Wintermantel J[1], Wachsmuth N[1], Schmidt W[1]

ORIGINALIA

ACCEPTED October 2016
PUBLISHED ONLINE November 2016
DOI 10.5960/dzsm.2016.258

Wintermantel J, Wachsmuth N, Schmidt W. Doping Cases among Elite Athletes from 2000 to 2013. Dtsch Z Sportmed. 2016; 263-269.

Doping Cases among Elite Athletes from 2000 to 2013

Dopingfälle bei Spitzenathleten in den Jahren 2000 bis 2013

Summary

› **Background** The World Anti-Doping Agency (WADA) did not publish the number of anti-doping rule violations (ADRVs) in sports before 2013, leading to a lack of information regarding ADRVs in certain countries and sporting disciplines. The present study aimed to provide an overview of the number and distribution of ADRVs among elite athletes of Olympic sports.

› **Methods** A database of ADRVs was created for Olympic sports between 2000 and 2013 on an Internet search. The inclusion criterion was success of the athlete at the international level. The data were analyzed using descriptive statistics.

› **Results** A total of 1,236 cases were found. The most frequent violations were the use of anabolic substances (>38%), followed by blood doping (15.3%) and stimulant use (14.2%). ADRVs were found in 120 countries; the countries that accounted for most cases were Russia (10.4%), the USA (6.8%), and Italy (4.9%). The most a ected sports were track and eld (29.4%), weightlifting (21.8%), and cycling (13.0%). Related to Olympic disciplines, however, weightlifting was by far in front. Numerous ADRVs were observed among Russian women athletes. The highest numbers of ADRVs in track and eld were committed by athletes from Russia (n=53), the USA (n=37), and Jamaica (n=19). The prevalence of ADRVs among Russian track and eld athletes was 4.1-times higher during Olympic versus non-Olympic years.

› **Conclusion** Targeted and organized doping can be assumed to occur in certain disciplines and countries.

Zusammenfassung

› **Problemstellung** Bis zum Jahr 2013 wurde von der WADA die Anzahl der sanktionierten Dopingbefunde (anti-doping rule violations, ADRVs) nicht veröffentlicht und es konnte somit keine Zuordnung zu bestimmten Ländern und häufig auch nicht zu bestimmten Sportarten erfolgen. Das Ziel der vorliegenden Studie war es, eine Übersicht über die Anzahl und Verteilung von ADRVs bei Weltklasse-Athleten in den olympischen Disziplinen zu erstellen.

› **Methode** Es wurde eine Internet-basierte Recherche durchgeführt und alle sanktionierten Dopingfälle aus den olympischen Sportarten der Jahre 2000 bis 2013 in eine Datenbank eingefügt. Einschlusskriterium war der höchstrangige internationale Erfolg. Es wurde eine rein deskriptive statistische Auswertung durchgeführt.

› **Ergebnisse** Insgesamt wurden 1236 Fälle registriert. Die häufigste Manipulationsart waren anabole Substanzen mit 38% vor Bluttransfusionen (15,3%) und Stimulantien (14,2%). ADRVs wurden in 120 Länder; die bei weitem meisten Fälle (10,4%) traten in Russland auf, gefolgt von den USA (6,8%) und Italien (4,9%). Die am stärksten betro ene Sportart war die Leichtathletik mit 29,4%, gefolgt von Gewichtheben (21,8%) und Radsport (13,0%). Bezogen auf die Anzahl olympischer Disziplinen lag allerdings Gewichtheben bei weitem vorn. Au ällig war der hohe weibliche Anteil in Russland mit 58%. In der Leichtathletik war Russland mit 53 Fällen vertreten vor den USA (37) und Jamaika (19). Die Dopingprävalenz der russischen Leichtathleten war in olympischen Jahren um das 4,1-fache höher als in anderen Jahren.

› **Schlussfolgerungen** Ein zielgerichtetes und organisiertes Doping kann für bestimmte Länder und Sportarten vermutet werden.

