Drug Testing in Elite Athletes — The Israeli Perspective

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Abstract

Background: The use of performance-enhancing drugs by athletes, in particular anabolic steroids, is probably one of the major problems in sports today. During the early 1990s the Israeli Sports Federation and Olympic Committee established the Israeli Sports Anti-Doping Committee.

Objectives: To present a follow-up on tests for use of performance-enhancing drugs among elite Israeli athletes from 1993 until the present.

Methods: Since 1993, 273 drug tests (urine samples) were performed in elite Israeli athletes. These tests were done during major competitions, and at random during the regular training season without prior notice to the athletes. The urine samples were sent for analysis to an official drug laboratory of the Olympic Committee in Cologne, Germany.

Results: Since 1993, seven (2.7%) male Israeli elite athletes (5 weight lifters, a javelin thrower, and a sprinter) tested positive for performance-enhancing drugs — all of them for anabolic steroids, and two for diuretics as well.

Discussion: These findings suggest that the phenomenon of performance-enhancing drug use by elite athletes has also entered Israeli sports, and probably represent the tip of the iceberg among Israeli sportsmen. Therefore, more drug tests should be performed, especially at random without prior notice and during the regular season. Athletes in the most popular sports such as soccer and basketball should also be tested. The concern over the use of these agents is both medical and ethical.

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The use of performance-enhancing drugs by athletes (particularly anabolic steroids) is a serious problem in sports today. The use of drugs to enhance physical performance has been a feature of athletic competition since the beginning of recorded sports history [1,2]. During the 1970s little public attention was paid to the use of performance-enhancing drugs, it being believed that these drugs were used predominantly by athletes from Eastern European countries. The media simply expressed some comments regarding the masculine appearance of female athletes from these countries. These speculations were confirmed during the reunification of Germany in the mid-1990s by documents found in East Germany on the extensive use of performance-enhancing drugs among athletes from the Eastern bloc countries [3]. It was only during the 1983 Pan American games in Caracas, Venezuela, that international attention focused on 19 athletes who tested positive for anabolic steroids, and several others who returned home before competing — probably to avoid detection, suspension and sanctions. The public interest increased again during the Seoul Olympic games in 1988, when 100-meter gold medallist and world record holder Ben Johnson was stripped of his gold medal because he had used anabolic steroids. Concern about the use of anabolic steroids emerged again a few months ago with the sudden death of 38-year-old Florence Griffith-Joiner, a world record holder and Olympic 100 and 200 meter champion (Seoul 1988). Griffith-Joiner never tested positive for performance-enhancing drugs, and the cause of her death was officially given as suffocation following an epileptic seizure. However, her masculine appearance, the rapid improvement of her own best results, her spectacular world records, and her immediate disappearance from the track after the 1988 games raised the uncomfortable question regarding her possible use of these drugs.

There is no doubt that performance-enhancing drugs are widely used today by competitive athletes. The record-breaking obsession, the glory, and the financial benefits for those ranked at the top of major sports events are clearly more important than the health of the competitors. Today athletes employ a wide variety of drugs to improve their performance. These drugs include anabolic steroids, amphetamines, human growth hormone, human chorionic gonadotropin, gonadotropin-releasing hormone, erythropoietin, beta blockers, diuretics and many more. The mechanism of action of each drug is different [4]. For example, a) anabolic steroids and peptide hormones such as human growth hormone increase muscle mass and muscle strength; b) stimulant drugs such as amphetamines are taken just before the competition to improve performance; c) erythropoietin, used in aerobic sports such as long-distance running and cycling, stimulates red blood cell production, raises hemoglobin level and increases oxygen-carrying capacity; d) beta blockers, which are used in sports that require concentration and accuracy like shooting, decrease the heart rate; and e) diuretics, used for rapid weight loss in weight-categorized sports such as

wrestling, dilute the urine and prevent detection of other drugs.

The concern regarding use of these drugs includes both medical and ethical issues — the medical aspect relating to undesirable physical and psychological side effects, and the ethical aspect to the unfair advantage over athletes who do not use drugs [5,6]. In order to prevent the use of performance-enhancing drugs, sports federations in many countries began to test athletes for drug use. Drug testing of athletes began in the 1950s on a very limited scale. However, only in the last two decades, with the development of new laboratory techniques such as gas chromatography and mass spectrometry to screen for anabolic steroids [7], did the potential of detecting abusing athletes markedly increase. Most drug-testing programs analyze urine. The main reasons for using urine and not blood samples are to avoid unnecessary trauma and invasive procedures, minimize the chances of disease transmission, and avert legal and religious considerations. However, if indicated, blood sampling is permitted to confirm the use of performance-enhancing drugs. Currently, hundreds of substances — including more than 20 anabolic steroids and related compounds — are banned by the International Olympic Committee. During the early 1990s the Israeli Sports Federation and Olympic committee established the Israeli Sports Anti-Doping Committee (ISADC). The present study summarizes the activity of this committee, and presents a follow-up on drug tests among elite Israeli athletes from 1993 until the present.

