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SHORT COMMUNICATION

Analgesics use in competitive triathletes: its relationship to doping and on predicting its usage

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ABSTRACT

The two major objectives of this study were (i) to assess variables that predict the use of analgesics in competitive athletes and (ii) to test whether the use of analgesics is associated with the use of doping. A questionnaire primarily addressing the use of analgesics and doping was distributed among 2,997 triathletes. Binary logistic regression analysis was performed to predict the use of analgesics. Moreover, the randomised response technique (RRT) was used to estimate the prevalence of doping in order to assess whether users of analgesics have a higher potential risk for doping than non-users. Statistical power analyses were performed to determine sample size. The bootstrap method was used to assess the statistical significance of the prevalence difference for doping between users and non-users of analgesics. Four variables from a pool of 16 variables were identified that predict the use of analgesics. These were: "version of questionnaire (English)", "gender (female)", "behaviour in case of pain (continue training)", and "hours of training per week (>12 h/week)". The 12-month prevalence estimate for the use of doping substances (overall estimate 13.0%) was significantly higher in athletes that used analgesics (20.4%) than in those athletes who did not use analgesics (12.4%). The results of this study revealed that athletes who use analgesics prior to competition may be especially prone to using doping substances. The predictors of analgesic use found in the study may be of importance to prepare education material and prevention models against the misuse of drugs in athletes.

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Gateway; triathlon; epidemiology; doping; statistics

Introduction

According to several epidemiological studies, the use of doping substances – substances which are prohibited by the World Anti-Doping Agency (WADA) and which are assumed to enhance physical performance (e.g., anabolic steroid hormones, EPO, growth hormones, amphetamines) – has been reported to be common practise among competitive athletes (Dietz et al., 2013b; Striegel, Ulrich, & Simon, 2010). Further studies showed that non-prohibited physical performance-enhancing substances, such as nutritional supplements (NS), provide a gateway for using doping substances (Backhouse, Whitaker, & Petroczi, 2013). Additionally, the use of non-steroidal anti-inflammatory drugs (NSAIDs), including over-the-counter (OTC) analgesics, directly before a competition, has also been reported to be common use among endurance athletes such as marathon runners (Almond et al., 2005; Kuster, Renner, Oppel, Niederweis, & Brune, 2013) and triathletes (Gorski et al., 2011). Dominant motives for using analgesics in athletes are for reducing muscle pain during and following competition, and also improving physical performance. This is despite the fact that studies concerning the potential effects of analgesics use during competition on performance and muscle pain deliver inconsistent results. For example, Nieman et al. (2006) showed, in a controlled trial in 54 competitive runners, that the use of high dosages of ibuprofen prior to- and during-competition do not positively affect subjective muscle pain nor race time.

As the use of analgesics in endurance sports seems to be prevalent and frequently associated with several adverse events (e.g., cardiovascular, renal, and gastrointestinal) (Almond et al., 2005; Gorski et al., 2011; Kuster et al., 2013), sport would benefit from prevention models and education material that reflect these issues properly. However, so far little is known about the aspects associated with misuse of analgesics. Therefore, the aim of this study was to assess variables that predict the use of analgesics. Additionally, the potential of analgesics use to provide a gateway to doping, as described above for NS, has not been evaluated so far. We hypothesise that the use of analgesics prior to competition is associated with the use of doping substances or, in other words, that athletes who use analgesics prior to competition may be especially prone to using doping substances. Therefore, we addressed both the predictor variables for the use of analgesics and the prevalence of doping in triathletes with present use of analgesics by retrospectively analysing the data from a large survey about the prevalence of doping in triathletes (Dietz et al., 2013b) using the randomised response technique (RRT). The RRT (Dietz et al., 2013a; Franke et al., 2013) is an indirect survey technique which allows for obtaining more

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valid prevalence estimates for socially sensitive issues, whilst assuring the participants a maximum degree of anonymity. In addition, the RRT enabled us to assess separate doping estimates for users and non-users of analgesics.