1. UNIVERSITY OF BAYREUTH, Department of Sports Medicine and Physiology, Bayreuth

KEY WORDS:
Anti-Doping Rule Violation, Olympic Disciplines, Athletics, Doping Prevalence, Russia

SCHLÜSSELWÖRTER:
Anti-Doping Regelverletzung, Olympische Disziplinen, Leichtathletik, Doping-Prävalenz, Russland

Introduction

Doping is the most serious threat to elite sports because it harms athlete health, decreases equal opportunities for athletes, and leads the argument that the function of athletes is reductio ad absurdum. Therefore, it is surprising that athletes, coaches, officials, politicians and others involved in elite sports groups have not acknowledged the data concerning the prevalence of doping, which has been reported to range between 4.2% and 35% and potentially even above 50% in track and eld in certain countries (2, 4, 5, 6, 7). Additionally, even the World Anti-Doping Agency (WADA) assumes a double-digit percentage of doping incidents (8).

In contrast to the high prevalence of doping, the number of positive anti-doping tests has remained consistently low in the past 30 years, at ›

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CORRESPONDING ADDRESS:
Prof. Dr. Walter Schmidt
University of Bayreuth, Department of Sports Medicine and Physiology
Universitätsstrasse 30
95440 Bayreuth, Germany
✉: walter.schmidt@uni-bayreuth.de

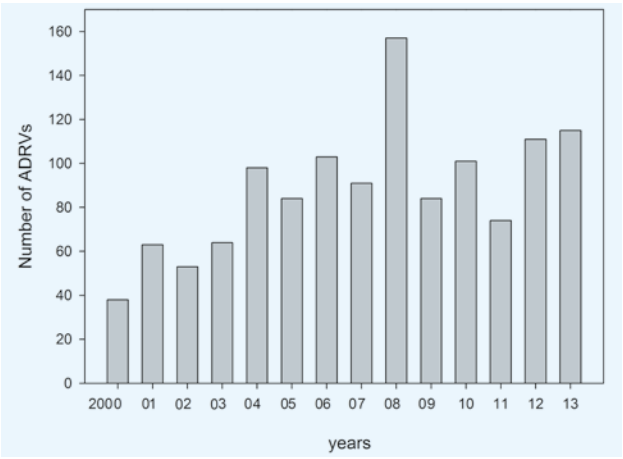

Figure 1

Characteristics of anti-doping rule violations (ADRVs) during the years 2000 until 2013: Number of annual ADRVs.

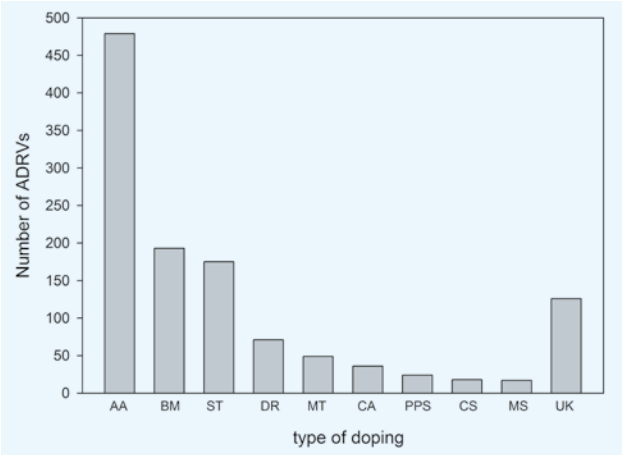

Figure 2

Characteristics of anti-doping rule violations (ADRVs) during the years 2000 until 2013: Type of ADRVs, AA=anabolic agents, BM=blood manipulation, ST=stimulants, DR=diuretics, MT=missed tests, CA=cannabinoids, PPS=possession of prohibited substances, CS=corticosteroids, MS=manipulation of samples, UK=un-known.

approximately 2%. For example, in 2012, 4,723 (1.76%) positive tests were detected out of 267,645 total anti-doping tests (1). Until recently, insufficient detection methods were considered the major reason for the discrepancy between the high prevalence of doping and the relatively low number of positive doping-cases. However, given the exposure of structural doping practices and the involvement of anti-doping laboratories (e.g., in Russia) of federations and of governmental organizations (15), we can suggest that the high prevalence of doping mentioned above is more realistic than the low number of positive doping cases.