Methods

In 1993 the Israeli Sports Anti-Doping Committee began to perform drug tests in elite Israeli athletes. Initially, these tests were done predominantly during major competitions, but since 1995 the tests were carried out more often, at random during the regular training season and without advance notice to the athletes. The selection of athletes was done randomly during the regular season, or according to their ranking at a major competition or race, e.g., the first three winners.

During major competitions the athletes were notified about the drug test immediately after they participated in the sports event. From that moment until collection of the urine sample, each athlete was under direct supervision of a member of the drug committee. For tests that were performed during the regular season, the athlete received a notice to present at the drug testing site 24 hours prior to the test. The athletes were supervised by a member of the drug committee from their arrival at the site until urine was collected. A single urine sample of ≥ 70 ml was collected from each athlete. The sample was divided, separated and sealed in two boxes. Once sealed, it was impossible to reopen the box. Each sealed urine box received a serial I.D. number with no mention of the athlete's name, and the matching list was kept in a metal safe. These procedures were followed to preclude any possibility of malicious action by competitors or other interested parties.

Both urine samples were sent to an official drug laboratory of the Olympic Committee in Cologne, Germany. Only one sample was tested, the second sample being kept frozen. If the first sample tested positive, the second sealed sample was analyzed for confirmation. *All* the samples (the first, and if necessary the second) from *each* athlete were analyzed by gas chromatography and high-resolution mass spectrometry. If the first urine sample was found to be positive a different technical staff analyzed the second sample. The athlete or his/her representative was allowed to be present during the second analysis. If an athlete selected for testing by the drug committee refused to give a urine sample, he or she was considered as having tested positive and was subjected to sanctions and/or suspension.

The Olympic Committee [8] established cut-off limits for many of the banned drugs; for example, caffeine >12 μg/ml, cathine >5 μg/ml, ephedrine >5 μg/ml, methylephedrine >5 μg/ml, morphine >1 μg/ml, phenylpropanolamine >10 μg/ml, pseudoephedrine >10 μg/ml, epitestosterone >200 ng/ml, and testosterone/epitestosterone ratio >6. Some of the detecting techniques used by the laboratory are confidential in order to minimize the possibility of performance-enhancing drug users escaping detection.

Results

Since 1993 a total of 273 elite Israeli athletes, including members of the Israeli Olympic team, were tested for drug use by the Israeli Sports Anti-Doping Committee. Fifty-six were tested in 1993, 64 in 1994, 42 in 1995, 43 in 1996, 37 in 1997 and 31 in 1998. Of the athletes tested 90% were males and 10% females. Altogether, 150 athletes were tested during a regular training season, and the other 123 athletes were tested at the end of an official competition. Table 1 summarizes the sport specialties of the athletes tested.

Since 1993, seven male Israeli elite athletes tested positive for performance-enhancing drugs. Five of them were weight lifters, one was a javelin thrower, and one was a sprinter (400 m hurdler). All of them tested posi-

Table 1. Sport specialties of the tested athletes (n=273)

Sports	No. of athletes
Track & field	97
Weight lifting	91
Swimming	35
Wrestling	12
Triathlon	10
Judo	8
Fencing	7
Water skiing	6
Karate	3
Shooting	2
Kayak	1
Boxing	1

tive for anabolic steroids (three for methandionone, two for testosterone/epitestosterone ratio >6, one for methyltestosterone, and one for stanozolol). In addition to the anabolic steroids, two of the subjects also tested positive for diuretics (furosamide).

In three other cases there was a high suspicion of performance-enhancing drug use, but this presumption was not ultimately proven. In one case the first urine sample tested positive for anabolic steroids, but the second sample was broken during delivery and therefore could not be tested. In the second case the athlete placed apple juice instead of urine into his urine sample; and in the third case the athlete left the doping control station without urinating. In the latter two cases the athletes were obviously suspended.

