” of higher doping tendency), but in some other cases, causality must not be simplified. Therefore, further prospective studies are needed. Second, this study explored only swimming sport and athletes

involved in swimming from one country, and results could be generalized solely to similar samples. Finally, this study did not observe actual doping behavior but rather a tendency toward doping, which was self-reported. Therefore, there is a certain possibility that participants leaned toward socially desirable answers.

This is one of the rare studies where a sample of participants presented practically the whole population of athletes in one sport from one country. Additionally, specific analyses in which the consumption of different dietary supplements was independently correlated with doping tendency allowed us to explore this problem more specifically. Therefore, although results are not the final word on a topic, this research will hopefully make certain contributions to a field and initiate further research.

Conclusions

While male gender was found to be a significant correlate of (higher) doping tendency in swimming, studies have pointed to the necessity of further gender-specific evaluations of factors associated with doping in sports and/or controlling for gender in studies of this type. Otherwise, some specific factors related to each gender could appear to be significantly related to doping. Since our results revealed a correlation between opinions about the presence of doping in swimming and doping tendencies, even in gender-specific studies, personal opinions on the presence of doping in sports should be included as possible covariate of relationships.

Initially, we hypothesized that the (higher) consumption of specific dietary supplements would be correlated with a greater positive doping tendency in high-level swimmers. The results support the initial hypothesis of the study. Specifically, the consumption of recovery supplements was found to be greater among swimmers who reported more positive attitudes toward doping. It is possible that the consumption of (legal) recovery supplements paves the way for a positive doping tendency due to factors such as psychological dependency, pressures to recover and perform, and an evolving acceptance of performance enhancement. While not all athletes who use recovery supplements will turn to doping, the correlation is probably influenced by a range of physiological, psychological, and social factors, which could blur the boundaries between legal recovery aids and illegal performance enhancement. However, our results clearly identified swimmers who consumed recovery supplements as a group of athletes at greater risk of future doping behavior. Therefore, in future studies, specific contextual factors should be identified and incorporated into analyses to clearly identify the possible correlates of doping behavior in sports.

The most important practical implications of this study should be found in the targeted prevention of doping in swimming. Specifically, in doing so, focus should be placed on males, swimmers who are convinced that doping is prevalent in their sport, and particularly swimmers who consume recovery supplements. By all means, all of these factors are easily obtainable. Therefore, information on our findings should be disseminated, whereas coaches and support staff should continuously monitor the opinions of swimmers on the presence of doping in swimming, as well as their practice of specific dietary supplementation.

Conflicts of interest: The authors declare no conflicts of interest.

References

- Alaranta, A., Alaranta, H., Holmila, J., Palmu, P., Pietilä, K., & Helenius, I. (2006). Self-reported attitudes of elite athletes towards doping: differences between type of sport. *International journal of sports medicine*, 27(10), 842-846. doi: 10.1055/s-2005-872969.
- Alexandrescu, V. M., & Mihailescu, L. (2021). Methodological arguments support in maintaining the development of an antidoping competence in the formal education of high school sports program students. *Journal of Physical Education and Sport*, 21(6), 3586-3592. doi: 10.7752/jpes.2021.06484
- Backhouse, S., Whitaker, L., & Petróczy, A. (2013). Gateway to doping? Supplement use in the context of preferred competitive situations, doping attitude, beliefs, and norms. *Scandinavian journal of medicine & science in sports*, 23(2), 244-252. doi: 10.1111/j.1600-0838.2011.01374.x
- Bird, S. R., Goebel, C., Burke, L. M., & Greaves, R. F. (2016). Doping in sport and exercise: anabolic, ergogenic, health and clinical issues. *Ann Clin Biochem*, 53(Pt 2), 196-221. doi: 10.1177/0004563215609952
- Blank, C., Kopp, M., Niedermeier, M., Schnitzer, M., & Schobersberger, W. (2016). Predictors of doping intentions, susceptibility, and behaviour of elite athletes: a meta-analytic review. *SpringerPlus*, 5, 1-14. doi: 10.1186/s40064-016-3000-0.
- Boardley, I. D., & Kavussanu, M. (2011). Moral disengagement in sport. *International Review of Sport and Exercise Psychology*, 4(2), 93-108.
- Bucci, L. R. (2022). Dietary supplements as ergogenic aids. In *Nutrition in Exercise and Sport*, Third Edition (pp. 315-368). CRC Press.
- Burnett, C. (2023). We all stand accused in the fight against 'doping' among young South African rugby players. *Journal of Physical Education & Sport*, 23(7). doi:10.7752/jpes.2023.07205
- Close, G. L., Kasper, A. M., Walsh, N. P., & Maughan, R. J. (2022). "Food first but not always food only": recommendations for using dietary supplements in sport. *International journal of sport nutrition and exercise metabolism*, 32(5), 371-386. doi: 10.1123/ijsnem.2021-0335