To optimize doping tests and prevention measures, it is important to have accurate information on the current state of doping. However, surprisingly few studies have been conducted on doping cases, even for Olympic sports. Before 2013, neither the WADA nor any national anti-doping organization or sports federation published data on doping cases, enabling cross-linked information of doping in specific countries and sporting disciplines. Beginning in 2013, the WADA began publishing a yearly anti-doping rule violation (ADRV, sanctioned doping cases) report (12). The most recent report described 1,693 doping cases, and the highest number of cases occurred in Russia (148 cases), followed by Italy (123 cases), India (96 cases), and Belgium and France (both with 91 cases). The sports with the highest number of doping cases were track and field (207 cases) followed by cycling (168 cases) and weightlifting (143 cases). Germany was on the lower end of the scale, with 20 total cases and only one in track and field (14).

Before 2013, neither cross-linked information on doping cases nor data on doping cases in elite athletes were available. Therefore, the current study aimed to provide an overview of the doping cases in the period between the establishment of the WADA and December 2013. Because the inclusion of all doping cases of athletes competing in Olympic disciplines would exceed the scope of this study, we focused on elite international athletes, as defined below. This study was based on a self-created database of the included doping cases and sought to answer the following questions:

- How many doping cases exist among elite athletes who compete in Olympic disciplines?
- For which countries do these elite athletes compete?
- Is there a relationship between certain Olympic sports and the number of doping cases?
- Which substances and methods are used most often to increase performance?

Methods

Data Acquisition

This study is based on a self-created database that contains information on doping cases that occurred from the establishment of the WADA on November 10, 1999, to December 31, 2013, among elite athletes competing in Olympic sports and Ironman-distance triathlons. Because of the lack of literature on this topic, the data are primarily based on information from international sports federations, official documents from the WADA, reports from national anti-doping agencies, and reliable articles from newspapers and the Internet. First, we searched the Internet for existing doping lists, which were largely found in non-quotable forums. Second, we sought to verify the identified doping cases in quotable literature (e.g., annual reports of individual sports organizations or reliable newspaper articles). We also determined whether the athletes had been successful in a high-profile sporting event during their career. The exact definition of an elite athlete in this study is described below.

We specifically searched for the following information: name, gender, sport, nationality, year of doping offense, sanction, greatest athletic achievement and type of control process. The search included every Olympic sport until 2012 (excluding baseball and softball). We entered the name of the sport-combined with the words “doping”, “drugs”, “doping case”, “doping list”, “sanction”, “doping suspension” or “disqualification” in English, German, French and Spanish into www.google.com, www.bing.com and the search function of international websites and newspapers (e.g., http://espn.go.com/ and http://www.spiegel.de/). When the name of an athlete was found, a search for documents and articles containing that name was conducted using the same method as above.

In addition to the online search described above, international sports federations were contacted, and annual doping reports were requested. Most of the federations did not provide reports because of a lack of documentation regarding their-doping cases. Only the International Swimming Federation (FINA) provided complete detailed lists of the official annual doping cases and offered reports for the last 12 years. The website of the International Weightlifting Federation (IWF) states that all

sanctioned athletes have been documented in annual reports since 2003. In addition, the International Basketball Federation has published all doping cases occurring in basketball since 2007. e recent requirement that sports federations must-report all currently sanctioned athletes facilitated our research for the most recent years. e International Association of Athletics Federations (IAAF), the International Tennis Federation (ITF) and the Union Cycliste Internationale (UCI) provided lists of currently sanctioned athletes.