Methods

In the year 2011, a survey concerning the use of performance enhancing substances was distributed to a sample of 2,997 competitive triathletes at the race offices of three triathlon-competitions in Germany (Ironman European Championship Frankfurt, Ironman European Championship 70.3 Wiesbaden, and Ironman Regensburg). Training characteristics and biographical data were also obtained. A total of 2,987 long- and half-distance triathletes (response rate 99.7%) returned the anonymous questionnaire and 2,975 participants (99.3%) provided a valid response to the question whether they "currently take analgesics (e.g., Diclofenac, Voltaren, Paracetamol. ASS, etc.)" (yes/no). The randomised response technique (RRT) was used to obtain separate doping estimates for users (yes) as well as for non-users (no) of analgesics. Statistical power analyses (Ulrich, Schröter, Striegel, & Simon, 2012) were performed a priori to determine sample size. The bootstrap method (Efron & Gong, 1983) was used to compute the statistical significance of the prevalence difference for doping between users and non-users of analgesics. The sampling distribution of this difference was based on 100,000 bootstrap samples. In total, 2,702 (90.5%) of the 2,987 surveyed participants provided valid answers to the RRT part of the questionnaire concerning doping. Within the whole questionnaire, the term doping was deliberately avoided. Instead, the term "substances to enhance physical performance that you can only receive at a pharmacy, a physician, or on the black market (e.g., anabolic steroid hormones, EPO, growth hormones, amphetamines)" was used. In a first step of data analysis, 16 variables of the questionnaire were analysed concerning their influence on the dependent variable "analgesics use": variables were (1) gender (male/female), (2) A-level – final qualification for university entrance (yes/no), (3) do you train with a structured training plan (yes/no), (4) behaviour in case of pain during training (continue/take a pause), (5) 12-month prevalence for the use of legal and freely available substances for physical enhancement (yes/no), (6) version of the questionnaire (German/English), (7) and location of the competition. Metric scaled variables were dichotomized. These were (8) age, (9) height, (10) weight, (11) body-mass-index (BMI), (12) years of training, (13) hours of training per week and kilometres per week, (14) swimming, (15) cycling and (16) running (Dietz et al., 2013b). Continuous variables were analysed using the non-parametric Mann–Whitney-U test and categorical variables using Pearson's Chi-square test. *P*-values were corrected by the method of Bonferroni–Holm (Table 1). In a second step, variables that were significantly different between those athletes that reported the use of analgesics and those that did not report the use of analgesics were included into a binary logistic regression to predict the use of analgesics. Statistical analyses were carried out using SPSS for Windows 19.0 and MATLAB 2010. Ethical approval to conduct this study was obtained by the Eberhard Karls University of Tuebingen Ethics Committee. By filling in the questionnaire, the athletes gave informed consent to participate in the survey.

Results

Most of the participants (N = 2,987) were male (87.3%), the mean age was 39.5 ± 9.2 years and 65.3% (N = 1,956) completed the German version of the questionnaire. Of the 2,975 athletes who answered the question concerning analgesics use, 273 athletes (9.2%) answered with "yes". Binary regression using backward elimination identified four independent variables that predicted the use of analgesics. For this model, the area under the receiver operating characteristics (ROC) curve was 66.8%. According to this analysis, athletes who filled in the English version of the questionnaire ($P < 0.001$), female athletes ($P = 0.032$), athletes who continue training in case of pain during training ($P < 0.001$), and athletes who trained more than 12 h/week ($P = 0.015$) had a higher potential relative risk to use analgesics (Table 2). The 12-month prevalence estimate for doping assessed with RRT was 20.4% in athletes who answered "yes" to having used analgesics and 12.4% in athletes who answered "no" to having used analgesics (Table 3). Bootstrapping revealed that this difference of 8.0% (SE = 4.6%) was significantly larger than zero, $P = 0.039$.

Discussion and conclusion

The present survey identified four variables that can predict the use of analgesics (Table 2). Female athletes, athletes completing the English version of the questionnaire (non-German athletes), athletes who continue training in case of pain during training as well as athletes who train more than 12 h a week have a higher risk of using analgesics. In agreement with the present results are the findings of Almond et al. (2005) as well as Kuster et al. (2013) who surveyed recreational marathon runners (Boston marathon 2002 and Bonn marathon 2010, respectively) and found that female athletes used analgesics more frequently than males. In addition, Brewer et al. (2014) showed that female athletes are significantly more likely to use analgesics for the relief of exercise-associated pain than male athletes. Whether this is because of a well-known higher frequency of pain medication in pre-menopausal women in general, or because of any sports specific issues, remains to be elucidated.

