©Journal of Sports Science and Medicine (2018) **17,** 82-91
http://www.jssm.org

Research article

Examination of Factors Explaining Coaching Strategy and Training Methodology as Correlates of Potential Doping Behavior in High-Level Swimming

Silvester Liposek [1,2], Natasa Zenic [3]✉, Jose M Saavedra [4], Damir Sekulic [3], Jelena Rodek [3], Miha Marinsek [1] and Dorica Sajber [2,5]

[1] University of Maribor, Maribor, Slovenia; [2] Slovenian Swimming Federation, Ljubljana, Slovenia; [3] University of Split, Faculty of Kinesiology, Split, Croatia; [4] Reykjavik University, Physical Activity, Physical Education, Sport and Health Research Centre, Sports Science Department, School of Science and Engineering, Reykjavik, Iceland; [5] University of Ljubljana, Faculty of Sport, Ljubljana, Slovenia

Abstract

Although coaching is considered an important determinant of athletes' potential doping behavior (PDB), there is an evident lack of studies that have examined coaching-strategy-and-training-methodology (CS&TM) in relation to PDB. This study was aimed to identify the specific associations that may exist between CS&TM -factors and other factors, and PDB in high-level swimming. The sample comprised 94 swimmers (35 females; 19.7 ± 2.3 years of age) and consisted of swimmers older than 18 years who participated in the 2017 National Championship. Variables were collected by previously validated questionnaires, with the addition of questions where athletes were asked about CS&TM to which they had been exposed. Multinomial logistic regression was applied for the criterion PDB (Negative PDB – Neutral PDB – Positive PDB). The higher risk for positive-PDB was found in males (OR: 6.58; 95%CI: 1.01-9.12); therefore, all regressions were adjusted for gender. Those swimmers who achieved better competitive result were less prone to neutral-PDB (0.41; 0.17-0.98). The positive-PDB was evidenced in those swimmers who perceived that their training was monotonous and lacked diversity (1.82; 1.41-5.11), and who were involved in training which was mostly oriented toward volume (1.76; 1.11-7.12). The lower likelihood of positive-PDB is found in those who replied that technique is practiced frequently (0.12; 0.01-0.81), those who replied that coach regularly provided the attention to explain the training aims (0.21; 0.04-0.81), and that coach frequently reviewed and discussed the quality of execution of specific tasks (0.41; 0.02-0.81). The findings on the relationships between the studied variables and PDB should be incorporated into targeted anti-doping efforts in swimming. Further studies examining sport-specific variables of CS&TM in younger swimmers and other sports are warranted.

Key words: Performance enhancing substances, swimming, training methodology.

Introduction

Doping can be defined as the occurrence of one or more anti-doping code violations and is usually observed by the presence of a prohibited substance, its metabolites or markers in a biological specimen from an athlete (Sajber et al., 2013). Doping usage in sport is known to be related to negative health-related consequences and even death (Honour, 2016; Mazanov et al., 2012). Additionally, doping corrupts the main essence of sport and fair play and is therefore considered non-ethical behavior (Ljungqvist et al., 2008). As a result, the global fight against doping is highly prioritized in all organized sport societies (Ljungqvist, 2014).

The World Anti-Doping Agency (WADA), a global governing body for anti-doping in sports, has put special efforts into the development and application of differentially targeted approaches in the fight against doping. Generally, two approaches can be recognized in an anti-doping campaign. The first approach includes the development of reliable and applicable measurement tools and protocols that allow the precise identification and consequent penalization of athletes who have resorted to doping (Kiss et al., 2013; Malm et al., 2016). The second approach in global anti-doping efforts is more "preventive" in its nature and includes the identification of the cultural and sport-specific factors that influence doping behavior in each sport society (Furjan Mandic et al., 2013; Morente-Sanchez et al., 2013; Rodek et al., 2013). The idea is to identify certain precipitating factors of doping behavior in sports and to evaluate the nature of their influence (i.e., risk or protective effects on doping behavior) (Kisaalita and Robinson, 2014).

Several factors have been studied to identify possible associations with doping in sports, including sport-specific factors, socio-demographic variables, socio-cognitive factors (i.e., variables identified throughout the self-determination theory), and motivational variables (Barkoukis et al., 2013; Chan et al., 2015; Kondric et al., 2011; Matosic et al., 2016; Zenic et al., 2010). However, the studies conducted to date suggest that the factors associated with doping behavior (either actual or potential behavior) in one group of athletes (sport, gender, socio-cultural environment) could be differentially associated with doping behavior in other sport-specific groups (Rodek et al., 2013).

The specific influence of precipitating factors on doping behavior in different sports and societies is even more aggravated by the fact that the prevalence of doping is very different in relation to sport, gender, age and athlete (Lentillon-Kaestner and Ohl, 2011). Moreover, the doping intentions of athletes are influenced by distal influences (e.g., self-determination, sportpersonship orientations, and achievement goals), and proximal influences (e.g., situational temptation and perceived behavioral control, descriptive and subjective norms, and attitudes) (Barkoukis et al., 2013; Ntoumanis et al., 2017). Therefore, specific analyses of different sports and socio-cultural environments are needed.

It is widely accepted that characteristic relationships that exist between coaches and athletes should be

Received: 24 October 2017 / Accepted: 25 December 2017 / Published (online): 01 March 2018

observed as important determinant of athletes' attitudes toward doping, and the importance of coaches as potential agents in the prevention of doping amongst athletes has been repeatedly emphasized (Backhouse and McKenna, 2012; Barkoukis et al., 2013; Lonsdale et al., 2017). In studies where type of coaching (i.e. style of coaching) was observed as a determinant of athletes' doping-behavior, the authors used the self-determination theory to evidence coaches' personal behavior, and observed the influence of the contextual climate that the coach creates on athletes' motivation and pro- and antisocial behavior, including doping attitudes (Chen et al., 2017; Hodge and Lonsdale, 2011). Indeed, the coaching style (i.e., coaching behavior: autonomy supportive vs. controlling) is an important determinant that can modulate athletes' attitudes (Chen et al., 2017; Hodge et al., 2013). However, behavioral characteristics are partially inherited but are mostly shaped throughout maturation-experience interactions, and each individual (i.e., coach) develops distinct behavioral characteristics as a result of the specific maturational-experimental interactions that influence him/her (Lerner, 2013). Therefore, the possible influence of coaching behavior on athletes' doping tendencies can be used to identify at-risk athletes.