Characteristics of the Included Athletes

With the exception of Ironman-distance triathletes, only elite athletes competing in Olympic sports were considered in this study. An elite athlete was de ned as an athlete who had achieved one of the following successes at least once in his or her career: placing in the top 20 in the Olympic Games (individual sports), top 15 in the World Championships (individual sports), top 10 in the Olympic Games or World Championships (team sports), top 10 in continental championships, top 10 in the Indoor Track and Field World Championships, top 10 in the World Cup, top 10 in the Big Five (marathon), top 10 in the Ironman Hawaii, top 10 in the general classi cation of the Tour de France/Giro d'Italia/Vuelta a Espana, or top 40 in the tennis world ranking list; being a World Record holder, a Golden League meeting podium nisher, a Commonwealth Games podium nisher, an Ironman triathlon winner, a stage winner in the Tour de France/Giro d'Italia/Vuelta a Espana, a (stage) winner of the World Tour race, a professional boxer, a National Team member in team sports, or a player for a team in the Bundesliga (soccer), Serie A, Premier League, Primera Division, National Basketball Association, Basketball Bundesliga, Liga ACB, Liga Nacional de Basquet, or National Hockey League; and having a record marathon time of under 2:10 h for men and under 2:24 h for women. Any success had to have been accomplished in the male or female elite categories. Junior Championships, the Masters, U23, and other similar events were not considered in this study. e current paper represents approximately 3.5% of all ADRVs between 2000 and 2013 (see discussion).

Types of Violations, Sports Pro les and Classi cation of Doping Cases

For all cases, the type of doping violation was documented, and the cases were classi ed into groups to conduct better comparisons. Group classi cations were based on the WADA Code and consisted of the following groups: Blood manipulation (blood transfusions, erythropoietin use [EPO], or suspicious blood values), anabolic agents, peptide hormones, growth factors, stimulants, cannabinoids, narcotics, agonists, diuretics and other masking agents, missed tests, tampering or attempted tampering with doping control and possession of prohibited substances.

e types of control processes were divided into out-of-competition (OOC) control, in-competition control, ex-post examination of the sample, investigation and confession. For all doping cases, the year of the doping o ense was also investigated, as in some cases, this date di ered from the initiation of the ban. Furthermore, we distinguished between doping o enses during Olympic and non-Olympic years. To compare the extent of the sanctions, the 'consequences' category was divided into the following groups: a ban of less than 6 months, a ban of 6 to 12 months, a ban of 12 to 24 months, a ban of over 24 months, a lifetime ban or a suspension. In addition, we also noted whether an athlete had a second or third recorded violation.

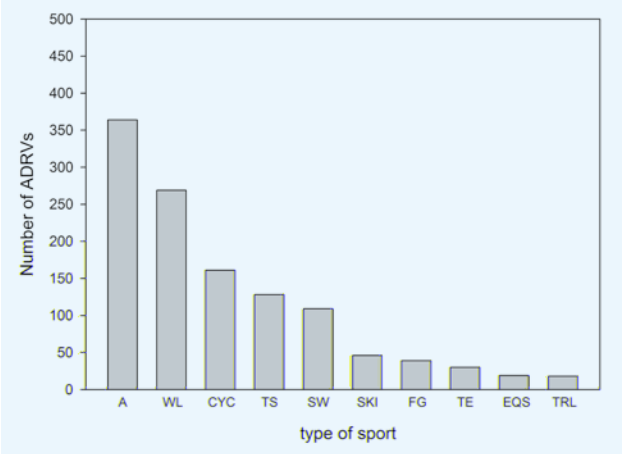

Figure 3

Characteristics of anti-doping rule violations (ADRVs) during the years 2000 until 2013: Sports disciplines most affected by ADRVs, A=athletics, WL=weightlifting, CYC=cycling, TS=team sports, SW=swimming, SKI=skiing, FG= ghting, TE=tennis, EQS=equestrian, TRL=triathlon.