Furthermore, athletes that may show a higher achievement-orientation (train more hours per week, continue training in case of pain) had a higher relative risk for using analgesics. In contrast, Brewer et al. (2014), who also used logistic regression analyses to predict analgesics use in recreationally trained college-aged students, showed that "length of time performing exercise" and "frequency of exercise" did not significantly predicted analgesics use. However, all collegiate athletes and military personnel were excluded from participation in their survey because of their advanced training status. Thus, one reason explaining the difference between their findings and ours may be because their collective (30% do regular exercise less than six times per month) is not as

Table 1. Associations between the dependent variable "analgesics use" and each predictor variable.

	Analgesics use		
	Yes	No	*P-value*
Location			[a]**0.011***
Frankfurt	N = 110 (3.7%) **rel. 11.8%**	N = 821 (27.6%) **rel. 88.2%**	
Regensburg	N = 87 (2.9%) **rel. 9.0%**	N = 881 (29.6%) **rel. 91.0%**	
Wiesbaden	N = 76 (2.6%) **rel. 7.1%**	N = 1000 (33.6%) **rel. 92.9%**	
Questionnaire			[a]**0.000*****
German	N = 125 (4.2%) **rel. 6.4%**	N = 1823 (61.3%) **rel. 93.6%**	
English	N = 148 (5.0%) **rel. 14.4%**	N = 879 (29.5%) **rel. 85.6%**	
Gender			[a]**0.040***
Female	N = 49 (1.7%) **rel. 13.2%**	N = 323 (11.0%) **rel. 86.8%**	
Male	N = 221 (7.5%) **rel. 8.6%**	N = 2348 (79.8%) **rel. 91.4%**	
A-level			[a]**ns**
Yes	N = 167 (6.3%) **rel. 9.6%**	N = 1572 (59.1%) **rel. 90.4%**	
No	N = 67 (2.5%) **rel. 7.3%**	N = 852 (32.1%) **rel. 92.7%**	
Training plan			[a]**0.010***
Yes	N = 204 (6.9%) **rel. 10.5%**	N = 1742 (58.7%) **rel. 89.5%**	
No	N = 69 (2.3%) **rel. 6.8%**	N = 953 (32.1%) **rel. 93.2%**	
Behaviour in case of pain			[a]**0.000*****
Continue	N = 152 (5.2%) **rel. 13.3%**	N = 989 (33.7%) **rel. 86.7%**	
Pause	N = 117 (4.0%) **rel. 6.5%**	N = 1675 (57.1%) **rel. 93.5%**	
Physical enhancement			[a]**ns**
Yes	N = 42 (1.5%) **rel. 10.5%**	N = 358 (12.6%) **rel. 89.5%**	
No	N = 214 (7.5%) **rel. 8.8%**	N = 2226 (78.4%) **rel. 91.2%**	
Age, years; median (quartil 25; 75)	40 (33, 46)	40 (32, 45)	[b]**ns**
Height, cm; median (quartil 25; 75)	179 (172, 183)	180 (175, 184)	[b]**ns**
Mass, kg; median (quartil 25; 75)	74 (68, 81)	74 (69, 80)	[b]**ns**
BMI, kg*m^{-2}; median (quartil 25; 75)	23 (22, 25)	23 (22, 24)	[b]**ns**
Years of training, years; median (quartile 25; 75)	6 (4, 10)	7 (4, 13)	[b]**ns**
Hours/week, hours; median (quartil 25; 75)	15 (10, 18)	12 (10, 15)	[b]**0.000*****
Km/week bike, km; median (quartil 25; 75)	200 (120, 250)	185 (120, 250)	[b]**ns**
Km/week running, km; median (quartil 25; 75)	40 (30, 50)	40 (30, 50)	[b]**ns**
Km/week swimming, km; median (quartil 25; 75)	6 (4, 10)	5 (4, 8)	[b]**0.000*****

Levels of significance: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
P-values corrected by the method of Bonferroni–Holm
[a]Pearson´s Chi-square test
[b]Mann–Whitney-U test (when the assumption of normality was violated)
ns: not significant; SD: standard deviation.

Table 2. Odds ratios for the dependent variable "analgesics use" and each predictor variable (stepwise, feed backward elimination).