Meanwhile, coaching strategy and training methodology (CS&TM) have not been studied as factors potentially related to doping behavior in athletes. In short, CS&TM can be defined as a set of methods that coaches use throughout the sport training process to improve the athlete's physiological capacities and sport-specific skills. The CS&TM includes (but is not limited to) the application of different types of training, training regimes and methodological/didactical approaches in sport training. Of particular importance is the fact that the CS&TM is modifiable and adaptable (Bompa and Haff, 2009). Therefore, if some aspects of the CS&TM are identified as being related to athletes' doping susceptibility, it would implicate its applicability in anti-doping efforts, either by detecting those athletes who are at certain risk for doping behavior, or throughout instructing the coaches and informing them that certain type of CS&TM is recognized as a risk factor for PDB in athletes.

Despite the fact that the variables of CS&TM could influence doping susceptibility in different sports, this problem is particularly important in individual, monostructural, cyclic sports, which are performed in systematically controlled environment, such as swimming. Namely, to improve the competitive achievement (sport-result) in swimming, the variables which are controlled throughout the training process are training-volume, training-intensity, and mastering of the specific swimming-skills (i.e. swimming-technique) (Colwin, 2014). While doping in sport is mostly used in order to enhance athletes' physiological capacities (i.e. to overcome physiological stress induced by training volume and intensity, and to boost the mechanism of supercompensation) (Colwin, 2014; Rodek et al., 2013), it is reasonable to expect that the influence of CS&TM on doping susceptibility in swimmers is higher than influence of CS&TM on doping susceptibility in athletes involved in "multifaceted" sports (i.e. sport games, team sports).

The aims of this study were to identify the prevalence of potential doping behavior (PDB) in high-level swimmers and to identify the factors associated with their PDB. We were mainly focused on variables of CS&TM but also studied those factors that were previously reported as being potentially important determinants of PDB in sports The increased knowledge on a problem will allow the development of a meaningful and accurate anti-doping strategy in swimming, Initially, we hypothesized certain associations between CS&TM variables and PDB in swimmers. As a methodological remark, it must be emphasized that this study included practically the whole population of high-level competitive swimmers older than 18 years in a country (see Methods for more details) and therefore allows a substantial generalization of the findings.

Methods

Participants

The original sample in this study comprised 97 swimmers from Slovenia (35 females; 19.7 ± 2.3 years of age; 11.3 ± 3.1 years of experience in swimming sport). All participants were older than 18 years and were tested during the 2017 National Championship. An invitation to participate in the study was sent by the national swimming federation, and none of the athletes refused to participate; therefore, all swimmers who participated in the championship were included. The study was originally initiated and approved by the national swimming federation, complied with all ethical guidelines and received approval from the Institutional Ethics Review Board at the corresponding author's institution (EBO 10/09/2014-1).

Variables and measurement

The previously validated questionnaire on substance use (QSU) was used to test the athletes (Zenic et al., 2010). Additionally, participants were questioned about CS&TM they were exposed to.

The QSU included questions on socio-demographics (age [in years], and gender), sports factors, doping factors and questions on CS&TM. Sport factors were assessed by questions on the (i) athlete's experience in swimming (in years) and (ii) competitive results achieved in (iia) non-Olympic events (25-m pool) and (iia) Olympic events (50-m pool) ("Regional-level medalist", "National championship - finals", "National championship - medal", "European and World Championship - finals", "European and World Championship – medalist", "Olympics"), (iii) preferred style of swimming (i.e., front crawl, butterfly, breaststroke, backstroke, medley), and (iv) competitive discipline in which they mostly compete (i.e., short distance, middle distance, long distance).

Doping-related factors were assessed by asking participants their opinions about (i) the occurrence of doping in swimming ("I don't think doping is used in swimming", "Not sure about it", "Occurs, but rarely", "Doping is often"), (ii) the number of doping tests ("Never tested on doping", "Once or twice", "Three times or more"), and (iii) PDB. The PDB was tested on scale which included four possible answers ("I would engage in doping if it would help me", "I would engage in doping if it would help me with no negative health consequences", "Not sure" and "I do not intend to engage in doping in the future"), but for

the purpose of logistic regression analysis the responses on PDB were specifically clustered (see later text on Statistical analyses). This scale was found to be valid in evaluation of PDB in different sports, including tennis, synchronized swimming, and various team sports (Furjan Mandic et al., 2013; Kondric et al., 2013; Sekulic et al., 2014; Sekulic et al., 2016). What is also important, recent investigation done on team sport athletes of both genders confirmed high correlation between PDB and another commonly used measurement tool (Performance Enhancement Attitude Scale - PEAS) (Morente-Sanchez et al., 2014; Sekulic et al., 2016).

The CS&TM questions examined swimmers opinion on training methodology and coaching strategy he/she has been experiencing. Some questions were assessed on binomial scale (Yes – No), while some others were assessed on scales that included more possible answers. With regard to training methodology swimmers were asked on their perception about: (i) general characteristics of their training, (ii) attention paid on mastering of the swimming technique during training, (iii) training volume they were exposed to (i.e. swam distance), and (iv) characteristic training intensity.

The general characteristics of the training were evaluated by three statements on binomial (Yes-No) scale: "Swimming technique is an important part of my training", "Training is monotonous and lacks diversity", and "Training is mostly oriented toward volume (swam distance)". The attention paid on swimming technique during training was asked by one question ("The swimming-technique is practiced …") and swimmers had to choose one of three responses ("… in less than 10% of training", "… in 10-30% of training", "… in more than one-third of training"). Swimmers self-reported their training volume on one question ("My average training volume is…"), and had to choose one of five possible answers ("… approximately 20-30 km per week", "… 30-40 km per week", "… 40-50 km per week", "… 50-60 per week", "… >60 km per week"). The question on self-estimated "Training intensity" included six possible responses ("Training is high in intensity when I have to swim >6 km per session", "… >2 km in one sequence", "… repeated sets of maximal intensity, regardless of distance", "… different relays while being highly focused on stroke technique, speed and force", "… some specific sets which I have never/rarely performed before", "Intensity is high but with no specific reason").