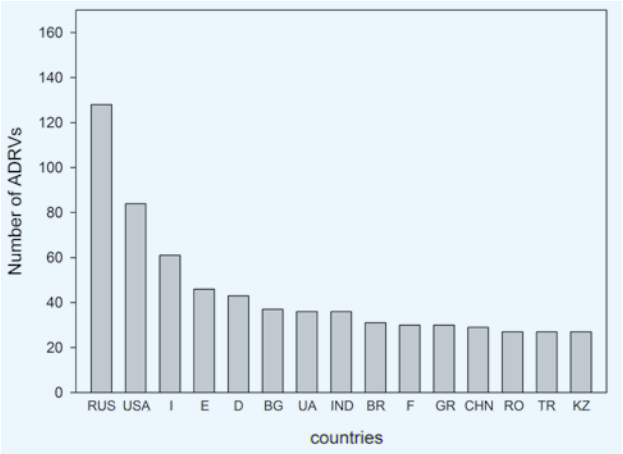

Figure 4

Characteristics of anti-doping rule violations (ADRVs) during the years 2000 until 2013: Countries most involved in ADRVs, RUS=Russia, I=Italy, E=Spain, D=Germany, BG=Bulgaria, UA=Ukraine, IND=India, BR=Brazil, F=France, GR=Greece, CHN=China, RO=Romania, TR=Turkey, KZ=Kazakhstan.

Statistics

e descriptive data obtained in this study were analyzed using SPSS Version 21 (IBM, Armonk, NY, USA).

Results

All Disciplines

A total of 1,236 cases were found. No doping cases were identi ed during the relevant periods for the following Olympic sports: trampoline, BMX, modern pentathlon, canoe slalom, archery, snowboarding, ice skating and Nordic combined. In total, 1,149 athletes (93% of all cases) were sanctioned once, and 55 athletes were sanctioned two or more times. In 812 (65.7%) cases, the athletes were male, and in 424 (34.3%), the athletes were female. Furthermore, 771 cases (62.4%) were detected through in-competition testing, 268 (21.7%) through OOC testing, 67 (5.4%) via investigations, 13 (1.1%) via confessions, and 5 (0.4%) via retesting. e cause for the sanction could not be determined in 112 (9.0%) cases.

Table 1

Doping cases in different sports.

ATHLETICS	N=	(%)	WEIGHT-LIFTING	N=	(%)	CYCLING	N=	(%)	SWIMMING	N=	(%)
Total	364			269			161			109	
Russia	53	15,6	Bulgaria	27	10	Italy	33	20,5	China	16	14,7
USA	37	10,2	India	18	6,7	Spain	28	17,4	Brazil	15	13,8
Jamaica	19	5,2	Russia	17	6,3	Belgium	14	8,7	Russia	14	12,8
Ukraine	18	4,9	Kazakhstan	14	5,2	USA	12	7,5	Greece, India, USA	5	4,6
Morocco	17	4,7	Greece	12	4,5	Russia	10	6,2			

Fig. 1 shows the number of annual doping cases. e number of doping cases increased until the year 2004 and remained relatively stable thereafter, with the exception of the year 2008. During the years of the summer and winter Olympic Games, 416 (33.7%) cases were detected, and the number of cases during non-Olympic years was 820 (66.3%).

e most common type of violation was anabolic agent use (479 cases, 38.8%), followed by blood manipulation (193, 15.6%) and stimulant use (175, 14.2%) (Fig. 2). Diuretics (5.7%) and missed tests (4.0%) were 4th and 5th most common. e reason for the sanction could not be determined in 126 cases (10.2%); however, for the vast majority of these cases, anabolic agent use can be assumed to be the cause of the sanction (see Discussion).

e sport with the most doping cases was track and eld (364 cases, 29.4%), followed by weightlifting (269 cases, 21.8%) and cycling (161, 13.0%) (Fig. 3, Tab. 1). Cases of doping were detected in 120 countries. e largest percentage of cases was found in Russia (128 cases, 10.4%), followed by the USA (84 cases, 6.8%), Italy (61 cases, 4.9%), Spain (46 cases, 3.7%), and Germany (43 cases, 3.5%) (see Fig. 4, Tab. 2).

e most common sanction of athletes was a 2-year ban (58.5%), followed by a 1-year ban (13.3%) and a ban for a variable period of time (between 15 days and 9 months). For tennis and soccer, athletes missed a speci c number of matches.