Unfortunately, medical data are not available regarding the presence of drug-specific side effects in the athletes who tested positive. In some of these athletes follow-up was discontinued by the medical staff of the Israeli Olympic team, and several athletes even left Israel after their suspension.

Discussion

Since 1993, seven elite Israeli male athletes tested positive for performance-enhancing drugs (2.7%) and three others were suspected of using them (1.1%). This incidence is higher than published data from other countries. For example, during the Los Angeles Olympic Games in 1984 and the Seoul Olympic Games in 1988, 1.1% and 2.0% of urine analyses of athletes, respectively, tested positive [9]. In addition, less than 1% of athletes tested positive during announced drug tests in sporting events sponsored by the U.S. Olympic Committee between 1984 and 1989 [10]. In Denmark about 1% of athletes tested positive for performance-enhancing drugs at both competition and training sessions between 1991 and 1996 [11]. A higher drug use rate, 7.8%, was detected in unannounced tests among Belgium cyclists including amateur cyclists between 1987 and 1994 [12]. The findings demonstrate that Israeli sports have not escaped the phenomenon of performance-enhancing drug use by elite athletes. Moreover, the prevalence of drug abuse by Israeli athletes found in the present study probably represents the tip of the iceberg, since relatively few tests were performed (273 in 6 years, compared to 1,510 and 1,500 in the Los Angeles and Seoul Olympic games, respectively; 5,084 in Denmark, and 4,374 in Belgium). In addition, soccer and/or basketball players were not tested. These sports might be more prone to the use of performance-enhancing substances, since they are the two most popular sports in Israel, they receive most of the media's attention, and the average income of the players is extremely high. Thus, drug testing of soccer and basketball players could considerably change the incidence of performance-enhancing drug use by Israeli athletes. In fact, recently, during the first drug test ever done among soccer players (n=20) in the Israeli premier league, one player tested positive for ephedrine. In contrast, however, 1993 data from International Olympic Committee accredited laboratories indicate that only 0.27% and 1.24% of soccer and basketball players tested positive, respectively.

The data demonstrate positive tests in male athletes only. Hopefully, this implies that the use of performance-enhancing drugs by female athletes is not common in Israeli sports. On the other hand, it might indicate that since female sports in Israel are less popular, are not well covered by the media, and are not so financially profitable, the use of drugs such as anabolic steroids is not worth the risk of side effects [for review of anabolic steroid side effects see ref. 13].

All seven of the athletes who tested positive for anabolic steroids, except for one who was a sprinter, participated in strength sports (five weight lifters and a javelin thrower). This is not surprising, since historically, anabolic steroids were extensively used by weight lifters and javelin throwers who were easily convinced that steroids make them bigger and stronger [14]. But perhaps the most interesting finding was that six of the seven athletes who tested positive for anabolic steroids were newcomers from the Soviet Union, two of whom were caught within the first year of their stay in Israel. These findings emphasize again the frequent use of performance-enhancing drugs by athletes from East Europe.

It is worth mentioning that detecting anabolic steroids in urine samples is not easy. First, most anabolic steroids are secreted in the urine as metabolites (structures chemically different from the original drug). Therefore, updated information regarding the metabolism of these substances, which is not always available, is mandatory. Second, many variables (such as dilution of the urine and/or prevention of excretion, etc.) can affect the drug elimination/excretion process of anabolic steroids. For example, two of the athletes in this report used diuretics in addition to anabolic steroids in order to dilute the urine and decrease the chances of anabolic steroid detection. Given that the use of diuretics has been illegal for several years, they would have been suspended even if anabolic steroids were not detected in their urine samples. Third, the athlete can decrease dosing soon enough, resulting in the steroid levels dropping below the threshold for detection. To overcome this, many sports federations (including the Israeli Olympic Committee) have implemented al-year-round, unannounced, random and frequent drug testing. In the present report three of the seven athletes tested positive during the regular training season, indicating that this approach is indeed effective. However, it does not completely solve the problem; for instance it is almost impossible to detect low to moderate doses of testosterone. Moreover, the difficulty of detection is even greater for other performance-enhancing drugs, such as human growth hormone and erythropoietin, for which there are are no reliable laboratory tests to differentiate between exogenous and endogenous levels. The use of

blood tests might improve detection of at least some of the drugs. Indeed, blood tests have been used in aerobic sports such as cycling, with the International Cycling Federation defining hematocrit levels >50% as indirect evidence of the use of erythropoietin. These data further emphasize that the prevalence of performance-enhancing substance use among athletes is truly underestimated.