Coaching strategy was evaluated by the following "Yes-No" statements: (i) Coach frequently explains the training aims, (ii) Coach overviews and discusses the quality of (my) execution of specific tasks, (iii) Coach is very strict and rigid, (iv) Discipline is an important part of our training regime, (v) Coach pushes me very hard, and (vi) Sometimes, I don't know what the Coach wants me to do in training.

Testing was conducted in the local language in groups of at least five athletes who were informed that the survey was anonymous, they could refuse to participate, they could leave some of the questions and/or the entire questionnaire unanswered and returning the completed questionnaire was considered consent to participate in the study. After testing, the questionnaires were placed in a sealed box that was opened on the day after the testing. For those athletes who participated in the testing, the response rate was high, and only three athletes returned the questionnaire unanswered. Therefore, the final sample comprised 94 athletes. The statements included in the CS&TM were originally suggested by the head coach of the national swimming federation and then checked and defined in their final forms through consultations among five swimming experts (two university teachers - former swimmers, two high-level coaches - officials of the national swimming federation, and one former swimmer - Olympic medalist), which contribute to ensure content validity of the CS&TM. Also, before this study, the reliability of the CS&TM was checked via a test-retest procedure. Briefly, 15 athletes (not included in this study) responded to the CS&TM questions twice in a 10-d time frame while using self-determined codes for identification purposes (i.e., they were advised to use the last three digits of their e-mail password as the identification code for easier recollection). While the CS&TM variables were in most cases ordinal in nature ("Yes-No" statements), the percentage of equally responded queries was calculated to establish reliability, as previously done in similar studies (Sekulic et al., 2014; Sekulic et al., 2016). The percentage of equally answered statements was 92% on average (from 85% for statement "Technique is practiced in 10-30% of training", up to 98% for statement "Intensity is high but with no specific reason"), thus demonstrating the high reliability of the CS&TM.

Statistical analyses

The statistics included counts and frequencies (for categorical and ordinal variables), or means and standard deviations (for continuous variables). Multinomial logistic regression models were employed to examine how variables derived by the questionnaires were associated with the PDB (Negative PDB [Those who responded: "I don't intend to engage in doping in the future"] – Neutral ["Not sure"] – Positive PDB ["I would engage in doping if it would help me", and "I would engage in doping if it would help me with no negative health consequences"]). The negative PDB was set as the reference value. Previous studies frequently reported significant associations between sociodemographic variables and personal opinion on doping presence in sports and PDB (Sekulic et al., 2014; Sekulic et al., 2016). Therefore, we first evaluated associations between sociodemographic variables and personal belief about doping presence in swimming, and PDB. The analyses showed a significant association between Gender and PDB (Neutral-PDB: OR: 1.64; 95%CI: 1.32-5.01; Positive-PDB: 6.58; 1.01-9.12). Consequently, multinomial regression models were adjusted for Gender as a possible confounding factor. For all analyses, *Statistica* 13.0 (Dell, Tulsa, OK, USA) was used, and a *p*-level of 95% was applied.

Results

Males and females had equal experience in swimming (11.51 ± 3.4 and 11.20 ± 3.0 years, respectively; t-test: 0.01, p = 0.99), and were of similar age (19.9 ± 2.0 and 19.6±1.9 years, respectively; t-test: 1.05, p = 0.29). Almost

all studied swimmers observed swimming as sport being contaminated with doping, with 43% who perceived that doping is common in their sport. Approximately 11% of swimmers declared positive PDB, and additional 14% reported neutral PDB (Table 1).

Data on CS&TM are presented in Table 2. More than 71% of swimmers stated that they frequently master swimming technique during their training, with 35% of swimmers who stated that swimming technique is practiced at more than one-third of all training sessions. Approximately, one-third of swimmers approximated their average training volume on 40-50 km per week. The 16% of swimmers stated that they "sometimes don't know what does the Coach wants from them to do in training".

The results of the multinomial regression analyses between studied predictors and PDB-criterion are summarized in Tables 3 and 4. Those swimmers who achieved better competitive result in Olympic-pools (i.e. Olympic disciplines in 50-m pools) were less likely to report neutral-PDB (OR: 0.41; 95%CI: 0.17-0.98) (Table 3). The neutral-PDB was less frequent in those swimmers who stated that technique is an important part of their training regime (OR: 0.45; 95%CI: 0.12-0.78). Further, the positive-PDB was evidenced in those swimmers who perceived that their training was monotonous and lacked diversity (OR: 1.82; 95%CI: 1.41-5.11). Also, those swimmers who perceived that they were involved in training which was mostly oriented toward volume were more likely to declare positive-PDB (OR: 2.76; 95%CI: 1.11-7.12), and neutral-PDB (OR: 1.64; 95%CI: 1.09-3.12). The lower likelihood of neutral-PDB (OR: 0.14; 95%CI: 0.03-0.96), and positive-PDB (OR: 0.12; 95%CI: 0.01-0.81) was evidenced in those swimmers who declared more frequent practicing of the swimming-technique. Statement "Sometimes, I don't know what does the Coach wants me to do in training" was positively related to negative-PDB (OR: 1.67; 95%CI: 1.01-4.21). Those who stated that training intensity was high in those situations when they had to be focused on stroke-technique, -speed and –force; were less oriented toward positive-PDB (OR: 0.18; 95%CI: 0.02-0.62). Also, swimmers who replied that their coach regularly provided the attention to explain the training aims, were less likely to declare positive-PDB (OR: 0.21; 95%CI: 0.04-0.81), and neutral-PDB (OR: 0.10; 95%CI: 0.01-0.67). Similarly, opinion that coach frequently reviewed and discussed the quality of the athlete's execution of specific tasks, was negatively correlated with positive-PDB (OR: 0.41; 95%CI: 0.02-0.81), and neutral-PDB (OR: 0.19; 95%CI: 0.11-0.98) (Table 4).

Table 1. Responses on variables derived by questionnaire on substance use (F – frequency; % - percentage).