Olympic Core Disciplines

In certain Olympic disciplines (including team sports such as soccer and basketball as well as road cycling and tennis), athletes and federations focused much more on World Championships, professional leagues or international tournaments than to the Olympic Games. To obtain an accurate assessment of the number of disciplines in which the Olympics represent the highlight of an athlete's career, a similar analysis was conducted for the Olympic disciplines after excluding team sports, road cycling, triathlon, and tennis. is analysis revealed 899 cases (517 males and 382 females). A total of 553 cases (61.5%) were detected through in-competition testing, and 207 (23.0%) cases were detected through OOC testing. During Olympic years, 326 (36.3%) cases were found compared with the 573 cases (63.7%) identi ed during the years between the Olympic Games.

e most common type of violation was anabolic agent use (398 cases, 44.3%) followed by stimulant use (104 cases, 11.7%), blood manipulation (96 cases, 10.7%), diuretic use (49 cases, 5.5%) and missed tests (35 cases, 3.9%). e highest number of cases was found in Russia (113, 12.6%), followed by the USA (56, 6.2%), India (36, 4.0%), Bulgaria (34, 3.8%), and Ukraine (33, 3.6%). Germany ranked 14th, with 19 cases (2.1%).

Individual Countries

Table 2 shows the doping characteristics of the ve countries with the highest doping rates. In Russia, more female athletes (58%) were sanctioned, whereas less than 20% of the cases involved female athletes in Italy and Spain. e most common violations were anabolic agent use and blood manipulation in Russia, whereas anabolic agent use was the most common in the USA, and blood manipulation was the most common in Italy and Spain. Track and eld was the most a ected discipline in Russia (53 cases) and the USA (37 cases), whereas the most a ected discipline was cycling in Italy (33 cases) and Spain (28 cases). In Germany, a relatively high number of doping cases (8 cases) was found in equestrian.

Discussion

To our knowledge, this descriptive study presents the rst compiled set of data on doping cases among elite athletes and is the only cross-linked dataset of cases prior to 2013 that includes information such as the origin of the case, doping method, sports discipline, and type of control process. e most important results are that the doping cases most commonly occurred in Russia (10.4%), followed by the USA and Italy. Furthermore, the sport most frequently associated with doping was track and eld (29.4%), followed by weightlifting (21.8%) and cycling (13.0%). Additionally, the most common violation was anabolic agent use (38.8%), followed by blood manipulation (15.6%) and stimulant use (14.2%).

Between 2000 and 2013, the WADA published 55,258 Adverse Analytical Findings (AAF, positive test results), but did not indicate the number of ADRVs until 2013 (1). In two recent ADRV reports, the ratio of ADRVs to AAFs in Olympic disciplines was approximately 0.65 (12, 14). Assuming that this ratio is also valid for the entire course of our study, the current paper represents approximately 3.5% of all ADRVs between 2000 and 2013.

e number of doping cases in this study increased from approximately 40 in 2000 to 100 in 2004 and uctuated around this number (except in 2008) in the ensuing years (Fig. 1). is pattern roughly corresponds to the number of anti-doping tests administered (117,314 tests in 2000; 274,615 tests in 2008). During this time span, the WADA published a relatively constant percentage of AAFs, at approximately 2%, which most likely corresponds to a 1.3% prevalence of ADRVs (1).