The next question that arises is where do the athletes who use performance-enhancing drugs obtain them? According to the 1991 U.S. Interagency Task Force on Anabolic Steroids [15], these drugs come mainly from illicit sources — smuggled from other countries; manufactured by licensed pharmaceutical companies and diverted to the black market by distributors, physicians etc; and/or manufactured by underground laboratories. Recent data from Germany [3] emphasize the role of scientists and sports physicians in drug doping in the Eastern bloc, and contend that they in fact contributed to the development of drug administration methods that would evade detection by international doping controls. Whether these conclusions can be extrapolated to Israeli sports is not known. Yet, as mentioned, six of the athletes who tested positive for anabolic steroids were newcomers from the Soviet Union, two of whom tested positive during the first year of their stay in Israel. Therefore, the possibility exists that either they brought the anabolic steroids with them originally, or obtained them from former friends while participating in competitions and/or training camps outside Israel.

In summary, similar to the rest of the world, the use of performance-enhancing drugs by athletes is a serious problem facing competitive sports in Israel. During recent years much effort has been invested in improving drug-testing techniques, and many methods used by athletes to prevent drug detection have been banned. However, as athletes become aware of these new laboratory procedures, so they succeed in finding ways to evade them. Laboratories will have to learn about the new drugs and maneuvers, and take the appropriate steps. And the process will begin all over again.

References

1. Prokop L. The struggle against doping and its history. *J Sports Med Phys Fit* 1970;10:45–8.
2. Strauss RH, Curry TJ. Magic science and drugs. In: Strauss RH, ed. Drug and Performance in Sports. Philadelphia, W. B. Saunders, 1987:3–9.
3. Franke WW, Berendonk B. Hormonal doping and androgenization of athletes: a secret program of the German Democratic Republic government. *Clin Chem* 1997;43:1262–79.
4. Clarkson PM, Thompson HS. Drugs and sports. Research findings and limitations. *Sports Med* 1997;24:366–84.
5. Gardner R. On performance-enhancing substances and the unfair advantage argument. *J Philos Sport* 1989;16:59–83.
6. Simon RL. Good competition and drug-enhanced performance. *J Philos Sport* 1984;11:6–13
7. Catlin DH, Kammerer RC, Hatton CK, Sekera MH, Merdink JL. Analytical chemistry at the games of the XXIII Olympiad in Los Angeles. *Clin Chem* 1984;33:319–27.
8. International Olympic Committee list of classes of prohibited substances and methods of doping, Lousanne, 1999.
9. Yesalis CE, Wright JE, Lombardo JA. Anabolic-androgenic steroids: a synthesis of existing data and recommendations for future research. *Clin Sports Med* 1989;1:109–34.
10. Yesalis CE. Incidence of anabolic steroid use: a discussion of methodological issues. In: Yesalis CE, ed. Anabolic Steroids in Sports and Exercise. Champaign, IL: Human Kinetics Publishers, 1993:49–69.
11. Keld DB, Bendsen AK. Doping — a medical problem in Denmark? *Ugeskr Laeger* 1998;10:4749–53.
12. Delbeke FT. Doping in cyclism: results of unannounced controls in Flanders (1987–1994). *Int J Sports Med* 1996;17:434–8.
13. Friedel KE. Effects of anabolic steroids on physical health. In: Yesalis CE, ed. Anabolic Steroids in Sports and Exercise. Champaign, IL: Human Kinetics Publishers, 1993:107–50.
14. Todd T. Anabolic steroids: the gremlins of sport. *J Sports History* 1987;14:87–107.
15. Interagency Task Force on Anabolic Steroids. Washington DC: U.S. Department of Health and Human Services, Public Health Service, 1991.

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Capsule

Delivery across the blood-brain barrier

Delivery of therapeutic proteins into tissues and across the blood-brain barrier is severely constrained by protein size. Schwarze et al. from the Howard Hughes Medical Institute in St. Louis achieved efficient delivery of a large biologically active protein into mice by a method called protein transduction. The protein of interest is fused to an 11-amino acid sequence from the human immunodeficiency virus Tat protein, a sequence shown in earlier cell culture studies to mediate passage of proteins through lipid bilayers. Mice that had been injected intraperitoneally with a Tat-beta-galactosidase fusion protein showed beta-alactosidase activity in all tissues, including the brain, within 4 hours. This method may lead to new possibilities for experimental manipulation of model organisms as well as for delivery of therapeutic proteins.

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