	F	%
COMPETITIVE RESULTS IN NON-OLYMPIC DISCIPLINES		
Regional level medalist	4	4.26
National Championship finals	16	17.02
National Championship medal	69	73.40
International level - finals & medal	5	5.32
COMPETITIVE RESULTS IN OLYMPIC DISCIPLINES		
Regional level medalist	4	4.26
National Championship finals	10	10.64
National Championship medal	68	72.34
International level - finals & medal	12	12.77
PREFERRED SWIMMING STYLE		
Front crawl	35	37.23
Butterfly	26	27.66
Backstroke	16	17.02
Breaststroke	12	12.77
Medley	5	5.32
PREFERRED DISCIPLINE		
Short distance (up to 100 m)	49	52.13
Middle distance (200-400 m)	28	29.79
Long distance (800m, 1500m)	17	18.09
OPINION ABOUT DOPING PRESENCE IN SWIMMING		
No, I don't think doping is used	0	0.00
I don't know - Not sure	4	4.26
Occurs, but rarely	50	53.19
Doping is common in swimming	40	42.55
NUMBER OF DOPING TESTING		
Never tested on doping	86	91.49
Once or twice	4	4.26
Three times and more	4	4.30
POTENTIAL DOPING BEHAVIOR		
I would engage in doping if it would help me	0	0.00
I would engage in doping if it would help me with no negative health-consequences	10	10.64
Not sure	13	13.83
I don't intend to engage in doping	71	75.53

Table 2. Responses on variables of coaching strategy and training methodology.

	NO		YES	
	F	%	F	%
GENERAL OPINION ABOUT TRAINING*				
Technique is an important part of my training	27	28.72	67	71.28
Training is monotonous and lacks diversity	57	60.64	37	39.36
Training is mostly oriented toward volume	53	56.38	41	43.62
INTENSITY HIGH WHEN I HAVE TO SWIM … *				
… >6 km per session	52	55.32	42	44.68
… >2 km in one sequence	83	88.30	11	11.70
… repeated sets of maximal intensity	24	25.53	70	74.47
… different relays while being highly focused on stroke-technique, -speed, and -force	55	58.51	39	41.49
… sets I have never/rarely performed before	82	87.23	12	12.77
Intensity is high but with no specific reason	88	93.62	6	6.38
COACHING *				
Coach frequently explains the training aims	35	37.23	59	62.77
Coach overviews and discuss the quality of (my) execution of specific tasks	32	34.04	62	65.96
Coach is very strict and rigid	82	87.23	12	12.77
Discipline is an important part of our training regime	60	63.83	34	36.17
Coach pushes me very hard	54	57.45	40	42.55
Sometimes, I don't know what does the Coach wants me to do in training	79	84.04	15	15.96
	F	**%**		
TRAINING VOLUME				
Average volume is about 20-30 km per week	9	9.57		
Average volume is about 30-40 km per week	16	17.02		
Average volume is about 40-50 km per week	29	30.85		
Average volume is about 50-60 km per week	18	19.15		
Average volume is >60 km per week	13	13.83		
Missing (don't know)	9	9.57		
TECHNIQUE (APPROXIMATION)				
Technique is practiced in less than 10% of training	19	20.21		
Technique is practiced in 10-30% of training	38	40.43		
Technique is practiced in more than one-third of training	33	35.11		
Missing (don't know)	4	4.26		

* indicates variables with multiple possible answers

Table 3. Multinomial regression results for potential doping behavior (PDB) with negative PDB as reference value - variables derived from Questionnaire of Substance Use (OR – Odds Ratio; CI – Confidence Interval.

	POSITIVE PDB OR (95%CI)	NEUTRAL PDB OR (95%CI)
AGE CONT	1.20 (0.93-1.56)	1.01 (0.76-1.33)
EXPERIENCE IN SWIMMING CONT	0.97 (0.78-1.19)	0.98 (0.81-1.19)
COMPETITIVE RESULTS IN NON-OLYMPIC DISCIPLINES CONT	0.73 (0.26-2.08)	0.69 (0.27-1.78)
COMPETITIVE RESULTS IN OLYMPIC DISCIPLINES CONT	0.59 (0.21-1.71)	0.41 (0.17-0.98)
OPINION ABOUT DOPING PRESENCE IN SWIMMING		
No, I don't think doping is used	0.13 (0.01-1.15)	0.49 (0.01-1.84)
I don't know - Not sure	0.53 (0.13-2.09)	0.25 (0.07-1.05)
Occurs, but rarely/Doping is common	REF	REF
NUMBER OF DOPING TESTING		
Never tested on doping	0.99 (0.11-5.11)	0.98 (0.10-5.81)
Once or twice	0.98 (0.22-2.81)	0.97 (0.24-3.01)
Three times and more	REF	REF

CONT – indicates variables considered as continuous for the purpose of regression calculation; REF – reference value

Discussion

There are several most important findings of this investigation. First, prevalence of PDB in swimmers was within expected values. Next, male swimmers were found to be more prone to PDB than were females. Additionally, opinions about doping presence in swimming were not associated with athletes' doping susceptibility. Finally, several factors related to CS&TM were associated with PDB. Therefore, results support our initial hypothesis on significant association between CS&TM variables and PDB.

The prevalence of PDB in the swimmers was within the expected values, mostly because a previous study showed similar figures with regard to the tendency toward PDB in similar-level swimmers from Croatia (Sajber et al., 2013). Although the comparison between the current study and the previous Croatian study is biased to some extent (i.e., the studies observed swimmers from different countries), it seems that the trend of positive PDB increased slightly (i.e. 80% and 75% swimmers who declared negative-PDB in Croatia and Slovenia, respectively). However, increased percentage of swimmers with positive

Table 4. Multinomial regression results for potential doping behavior (PDB) with negative PDB as reference value - variables of coaching strategy and training methodology (OR – Odds Ratio; CI – Confidence Interval).