e absolute number of doping cases was highest in track and eld, ahead of weightlifting. However, this result does not consider the number of active athletes and disciplines or medals in the respective sports. erefore, when relating the cases to the number of disciplines (i.e., 47 in track and eld, 12 in weightlifting, 34 in swimming), the most cases by far were found in weightlifting (22.4/discipline), followed by track and eld (7.7/discipline) and swimming (3.2/discipline). is nding is con rmed by the high number of positive cases identi ed through retrospective testing following the 2008 and 2012 Olympics, although the violations are not yet sanctioned by anti-doping authorities. e predominance of weightlifting is also supported by the number of positive analytical ndings reported in the sport; e.g., in 2013, the

Table 2

Doping information on individual countries. OOC-tests 2013=out of competition tests conducted in 2013 by the respective national anti-doping a

	CASES (NUMBER)	SEX (%)		MANIPULATION (NUMBER OF CASES)				
		MALE	FEMALE	ANABOLIC AGENTS	BLOOD MANIPULATION	STIMULANTS	DIURETICS	CANABINOIDS
Russia	128	42,2	57,8	31	35	15	8	1
USA	84	76,2	23,8	32	12	10	4	12
Italy	61	88,5	11,5	13	23	11	2	1
Spain	46	80,4	19,6	6	25	5	5	2
Germany	43	69,8	30,2	15	7	4	2	4

	DISCIPLINE (NUMBER OF CASES)							CONTROL (NUMBER OF CASES)		OOC-TESTS 2013 (NUMBER)
	ATHLETICS	CYCLING	SKI NORDIC	WEIGHT LIFTING	SWIMMING	TEAM SPORTS	EQUESTRIAN	IN-COMPETITION	OUT OF COMPETITION	
Russia	53	10	18	17	14	4	2	55	33	7497
USA	37	12	0	2	5	13	0	46	19	4604
Italy	6	33	0	0	4	16	0	37	6	1306
Spain	4	28	1	1	2	3	0	31	8	77
Germany	5	9	0	0	2	10	8	25	15	6795

proportion of cases in weightlifting (3.4% out of 8553 tests) was greater than those of cycling, track and eld (1.2% each) and swimming (0.8%) (10).

Most ADRVs (38.8%) referred to anabolic substance use (36.2%, anabolic steroids; 2.6%, clenbuterol); however, this rate is lower than the percentage indicated in the recent WADA 2014 Anti-Doping Testing Figures Report (48%) (13). is discrepancy is most likely due to the fact that this study includes 126 cases in which the cause of the sanction is unknown, particularly in weightlifting (91). Because anabolic steroids are the predominant pharmaceutical drug used in weightlifting (84%), the percentage of cases in this study that involved anabolic agents should correspond to the numbers published by the WADA for the entire population (13).

e percentage of cases of stimulant and diuretic use was similar to the numbers identi ed in recent WADA reports, whereas the incidence of blood manipulation (15.3% overall; 12.1% for erythropoietic stimulating agents (ESAs)) was higher than those in the entire population (1.2% ESAs in 2013; 1.8% ESAs in 2014) (9, 13). erefore, we suggest that the proportion of blood manipulation among elite athletes is several times higher than that in the entire population of tested athletes.

Our country-speci c results are consistent with two recent WADA reports, in which Russia had more cases than Turkey (n=144) and India (n=90) as well as Italy (n=125) in 2013 and more than Italy (125) and India (n=96) in 2014, with 184 and 148 cases, respectively (12, 14). Surprisingly, a high proportion of the sanctioned athletes in Russia were female (58% overall; 74% in track and eld), which contrasts with the nding of fewer sanctioned female athletes in other countries, particularly in Italy and Spain. is di erence might be partially explained by the higher proportion of female athletes from Russia at the Olympic Games, which in turn might be a result of certain sociocultural and structural factors. Conversely, the low proportion of female cases in Italy and Spain might be due to the popularity of sports such as cycling, which is practiced by more male athletes in those two countries.