- Daher, J., Mallick, M., & El Khoury, D. (2022). Prevalence of Dietary Supplement Use among Athletes Worldwide: A Scoping Review. *Nutrients*, 14(19). doi: 10.3390/nu14194109
- Duiven, E., van Loon, L. J. C., Spruijt, L., Koert, W., & de Hon, O. M. (2021). Undeclared Doping Substances are Highly Prevalent in Commercial Sports Nutrition Supplements. *J Sports Sci Med*, 20(2), 328-338. doi: 10.52082/jssm.2021.328
- Forbes, S. C., Best, R., & Dominguez, R. (2024). Editorial: Dietary supplements and ergogenic aids in relation to health and performance. *Front Sports Act Living*, 6, 1450604. doi:spor.2024.1450604
- Hurst, P., Schiphof-Godart, L., Kavussanu, M., Barkoukis, V., Petróczi, A., & Ring, C. (2023). Are dietary supplement users more likely to dope than non-users?: A systematic review and meta-analysis. *International Journal of Drug Policy*, 117, 104077. doi: 10.1016/j.drugpo.2023.104077.
- Lauritzen, F. (2022). Dietary supplements as a major cause of anti-doping rule violations. *Frontiers in sports and active living*, 4, 868228. doi: 10.3389/fspor.2022.868228.
- Liposek, S., Zenic, N., Saavedra, J. M., Sekulic, D., Rodek, J., Marinsek, M., & Sajber, D. (2018). Examination of Factors Explaining Coaching Strategy and Training Methodology as Correlates of Potential Doping Behavior in High-Level Swimming. *J Sports Sci Med*, 17(1), 82-91. <https://www.ncbi.nlm.nih.gov/pubmed/29535581>
- Martinez-Sanz, J. M., Sospedra, I., Ortiz, C. M., Baladia, E., Gil-Izquierdo, A., & Ortiz-Moncada, R. (2017). Intended or Unintended Doping? A Review of the Presence of Doping Substances in Dietary Supplements Used in Sports. *Nutrients*, 9(10). doi: 10.3390/nu9101093
- Mathews, N. M. (2018). Prohibited Contaminants in Dietary Supplements. *Sports Health*, 10(1), 19-30. doi: 10.1177/1941738117727736
- Mazzeo, F., Santamaria, S., & Montesano, P. (2019). Gender difference, nutritional supplements and drug use in sport to enhancing performance: An Italian revision over the last decade. *Sport Mont*, 17(1), 69-73. doi: 10.26773/smj.181020
- Overbye, M., Knudsen, M. L., & Pfister, G. (2013). To dope or not to dope: Elite athletes' perceptions of doping deterrents and incentives. *Performance Enhancement & Health*, 2(3), 119-134.
- Rodek, J., Sekulic, D., & Kondric, M. (2012). Dietary supplementation and doping-related factors in high-level sailing. *J Int Soc Sports Nutr*, 9(1), 51. doi: 10.1186/1550-2783-9-51
- Ronis, M. J. J., Pedersen, K. B., & Watt, J. (2018). Adverse Effects of Nutraceuticals and Dietary Supplements. *Annu Rev Pharmacol Toxicol*, 58, 583-601. doi:10.1146/annurev-pharmtox-010617-052844
- Sekulic, D., Bjelanovic, L., Pehar, M., Pelivan, K., & Zenic, N. (2014). Substance use and misuse and potential doping behaviour in rugby union players. *Res Sports Med*, 22(3), 226-239. doi: 10.1080/15438627.2014.915839
- Sekulic, D., Tahiraj, E., Zvan, M., Zenic, N., Uljevic, O., & Lesnik, B. (2016). Doping Attitudes and Covariates of Potential Doping Behaviour in High-Level Team-Sport Athletes; Gender Specific Analysis. *J Sports Sci Med*, 15(4), 606-615. <https://www.ncbi.nlm.nih.gov/pubmed/27928206>
- Sekulic, D., Zenic, N., Versic, S., Maric, D., Gabrilo, G., & Jelicic, M. (2017). The Prevalence and Covariates of Potential Doping Behavior in Kickboxing; Analysis among High-Level Athletes. *J Hum Kinet*, 59, 67-77. doi: 10.1515/hukin-2017-0148
- Singhammer, J. (2012). Age and gender specific variations in attitudes to performance enhancing drugs and methods. A cross-sectional study. *Sport science review*, 21(5-6), 29.
- Sjöqvist, F., Garle, M., & Rane, A. (2008). Use of doping agents, particularly anabolic steroids, in sports and society. *The Lancet*, 371(9627), 1872-1882.
- Torres, C. L., de Oliveira, F. A. G., Jooris, L. F., Padilha, M. C., & Pereira, H. M. G. (2024). The presence of doping agents in dietary supplements: A glimpse into the Brazilian situation. *Drug Test Anal*, 16(1), 38-48. doi: 10.1002/dta.3517
- Valentina, Ș. (2022). Study on the dynamics of the use of food supplements in amateur sports. *Journal of Physical Education and Sport*, 22(8), 1900-1904. doi: 10.7752/jpes.2022.08240