Predictor	OR (95% CI)
Version of the questionnaire (English)	2.166*** (1.655–2.834)
Gender (female)	1.481* (1.034–2.121)
Behaviour in case of pain (continue training)	1.930*** (1.473–2.527)
Hours of training per week (> 12 h/week)	1.399* (1,067–1.834)

Levels of significance: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$***
CI: confidence interval; OR: odds ratio.

achievement-oriented as the competitive collective of triathletes (mean training hours per week: 13.2 h) surveyed in the present study.

Table 3. Estimated 12-month prevalence for doping ($\hat{\pi}_s$) dependent on analgesics use using the randomised response technique (RRT). SE denotes the standard error of estimate.

Using analgesics prior to competition	"Yes"	"No"	a	$\hat{\pi}_s$	$SE(\hat{\pi}_S)$	95% CI
"Yes"	72	168	0.300	20.4%	4.4%	11.8–29.0
"No"	603	1848	0.246	12.4%	1.3%	9.8–14.9

Interestingly, athletes who completed the English version of the questionnaire (non-German athletes) used analgesics more often than German athletes. This result can be interpreted as evidence that foreign athletes, who completed the English version, are more likely to use analgesics than Germans athletes. But even more plausible, is that athletes, who travel to other countries to compete in a triathlon, and therefore invest more resources (such as time and money) in their sport, are possibly less likely to forgo a race because of pain, and consequently use analgesics more often during competition. Both the Ironman 70.3 in Wiesbaden, as well as the Ironman in Frankfurt, are European Championships where athletes can earn a lot of points for qualification to the World Championships in both distances. This is perhaps an additional argument for achievement-orientation: foreign athletes who travel to the European Championships to earn more points for qualification to the World Championships may be more achievement-oriented and therefore, may be more likely to use analgesics.

Using the RRT, this study showed that athletes who use analgesics prior to competition are more prone to doping than those athletes who do not use analgesics. As we did not ask the participants of our survey which substances they consumed first, analgesics or doping substances, we cannot directly evaluate the gateway hypothesis (Backhouse et al., 2013) that the intake of analgesics promotes the intake of doping substances. However, as OTC analgesics are freely accessible – and are used in many different sports with a high frequency – it seems reasonable to conclude that analgesics were used prior to doping substances and therefore provide a gateway to doping. Similar associations have been reported between the use of NS and doping (Backhouse et al., 2013) as well as between the use of cognitive-enhancing drugs and doping (Dietz et al., 2013b). To verify the gateway hypothesis between analgesics and doping more directly, future surveys need to explicitly ask whether the use of analgesics precedes the use doping substances or vice versa.

As a practical implication of the present findings, we recommend athletes and coaches to handle the consumption of analgesics with care, and only use them for therapeutic reasons instead of pain prevention. In fact, former studies have shown inconsistent results concerning the use of analgesics prior to competition and its effects on preventing muscle pain during and after competition (Almond et al., 2005; Kuster et al., 2013). The present study also implies a potential gateway to doping. Therefore, the four predictor variables presented within the present study may help to plan individual education and prevention material for the use of analgesics in athletes. Similar considerations have been made for the consumption of nutritional supplements (Dietz et al., 2014; Maughan, Depiesse, & Geyer, 2007).

Limitations of the study

One aim of the study was to assess whether the use of analgesics per se (not specific analgesics) is associated with the use of doping substances. Therefore, we did not differentiate within the present survey between specific analgesics that had been used by the athletes. Consequently, we were not able to identify specific analgesics which pose a higher risk. Future studies should consider this aspect and ask for specific analgesics consumption behaviour.

Furthermore, we did not use the doping definition given by the WADA (2015) entitled “doping is the occurrence of one or more of the anti-doping rule violations set forth in Article 2.1 through Article 2.10 of the Code” within our questionnaire. As recreational athletes are not as familiar as professional athletes with the World Anti-Doping Code, and the prohibited-list of the WADA, we explained the definition of doping to the participants of the present survey in a comprehensive fashion. Consequently, the presented doping estimates are not representative for the doping definition of WADA.

It has to be emphasised that the present results are restricted to half- and full-distance competitive triathletes. Therefore, future studies are needed to examine the generalisability of these results for other domains where the use of analgesics has been reported to be common practise (e.g., marathon runners, handball players).

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Disclosure statement

No potential conflict of interest was reported by the authors.

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