	POSITIVE PDB OR (95%CI)	NEUTRAL PDB OR (95%CI)
GENERAL OPINION ABOUT TRAINING * #		
Technique is an important part of my training	1.06 (0.32-5.12)	0.45 (0.12-0.78)
Training is monotonous and lacks diversity	1.82 (1.41-5.11)	1. 55 (0.65-7.39)
Training is mostly oriented toward volume	2.76 (1.11-7.12)	1. 64 (1.09-3.12)
INTENSITY HIGH WHEN I HAVE TO SWIM … #		
… >6 km per session	2.17 (0.51-9.32)	1.47 (0.44-4.98)
… >2 km in one sequence	0.19 (0.04-1.04)	0.49 (0.09-2.78)
… repeated sets of maximal intensity	2.43 (0.59-10.10)	2.31 (0.66-8.15)
… different relays while being highly focused on stroke-technique, -speed, and -force	0.18 (0.02-0.62)	0.86 (0.25-2.96)
… sets I have never/rarely performed before	0.89 (0.09-8.56)	0.38 (0.09-1.75)
Intensity is high but with no specific reason	0.25 (0.02-3.31)	0.09 (0.01-0.65)
COACHING STRATEGY #		
Coach frequently explains the training aims	0.21 (0.04-0.81)	0.1 (0.01-0.67)
Coach overviews and discuss the quality of (my) execution of specific tasks	0.41 (0.02-0.81)	0.19 (0.11-0.98)
Coach is very strict and rigid	0.98 (0.04-7.11)	1.05 (0.09-3.65)
Discipline is an important part of our training regime	1.41 (0.23-9.80)	1.98 (0.41-7.18)
Coach pushes me very hard	0.89 (0.11-6.85)	0.45 (0.02-5.14)
Sometimes, I don't know what does the Coach wants me to do in training	1.31 (0.98-1.99)	1.67 (1.01-4.21)
VOLUME OF TRAINING ^{CONT}	1.03 (0.65-1.66)	0.71 (0.45-1.12)
TECHNIQUE (APPROXIMATION) ^{CONT}	0.14 (0.03-0.96)	0.12 (0.01-0.81)

# indicates variables answered on "yes-no" scale where "no" was set as reference value, * indicates variables with multiple possible answers: ^{CONT} – indicates variables considered as continuous for the purpose of regression calculation.

PDB could be a result of the recent doping scandals in domestic swimming and a consequent (higher) belief in the high doping prevalence in swimming, which also resulted in an increased positive PDB.

Our results showed a higher doping tendency in male swimmers. The differences between males and females with regard to doping attitudes and doping tendencies were already studied. Some epidemiological data suggest higher doping prevalence in male athletes, which could indirectly demonstrate higher positive doping tendencies in males (Nicholls et al., 2017; Zaletel et al., 2015). However, higher doping susceptibility in males was not always supported in studies where specific samples of athletes were investigated. For example, although males were more prone to PDB in basketball and handball, no significant gender differences toward PDB were established for volleyball and soccer (Sekulic et al., 2016). Similarly, gender was not associated to PDB in kick-boxing (Sekulic et al., 2017), and attitudes toward doping among athletes involved in different sports (Zucchetti et al., 2015). Even more, a recent study reported female soccer players as being at a higher risk for PDB than their male peers (Zvan et al., 2017). Meanwhile, this is one of the first studies to examine gender-differences in PDB for swimming. As a result, it seems that for the studied country and sport, male gender should be recognized as a risk factor for PDB.

Studies regularly found higher doping susceptibility in those athletes who perceive their sport as being doping-contaminated (Furjan Mandic et al., 2013; Kondric et al., 2013; Sekulic et al., 2014; Sekulic et al., 2016), and these findings have been elegantly explained by the socio-psychological theory of self-categorization (Oakes and Turner, 1986). In short, it is generally known that people adopt the norms, beliefs and behaviors of "their group" (Page et al., 2015). Consequently, if athletes perceive their sport as being doping-contaminated, it is more likely that he/she will engage in doping in the future (Rodek et al., 2009; Wiefferink et al., 2008). Meanwhile, our results showed a non-significant association between athletes' opinions about doping presence in swimming and their PDB. Interestingly, this finding is in accordance with only study which examined this problem in swimmers (Sajber et al., 2013). It is important to note that none of the swimmers declare that "swimming is doping-free sport", while only approximately 5% of the swimmers stated were "not sure about doping presence in swimming", and these results may be observed as plausible because almost identical values were reported for Croatian swimmers several years ago (Sajber et al., 2013).

Our results showed several significant relationships between the variables explaining CS&TM and PDB. Since the discussion for each pair of established associations will extensively broaden this discussion, we have tried to cluster the variables that were correlated with PDB and discuss them accordingly. The first cluster points to a specific relationship between athletes' perception of characteristics of their training (i.e., training methodology) with doping susceptibility. Briefly, swimmers were generally more susceptible to doping if they perceived that their training is: monotonous, strictly oriented toward volume, and lacked work on improvement and mastering of the swimming technique.

Basically, training volume, intensity, and load are modulated to improve an athlete's metabolic capacities, which consequently lead to better performance such as better endurance- , and/or sprinting-capacity (Bompa and Haff, 2009; Drew and Finch, 2016; Toubekis et al., 2013). The performance-enhancing substances, including doping substances, are frequently used to enhance recovery of the metabolic demands of training and competition (Bahrke and Yesalis, 2002). Therefore, the athletes' perception of a high training-volume and -load indirectly implies high

metabolic demands of training, which altogether in our study result in doping vulnerability. On the other hand, self-estimated intensity of training is not found as significantly related to PDB, although this training parameter also influence overall training load. Although the profound interpretation of such relative inconsistency (i.e. training volume is "positively correlated", while training intensity is not correlated to PDB) exceeds the aims and design of this study, the following explanation can be offered.