To evaluate the number of doping cases in di erent countries, the number of doping controls and the type of control process, i.e., in-competition or OOC tests, as well as whether the athletes were tested by an own national or by an international authority must be considered. Unfortunately, the last point can not be exactly assessed by o cial statistics. For a rough measure of national controls, we therefore consider the number of OOC-tests of the respective national anti-doping authority. In recent years, individual countries and federations have shown very di erent behaviors regarding anti-doping issues, and OOC tests were introduced with temporary di erences, likely leading to distortions of our results. Assuming that athletes from different nations are similarly controlled during international events, OOC tests of national anti-doping agencies gain importance. For instance, in 2013, most OOC tests were performed in Russia and in Germany, while far fewer tests were conducted in the USA , Italy and Spain (see Tab. 2) (11). us, it seems possible that the high number of Russian doping cases is partly due to the high number of OOC tests and that the number of cases underrepresents the doping practices in Italy and especially in Spain. On the other hand, the McLaren report clearly demonstrates a manipulation of positive test results in Russia which hints to a possible ine ciency of national anti-doping controls (15). In Russia, the number of doping cases was equally divided between anabolic substance use and blood manipulation, whereas the majority of the cases in the USA and Germany involved anabolic substance use. Bulgaria was unique in that at least 27 cases of anabolic steroid use occurred in weightlifting, representing 10% of the violations in this sport (Tab. 2). e majority of the cases in Italy and Spain involved blood manipulation, and this nding can be attributed to the high doping rate in professional cycling and the leading role that these countries play in this sport. Furthermore, 43% of all cases involving sanctions for blood manipulation occurred in Russia, Italy and Spain, whereas the total proportion of doping cases in these three countries was “only” 19%. erefore, these countries can be considered as hot spots for blood manipulation.

In Russia and the USA, the highest proportion of ADRVs was found in track and eld, especially during Olympic years. e mean number of ADRVs in Russian track and eld athletes was 33 in the four Olympic and 20 in the nine non-Olympic years (for the USA, this number was 16 in Olympic and 21 in non-Olympic years). e resulting ratio of ADRVs between Olympic and non-Olympic years was 4.1 for Russia and 1.9 for the USA. It is unclear whether this ratio is the result of providing more effective target testing or systematic doping programs for the Olympic Games. Given the numerous positive results obtained

through retrospective testing following the 2008 and 2012 Olympics (currently up to 98 cases, although not all of them have yet been sanctioned by anti-doping authorities), a higher prevalence of doping may exist during Olympic years. us far, the International Olympic Committee (IOC) has denied these results, claiming that there was a low prevalence of doping in Beijing, as only 5 cases were detected out of approximately 4,500 tests (plus 4 ADRVs in equestrian sports), and only one case was detected in London out of approximately 5,000 tests.

Limitations

e present study is based on an Internet search, and it is pos sible that some cases were not found. e completeness of our database was checked twice. A comparison with the o cial 2006 anti-doping violations list of the UCI showed a complete match of all documented doping cases. Another helpful referen ce was a book by Matschiner that listed all of the cases already included in our database (3).

Our inclusion criteria for ADRVs could be criticized. Our cri teria were de ned before starting the Internet search; however, in our opinion, we ful lled the criterion for “elite athletes” by providing a su cient number of cases.

One limitation of our results is the variety of confounding factors that in uence the reporting of doping cases in di erent countries and federations. Because this study could not assess many of these factors, we focused on using descriptive statistics and did not perform additional statistical analyses.

Conclusions

Our data, and the results of recent re-testing, strongly suggest that the prevalence of doping is very high among elite athletes in several countries and in special disciplines. A reliable study about doping prevalence in Olympic Dutch athletes revealed a prevalence of 4%. However, such data cannot be easily genera lized to other countries in which the prevalence may be much higher. For Russia, the numerous ADRVs in track and eld and weightlifting, the multiple positive results found during re-tes ting after the Beijing and London Olympics, and the data from

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