One of the most important issues in sport training is a problem of overtraining. Overtraining can be defined as an accumulation of training and/or non-training stress resulting in long-term decrement in performance capacity with or without related physiological and psychological signs and symptoms (Halson and Jeukendrup, 2004). In general, two types of overtraining are recognized: parasympathetic-, and sympathetic-overtraining. The first one (parasympathetic) is related to accumulation of training with high volume, and includes heavy fatigue, insomnia, no libido, chronic tiredness, low motivation, low resting heart rate, and low blood pressure. The second one (sympathetic) is mostly induced by training intensity and characterized by high levels of stress hormones (cortisol), and results in irritability, restlessness, poor sleep, weight loss, poor performance, and low libido. In swimming, volume is basically modified throughout swam distance (i.e. the longer is the distance - the higher is the volume). Meanwhile, intensity can be regulated by various mechanisms (e.g. stroke, specific exercises, sets vs. rests). Supportively, volume of training is already found to be associated to overtraining in swimming, with positive correlation between swam distance and psychological indicators of overtraining (Pierce Jr, 2002). Therefore, here evidenced association between self-evidenced training volume and PDB can be at least partially described on a basis of such influence (i.e. higher volume increases the risk of overtraining and consequently increases the risk for PDB).

The mastering of the sport-specific technique improves an athlete's sport-related skills (Bompa and Haff, 2009; Marinho et al., 2010). In swimming, this is mostly related to improvement of the stroke-technique, which is particularly beneficial with regard to long-term development and possibility of improvement in swimming results in later stages of sport career (Colwin, 2014). The fact that those who were susceptible to doping also reported that "less attention is paid to swimming technique" corresponds to a correlation between high volume and PDB, and indicates high doping susceptibility in those swimmers who were involved in training of high metabolic demands, which is discussed in previous paragraphs.

The second cluster of CS&TM variables correlated to PDB, consisted of variables related to coaching strategy. The coaching style is recognized as being an important determinant of athletes' behavior, including athletes' doping vulnerability (Barkoukis et al., 2013; Lonsdale et al., 2017). Investigators repeatedly evidenced coaching behavior (autonomy supportive vs. controlling) and contextual climate, and evaluated its influence on athletes' doping attitudes (Chen et al., 2017; Hodge and Lonsdale, 2011). However, to the best of our knowledge, this is the first investigation where variables of coaching strategy were studied as possible determinants of doping susceptibility in athletes.

Briefly, variables explaining coaching strategy that were found to be associated with a positive doping attitude underlined the athletes' perception on coaches' indifference and nonchalance in regards to the athletes' performance (i.e., coach does not explain training aims, coach does not overview the quality of work). Swimmers who experienced this type of coaching style were discontent and, consequently, were more prone toward PDB in the future. Although the explained causality is hypothetical to some extent, it is indirectly confirmed by the established relationship between achieved competitive results and doping attitude. Briefly, those swimmers with lower competitive achievement were more prone toward PDB, which is consistent with previous reports, in which similar correlations were observed in other sports (Furjan Mandic et al., 2013; Kondric et al., 2010; Sekulic et al., 2014).

One can argue that the previously described associations between CS&TM and PDB can be generated by "objective" or "subjective" perceptions. In other words, it is questionable whether specific characteristics of CS&TM truly occurred, or the athlete just subjectively perceived it as apparent. Indeed, while it is possible that the training and coaching truly were as judged by the athletes (i.e., "… strictly oriented toward volume and load", "… lacked diversity"), it is also possible that athletes did not objectively evaluate CS&TM either because they lacked motivation, or they were not satisfied with the achieved results. Indeed, future studies should explore this dilemma more profoundly. However, regardless of the true origin of perception, it is clear that athletes' opinions on CS&TM are related to their doping attitudes, and therefore these variables deserve attention as covariates of potential doping behavior.

Limitations

Although the study was designed as anonymous, there is a certain possibility that athletes could lean toward socially desirable answers. However, we believe that the study design and our experience from previous studies decreased this possibility. Also, we studied "doping intentions", and not "doping usage", and therefore we may not speak about protective- and/or risk-factors without any doubt. Finally, although study involved large percentage of high-level swimmers (all senior age participants of the National Championship), the relatively small sample (i.e. less of 100 swimmers) should be emphasized as a certain limitation of this investigation. Namely, the number of subjects, together with multinomial statistical design (i.e. athletes were grouped into three clusters on a basis of PDB), probably decreased the possibility of reaching the appropriate statistical significance of some associations.

Conclusions

This study confirmed previous figures on the large percentage of swimmers who were convinced of the doping presence in their sport. Additionally, there is evidence that the tendency toward PDB in swimming has increased over the last several years. However, for a more profound analysis

of this problem, longitudinal studies on athletes from the same country are needed. The results of this study support previous findings from swimming, where personal belief about doping presence in the sport was not found to be correlated with PDB in swimmers.

This study highlighted specific associations between CS&TM variables and PDB, with the following athletes being more susceptible to doping: (i) those who perceived their training as being mostly oriented toward training-volume (and not swimming technique) and (ii) those who perceived their coach as being indifferent to the evaluation of training goals and athletes' achievement. While this is one of the first studies to observe CS&TM as possible covariates of PDB and to find several consistent associations explaining specific relationships among the variables, a similar approach is warranted in other sports.

Acknowledgements

Authors are particularly grateful to all athletes for their voluntary participation in study. The authors have no conflict of interest. The reported experiments comply with the current laws of the country in which they were performed.

References

Backhouse, S.H. and McKenna, J. (2012) Reviewing coaches' knowledge, attitudes and beliefs regarding doping in sport. *International Journal of Sports Science & Coaching* **7**, 167-175.

Bahrke, M.S. and Yesalis, C. (2002) Performance-enhancing Substances in Sport and Exercise. Human Kinetics, Champaign, Ill

Barkoukis, V., Lazuras, L., Tsorbatzoudis, H. and Rodafinos, A. (2013) Motivational and social cognitive predictors of doping intentions in elite sports: an integrated approach. *Scandinavian Journal of Medicine and Science in Sports* **23**, e330-40.

Bompa, T.O. and Haff, G. (2009) *Periodization: Theory and Methodology of Training*. Human Kinetics, Champaign, Ill

Chan, D.K., Dimmock, J.A., Donovan, R.J., Hardcastle, S., Lentillon-Kaestner, V. and Hagger, M.S. (2015) Self-determined motivation in sport predicts anti-doping motivation and intention: a perspective from the trans-contextual model. *Journal of Science and Medicine in Sport* **18**, 315-322.

Chen, Z.S., Wang, D., Wang, K. and Huang, T. (2017) Coaching style and attitudes toward doping in Chinese athletes: The mediating role of moral disengagement. *International Journal of Sports Science & Coaching* **12**, 312-318.

Colwin, C.M. (2014) *Breakthrough Swimming*. Human Kinetics. Champaign, Ill

Drew, M.K. and Finch, C.F. (2016) The Relationship Between Training Load and Injury, Illness and Soreness: A Systematic and Literature Review. *Sports Medicine* **46**, 861-883.

Furjan Mandic, G., Peric, M., Krzelj, L., Stankovic, S. and Zenic, N. (2013) Sports Nutrition and Doping Factors in Synchronized Swimming: Parallel Analysis among Athletes and Coaches. *Journal of Sports Science and Medicine* **12**, 753-760.

Halson, S.L. and Jeukendrup, A.E. (2004) Does overtraining exist? *Sports Medicine* **34**, 967-981.

Hodge, K., Hargreaves, E.A., Gerrard, D. and Lonsdale, C. (2013) Pschological mechanisms underlying doping attitudes in sport: motivation and moral disengagement. *Journal of Sport and Exercise Psychology* **35**, 419-432.

Hodge, K. and Lonsdale, C. (2011) Prosocial and antisocial behavior in sport: the role of coaching style, autonomous vs. controlled motivation, and moral disengagement. *Journal of Sport and Exercise Psychology* **33**, 527-447.

Honour, J.W. (2016) Doping in sport: consequences for health, clinicians and laboratories. *Annals of Clinical Biochemistry* **53**, 189-190.

Kisaalita, N.R. and Robinson, M.E. (2014) Attitudes and motivations of competitive cyclists regarding use of banned and legal performance enhancers. *Journal of Sports Science and Medicine* **13**, 44-50.

Kiss, A., Lucio, M., Fildier, A., Buisson, C., Schmitt-Kopplin, P. and Cren-Olive, C. (2013) Doping control using high and ultra-high resolution mass spectrometry based non-targeted metabolomics-a case study of salbutamol and budesonide abuse. *PLoS One* **8**, e74584.

Kondric, M., Sekulic, D. and Mandic, G.F. (2010) Substance use and misuse among Slovenian table tennis players. *Substance Use & Misuse* **45**, 543-553.

Kondric, M., Sekulic, D., Petroczi, A., Ostojic, L., Rodek, J. and Ostojic, Z. (2011) Is there a danger for myopia in anti-doping education? Comparative analysis of substance use and misuse in Olympic racket sports calls for a broader approach. *Substance Abuse Treatment Prevention and Policy* **6**, 27.

Kondric, M., Sekulic, D., Uljevic, O., Gabrilo, G. and Zvan, M. (2013) Sport nutrition and doping in tennis: an analysis of athletes' attitudes and knowledge. *Journal of Sports Science and Medicine* **12**, 290-297.

Lentillon-Kaestner, V. and Ohl, F. (2011) Can we measure accurately the prevalence of doping? *Scandinavian Journal of Medicine and Science in Sports* **21**, e132-42.

Lerner, R.M., Hershberg, R.M., Hilliard, L.J. and Johnson, S.K. (2015) Concepts and Theories of Human Development. In: *Developmental Science: an Advanced Textbook*. Eds: Marc H. Bornstein and Michael E. Lamb. 7th edition. New York, NY: Psychology Press.

Lonsdale, C., Lester, A., Owen, K.B., White, R.L., Peralta, L., Kirwan, M., Diallo, T.M.O., Maeder, A.J., Bennie, A., MacMillan, F., Kolt, G.S., Ntoumanis, N., Gore, J.M., Cerin, E., Cliff, D.P. and Lubans, D.R. (2017) An internet-supported school physical activity intervention in low socioeconomic status communities: results from the Activity and Motivation in Physical Education (AMPED) cluster randomised controlled trial. *British Journal of Sports Medicine*, Oct 9.

Ljungqvist, A. (2014) The fight against doping is a fight for the protection of the clean athlete, the health of the athlete and the integrity of sport. *British Journal of Sports Medicine* **48**, 799.

Ljungqvist, A., Horta, L. and Wadler, G. (2008) Doping: world agency sets standards to promote fair play. *Nature* **455**, 1176.

Malm, C.B., Khoo, N.S., Granlund, I., Lindstedt, E. and Hult, A. (2016) Autologous Doping with Cryopreserved Red Blood Cells - Effects on Physical Performance and Detection by Multivariate Statistics. *PLoS One* **11**, e0156157.

Marinho, D.A., Barbosa, T.M., Costa, M.J., Figueiredo, C., Reis, V.M., Silva, A.J. and Marques, M.C. (2010) Can 8-weeks of Training Affect Active Drag in Young Swimmers? *Journal of Sports Science and Medicine* **9**, 71-78.

Matosic, D., Ntoumanis, N., Boardley, I.D., Stenling, A. and Sedikides, C. (2016) Linking Narcissism, Motivation, and Doping Attitudes in Sport: A Multilevel Investigation Involving Coaches and Athletes. *Journal of Sport and Exercise Psychology* **38**, 556-566.

Mazanov, J., Huybers, T. and Connor, J. (2012) Prioritising health in anti-doping: what Australians think. *Journal of Science and Medicine in Sport* **15**, 381-385

Morente-Sanchez, J., Femia-Marzo, P. and Zabala, M. (2014) Cross-cultural adaptation and validation of the Spanish version of the performance enhancement attitude scale (Petroczi). *Journal of Sports Science and Medicine* **13**, 430-438.

Morente-Sanchez, J., Mateo-March, M. and Zabala, M. (2013) Attitudes towards doping and related experience in Spanish national cycling teams according to different Olympic disciplines. *PLoS One* **8**, e70999.

Nicholls, A.R., Cope, E., Bailey, R., Koenen, K., Dumon, D., Theodorou, N.C., Chanal, B., Saint Laurent, D., Muller, D., Andres, M.P., Kristensen, A.H., Thompson, M.A., Baumann, W. and Laurent, J.F. (2017) Children's First Experience of Taking Anabolic-Androgenic Steroids can Occur before Their 10th Birthday: A Systematic Review Identifying 9 Factors That Predicted Doping among Young People. *Frontiers in Psychology* **8**, 1015.

Ntoumanis, N., Barkoukis, V., Gucciardi, D.F. and Chan, D.K.C. (2017) Linking Coach Interpersonal Style With Athlete Doping Intentions and Doping Use: A Prospective Study. *Journal of Sport and Exercise Psychology* **39**, 188-198.

Oakes, P.J. and Turner, J.C. (1986) The significance of the social identity concept for social-psychology with reference to individualism, interactionism and social-influence - rejoinder. *British Journal of Social Psychology* **25**, 257-258.

Page, E., Shute, R. and McLachlan, A. (2015) A self-categorization theory perspective on adolescent boys' sexual bullying of girls.

Journal of Interpersonal Violence **30**, 371-383.
Pierce Jr, E.F. (2002) Relationship between training volume and mood states in competitive swimmers during a 24-week season. *Perceptual and Motor Skills* **94**, 1009-1012.
Rodek, J., Idrizovic, K., Zenic, N., Perasovic, B. and Kondric, M. (2013) Differential analysis of the doping behaviour templates in three types of sports. *Collegium Antropologicum* **37**, 211-217.
Rodek, J., Sekulic, D. and Pasalic, E. (2009) Can we consider religiousness as a protective factor against doping behavior in sport? *Journal of Religion & Health* 48, 445-453.
Sajber, D., Rodek, J., Escalante, Y., Olujic, D. and Sekulic, D. (2013) Sport nutrition and doping factors in swimming; parallel analysis among athletes and coaches. *Collegium Antropologicum* **37 Suppl 2**, 179-186.
Sekulic, D., Bjelanovic, L., Pehar, M., Pelivan, K. and Zenic, N. (2014) Substance use and misuse and potential doping behaviour in rugby union players. *Research in Sports Medicine* **22**, 226-39.
Sekulic, D., Tahiraj, E., Zvan, M., Zenic, N., Uljevic, O. and Lesnik, B. (2016) Doping attitudes and covariates of potential doping behaviour in high-level team-sport athletes; gender specific analysis. *Journal of Sports Science and Medicine* **15**, 606-615.
Sekulic, D., Zenic, N., Versic, S., Maric, D., Gabrilo, G. and Jelicic, M. (2017) The Prevalence and Covariates of Potential Doping Behavior in Kickboxing; Analysis among High-Level Athletes. *Journal of Human Kinetics* **59**, 67-77.
Toubekis, A.G., Drosou, E., Gourgoulis, V., Thomaidis, S., Douda, H. and Tokmakidis, S.P. (2013) Competitive performance, training load and physiological responses during tapering in young swimmers. *Journal of Human Kinetics* **38**, 125-134.
Wiefferink, C.H., Detmar, S.B., Coumans, B., Vogels, T. and Paulussen, T.G. (2008) Social psychological determinants of the use of performance-enhancing drugs by gym users. *Health Education Research* **23**, 70-80.
Zaletel, P., Versic, S., Peric, M., Zenic, N., Sekulic, D. and Kondric, M. (2015) Toward (more) effective antidoping policy in sports: what should we target in antidoping efforts? *Medicina Dello Sport* **68**, 447-460.
Zenic, N., Peric, M., Zubcevic, N.G., Ostojic, Z. and Ostojic, L. (2010) Comparative analysis of substance use in ballet, dance sport, and synchronized swimming: results of a longitudinal study. *Medical Problems of Performing Artists* **25**, 75-81.
Zucchetti, G., Candela, F. and Villosio, C. (2015) Psychological and social correlates of doping attitudes among Italian athletes. *International Journal of Drug Policy* **26**, 162-168.
Zvan, M., Zenic, N., Sekulic, D., Cubela, M. and Lesnik, B. (2017) Gender- and Sport-Specific Associations Between Religiousness and Doping Behavior in High-Level Team Sports. *Journal of Religion & Health* **56**, 1348-1360.

Key points

- The opinions about doping presence in swimming were not associated with athletes' doping susceptibility, but a higher doping tendency is found in male swimmers
- Swimmers were generally more susceptible to doping if they perceived that their training lacked work on improvement and mastering of the swimming technique
- Those swimmers who are more prone to doping frequently stated that their coach did not provide the necessary attention to explain the training aims, and did not sufficiently review and discuss the quality of the athlete's execution of specific tasks
- Results highlight importance of coaching strategy and training methodology as possible covariates of doping susceptibility in sports.

AUTHOR BIOGRAPHY

Silvester LIPOSEK
Employment
University of Maribor, Maribor, Slovenia
Degree
MSc; PhD Candidate
Research interests
Swimming, Doping in sport
E-mail: silvester.liposek@um.si

Natasa ZENIC
Employment
Full Professor. Faculty of Kinesiology, University of Split, Croatia.
Degree
PhD
Research interests
Test construction and validation, Swimming, Substance Use and Misuse
E-mail: natasazenic@yahoo.com

Jose M SAAVEDRA
Employment
Professor, Reykjavik University, Reykjavik, Iceland
Degree
PhD
Research interests
Swimming, Health related issues in sport and exercise, Water polo, Handball
E-mail: saavedra@ru.is

Damir SEKULIC
Employment
Professor. Faculty of Kinesiology, University of Split, Croatia.
Degree
PhD
Research interests
Substance use and misuse in sport and exercise, Test construction and validation, Strength and Conditioning,
E-mail: dado@kifst.hr

Jelena RODEK
Employment
Assistant Professor. Faculty of Kinesiology, University of Split, Croatia.
Degree
PhD
Research interests
Substance use and misuse in sport and exercise, Sociology of sport and exercise
E-mail: jelena.rodek@kifst.hr

Miha MARINSEK
Employment
Associate Professor, University of Maribor, Slovenia
Degree
PhD
Research interests
Teaching and pedagogics in sport and physical education
E-mail: miha.marinsek@um.si

Dorica SAJBER
Employment
Assistant Professor, Faculty of Sport, University of Ljubljana, Slovenia.
Degree
PhD
Research interests
Substance use and misuse in sport and exercise, Swimming
E-mail: dorica.sajber@fsp.uni-lj.si

✉ **Natasa Zenic**
University of Split, Faculty of Kinesiology, Teslina 6, Split – 21000, Croatia